PV-WAVE *Advantage*™
PV-WAVE Command Language™

Reference
Volume 2

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Contents Summary

Volume 1

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Preface

The *PV-WAVE Reference* is a two-volume set that describes the PV-WAVE *Advantage* and CL functions and procedures, keywords, and system variables.

This reference is part of a larger set of documentation; the entire set is shown in Figure I. Start with the *PV-WAVE Tutorial*, and then refer to this reference for details about the basic elements of the PV-WAVE Command Language. You will also want to refer to the *PV-WAVE User's Guide for Advantage and CL* and the *PV-WAVE Programmer's Guide for Advantage and CL* for detailed information.

For your convenience, all of the documents shown in Figure I are available online, as well as being available in a hardcopy format. Additional copies of the hardcopy documentation can also be ordered from Visual Numerics, Inc., by calling 800/447-7147.

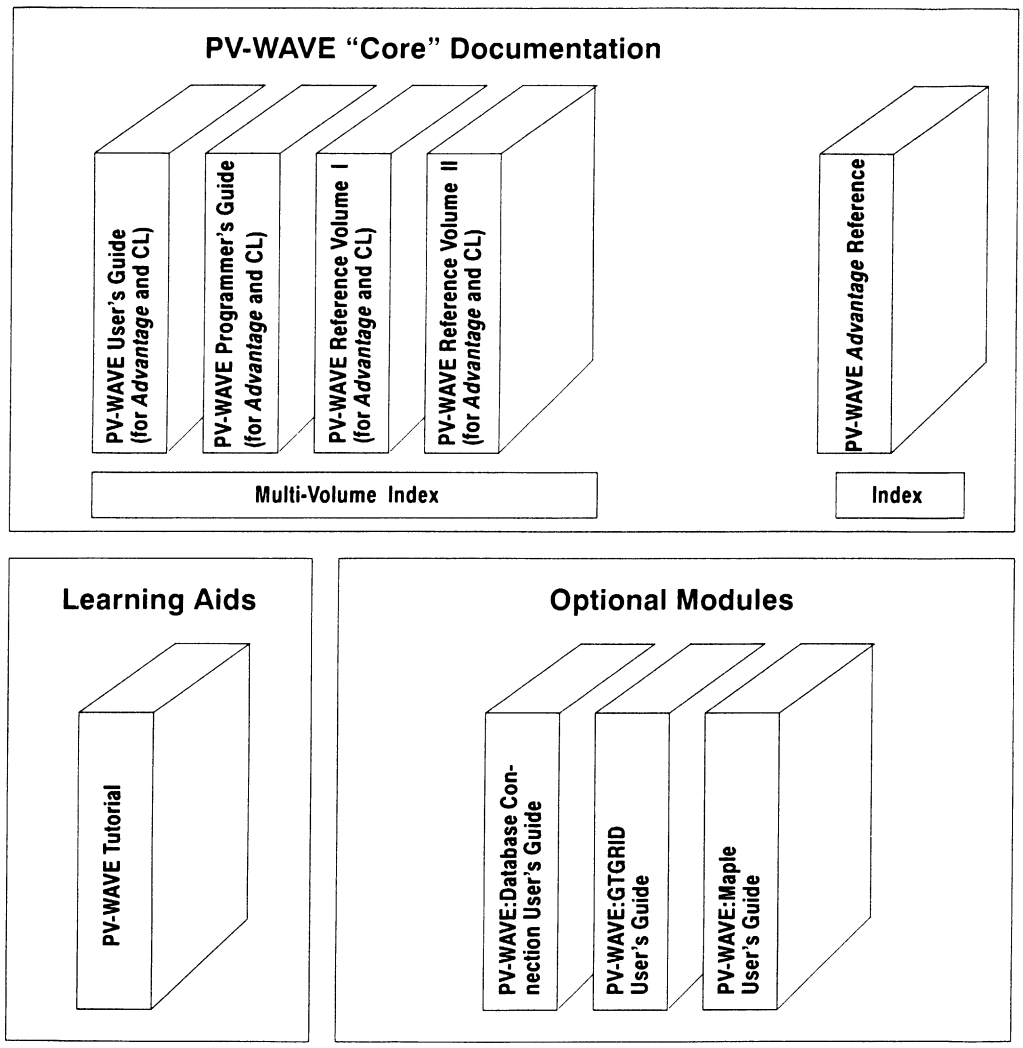

Figure I PV-WAVE documentation set; for more information about any one book you see shown here, refer to its preface, where the contents of each chapter are explained briefly. All documents are available both online and in a hardcopy format. Additional copies of the hardcopy documentation can be ordered by calling Visual Numerics, Inc., at 303/447-7147.

Contents of this Reference

Volume 1 Contains:

- **Preface** – Describes the contents of this guide, lists the typographical conventions used, explains how to use the PV-WAVE documentation set, and explains how to obtain customer support.
- **Chapter 1: Functional Summary of Routines** – A handy listing of PV-WAVE functions and procedures arranged into functional groups, such as image processing routines, input/output routines, programming routines, and string processing routines. The basic syntax for each routine is also shown.
- **Chapter 2: Procedure and Function Reference: A – P** – An alphabetically arranged reference for all PV-WAVE procedures and functions. Most descriptions include one or more examples and cross references to related information.
- **Appendix A: Picture Index** – A graphical index of the illustrations that appear in the PV-WAVE documentation set.
- **Index** – A multivolume index that includes references to the *PV-WAVE User's Guide*, *PV-WAVE Programmer's Guide*, as well as both volumes of the *Reference.*

Volume 2 Contains:

- **Preface** – Describes the contents of this guide, lists the typographical conventions used, explains how to use the PV-WAVE documentation set, and explains how to obtain customer support.
- **Chapter 2 (Continued: Q – Z)** – Procedure and Function Reference.
- **Chapter 3: Graphics and Plotting Keywords** – Describes the keywords that can be used with the PV-WAVE graphics and plotting system routines.

- **Chapter 4: System Variables** – Describes each of the PV-WAVE system variables.
- **Chapter 5: Software Character Sets** – Shows each of the software character sets supported by PV-WAVE.
- **Appendix A: Picture Index** – A graphical index of the illustrations that appear in the PV-WAVE documentation set.
- **Index** – A multivolume index that includes references to the *PV-WAVE User's Guide*, *PV-WAVE Programmer's Guide*, as well as both volumes of the *Reference*.

Typographical Conventions

The following typographical conventions are used in this guide:

- PV-WAVE code examples appear `in this typeface`. For example:

  ```
  PLOT, temp, s02, Title='Air Quality'
  ```

- Code comments are shown in this typeface, below the commands they describe. For example:

  ```
  PLOT, temp, s02, Title='Air Quality'
  ```
  This command plots air temperature data vs. sulphur dioxide concentration.

  Comments are used often in this reference to explain code fragments and examples. Note that in actual PV-WAVE code, all comment lines must be preceded by a semicolon (;).

- PV-WAVE commands are not case sensitive. In this reference, variables are shown in lowercase italics (*myvar*), function and procedure names are shown in uppercase (XYOUTS), keywords are shown in mixed case italic (*XTitle*), and system variables are shown in regular mixed case type (!Version). For better readability, all widget routines are shown in mixed case (WwMainMenu).
- A $ at the end of a PV-WAVE line indicates that the current statement is continued on the following line. By convention,

use of the continuation character ($) in this document reflects its syntactically correct use in PV-WAVE. This means, for instance, that *strings* are never split onto two lines without the addition of the string concatenation operator (+). For example, the following lines would produce an error if entered literally in PV-WAVE:

```
WAVE> PLOT, x, y, Title = 'Average $
   Air Temperatures by Two-Hour Periods'
```

Note that the string is split onto two lines; an error message is displayed if you enter a string this way.

The correct way to enter these lines is:

```
WAVE> PLOT, x, y , Title ='Average '+$
   'Air Temperatures by Two-Hour Periods'
```

This is the correct way to split a string onto two command lines.

- The | symbol means "or" when used in a usage line. It is not to be typed. For example, in the following command:

  result = QUERY_TABLE(*table*,
  ' [Distinct] * | col_i [*alias*] [, ..., col_n [*alias*]] ...

  the | means use either * or col_i [*alias*] [, ..., col_n [*alias*]], but not both.

- Reserved words, such as FOR, IF, CASE, are always shown in uppercase.

Customer Support

If you have problems unlocking your software or running the license manager, you can talk to a Visual Numerics Customer Support Engineer. The Customer Support group researches and answers your questions about all Visual Numerics products.

Please be prepared to provide Customer Support with the following information when you call:

- The name and version number of the product. For example, PV-WAVE 4.2 or PV-WAVE P&C 2.0.
- Your license number, or reference number if you are an Evaluation site.
- The type of system on which the software is being run. For example, Sun-4, IBM RS/6000, HP 9000 Series 700.
- The operating system and version number. For example, SunOS 4.1.3.
- A detailed description of the problem.

The phone number for the Customer Support group is 303/530-5200.

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QUERY_TABLE Function

Subsets a table created with the BUILD_TABLE function.

Usage

result = QUERY_TABLE(*table*,
' [Distinct] * | col_1 [*alias*] [, ... , col_n [*alias*]]
[Where *cond*]
[Group By $colg_1$ [,... $colg_n$]] |
[Order By $colo_1$ [*direction*][, ... , $colo_n$ [*direction*]]] ')

Note that the entire second parameter is a string and must be enclosed in quotes.

Input Parameters

table — The original table (created with the BUILD_TABLE function) on which the query is performed.

* — An optional wildcard character that includes *all* columns from the original table in the resulting table.

Distinct — A qualifier that removes duplicate rows from the resulting table.

col_i — The list of columns that you want to appear in the resulting table. Use the asterisk (*) wildcard character to select *all* columns in the original table. The *col* names can be arguments to the calculation functions used with the Group By clause.

alias — Changes the input table's column name, col_i, to a new name in the output table. If no alias is specified, the input table's column name is used in the resulting table.

Where *cond* — A clause containing a conditional expression, *cond*, that is used to specify the rows to be placed in the resulting table. The expression can contain Boolean and/or relational operators.

Group By $colg_i$ — A clause specifying one or more columns by which the rows are grouped in the resulting table. Normally, the

grouped rows are data summaries containing results of calculation functions (Sum, Avg, etc.) applied to the columns. (Group By and Order By clauses are mutually exclusive: they cannot be used in the same function call.)

Order By $colo_i$ — Name of the column(s) to be sorted (ordered) in the resulting table. The first column named is sorted first. The second column named is sorted within the primary column, and so on. (Group By and Order By clauses are mutually exclusive: they cannot be used in the same function call.)

direction — Either Asc (the default) or Desc. Asc sorts the column in ascending order. Desc sorts the column in descending order. If neither are specified, the column is sorted in ascending order.

Returned Value

result — The resulting table, containing the columns specified by col_i, and the rows specified by the query qualifiers and clauses. If the query result is empty, and no syntax or other errors occurred, the result returned is –1.

Keywords

None.

Discussion

Before you can use QUERY_TABLE, you must create a table with the BUILD_TABLE function. For details on BUILD_TABLE, see the discussion of the BUILD_TABLE function in this chapter. See also Chapter 8, *Creating and Querying Tables*, in the *PV-WAVE User's Guide*.

A table query always produces a new table containing the query results, or –1 if the query is empty.

Any string or numeric constant used in a QUERY_TABLE call can be passed into the function as a variable parameter. This means that you can use variables for numeric or string values in relational or Boolean expressions. For more information on passing param-

eters into QUERY_TABLE, see *Passing Variable Parameters into Table Functions* on page 279 of the *PV-WAVE User's Guide.*

Note Within a QUERY_TABLE call, the Group By and Order By clauses are mutually exclusive. That is, you cannot place both Group By and Order By in the same QUERY_TABLE call.

Boolean and Relational Operators Used in Queries

The Where clause uses Boolean and relational operators to "filter" the rows of the table. You can specify any of the following conditions within a Where clause. Use parentheses to control the order of evaluation, if necessary.

- **Comparison operators** — = (equal to), <> (not equal to), < (less than), <= (less than or equal to), > (greater than), >= (greater than or equal to)
- **Compound search condition** — Not, And, Or
- **Set membership test** — In

See the *Examples* section for more information on these operators.

You can also use PV-WAVE relational operators (EQ, GE, GT, LE, LT, and NE) in a Where clause instead of the SQL-style operators listed above.

Note When a literal string is used in a comparison, it must be enclosed in quotes—a different set of quotes than those used to delimit the entire QUERY_TABLE parameter string. For more information on using strings in comparisons, see *Using Strings in Where Clauses* on page 278 of the *PV-WAVE User's Guide.*

Calculation Functions Used with GROUP BY

The Group By clause is used in conjunction with calculation functions that operate on the values in the specified groupings. Each function takes one column name as its argument. See the *Examples* section for examples showing the use of calculation functions with Group By.

The calculation functions used with Group By are the following, where *col* is the name of a column:

- **Avg**(*col*) — Averages the values that fall within a group.
- **Count**(*col*) — Counts the number of occurrences of each data value that falls within a group.
- **Max**(*col*) — Returns the maximum value that falls within a group.
- **Min**(*col*) — Returns the minimum value that falls within a group.
- **Sum**(*col*) — Returns the sum of the values that fall within a group.

Examples

For the following examples, assume table called `phone_data` contains information on company phone calls. This table contains eight columns of phone information: the date, time, duration of call, caller's initials, phone extension, cost of call, area code of call, and number of call.

The table used in these examples and the data used to create it are available to you. Enter the following command at the `WAVE>` prompt to restore the table and data:

```
WAVE> RESTORE, !dir+'/data/phone_example.sav'
```

For more information on the structure of this table and more examples, see *Querying a Table* on page 270 of the *PV-WAVE User's Guide*.

For an example showing the use of the Distinct qualifier, see *Rearranging a Table* on page 271 of the *PV-WAVE User's Guide*.

The following examples show how to query this table in various ways using QUERY_TABLE.

Example 1

Create a new table containing only the phone extensions, area code, and phone number of each call made.

This example demonstrates a simple table query that produces a three-column subset of the original table.

```
new_table = QUERY_TABLE(phone_data, $
   'EXT, AREA, NUMBER')
```

A portion of the resulting table is organized as follows:

EXT	AREA	NUMBER
311	215	2155554242
358	303	5553869
320	214	2145559893
289	303	5555836
248	617	6175551999

For information on printing tables, see *Formatting and Printing Tables* on page 284 of the *PV-WAVE User's Guide*.

Example 2

Show me data on the calls that cost more than one dollar.

This example demonstrates how a Where clause is used to produce a subset of the original table, where all rows that contain a cost value of less than one dollar are filtered out.

```
new_tbl = QUERY_TABLE(phone_data, $
   '* Where COST > 1.0')
```

The following is an excerpt from the resulting table:

DATE	TIME	DUR	INIT	EXT	COST	AREA	NUMBER
901002	093200	21.40	TAC	311	5.78	215	2155554242
901002	094700	17.44	EBH	320	4.71	214	2145559893
901004	095000	3.77	DJC	331	1.02	512	5125551228

Example 3

Show the total cost and duration of calls made from each phone extension for the period of time the data was collected.

This example demonstrates the use of the Group By clause. The column specified *after* Group By is the column by which the other specified columns are grouped. The calculation function Sum( ) is used to return the total cost and duration for each extension in the table.

The following command produces this result:

```
sum_table = QUERY_TABLE(phone_data, $
   'EXT, SUM(COST), SUM(DUR) Group By EXT')
```

This produces the new table, called `sum_table` containing the columns EXT, SUM_COST, and SUM_DUR:

EXT	SUM_COST	SUM_DUR
0	0.00000	4.49000
248	0.350000	1.31000
289	0.00000	16.2300
311	5.78000	21.4000
320	4.71000	17.4400
331	1.02000	3.77000

The cost and duration columns are named in the result table, by default, with the prefix SUM_. This prevents any confusion with the existing table columns that are already named COST and DUR. You can change these default names by including aliases in the QUERY_TABLE function call.

The INFO command can be used to show the basic structure of this new table:

```
INFO, /Structure, sum_table
** Structure TABLE_GB_2, 3 tags, 12 length:
   EXT            LONG          0
   SUM_COST       FLOAT         0.000000
   SUM_DUR        FLOAT         4.49000
```

Note The *Structure* keyword is used because tables are represented in PV-WAVE as an array of structures. For more information, see *Tables and Structures* on page 287 of the *PV-WAVE User's Guide*.

Example 4

Show me the extension, date, and total duration of all calls made from each extension on each date.

This example demonstrates a multiple Group By clause. For example, you can obtain a grouping by extension and by date. The result is a "grouping within a grouping".

The following command produces the desired result:

```
tbl = QUERY_TABLE(phone_data, $
   'EXT, DATE, Sum(DUR) Group By EXT, DATE')
```

EXT	DATE	SUM_DUR
0	901003	2.33000
0	901004	2.16000
248	901002	1.31000
289	901002	16.2300
311	901002	21.4000
320	901002	17.4400
331	901004	3.77000
332	901003	2.53000
358	901002	1.05000
370	901003	0.450000
370	901004	0.160000
379	901003	1.53000
379	901004	1.93000
418	901003	0.350000

Note that each multiple grouping produces one summary value. In this case the total duration is calculated for each extension/date grouping. For instance, in the table shown above, the row:

370	901003	0.450000

shows the total duration (0.450000) of all calls made from extension 370 on date 901003.

Example 5

Show the number of calls made from each extension for the period of time the data was collected.

This example demonstrates the Group By clause used with the Count function.

```
cost_sum = QUERY_TABLE(phone_data, $
   'EXT, Count(NUMBER) Group By EXT')
```

The result is a two-column table that contains each extension number and a count value. The count value represents the total number of times each extension number appears in the table.

EXT	COUNT_NUMBER
0	3
248	1
289	1
311	1
320	1
331	1
332	1
358	1
370	2
379	2
418	1

Note The parameter specified in the *Count* function has no real effect on the result, because the function is merely counting the number of data values in the primary column (that is, null values are not ignored). You can obtain the same result with:

```
cost_sum = QUERY_TABLE(phone_data, $
   'EXT, Count(DUR) Group By EXT')
```

Example 6

Sort the phone_data table by extension, in ascending order.

This example demonstrates how the Order By clause is used to sort a column in a table.

```
ext_sort = QUERY_TABLE(phone_data, $
   '* Order By EXT')
```

Here is a portion of the resulting table.

DATE	TIME	DUR	INIT	EXT	COST	AREA	NUMBER
901004	95300	1.360	JAT	0	0.00	303	5553200
901004	94700	0.800	JAT	0	0.00	303	5553200
901003	91600	2.330	JAT	0	0.00	303	5553440
901002	94800	1.310	RLD	248	0.35	617	6175551999
901002	94800	16.23	TDW	289	0.00	303	5555836
901002	93200	21.40	TAC	311	5.78	215	2155554242
901002	94700	17.44	EBH	320	4.71	214	2145559893

Example 7

Sort the phone_data table by extension, in ascending order, then by cost in descending order.

The table can be further refined by sorting the COST field as well.

```
cost_sort = QUERY_TABLE(phone_data, $
   '* Order By EXT, COST DESC')
```

This command produces a table organized like the previous table, except the COST column is now sorted in descending order within each group of extensions. The following illustrates the new table organization:

DATE	TIME	DUR	INIT	EXT	COST	AREA	NUMBER
901003	91600	0.450	MLK	370	0.12	212	2125557956
901004	95100	0.160	MLK	370	0.00	303	5551245
901004	94900	1.930	SRB	379	0.52	818	8185552880
901003	91600	1.530	SRB	379	0.41	212	2125556618

Example 8

The In operator provides another means of filtering data in a table. This operator tests for membership in a set (one-dimensional array) of values. For example, the following array contains a subset of the initials found in the `INIT` column of the `phone_data` table:

```
nameset = ['TAC', 'KAR', 'OLL', 'ERD']
```

The following QUERY_TABLE call produces a new table that contains information only on the members of `nameset`:

```
res = QUERY_TABLE(phone_data, $
   ' * Where INIT In nameset')
```

See Also

UNIQUE, BUILD_TABLE

For more information on QUERY_TABLE, see Chapter 8, *Creating and Querying Tables*, in the *PV-WAVE User's Guide*.

QUIT Procedure

Standard Library procedure that exits a PV-WAVE session.

Usage

QUIT

Parameters

None.

Keywords

None.

Discussion

QUIT simply prints a message and then calls the system routine EXIT.

See Also

EXIT

For more information, see *Exiting PV-WAVE* on page 13 of the *PV-WAVE User's Guide*.

RANDOMN Function

Returns one or more normally distributed floating-point pseudo-random numbers with a mean of zero and a standard deviation of 1.

Usage

result = RANDOMN(*seed* [, dim_1, ... , dim_n])

Input Parameters

seed — A named variable containing the seed value for random number generation. The initial value of *seed* should be set to different values in order to obtain different random sequences. *seed* is updated by RANDOMN once for each random number generated. If *seed* is undefined, it is derived from the current system time.

dim_i — The dimensions of the result. May be any scalar expression. Up to eight dimensions may be specified.

Returned Value

result — A single scalar or an array of the specified dimensions. Contains normally distributed floating-point pseudo-random numbers with a mean of zero and a standard deviation of 1. The floating-point numbers are in the range of $-6.0 < x < 6.0$.

Keywords

None.

See Also

RANDOMU

RANDOMU Function

Returns one or more uniformly distributed floating-point pseudo-random numbers over the range 0 < Y < 1.0.

Usage

result = RANDOMU(*seed* [, dim_1, ... , dim_n])

Input Parameters

seed — A named variable containing the seed value for random number generation. *seed* is updated by RANDOMU once for each random number generated. The initial value of *seed* should be set to different values in order to obtain different random sequences. If *seed* is undefined, it is derived from the current system time.

dim_i — The dimensions of the result. May be any scalar expression. Up to eight dimensions may be specified.

Returned Value

result — Returns a scalar or array of pseudo-random numbers over the range 0 < Y < 1.0. If no dimensions are specified, RANDOMU returns a scalar result.

Keywords

None.

Discussion

Uniform distribution means that, given a large enough sample of randomly-generated numbers, the same quantity of each number will be produced by RANDOMU. In other words, if you were to select a number generated by RANDOMU, you are as likely to pick any one number as another.

Example

This example simulates the result of rolling two dice 10,000 times, and plots the distribution of the total using RANDOMU:

```
PLOT, HISTOGRAM(FIX(6 * RANDOMU(S, 10000)) + $
   FIX(6 * RANDOMU(S, 10000)) + 2)
```

In the above statement, the expression `RANDOMU(S, 10000)` is a 10,000-element floating-point array of random numbers greater or equal to 0 and less than 1. Multiplying this by 6 converts the range to $0 < Y < 6$.

Applying the FIX function yields 10,000-point integer vectors from 0 to 5, one less than the numbers on one die. This is done twice, once for each die, and then 2 is added to obtain a vector from 2 to 12, the total of two die.

The HISTOGRAM function makes a vector in which each element contains the number of occurrences of dice rolls whose total is equal to the subscript of the element.

This vector is plotted by the PLOT procedure.

See Also

RANDOMN

RDPIX Procedure

Standard Library procedure that displays the X, Y, and pixel values at the location of the cursor in the image displayed in the currently active window.

Usage

RDPIX, *image* [, *x0, y0*]

Input Parameters

image — The image array loaded into the current window. May be any type. Pixel values are read from within the borders of the image; they are not read in relation to the full display area of the screen. This avoids scaling difficulties.

x0 — The X coordinate of the lower-left corner of the image displayed in the currently active window.

y0 — The Y coordinate of the lower-left corner of the image displayed in the currently active window.

Keywords

None.

Discussion

RDPIX runs on workstation displays only.

The X, Y, and pixel values under the cursor position are constantly displayed and updated. Pressing the left or center button makes a new line of output, saving the old line on the display. Pressing the right mouse button exits the procedure.

Example

```
OPENR, lun, !Data_dir + 'mandril.img', $
   /Get_lun
mandril_img = BYTARR(512, 512)
```

```
READU, lun, mandril_img
```
Read in the PV-WAVE mandril demo image file.

```
TV, mandril_img
```
Display the image.

```
RDPIX, mandril_img
```
Press the left or center mouse button to see pixel values, and the right mouse button to quit.

```
TV, mandril_img, 100, 100
```
Display the image offset on the screen by 100 pixels vertically and horizontally.

```
RDPIX, mandril_img, 100, 100
```
Read the pixel values from the offset image. Then press the left or center mouse button to see pixel values, and right mouse button to quit.

See Also

CURSOR

READ Procedures (READ, READF, READU)

Read input into PV-WAVE variables:

- READ reads ASCII (formatted) input from the standard input stream (PV-WAVE file unit 0).
- READF reads ASCII input from a specified file.
- READU reads binary (unformatted) input from a specified file. (No processing of any kind is done to the data.)

Usage

READ, var_1, ... , var_n
READF, *unit*, var_1, ... , var_n
READU, *unit*, var_1, ... , var_n

Input Parameters

unit – The file unit from which the input will be taken.

var_i – The named variables to receive the input.

Input Keywords

Format – (READ and READF only). Lets you specify the format of the input in precise detail, using a FORTRAN-style specification. FORTRAN-style formats are described in Appendix A, *FORTRAN and C Format Strings*, in the *PV-WAVE Programmer's Guide*.

If the *Format* keyword is not present, PV-WAVE uses its default rules for formatting the output. These rules are described in Table 8-7 on page 164 of the *PV-WAVE User's Guide*.

Discussion

READ and READF Procedures. If the *Format* keyword is not present and READ is called with more than one parameter, and the first parameter is a scalar string starting with the characters '$(', this initial parameter is taken to be the format specification, just as if it had been specified via the *Format* keyword. This feature is maintained for compatibility with Version 1 of PV-WAVE.

READU Procedure. For nonstring variables, the number of bytes required for var_i is input. For string variables, PV-WAVE reads exactly the number of bytes contained in the existing string.

Example 1

This example reads a string from the standard input stream using the READ procedure. The value of the string is then displayed.

```
b = ' '
```
Define a variable with string type.

```
READ, 'Enter a string: ', b
```
Read a string from the terminal.

```
Enter a string: This is a string.
```

```
PRINT, b
```
Display the contents of b.

```
This is a string.
```

Example 2

In this example, three integers are read from the standard input stream into a three-element integer array, *nums*, using READ. A file named `readex.dat` is then opened for writing, and the integers in *nums* are written to the file using PRINTF. The file is then closed. The *Format* keyword is used with PRINTF to specify the format of the integers in the file. The `readex.dat` file is then opened for reading, and the integers are read into a three-element integer array using READF with the *Format* keyword. The file is

then closed and the values that were read from `readex.dat` are displayed.

```
nums = INTARR(3)
```
Create a three-element integer array.

```
READ, 'Enter 3 integers: ', nums
```
Read three integers from the standard input stream.

```
Enter 3 integers: 3 5 7
```

```
PRINT, nums
3       5       7
```

```
OPENW, unit, 'readex.dat', /Get_Lun
```
Open the readex.dat file for writing.

```
PRINTF, unit, nums, Format = '(3i1)'
```
Write the integers to the file using a specified format.

```
FREE_LUN, unit
```
Close the file and free the file unit number.

```
OPENR, unit, 'readex.dat', /Get_Lun
```
Open the readex.dat file for reading.

```
ints = INTARR(3)
```
Create a new three-element integer array.

```
READF, unit, ints, Format = '(3i1)'
```
Read the three integers from the readex.dat file using the same specified format as when they were written.

```
PRINT, ints
```
Display the integers read from the file.

```
3       5       7
```

```
FREE_LUN, unit
```
Close the file and free the file unit number.

Example 3

In this example, READU is used to read an image of a galaxy from the file `whirlpool.img`, which is contained in the subdirectory `data` under the main PV-WAVE distribution directory.

```
OPENR, unit, FILEPATH('whirlpool.img', $
   Subdir = 'data'), /Get_Lun
```

Open the file galaxy.dat for reading.

```
a = BYTARR(512, 512)
```

Create a byte array large enough to hold the galaxy image.

```
READU, unit, a
```

Read the image data.

```
FREE_LUN, unit
```

Close the file and free the file unit number.

See Also

OPENR, GET_LUN

For more information and examples, see *READU and WRITEU* on page 193 of the *PV-WAVE Programmer's Guide.*

For more information on format specification codes, see Appendix A, *FORTRAN and C Format Strings*, in the *PV-WAVE Programmer's Guide.*

REBIN Function

Returns a vector or array resized to the given dimensions.

Usage

result = REBIN(*array*, dim_1, ... , dim_n)

Input Parameters

array – The array to be sampled. Cannot be of string or complex data type. Must have the same number of dimensions as the number of dimension parameters that you supply.

dim_i – The dimension(s) of the resampled array. Must be integral multiples or factors of the original array's dimension(s).

Returned Value

result – The resized (resampled) vector or array.

Input Keywords

Sample – If present and nonzero, specifies that nearest neighbor sampling is to be used for both magnifying and shrinking operations.

If not present, specifies that bilinear interpolation is to be used for magnifying and that neighborhood averaging is to be used for shrinking. (Bilinear interpolation gives higher quality results, but requires more time.)

Discussion

The expansion or compression of each dimension is independent of the others; REBIN can expand or compress one dimension while leaving the others untouched.

Example

This example creates an image of a shaded surface, resizes the image using REBIN, then displays the resized image.

```
x = DIST(20)
```

Create a 20-by-20 single-precision, floating-point array where each element is proportional to its frequency.

```
SHADE_SURF, x, Color = 0
```

Display a shaded-surface representation of x.

```
LOADCT, 7
y = TVRD(0, 0, 640, 512)
```

Get the content of the display subsystem's memory.

```
INFO, y
VARIABLE      BYTE           = Array(640, 512)
```

```
z = REBIN(y, 320, 256)
```

Resize the 640-by-512 array y and place the result in z.

```
WINDOW, 0, Xsize = 960, Ysize = 512
```

Create window of size 960-by-512.

```
TV, y, 0
```

Display larger image in position 0 of window.

```
TV, z, 5
```

Display resized image in position 3 of window.

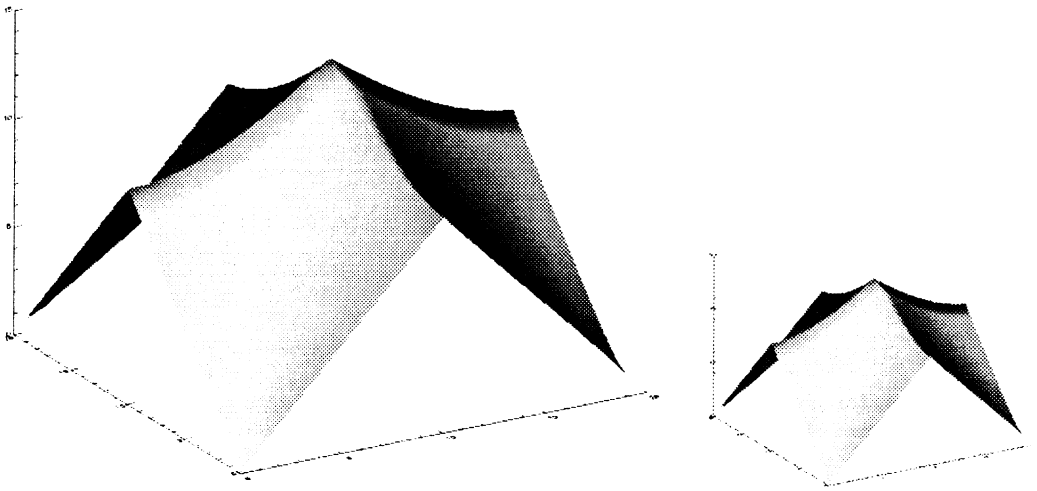


Figure 2-42 Original image (left); resized image (right).

See Also

CONGRID, REFORM

For more information on resampling and resizing images, see *Image Magnification and Reduction* on page 140 of the *PV-WAVE User's Guide.*

For information on interpolation methods, see *Efficiency and Accuracy of Interpolation* on page 170 of the *PV-WAVE User's Guide.*

REFORM Function

Reformats an array without changing its values numerically.

Usage

result = REFORM(*array*, dim_1, ... , dim_n)

Input Parameters

array — The array that is to have its dimensions modified. Must have the same total number of elements as specified by the new dimensions.

dim_i — The dimensions of the result.

Returned Value

result — The reformated array.

Keywords

None.

Discussion

REFORM returns a copy of *array* with the dimensions specified. If no dimensions are specified, then REFORM returns a copy of *array* with all dimensions of size 1 removed. Only the dimensions of *array* are changed; the actual data remains unaltered.

Tip REFORM is useful for removing degenerate leading dimensions of size one. These leading dimensions can be created when you extract a subarray from an array with more dimensions.

Example

To use REFORM to remove degenerate leading dimensions:

```
a = intarr(10,10, 10)
```
a is a 3-dimensional array.

```
b = a(5,*,*)
```
Extract a "slice" from a.

```
INFO, b, REFORM(b)
```
Use INFO to show what REFORM did.

Executing the above statements produces:

```
B               INT =    Array(1, 10, 10)
<Expression>    INT =    Array(10, 10)
```

Note that the statements:

```
b = REFORM(a,200,5)
```

```
b = REFORM(a,[200,5])
```

have identical effect. They create a new array b, with dimensions of (200,5), from a.

See Also

CONGRID, REBIN

REGRESS Function

Standard Library function that fits a curve to data using the multiple linear regression method.

Usage

result = REGRESS(*x, y, wt* [, *yf, a0, sig, ft, r, rm, c*])

Input Parameters

x — An array containing the independent values. Must be two-dimensional of size *m* by *n*, where *m* is the number of coefficients to be computed, and *n* is the number of data points.

y — A vector containing the dependent values. Must have *n* elements.

wt — A vector of weighting factors for determining the weighting of the multiple linear regression. Must have *n* elements.

Output Parameters

yf — An array containing the calculated values of *y*. It contains *n* number of elements

a_0 — The constant term (offset) of the output function.

sig — A vector containing the standard deviations for the coefficients.

ft — The value of F in the standard F Test for the goodness of fit.

r — A vector containing the linear correlational coefficients.

rm — The multiple linear correlation coefficient.

c — The value of X^2 in the Chi-Squared test for the goodness of fit.

Returned Value

result — A column vector containing the coefficients (a_1 to a_m) of the function in *x*.

Keywords

None.

Discussion

REGRESS performs a multiple linear regression fit to a dataset with a specified function which is linear in the coefficients. The general function is given by:

$$f(x) = a_0 + a_1x_1 + a_2x_2 + \ldots a_mx_m$$

Weighting is useful when you want to correct for potential errors in the data you are fitting to a curve. The weighting factor, *wt*, adjusts the parameters of the curve so that the error at each point of the curve is minimized. For more information, see the section *Weighting Factor* on page 149, in Volume 1 of this reference.

Example

```
x = FLTARR(3, 9)
x(0, *) = [0.,1.,2.,3.,4.,10.,13.,17.,20.]
x(1, *) = [0.,3.,6.,9.,12.,15.,18.,19.,20.]
x(2, *) = [0.,4.,8.,12.,13.,14.,15.,18.,20.]
y = [5.,4.,3.,2.,2.,4.,5.,8.,9.]
```

Create the data.

```
wt = FLTARR(9) + 1.0
coeff = REGRESS(x,y,wt,yf,a0,sig,ft,r,rm,c)
```

Perform multiple linear regression with no weighting.

```
PLOT, yf, title='REGRESS EXAMPLE'
```

Plot the fitted data.

```
PRINT, 'Fitted function:'
PRINT, ' f(x) = ',a0,' +', $
coeff(0, 0),' x1 +', $
coeff(0, 1),' x2 +', $
coeff(0, 2),' x3'
PRINT, 'Standard deviations for ' +$
   'coefficients: ', sig
```

```
PRINT, 'F Test value:', ft
PRINT, 'Linear correlation coefficients: ', r
PRINT, 'Multiple linear correlation ' +$
   'coefficient: ', rm
PRINT, 'Chi-squared value: ', c
```

Print all the output parameters.

See Also

CURVEFIT, GAUSSFIT, POLY_FIT, POLYFITW, SVDFIT

The REGRESS function is adapted from the program REGRES in *Data Reduction and Error Analysis for the Physical Sciences,* by Philip Bevington, McGraw-Hill, New York, 1969.

RENDER Function

Generates a ray-traced rendered image from one or more pre-defined objects.

Usage

result = RENDER(*object*$_1$, ..., *object*$_n$)

Input Parameters

object$_i$ — A previously-defined object. Valid object types include CONE, CYLINDER, MESH, SPHERE, and VOLUME.

Returned Value

result — A 2D byte array (image) of size X-by-Y.

Input Keywords

Lights — A double-precision floating-point array defining the position and intensity (X,Y, Z, intensity) of all point light sources in the scene. It is of size 4-by-number_of_lights.

If this keyword is omitted, then a single light source is defined; this light source coincides with the automatically generated viewer's eye-point.

Sample — A long integer containing the number of randomly distributed rays to fire per pixel to perform anti-aliasing. The default is `Sample=1`.

Scale — If present, indicates that the resultant image should be scaled prior to conversion to bytes. By default, all generated shaded values are assumed to be in the range {0...1} (see Discussion below).

Shadow — If present, indicates that shadow rays should be fired so that all points on all objects are not visible to all light sources. If not present, every point in a scene is visible to each light source.

For most visualization applications, you will want to omit the *Shadows* keyword, since this causes the ray tracer to run much faster.

Transform — A 4-by-4 double-precision floating-point array containing the local transformation matrix whose default is the identity matrix.

View — A 3-by-4 double-precision floating-point array used to override the auto-generation of the view to that specified. Uses the same format as is used for the *Info* keyword.

X — An integer defining the width of the byte image to be returned. Defaults to 256.

Y — An integer defining the height of the byte image to be returned. Defaults to 256.

Output Keywords

Info — A 3-by-4 double-precision floating-point array used to return the automatically calculated view as: [viewpoint, top_left_viewplane, bottom_left_viewplane, bottom_right_viewplane].

For example, you could define the variable k to contain this default view as follows:

```
k = DBLARR(3, 4)
RENDER(object, Info=k)
```

Discussion

RENDER generates an image from one or more objects using a technique called "ray tracing." The size of the returned byte image is X-by-Y, where X and Y each default to 256 unless overridden with the *X* and *Y* keywords. The returned image can be displayed using either the TV or TVSCL procedure.

Numerous objects can be rendered in the same scene. RENDER automatically generates the viewing information such that all objects are visible and the observer's viewpoint is on the positive Z axis looking towards the origin into the scene with a slight perspective. The *Transform* or the *View* keyword can be used to alter the default view. For more information, see *Setting Object and View Transformations* on page 201 of the *PV-WAVE User's Guide*.

The *Lights* keyword can be used to pass in an array of locations and intensities of point light sources. Except for the default light source (when none are specified by keyword), the light sources specified are not transformed. For best results, the sum of the intensities of light sources should equal 1.

The *Scale* keyword should be used in the following cases to ensure that all objects in the resulting image are in proportionate intensity:

- if the sum of the light source intensities is greater than 1, or
- if there exists a material property in the scene such that *Color(i) * (Kamb(i) + Kdiff(i) + Ktran(i))* > 1.

If all of the values are less than 1, then the *Scale* keyword is not required, but you may wish to view the resultant image using TVSCL to improve the contrast.

By default, shadow rays are turned off and thus all points on all objects are visible to all lights. The firing of shadow rays can be turned on using the *Shadows* keyword.

Examples

```
TV, RENDER(SPHERE())
```

For more detailed examples, see Chapter 6, *Advanced Rendering Techniques*, in the *PV-WAVE User's Guide*.

See Also

CONE, CYLINDER, MESH, SPHERE, VOLUME

For more information, see *Ray-tracing Rendering* on page 196 of the *PV-WAVE User's Guide*.

For details on the SHADE_VOLUME, TV, and TVSCL routines, see their descriptions in the *PV-WAVE Reference*.

REPLICATE Function

Forms an array with the given dimensions, filled with the specified scalar value.

Usage

result = REPLICATE(*value, dim*$_1$, ... , *dim*$_n$)

Input Parameters

value — The scalar value used for filling the resulting array. May be of any scalar type, including scalar structures.

dim$_i$ — The dimensions of the result.

Returned Value

result – An array with the given dimensions, filled with the specified *value*. The resulting data type is that of *value*.

Keywords

None.

Example

This example uses REPLICATE to create a 4-by-3 string array. Each element of the array contains the string "string".

```
strs = REPLICATE("string", 4, 3)

INFO, strs
VARIABLE        STRING         = Array(4, 3)

PRINT, strs
string    string    string    string
string    string    string    string
string    string    string    string
```

See Also

MAKE_ARRAY

RESTORE Procedure

Restores the PV-WAVE objects saved in a file by the SAVE procedure.

Usage

RESTORE [, *filename*]

Input Parameters

filename – The name of the file from which the PV-WAVE objects should be restored. If not specified, the `wavesave.dat` file is used.

Input Keywords

Filename – The name of the file from which the PV-WAVE objects should be restored. If not present, `wavesave.dat` is used. This keyword serves exactly the same purpose as the *filename* parameter; only one of them needs to be provided.

Verbose – If present and nonzero, prints an informative message for each restored object.

Example

```
WAVE> SAVE, /All, Filename='mysave.dat'
```

Save all local variables and system variables.

– User exits and then enters a new PV-WAVE session. –

```
WAVE> RESTORE, 'mysave.dat'
```

Restore all the saved variables.

See Also

SAVE, JOURNAL, COMPILE

For more information, see the section *Using the RESTORE Procedure* on page 40 of the *PV-WAVE User's Guide.*

RETALL Procedure

Issues RETURNs from nested routines. Used primarily to recover from errors in user-written procedures and functions.

Usage

RETALL

Parameters

None.

Keywords

None.

Discussion

RETALL issues RETURNs from nested procedures and functions until the main program level is reached. (The name RETALL is an abbreviation for RETurn ALL.)

When an error occurs in a procedure or function, control is left within that routine unless it contains special error handling instructions. Issuing the RETALL command causes control to return to the main level of PV-WAVE.

Tip Typing RETALL will often make "disappearing variables" reappear.

See Also

RETURN, STOP

For more information, see *Error Handling in Procedures* on page 250 of the *PV-WAVE Programmer's Guide*.

RETURN Procedure

Returns control to the caller of a user-written procedure or function.

Usage

RETURN [, *expr*]

Input Parameters

expr — (Functions only). Returns the result of the function to the caller. Cannot be used in a procedure.

Keywords

None.

Example

```
FUNCTION SQUARE_IT, val
   x = val * val
   RETURN, x
        Return the value of x to the calling program.

END
```

See Also

RETALL, STOP

For more information about the role of the RETURN procedure, see *Procedure or Function Calling Mechanism* on page 248 of the *PV-WAVE Programmer's Guide*.

REVERSE Function

Standard Library function that reverses a vector or array for a given dimension.

Usage

result = REVERSE(*array, dimension*)

Input Parameters

array — The vector or array to be reversed.

dimension — (optional) The dimension of *array* to be reversed (the default is to reverse the first dimension).

Returned Value

result — The vector or array that has been reversed.

Keywords

None.

Discussion

REVERSE is helpful in a variety of applications; one example is its use in obtaining perfectly symmetrical figures, such as an hourglass, by simply creating a portion of the needed figure and then making a reverse image for the rest.

Note Running REVERSE is equivalent to running the ROTATE function with the correct parameter.

Example 1

This example exhibits the result of applying REVERSE to a 4-by-3 integer array.

```
a = INDGEN(4, 3)
```

Create a 4-by-3 integer array. Each element has a value equal to its one-dimensional subscript.

```
PRINT, a
0       1       2       3
4       5       6       7
8       9      10      11
```

```
PRINT, REVERSE(a)
```

Reverse the rows of a.

```
 3       2       1       0
 7       6       5       4
11      10       9       8
```

```
PRINT, REVERSE(a, 2)
```

Reverse the columns of a.

```
8       9      10      11
4       5       6       7
0       1       2       3
```

```
PRINT, REVERSE(REVERSE(a), 2)
```

Reverse the columns and rows of a.

```
11      10       9       8
 7       6       5       4
 3       2       1       0
```

Example 2

The following commands first display the image contained in the PV-WAVE `scientist3.dat` file, and then rotate and redisplay it:

```
image1 = BYTARR(250, 200)
OPENR, 1, !Data_dir + 'scientist3.dat'
READU, 1, image1
TV, image1, 0
TV, REVERSE(image1), 1
```

See Also

ROTATE

REWIND Procedure

(VMS Only) Rewinds the tape on the designated PV-WAVE tape unit.

Usage

REWIND, *unit*

Input Parameters

unit – A number between 0 and 9 that specifies the magnetic tape unit to rewind. (Do not confuse this parameter with file logical unit numbers.)

Keywords

None.

See Also

For more information, see *Accessing Magnetic Tape* on page 229 of the *PV-WAVE Programmer's Guide.*

RGB_TO_HSV Procedure

Standard Library procedure that converts from the RGB color system to the HSV color system.

Usage

RGB_TO_HSV, *red, green, blue, h, s, v*

Input Parameters

red — Red color value(s). Can be scalar or vector, with values being short integers in the range 0 to 255.

green — Green color value(s). Must have the same number of elements as *red*.

blue — Blue color value(s).

Output Parameters

h — The Hue value. Must have the same number of elements as *red* and be in the range of 0 to 360.

s — The Saturation value. Must be in the range of 0 to 1.

v — The Value value. Must be in the range 0 to 1.

Keywords

None.

Discussion

RGB_TO_HSV converts colors from the RGB (Red, Green, Blue) color system to the HSV (Hue, Saturation, Value) color system.

See Also

HSV_TO_RGB, C_EDIT, COLOR_CONVERT, COLOR_EDIT, LOADCT, MODIFYCT, TVLCT, WgCeditTool, WgCtTool

For background information about color systems, see *Understanding Color Systems* on page 305 of the *PV-WAVE User's Guide.*

RM Procedure

Reads data into a one- or two-dimensional matrix.

Usage

RM, *a* [, *rows*, *columns*]

Input Parameters

rows — Number of rows in the matrix.

columns — Number of columns in the matrix.

Output Parameters

a — Named variable into which the data is stored.

Input Keywords

Complex — If present and nonzero, creates a complex matrix.

Double — If present and nonzero, creates a double-precision matrix.

Description

Procedure RM is used to read data into matrices according to the PV-WAVE matrix-storage scheme. If *rows* and *columns* are not specified, RM attempts to use the current definition of *A* to determine the number of rows and columns of *A*. If *rows* and *columns* are not specified and *A* is undefined or a scalar, an error is issued.

Upon invoking RM, the user is prompted with the row number for which input is expected. The prompt for the next row to be filled does not appear until the current row is filled. If the amount of data input for a particular row is larger than the defined number of columns of *A*, then the extra trailing input is ignored, and the prompt for the next row is given.

The matrix-printing procedures PM or PMF must be used to correctly print a matrix read in with RM.

Example 1: Reading a Simple Matrix

This example reads a 2 × 3 matrix and prints the results using the matrix-printing procedure PM.

```
RM, a, 2, 3
```

Read a 2 × 3 matrix.

```
row 0: 11 22 33
row 1: 40 50 60

PM, a
```

Output the matrix.

```
11.0000       22.0000       33.0000
40.0000       50.0000       60.0000
```

Example 2: Reading a Complex Matrix

In this example, a complex matrix is read. Notice that the elements input as integers are promoted to type complex with the value of the imaginary part set to zero.

```
RM, a, 3, 2, /Complex
```

Read the matrix; note that keyword Complex is set.

```
row 0: (1, 0)      (1, 1)
row 1:  1          -1
row 2: (10.0, 0)   (0, -10)
```

```
PM, a
```

Print the result.

```
(  1.00000, 0.00000)(  1.00000,  1.00000)
(  1.00000, 0.00000)( -1.00000,  0.00000)
( 10.0000,  0.00000)(  0.00000, -10.0000)
```

Example 3: Reading a Matrix to be Used with LUSOL

In this example, a 3 × 3 matrix and a 3 × 1 matrix are read. These matrices are then used in a call to the PV-WAVE Advantage function LUSOL.

```
RM, a, 3, 3
```

Read the coefficient matrix.

```
row 0: 1 3 3
row 1: 1 3 4
row 2: 1 4 3
```

```
RM, b, 3, 1
```

Read the right-hand side.

```
row 0:  1
row 1:  4
row 2: -1
```

```
x = LUSOL(b, a)
```

Call LUSOL to compute the solution.

```
PM, x
```
Output the results.

```
-2.00000
-2.00000
 3.00000

PM, a#x - b

0.00000
0.00000
0.00000
```

See Also

PM, PMF, RMF

See *Matrices* on page 93 of the *PV-WAVE Programmer's Guide* for more information.

RMF Procedure

Reads data into a one- or two-dimensional matrix from a specified file unit.

Usage

RMF, *unit*, *a* [, *rows*, *columns*]

Input Parameters

unit — File unit from which the input is taken.

rows — Number of rows in the matrix.

columns — Number of columns in the matrix.

Output Parameters

a — Named variable into which the data is stored.

Input Keywords

Complex — If present and nonzero, creates a complex matrix.

Double — If present and nonzero, creates a double-precision matrix.

Format — Scalar string specifying the precise format of the data to be read. If *Format* is not specified, PV-WAVE uses its default rules for formatting the input. The character string should start with a left parenthesis and end with a right parenthesis. For example:

```
Format = '(f10.5)'
```

Description

RMF is used to read data from a specified file unit into a matrix according to the PV-WAVE matrix-storage mode. If *rows* and *columns* are not specified, RMF attempts to use the current definition of *A* to determine the number of rows and columns of *A*. If the arguments *rows* and *columns* are not specified and *A* is undefined or a scalar, an error is issued.

The matrix-printing procedures PM or PMF must be used to correctly print a matrix read in with RMF.

Example

This example reads in a 2 x 3 matrix from standard input (*unit* = 0) and prints the results using the matrix-printing procedure PM.

```
RMF, 0, a, 2, 3
    Read matrix.

: 11 22 33
: 40 50 60

PM, a
    Output the matrix.
```

```
11.0000      22.0000      33.0000
40.0000      50.0000      60.0000
```

See Also

PM, PMF, RMF

See *Matrices* on page 93 of the *PV-WAVE Programmer's Guide* for more information.

ROBERTS Function

Performs a Roberts edge enhancement of an image.

Usage

result = ROBERTS(*image*)

Input Parameters

image — The two-dimensional array that is to be enhanced.

Returned Value

result — A two-dimensional array of integer type containing the image that has been edge-enhanced.

Keywords

None.

Discussion

The ROBERTS function performs edge sharpening and isolation on *image*. It returns an approximation to the Roberts edge enhancement operator for images. This approximation is shown below:

$$G_A(j,k) = |F_{j,k} - F_{j+1,k+1}| + |F_{j,k+1} - F_{j+1,k}|$$

The resulting image returned by ROBERTS has the same dimensions as the input *image*.

Caution Because the result image is saved in integer format, large original data values will cause overflow. Overflow occurs when the absolute value of the result is larger than 32,767.

Example

This example uses the ROBERTS function to apply the Roberts edge enhancement operator to an aerial image. The final edge enhanced image is the absolute value of the difference between the original image and the image resulting from the ROBERTS function.

```
OPENR, unit, FILEPATH('aerial_demo.img', $
   Subdir='data'), /Get_Lun
```

Open the file containing the image.

```
img = BYTARR(512, 512)
```

Create an array large enough to hold the image.

```
READU, unit, img
```

Read the image data.

```
FREE_LUN, unit
```

Close the file and free the file unit number.

```
WINDOW, 0, Xsize = 1024, Ysize = 512
```

Create a window large enough to hold two 512-by-512 images.

```
TV, img
```

Display the original image in the left half of the window.

```
HIST_EQUAL_CT, img

TV, ABS(img - ROBERTS(img)), 1
```

Display the absolute value of the difference between the original image and the result of the ROBERTS function in the right half of the window.

Figure 2-43 Original image (left), and Roberts edge enhanced image (right).

See Also

CONVOL, SHIFT, SOBEL

For background information, see *Image Sharpening* on page 160 of the *PV-WAVE User's Guide*.

ROT Function

Standard Library function that rotates and magnifies (or demagnifies) a two-dimensional array.

Usage

result = ROT(*image, ang*[, *mag, xctr, yctr*])

Input Parameters

image —The input image to be manipulated. Can be of any data type except string. Must be two-dimensional.

ang — The angle of rotation in degrees clockwise.

mag — The magnification or demagnification factor (see Discussion below).

xctr — The X subscript of the center of rotation. If omitted, *xctr* is equal to the number of columns in *image* divided by 2.

yctr — The Y subscript of the center of rotation. If omitted, *yctr* is equal to the number of rows in *image* divided by 2.

Returned Value

result — A rotated and magnified (or demagnified) image. The dimensions are the same as those for the input *image*.

Input Keywords

Interp — If present and nonzero, specifies that bilinear interpolation is to be used. Otherwise, the nearest neighbor interpolation method is used.

Missing — Data value to substitute for pixels in the output image that map outside the input image.

Discussion

ROT uses the POLY_2D function to rotate and scale the input image.

The magnification factor can be of integer or floating-point data type. It is specified as follows (with 1 being the default value):

mag = 1	no change
mag > 1	causes magnification
mag < 1	causes demagnification

For example, if *mag* is set to 0.5, this would result in an image half the size of the original image, and if *mag* is set to 3, this would result in an image three times the size of the original.

Tip If you only need to rotate an image by 90-degree increments, the ROTATE function is more efficient to use.

If you need a more accurate bilinear interpolation method, use the ROT_INT function.

Example

This example uses ROT to both rotate and demagnify an image. The image is rotated 135 degrees clockwise, while the demagnification factor is 0.63. Also, pixels that map outside the original image are assigned a value of 0.

```
OPENR, unit, FILEPATH('x2y2.dat', $
   Subdir = 'data'), /Get_Lun
```

Open the file containing the image.

```
image = BYTARR(320, 256)
```

Create an array large enough to hold the image.

```
READU, unit, image
```

Read the image.

```
FREE_LUN, unit
```

Close the file and free the file unit number.

```
WINDOW, 0, Xsize = 640, Ysize = 256
```
Create a window large enough to contain two 320-by-256 images.

```
TV, image, 0
```
Display the original image in the left half of the window.

```
a = ROT(image, 135, 0.63, Missing = 0)
```
Rotate the image 135 degrees clockwise, and demagnify it by a factor of 0.63. Also, pixels that map outside the original image are assigned a value of 0.

```
TV, a, 1
```
Display the rotated and demagnified image in the right half of the window.

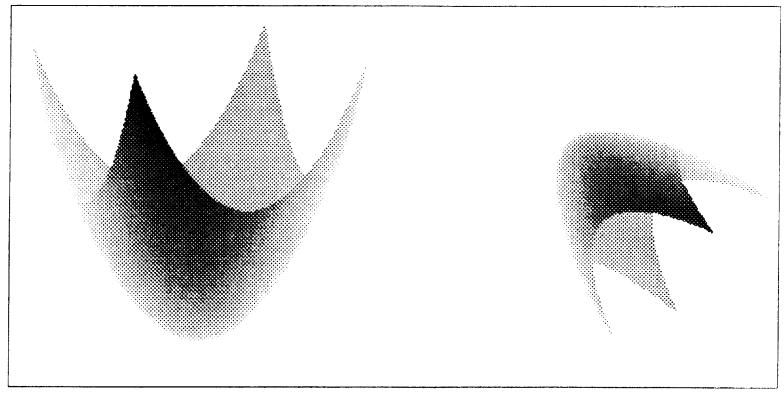


Figure 2-44 Original image (left); rotated/demagnified image (right).

See Also

POLY_2D, ROTATE, ROT_INT

For information on interpolation methods, see *Efficiency and Accuracy of Interpolation* on page 170 of the *PV-WAVE User's Guide*.

ROTATE Function

Returns a rotated and/or transposed copy of the input array.

Usage

result = ROTATE(*array, direction*)

Input Parameters

array — The array to be rotated. Must have either one or two dimensions.

direction — An integer that specifies the type of rotation to be performed, as shown below:

Direction	Transpose	Rotation Clockwise
0	No	None
1	No	90 °
2	No	180 °
3	No	270 °
4	Yes	None
5	Yes	90 °
6	Yes	180 °
7	Yes	270 °

direction is taken modulo 8, so a rotation of –1 is the same as 7, 9 is the same as 1, and so forth.

Returned Value

result — A copy of *array* that has been rotated and/or transposed by 90-degree increments.

Keywords

None.

Discussion

The resulting array is of the same data type as the input *array*. The dimensions of the result are the same as those of *array* if *direction* is equal to 0 or 2; the dimensions are switched if *direction* is 1 or 3.

Note To rotate by amounts other than multiples of 90 degrees, use the functions ROT and ROT_INT. However, note that ROTATE is more efficient than either of those functions.

Example 1

ROTATE may be used to reverse the order of elements in vectors. For example, to reverse the order of elements in the vector in variable X, use the expression:

```
ROTATE(X,2)
```

If

```
X = [0,1,2,3]
```

then

```
ROTATE(X,2) = [3,2,1,0]
```

Example 2

This example uses ROTATE to rotate an image of New York City by 90 degrees counterclockwise and displays the image both before and after the rotation.

```
OPENR, unit, FILEPATH('x2y2.dat', $
   Subdir ='data'), /Get_Lun
```

Open the file containing an image of New York City.

```
img = BYTARR(320, 256)
READU, unit, img
FREE_LUN, unit
```

Create array to hold the image, read the image, and free the LUN.

```
WINDOW, 0, Xsize = 640, Ysize = 640
```

Create a window.

```
TV, img, 0, 321
TV, ROTATE(img, 1), 321, 257
TV, ROTATE(img, 2), 0, 0
TV, ROTATE(img, 3), 321, 0
```

Display the image, before, and after rotations.

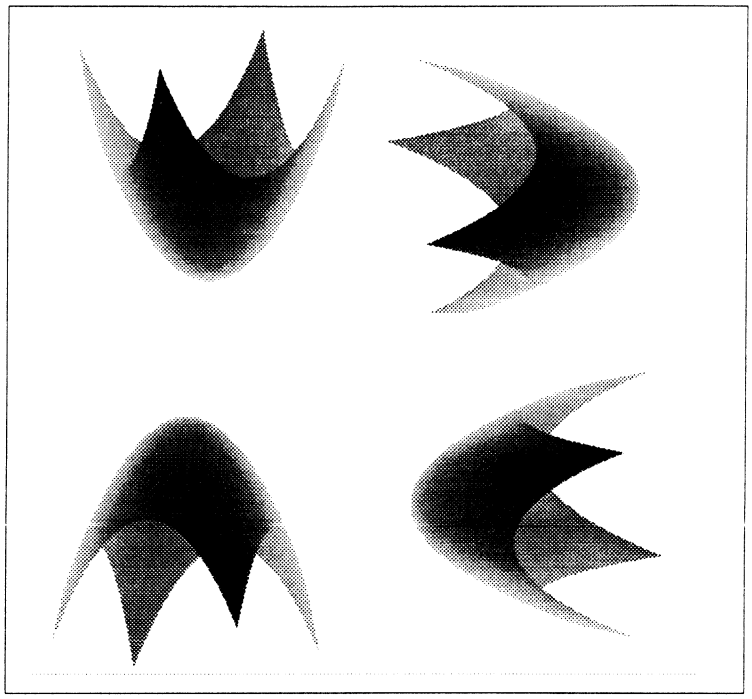


Figure 2-45 Original image (left) and rotations.

See Also

ROT, ROT_INT, REVERSE

ROT_INT Function

Standard Library function that rotates and magnifies (or demagnifies) an image on the display screen.

Usage

result = ROT_INT(*image, ang* [, *mag, xctr, yctr*])

Input Parameters

image —The input image to be manipulated. Can be of any data type except string. Must be two-dimensional.

ang — The angle of rotation in degrees clockwise.

mag — The magnification or demagnification factor (see Discussion below).

xctr — The X subscript of the center of rotation. If omitted, *xctr* is equal to the number of columns in *image* divided by 2.

yctr — The Y subscript of the center of rotation. If omitted, *yctr* is equal to the number of rows in *image* divided by 2.

Returned Value

result — A rotated and magnified (or demagnified) image. The dimensions are the same as those for the input *image*.

Keywords

None.

Discussion

ROT_INT calls the function POLY_2D to rotate and scale the input image.

The magnification factor can be of integer or floating-point data type. It is specified as follows (with 1 being the default value):

mag = 1	no change
mag > 1	causes magnification
mag < 1	causes demagnification

For example, if *mag* is set to 0.5, this would result in an image half the size of the original image, and if *mag* is set to 3, this would result in an image three times the size of the original.

ROT_INT uses the bilinear interpolation method to rotate and scale the input image.

Tip If a faster (but less accurate) method of interpolation is needed, use the related function ROT, which uses a nearest neighbor method.

See Also

ROT, POLY_2D, ROTATE

For information on interpolation methods, see *Efficiency and Accuracy of Interpolation* on page 170 of the *PV-WAVE User's Guide*.

SAVE Procedure

Saves variables or other specified objects in a file for later recovery by RESTORE.

Usage

SAVE [, var_1, ... , var_n]

Input Parameters

var_i — The named variables that are to be saved.

Input Keywords

All — If nonzero, specifies that everything (common blocks, system variables, local variables, compiled functions, and compiled procedures) should be saved.

Comm — If present and nonzero, causes all main level common block definitions to be saved.

Filename — The name of the file into which to save the PV-WAVE objects. If this keyword is not present, the file `wavesave.dat` is used.

Routines — If nonzero, saves all procedures and functions that are currently compiled in memory.

Variables — If present and nonzero, causes all current local variables to be saved.

Verbose — If present and nonzero, prints an informative message for each saved object.

XDR — If present and nonzero, causes the save file to be written in a portable format using XDR (eXternal Data Representation).

- Under UNIX, XDR is the only supported format, so specifying this keyword is unnecessary.

- Under VMS, XDR is used to interchange data with other versions of PV-WAVE. The default is a VAX-specific format that is more efficient to process.

See Also

JOURNAL, RESTORE, COMPILE

For more information, see *Using the SAVE Procedure* on page 40 of the *PV-WAVE User's Guide*.

SCALE3D Procedure

Standard Library procedure that scales a three-dimensional unit cube into the viewing area.

Usage

SCALE3D

Parameters

None.

Keywords

None.

Discussion

SCALE3D is useful for certain forms of perspective transformation, although it does not work for all forms.

SCALE3D does not use explicit parameters, but rather modifies the system variable !P.T for use as the implicit input and output parameters. Eight three-dimensional data points are created at the vertices of the three-dimensional unit cube. These eight points are transformed by !P.T. The system is translated to bring the mini-

mum (X, Y, Z) point to the origin, and then scaled to make each coordinate's maximum value equal to 1.

Example

For an example, see *Procedure Used to Draw a House* on page 122 of the *PV-WAVE User's Guide.*

See Also

!P.T

SEC_TO_DT Function

Converts any number of seconds into PV-WAVE Date/Time values.

Usage

result = SEC_TO_DT(*num_of_seconds*)

Input Parameters

num_of_seconds — A scalar representing the number of seconds elapsed from the date specified in the system variable !DT_Base.

Returned Value

result — A PV-WAVE Date/Time variable containing the converted values.

Input Keywords

Base — A string containing a date, such as "3-27-92". This is the base date from which the number of seconds is calculated. The default value for *Base* is taken from the system variable !DT_Base.

Date_Fmt – Specifies the format of the base date, if passed into the function. Possible values are 1, 2, 3, 4, or 5, as summarized in the following table:

Table 2-10: Valid Date Formats

Value	Format Description	Examples for May 1, 1992
1	MM*DD*[YY]YY	05/01/92
2	DD*MM*[YY]YY	01-05-92
3	ddd*[YY]YY	122,1992
4	DD*mmm[mmmmmm]*[YY]YY	01/May/92
5	[YY]YY*MM*DD	1992-05-01

where the asterisk (*) represents one of the following separators: dash (–), slash (/), comma (,), period (.), or colon (:).

For a detailed description of these formats, see *Converting Your Data into Date/Time Data* on page 229 of the *PV-WAVE User's Guide.*

Discussion

This function is useful for converting time stamps that count seconds to Date/Time values. Most time stamps count seconds from an arbitrary base date. For example, the UNIX time stamp counts seconds from January 1, 1970.

Example 1

This example shows how a value of 20 seconds is represented internally inside a PV-WAVE Date/Time variable after it has been converted with SEC_TO_DT. The example uses a base start date of January 1, 1970.

```
date = SEC_TO_DT(20, Base='1-1-70', $
   Date_Fmt=1)
PRINT, date
   { 1970 1 1 0 0 20.0000 79367.000 0}
```

Example 2

Assume you have the following dataset which contains time stamps and associated measurements. The file contains data collected from January 1, 1990 to January 5, 1990. The base date for the clock is January 1, 1970.

```
6.3119520e+08    113
6.3128160e+08    768
6.3136800e+08    632
6.3145440e+08    227
6.3154080e+08    224
```

Assume the above file has been read into two PV-WAVE variables. The first column is read into a double-precision array called `tarray`. The second column is read into an array called `fluid_level`, which indicates the water level of a lake for each specified time period. You can convert the Date/Time data in Column 1 to PV-WAVE Date/Time data with the SEC_TO_DT function:

```
dtarray = SEC_TO_DT(tarray, Base='1-1-70')
PRINT, dtarray
{ 1990 1 1 12 0 0.00000 86672.500 0}
{ 1990 1 2 12 0 0.00000 86673.500 0}
{ 1990 1 3 12 0 0.00000 86674.500 0}
{ 1990 1 4 12 0 0.00000 86675.500 0}
{ 1990 1 5 12 0 0.00000 86676.500 0}
```

Notice the SEC_TO_DT function creates an array containing a PV-WAVE Date/Time structure for each of the seconds values. The Julian day shown for each Date/Time is automatically adjusted to reflect the PV-WAVE system base date of September 14, 1752.

See Also

DT_TO_SEC, STR_TO_DT, VAR_TO_DT, JUL_TO_DT, !DT_Base

For more information, see Chapter 7, *Working with Date/Time Data*, in the *PV-WAVE User's Guide*.

SELECT_READ_LUN Procedure

Waits for input on any of a list of logical unit numbers.

Usage

SELECT_READ_LUN, *luns*

Input Parameters

luns — Vector of logical unit numbers.

Output Parameters

luns — Vector of logical unit numbers.

Input Keywords

Timeout — Amount of time, in seconds, this procedure should block while waiting for input. This may be a floating-point number. The default is to block forever.

Widget — If present and nonzero, selects the X11 socket.

Output Keywords

Widget — If there is no X11 input, then the value of this keyword is set to –1.

Description

This procedure checks for input on all the logical unit numbers specified in the *luns* vector. When it returns, those unit numbers *without* input are set to –1. By default, this procedure blocks forever waiting for input. Keyword *Timeout* can be used to reduce the

time the procedure blocks. This procedure always returns when any one of the listed LUNs has input to be read.

This procedure is an interface to the `select_read_lun` C routine in the `io.so` shared library.

See Also

EXEC_ON_SELECT, ADD_EXEC_ON_SELECT, DROP_EXEC_ON_SELECT

SETDEMO Procedure

Standard Library procedure that defines key bindings and system variables to run the PV-WAVE demonstration system for the system on which PV-WAVE is started.

Usage

SETDEMO

Parameters

None.

Keywords

None.

Discussion

SETDEMO is called when PV-WAVE is started, and defines the key bindings and system variables used to run the demonstration system. The message that appears at the start of a session identifying the key bindings is written by this procedure.

Note Some key definitions may not be possible on all platforms.

SETDEMO is called by the PV-WAVE startup file:

- In UNIX, this file is `/wave/bin/wavestartup`
- In VMS, this file is `WAVE_DIR:[000000.bin]wavestartup.dat`

During startup, SETDEMO sets up the key bindings for the PV-WAVE demonstration, accessing the Help system, outputting the PV-WAVE status, and creating a subprocess on your system. It then displays a message indicating that the key bindings were set.

You can use SETDEMO to customize your keys for commonly used commands (through the DEFINE_KEY routine), to change the message that is printed to the screen when you invoke PV-WAVE, or to change the default key bindings.

See Also

DEFINE_KEY, SETUP_KEYS

For more information on using a startup file, and defining function keys and environment parameters used by PV-WAVE, see Chapter 2, *Getting Started*, in the *PV-WAVE User's Guide*.

SETENV Procedure

(UNIX Only) Adds or changes an environment string in the process environment.

Usage

SETENV, *environment_expr*

Input Parameters

environment_expr — A scalar string containing an environment expression to be added to the environment.

Keywords

None.

Example

```
SETENV, 'SHELL=/bin/sh'
```

See Also

GETENV, ENVIRONMENT

SETLOG Procedure

(VMS Only) Defines a logical name.

Usage

SETLOG, *logname, value*

Input Parameters

logname – A scalar string containing the name of the logical to be defined.

value – A string giving the value to which *logname* will be set. If *value* is a string array, *logname* is defined as a multi-valued logical where each element of *value* defines one of the equivalence strings.

Input Keywords

Concealed – If set, RMS interprets the equivalence name as a device name.

Confine – If set, prevents *logname* from being copied from the PV-WAVE process to its spawned subprocesses.

No_Alias – If set, prevents *logname* from being duplicated in the same logical table at an outer access mode. If another logical name with the same name already exists at an outer access mode, it is deleted.

Table – A scalar string giving the name of the logical table from which to delete *logname*. If this keyword is not present, the table `LNM$PROCESS_TABLE` is used.

Terminal – If set, prevents further iterative logical name translation on the equivalence name from being performed when SETLOG attempts to translate *logname*.

See Also

DELETE_SYMBOL, DELLOG, GET_SYMBOL, SET_SYMBOL, TRNLOG

For more information on logical names and access modes, see the *VAX/VMS DCL Dictionary.* Information oriented to C programmers can be found in the *VMS System Services Manual.*

SET_PLOT Procedure

Specifies the device type used by PV-WAVE graphics procedures.

Usage

SET_PLOT, *device*

Input Parameters

device — A scalar string giving the name of the device to use. This parameter is case-insensitive.

Keywords

copy — If present and nonzero, PV-WAVE's internal color table is copied into the device. This is the preferred method if you are displaying graphics and each color index is explicitly loaded.

interpolate — If present and nonzero, the color table of the new device is loaded by interpolating the old color table to span the new number of color indices. This method works best when displaying images with continuous color ranges.

Discussion

The names of available devices are given in Table A-1 and Table A-2 on page A-2 of the *PV-WAVE User's Guide.*

If the *Copy* keyword parameter is set, the color table copying is straightforward as long as both devices have the same number of

color indices. However, if the new device has more colors than the old device, some color indices will be invalid. If the new device has less colors than the old, not all the colors are saved.

Examples

```
SET_PLOT, 'ps'
```
Send output to a PostScript file.

```
SET_PLOT, 'cgm'
```
Send output to a CGM file.

See Also

!D, DEVICE

For background information, see Appendix A, *Output Devices and Window Systems*, in the *PV-WAVE User's Guide*.

SET_SCREEN Procedure

Standard Library procedure that establishes a new position for the rectangular plot area based on input values specified using the device coordinate system.

Usage

SET_SCREEN, *xmin, xmax* [, *ymin, ymax*]

Input Parameters

xmin — The position of the left edge of the rectangular plot area in device coordinates.

xmax — The position of the right edge of the rectangular plot area in device coordinates.

ymin — The position of the bottom edge of the rectangular plot area in device coordinates.

ymax — The position of the top edge of the rectangular plot area in device coordinates.

Input Keywords

Cursor — Lets you set the region for the rectangular plot area interactively with the mouse:

- If nonzero, lets you set the boundaries by clicking the mouse at the corners of the rectangular plot area that you want to use. Click first to set the lower-left corner, then once again to set the upper-right corner. Any input parameters for SET_SCREEN are ignored.
- If zero, uses the input parameters as specified.

Region — If present, uses the system variable !P.Region to set the plot area. The default is to use !P.Position.

Discussion

SET_SCREEN is used to set up the area of the display that will be used for plotting. It is identical to the SET_VIEWPORT procedure, except that the input parameters are in device coordinates for SET_SCREEN.

If only *xmin* and *xmax* are provided, the values for *ymin* and *ymax* are calculated. Calling SET_SCREEN with four input parameters is the same as setting the !P.Position system variable or using the *Position* keyword with the plotting commands

SET_SCREEN overrides the effect of the system variables !X.Margin and !Y.Margin.

Tip To find out the current values of your device, type either:

```
INFO, /Structure, !D
PRINT, !D.X_Size, !D.Y_Size
```

Example

```
INFO, /Structure, !D
SET_SCREEN, !D.X_Size/10., !D.X_Size/2.

SET_SCREEN, !D.X_Size/10., !D.X_Size/2.1, $
   !D.Y_Size/1.7, !D.Y_Size/1.1
PLOT, [3, 4, 5], Title='Upper left plot'
SET_SCREEN, !D.X_Size/10., !D.X_Size/2.1, $
   !D.Y_Size/10., !D.Y_Size/2.3
PLOT, [5, 1, 6], Title='Lower left plot', $
   /Noerase
SET_SCREEN, !D.X_Size/1.8, !D.X_Size/1.1, $
   !D.Y_Size/1.7, !D.Y_Size/1.1
PLOT, [3, 4, 5], Title='Upper right plot', $
   /Noerase
SET_SCREEN, !D_X_Size/1.8, !D_X_Size/1.1, $
   !D_Y_Size/10., !D_Y_Size/2.3
PLOT, [2, 4, 3], title='Lower right plot', $
   /Noerase

SET_SCREEN, 1, 1, 1, 1, /Cursor
```

Click with the mouse button on the lower left corner of the desired plotting area and then again for the desired upper right corner.

```
PLOT, [3, 5, 4]

SET_SCREEN, !D_X_Size/10., !D_X_Size/1.1, $
   !D_Y_Size/10., !D_Y_Size/1.1
PLOT, [3, 4, 5],  $
   Title='Without setting the region keyword'
SET_SCREEN, !D_X_Size/10., !D_X_Size/1.1, $
   !D_Y_Size/10., !D_Y_Size/1.1, Region
PLOT, [3, 4, 5],  $
   Title='With the region keyword set',  $
   /Noerase
```

See Also

!P.Region, !P.Position, SET_VIEWPORT

SET_SHADING Procedure

Modifies the light source shading parameters affecting the output of SHADE_SURF and POLYSHADE.

Usage

SET_SHADING

Input Parameters

None.

Input Keywords

Gouraud — Controls the method of shading the surface polygons of the POLYSHADE procedure:

- If set to nonzero (the default), the Gouraud shading method is used.
- Otherwise, each polygon is shaded with a constant intensity.

Gouraud shading interpolates intensities from each vertex along each edge. Then, when scan converting the polygons, the shading is interpolated along each scan line from the edge intensities. Gouraud shading is slower than constant shading, but usually results in a more realistic appearance.

The SHADE_SURF procedure always uses the Gouraud method.

Light — A 3-element vector specifying the direction of the light source. The default light source vector is [0, 0, 1], with the light rays parallel to the Z axis.

Reject — If set (the default), causes polygons to be rejected as being hidden if their vertices are ordered in a clockwise direction as seen by the viewer.

- You should always set *Reject* when rendering enclosed solids whose original vertex lists are in counterclockwise order.

- You may also choose to set *Reject* when rendering surfaces that are not closed or are not in counterclockwise order, although this may cause shading anomalies at boundaries between visible and hidden surfaces to occur.

Discussion

SET_SHADING keywords let you control the light source direction, shading method, and the rejection of hidden surfaces. SET_SHADING first resets its keywords to their default values. The values specified in the call then overwrite the default values.

Example

This example creates a spherical volume dataset and then renders two isosurfaces from that dataset. The first isosurface does not use the Gouraud method of shading but instead shades each polygon with a constant intensity. This is achieved by using SET_SHADING with the *Gouraud* keyword set to 0. The second isosurface uses the Gouraud method of shading, which is achieved by using SET_SHADING with the *Gouraud* keyword set to 1.

```
sphere = FLTARR(20, 20, 20)
```
Create a three-dimensional single precision, floating-point array.

```
FOR x = 0, 19 DO FOR y = 0, 19 DO FOR $
   z = 0, 19 DO sphere(x, y, z) = $
   SQRT((x-10)^2 + (y-10)^2 + (z-10)^2)
```
Create the spherical volume dataset.

```
SHADE_VOLUME, sphere, 7, v, p
```
Find the vertices and polygons at a contour level of 7.

```
SURFACE, FLTARR(2, 2), /Nodata, /Save, $
   Xrange = [0, 20], Yrange = [0, 20], $
   Zrange = [0, 20], Xstyle = 4, Ystyle = 4, $
   Zstyle = 4
```
Set up an appropriate three-dimensional transformation.

```
SET_SHADING, Gouraud = 0
```
Turn Gouraud shading off.

```
image = POLYSHADE(v, p, /T3d)
```
Render the image.

```
TV, image
```
Display the image.

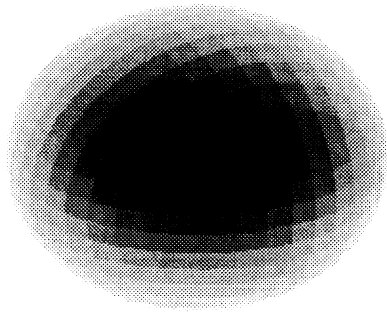


Figure 2-46 Spherical isosurface with constant intensity shading.

```
SET_SHADING, Gouraud = 1
```
Turn Gouraud shading on.

```
image = POLYSHADE(v, p, /T3d)
```
Render the image.

```
TV, image
```
Display the image.

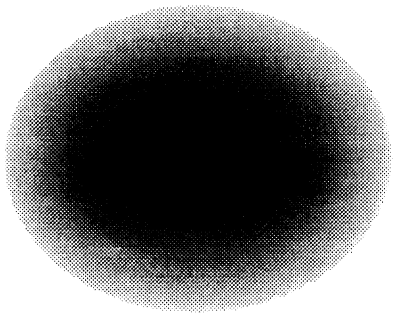


Figure 2-47 Spherical isosurface with Gouraud shading.

See Also

POLYSHADE, SHADE_SURF, SHADE_SURF_IRR

SET_SYMBOL Procedure

(VMS Only) Defines a DCL interpreter symbol for the current process.

Usage

SET_SYMBOL, *name, value*

Input Parameters

name – A scalar string containing the name of the symbol to be defined.

value – A scalar string containing the value with which *name* will be defined.

Input Keywords

Type – Indicates the VMS table into which *name* will be placed:

1 Specifies the local symbol table (the default).

2 Specifies the global symbol table.

See Also

DELETE_SYMBOL, DELLOG, GET_SYMBOL, SETLOG, TRNLOG

For more information, see the *VAX/VMS DCL Dictionary.* Information oriented to C programmers can be found in the *VMS System Services Manual.*

SETUP_KEYS Procedure

Standard Library procedure that sets up the functions keys for keyboards known to PV-WAVE.

Usage

SETUP_KEYS

Parameters

None.

Input Keywords

App_Keypad — Specifies the escape sequences for the group of keys in the numeric keypad, enabling these keys to be programmed within PV-WAVE.

Eightbit — Indicates that the 8-bit versions of the escape codes should be used instead of the default 7-bit versions when the VT200 function key definitions are entered. *Eightbit* is only valid if the *VT200* keyword is also used.

HP9000 — Specifies that function key definitions for an HP-9000 Series 300 keyboard should be established.

The upper right-hand group of four keys (at the same height as the function keys) are called <BLANK1> throught <BLANK4>, since they have no written labels.

Keys defined to have labels beginning with a capital <K> belong to the numeric keypad group; for example, <K9> refers to keypad key <9>.

Mips — Specifies that function key definitions for a MIPS RS series keyboard should be established.

Num_Keypad — Disables programmability of the numeric keypad.

Sun — Specifies that function key definitions for a Sun-4 keyboard should be established.

VT200 — Specifies that function key definitions for a VT200 keyboard should be established.

Discussion

SETUP_KEYS is handy for initializing or resetting the function key definitions of a particular keyboard, since the number of function keys, their names, and the escape sequences they send vary between various keyboards.

If no keyboard-specific keyword is specified, SETUP_KEYS uses the system variable !Version to determine the type of machine running PV-WAVE. It assumes the keyboard is the same type as the machine.

The function key definitions can be examined by running the SETUP_KEYS procedure and then typing `INFO, /Keys`.

Example

```
SETUP_KEYS, /Eightbit, /VT200
```

Establishes function key definitions for a VT200 keyboard using 8-bit versions of escape codes.

See Also

DEFINE_KEY, SETDEMO, !Version

SET_VIEW3D Procedure

Generates a 3D view, given a view position and a view direction.

Usage

SET_VIEW3D, *viewpoint, viewvector, perspective, izoom, viewup, viewcenter, winx, winy, xr, yr, zr*

Input Parameters

viewpoint — A three-element vector containing the point from which to view the data in data coordinates.

viewvector — A three-element vector containing the direction to look.

perspective — The perspective projection distance. The smaller the projection distance, the more "severe" the projection is. The larger the projection distance, the more "isometric" the projection is.

Tip To prevent a perspective projection, set perspective to 0 (or less than zero).

izoom — The magnification factor for the projection.

viewup — A two-element vector containing the final 2D view up vector. For a "right-side-up" view, set this parameter to [0.0, 1.0].

viewcenter — A two-element vector containing the window location on which to place the viewpoint. It is in normal coordinates and is usually set to [0.5, 0.5].

winx, winy — The X and Y dimensions, respectively, of the plot window in device coordinates. Typically, *winx* and *winy* are set to the X and Y size of the current PV-WAVE window.

xr, yr, zr — Two-element vectors containing the minimum and maximum X, Y, and Z values, respectively, found in the data to be plotted. The minimum value is in *xr(0), yr(0)*, and *zr(0)*; the maximum value in *xr(1), yr(1)*, and *zr(1)*.

Keywords

None.

Discussion

SET_VIEW3D creates a view transformation that preserves the correct aspect ratio of the data, even if the plot window is non-square.

Note SET_VIEW3D changes the system viewing matrix !P.T, as well as the system variables, !X.S, !Y.S, and !Z.S, which handle conversion from data coordinates to normal coordinates. (These system variables are described in Chapter 4, *System Variables.*

Examples

See the *Examples* section in the description of the POLY_DEV routine.

See Also

CENTER_VIEW

SET_VIEWPORT Procedure

Standard Library procedure that establishes a new position for the rectangular plot area based on input values specified using the normalized coordinate system.

Usage

SET_VIEWPORT, *xmin, xmax* [, *ymin, ymax*]

Input Parameters

xmin — The position of the left edge of the rectangular plot area in normal coordinates.

xmax — The position of the right edge of the rectangular plot area in normal coordinates.

ymin — The position of the bottom edge of the rectangular plot area in normal coordinates.

ymax — The position of the top edge of the rectangular plot area in normal coordinates.

Input Keywords

Cursor — Lets you set the region for the rectangular plot area interactively with the mouse:

- If nonzero, lets you set the boundaries by clicking the mouse at the corners of the rectangular plot area that you want to use. Click first to set the lower-left corner, then once again to set the upper-right corner. Any input parameters for SET_VIEWPORT are ignored.
- If zero, uses the input parameters as specified.

Region — If present, uses the system variable !P.Region to set the plot area. The default is to use !P.Position.

Discussion

SET_VIEWPORT is used to set up the area of the display that will be used for plotting. It is identical to the SET_SCREEN procedure, except that the input parameters are in normalized coordinates for SET_VIEWPORT.

If only *xmin* and *xmax* are provided, the values for *ymin* and *ymax* are calculated. Calling SET_VIEWPORT with four input parameters is the same as setting the !P.Postion system variable or using the *Position* keyword with the plotting commands.

SET_VIEWPORT overrides the effect of the system variables !X.Margin and !Y.Margin.

Example

```
SET_VIEWPORT, .2, .5
PLOT, [3, 5, 2]

SET_VIEWPORT, .1, .45, .55, .90
PLOT, [3, 4, 5], Title='Upper left plot'
SET_VIEWPORT, .1, .45, .1, .45
PLOT, [5, 1, 6], Title='Lower left plot', $
   /Noerase
SET_VIEWPORT, .55, .90, .55, .90
PLOT, [3, 4, 5], Title='Upper right plot', $
   /Noerase
SET_VIEWPORT, .55, .90, .1, .45
PLOT, [2, 4, 3], Title='Lower right plot', $
   /Noerase

SET_VIEWPORT, 1, 1, 1, 1, /Cursor
```

Click with the mouse button on the lower left corner of the desired plotting area and then again for the desired upper right corner.

```
PLOT, [3, 5, 4]

SET_VIEWPORT, .2, .8, .2, .8
PLOT, [3, 4, 5], $
   Title='Without setting the region keyword'
```

```
SET_VIEWPORT, .2, .8, .2, .8, /Region
PLOT, [3, 4, 5], $
   Title='With the region keyword set', $
   /Noerase
```

See Also

!P.Position, !P.Region, SET_SCREEN

SET_XY Procedure

Standard Library procedure that sets the default data axis range for either the X or Y axis. It should only be used for emulating Version 1 of PV-WAVE.

Usage

SET_XY, *xmin, xmax* [, *ymin, ymax*]

Input Parameters

xmin — The minimum default value for the X axis.

xmax — The maximum default value for the X axis.

ymin — The minimum default value for the Y axis.

ymax — The maximum default value for the Y axis.

Keywords

None.

Discussion

SET_XY is used for setting the range of data values that will be drawn in the rectangular display window. (Normally the axis range is determined automatically by scanning the data.)

Note that you should only use SET_XY if you are trying to emulate Version 1 of PV-WAVE. With more recent versions of PV-WAVE, you should use the system variables !X.Range and !Y.Range, or their corresponding keywords.

Caution SET_XY sets the Range, Crange, and S (scaling) fields of the system variables !X and !Y. This may cause subsequent plots of otherwise familiar data to appear skewed.

Example

```
PLOT, [12, 26, 35, 44], [50, 43, 89, 70]
PLOT, [12, 26, 35, 44], [50, 43, 89, 70], $
   XRange=[10, 50], YRange=[40, 100]
SET_XY, 10, 50, 40, 100
PLOT, [12, 26, 35, 44], [50, 43, 89, 70]
```

See Also

AXIS, PLOT, SET_VIEWPORT
!X.Range, !Y.Range, !X.Style, !Y.Style system variables
XRange, YRange, XStyle, YStyle plotting keywords

For more information, see *Drawing X Versus Y Plots* on page 61 of the *PV-WAVE User's Guide*.

SHADE_SURF Procedure

Creates a shaded surface representation of a regular or nearly regular gridded surface, with shading from either a light source model or from a specified array of intensities.

Usage

SHADE_SURF, *z* [, *x*, *y*]

Input Parameters

z — A two-dimensional array containing the values that make up the surface. If *x* and *y* are supplied, the surface is plotted as a function of the X,Y locations specified by their contents. Otherwise, the surface is generated as a function of the array index of each element of *z*.

x — A vector or two-dimensional array specifying the X coordinates for the contour surface. If *x* is a vector, each element of *x* specifies the X coordinate for a column of *z*.

For example, *x(0)* specifies the X coordinate for *z(0, *)*. If *x* is a two-dimensional array, each element of *x* specifies the X coordinate of the corresponding point in *z* (x_{ij} specifies the X coordinate for z_{ij}).

y — A vector or two-dimensional array specifying the Y coordinates for the contour surface. If a vector, each element of *y* specifies the Y coordinate for a row of *z*.

For example, *y(0)* specifies the Y coordinate for *z (*, 0)*. If *y* is a two-dimensional array, each element of *y* specifies the Y coordinate of the corresponding point in *z* (y_{ij} specifies the Y coordinate for z_{ij}).

Input Keywords

Shades — An array expression, of the same dimensions as *z*, containing the color index at each point. The shading of each pixel is interpolated from the surrounding *Shades* values. For most displays, this parameter should be scaled into the range of bytes. If this keyword is omitted, light source shading is used.

Other keywords are listed below. For a description of each keyword, see Chapter 3, *Graphics and Plotting Keywords*.

Ax	Position	XTicklen	YTickv
Az	Save	XTickname	YTitle
Background	Subtitle	XTicks	
Channel	T3d	XTickv	ZCharsize
Charsize	Thick	XTitle	ZGridstyle
Charthick	Tickformat		ZMargin
Clip	Ticklen	YCharsize	ZMinor
Color	Title	YGridstyle	ZRange
Data		YMargin	ZStyle
Device	XCharsize	YMinor	ZTickformat
Font	XGridstyle	YRange	ZTicklen
Gridstyle	XMargin	YStyle	ZTickname
Noclip	XMinor	YTickformat	ZTicks
Nodata	XRange	YTicklen	ZTickv
Noerase	XStyle	YTickname	ZTitle
Normal	XTickformat	YTicks	ZValue

Output Keywords

Image — The name of a variable into which the image containing the shaded surface is stored. If this keyword is omitted, the image is displayed but not saved.

Discussion

SHADE_SURF is similar to the SURFACE procedure. Given a regular or near-regular grid of elevations, SHADE_SURF produces a shaded surface representation of the data with the hidden surfaces removed.

If the graphics output device has scalable pixels, the output image is scaled so that its largest dimension is less than or equal to 512. When outputting to a device that prints black on a white background (e.g., PostScript devices), pixels containing the background color index of 0 are set to white.

Use the SET_SHADING procedure to control the direction of the light source and other shading parameters.

Note If the *T3D* keyword is set, the 3D to 2D transformation matrix contained in !P.T must project the Z axis to a line parallel to the device Y axis, or errors will occur.

If the X,Y grid is not regular or nearly regular, errors in hidden line removal will likely occur. In this case, you should use the SHADE_SURF_IRR procedure.

Caution SHADE_SURF is not supported on Tektronix terminals or the 4510 Rasterizer. If you try to display shaded image on such a device, PV-WAVE may abort. This is because of a limitation in the range of image coordinates available on Tektronix devices.

SHADE_SURF is also unsupported on VT240 terminals.

Example 1

This example uses SHADE_SURF to display a shaded surface representation of the function

$$f(x, y) = x\sin(y) + y\cos(x) - \sin(\frac{xy}{4})$$

where

$$(x, y) \in \{\mathbb{R}^2 | x, y \in [-10, 10]\}$$

```
x = FINDGEN(101)/5 -10
```

Create 101-element vector of x-coordinates such that $x \in [-10, 10]$.

```
y = x
```

Make the vector of y-coordinates the same as the vector of x-coordinates.

```
z = FLTARR(101, 101)
```
Create a 101-by-101 array to hold the function values.

```
FOR i = 0, 100 DO BEGIN &$
    z (i, *) = x(i)*SIN(y) + y*COS(x(i)) - $
    SIN(0.25*x(i)*y)
```
Insert the function values into z. Note that z is filled columnwise instead of elementwise.

```
SHADE_SURF, z, x, y, Ax = 50, XCharsize = 2, $
    YCharsize = 2, ZCharsize = 2
```
Display the shaded surface. The Ax keyword is used to specify the desired angle of rotation about the x-axis. The XCharsize, YCharsize, and ZCharsize keywords are used to enlarge the characters used to annotate the axes.

```
XYOUTS, 118, 463, $
"f(x, y) = x*sin(y) + y*cos(x) - sin(x*y)/4)",$
Charsize = 2, /Device
```
Place a title in the window. Note that the CURSOR procedure with the Device keyword was used to locate the proper position for the title.

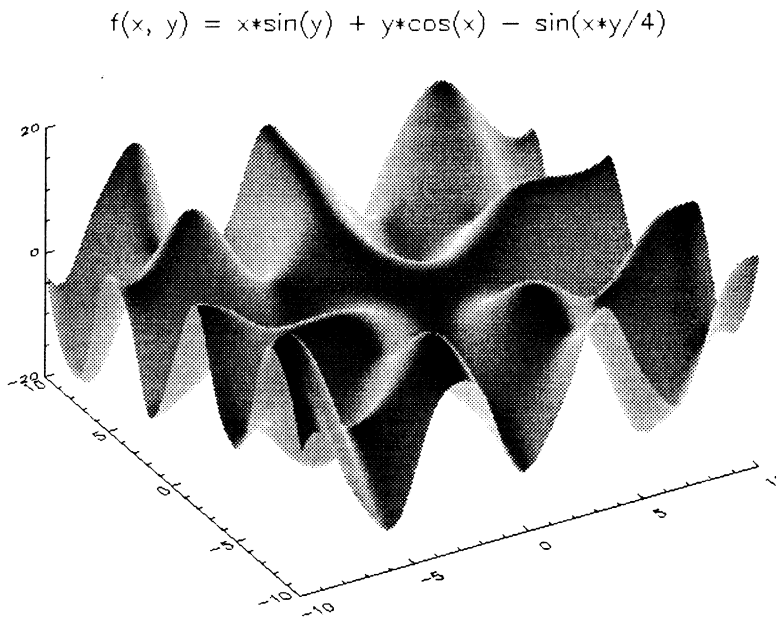


Figure 2-48 Shaded surface with title.

Example 2

Users often wish to store the data that describes a surface in a file. Each row of data in the file is a point on the surface so there are three columns of data in the file. The first column contains x-coordinates of the points, the second column contains y-coordinates of the points, and the third column contains z-coordinates of the points.

This example creates data describing the surface defined by the function

$$f(x, y) = xy\cos(0.575xy) - 10(x^2 + y^2)$$

where

$$(x, y) \in \{\mathbb{R}^2 \mid x, y \in [-10, 10]\}$$

and places that data in the file `shsurf.dat` in the columnar format described above. The data is then read from the file `shsurf.dat`, placed in the data structures expected by SHADE_SURF, and displayed.

```
.RUN

- FUNCTION f, x, y
- RETURN, x * y * cos(0.575 * x * y) - 10 * $
- (x^2 + y^2)
- END
```

Define the function.

```
x = FINDGEN(101)/5 - 10
y = x
```

Create vectors containing the x- and y- coordinates of the region of the xy-plane over the surface to be viewed.

```
z = FLTARR(101, 101)
```

Create a z-dimensional array large enough to hold the function values on the surface.

```
OPENW, 1, 'shsurf.dat'
```

Open the file that is to hold the data describing the surface.

```
FOR i = 0, 100 DO BEGIN & $
   FOR j = 0, 100 DO BEGIN & $
   PRINTF, 1, Format = '(3(f16.7))', $
   x(i), y(j), f(x(i), y(j)) & $
   ENDFOR & $
ENDFOR
```

Write the x-, y-, and z-coordinates of points on the surface to the file shsurf.dat.

```
FLUSH, 1
```

Flush any buffered output to the output file and close the file.

```
CLOSE, 1
```

```
q = FLTARR(3, 101 * 101)
```
Read the data describing the surface from shsurf.dat and display the surface. First, create an array large enough to hold the data contained in shsurf.dat.

```
OPENR, 1, 'shsurf.dat'
```
Open shsurf.dat for reading.

```
RMF, 1, q, 101 * 101, 3
```
Use RMF to read the data from the file. This reads the data as if it were a matrix.

```
CLOSE, 1
```
Close the input file.

```
q = TRANSPOSE(q)
```
Convert the matrix in Q to an array.

```
nx = q(0, *)
```
Copy the x-coordinates into nx.

```
nx = TRANSPOSE(REFORM(nx, 101, 101))
```
Convert nx from a vector to a two-dimensional array.

```
ny = q(1, *)
```
Copy the y-coordinates into ny.

```
ny = TRANSPOSE(REFORM(ny, 101, 101))
```
Convert ny from a vector to a two-dimensional array.

```
nz = q(z, *)
```
Copy the z-coordinates into nz.

```
nz = Transpose(REFORM(nz, 101, 101))
```
Convert nz from a vector to a z-dimensional array.

```
SHADE_SURF, nz, nx, ny, Ax = 50, $
   XCharsize = 2, YCharsize = 2, ZCharsize = 2
```
Display the surface. The Ax keyword is used to specify the desired angle of rotation about the x-axis. The XCharsize, YCharsize, and ZCharsize keywords are used to enlarge the characters used to annotate the axes.

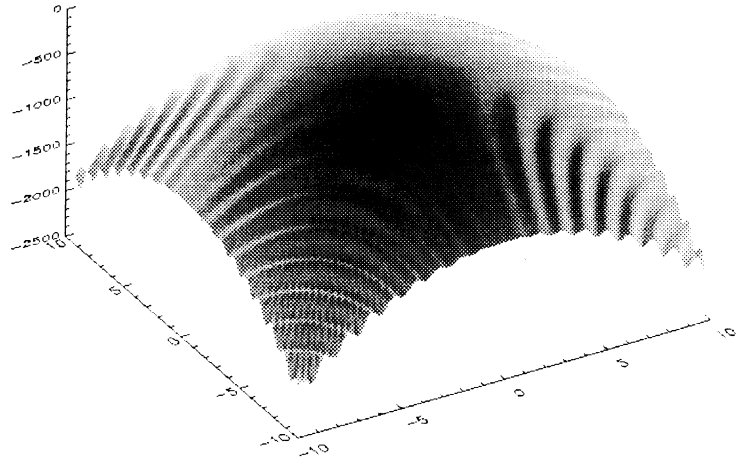


Figure 2-49 Shaded surface defined by $f(x, y) = xy \cos(0.575xy) - 10(x^2 + y^2)$.

Example 3

```
SHADE_SURF, DIST(100), Ax=60
```

See Also

SHADE_SURF_IRR, SET_SHADING, SURFACE

SHADE_SURF_IRR Procedure

Standard Library routine that creates a shaded-surface representation of a semiregularly gridded surface, with shading from either a light source model or from a specified array of intensities.

Usage

SHADE_SURF_IRR, *z* [, *x*, *y*]

Input Parameters

z — A two-dimensional array containing the values that make up the surface. If *x* and *y* are supplied, the surface is plotted as a function of the X,Y locations specified by their contents. Otherwise, the surface is generated as a function of the array index of each element of *z*.

x — A two-dimensional array specifying the X coordinates for the contour surface. Each element of *x* specifies the X coordinate of the corresponding point in *z* (x_{ij} specifies the X coordinate for z_{ij}).

y — A two-dimensional array specifying the Y coordinates for each elevation. Each element of *y* specifies the Y coordinate of the corresponding point in *z* (y_{ij} specifies the Y coordinate for z_{ij}).

Input Keywords

Shades — An array expression, of the same dimensions as *z*, containing the color index at each point. The shading of each pixel is interpolated from the surrounding *Shades* values. For most displays, this parameter should be scaled into the range of bytes. If this keyword is omitted, light source shading is used.

Other keywords are listed below. For a description of each keyword, see Chapter 3, *Graphics and Plotting Keywords*.

Ax	Normal	XTicks	YTitle
Az	Position	XTickv	
Background	Save	XTitle	ZCharsize
Charsize	T3D		ZMargin
Clip	Ticklen	YCharsize	ZMinor
Color		YMargin	ZRange
Data	XCharsize	YMinor	ZStyle
Device	XMargin	YRange	ZTickname
Font	XMinor	YStyle	ZTicks
Noclip	XRange	YTickname	ZTickv
Nodata	XStyle	YTicks	ZTitle
Noerase	XTickname	YTickv	ZValue

Output Keywords

Image — The name of a variable into which the image containing the shaded surface is stored. If this keyword is omitted, the image is displayed but not saved.

Discussion

The input data for SHADE_SURF_IRR must be able to be represented as an array of quadrilaterals. This procedure should be used when the (x, y, z) arrays are too irregular to be drawn by the SHADE_SURF procedure, but are still semiregular.

SHADE_SURF_IRR is similar to the SURFACE procedure. Given a semiregular grid of elevations, it produces a shaded surface representation of the data with hidden surfaces removed.

If the graphics output device has scalable pixels, the output image is scaled so that its largest dimension is less than or equal to 512. When outputting to a device that prints black on a white background (e.g., PostScript devices), pixels containing the background color index of 0 are set to white.

Use the SET_SHADING procedure to control the direction of the light source and other shading parameters.

Note If the *T3D* keyword is set, the 3D to 2D transformation matrix contained in !P.T must project the Z axis to a line parallel to the device Y axis, or errors will occur.

Example

This example uses SHADE_SURF_IRR to display a shaded surface over an irregular grid. The function defining the surface is

$$f(x, y) = x\sin(y) + y\cos(x)$$

where

$$(x, y) \in \{\mathbb{R}^2 \mid x \in [-10, 10], y \in [-5, 5]\}$$

```
x = FLTARR(200, 100)
```

Create a two-dimensional array for the x-coordinates.

```
pent = FLTARR(200)
```

Create a vector to hold perturbations of the x component of a regular grid.

```
FOR j = 0, 99 DO BEGIN & $
   pert = RANDOM(200) * (1.0/16.0) - $
   (1.0/32.0) & $
   x(*, j) = FINDGEN(200)/10 + pert - 10 & $
ENDFOR
```

Compute the x-components of the irregular grid by perturbing the x-component of a regular grid.

```
y = FLTARR(200, 100)
```

Create a two-dimensional array for the y-coordinates.

```
pert = FLTARR(100)
```

Create a vector to hold perturbation of the y-component of a regular grid.

```
FOR i = 0, 199 DO BEGIN & $
   pert = RANDOM(100) * (1.0/16.0) - $
   (1.0/32.0) & $
   y(i, *) = FINDGEN(100)/10 + pert - 5 & $
ENDFOR
```

Compute the y-components of the irregular grid by perturbing the y-components of a regular grid.

```
.RUN
- FUNCTION f, x, y
- RETURN, x * SIN(y) + y * COS(x)
- END
```

Define a function of two variables to compute elevations.

```
z = FLTARR(200, 100)
```

Create a two-dimensional array for elevations.

```
FOR i = 0, 199 DO BEGIN & $
   FOR j = 0, 99 DO BEGIN & $
   z(i, j) = f(x(i, j), y(i, j)) & $
   ENDFOR & $
ENDFOR
```

Compute elevations.

```
SHADE_SURF_IRR, z, x, y, Ax = 70
```

Display the shaded surface. The Ax keyword is used to specify the angle of rotation about the x-axis.

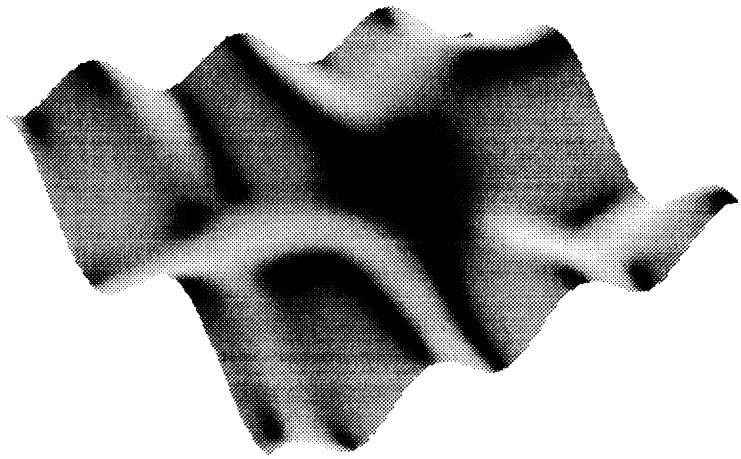


Figure 2-50 Shaded surface defined by $f(x, y) = x\sin(y) + y\cos(x)$ over irregular grid.

See Also

SHADE_SURF, SET_SHADING, SURFACE

SHADE_VOLUME Procedure

Given a 3D volume and a contour value, produces a list of vertices and polygons describing the contour surface.

Usage

SHADE_VOLUME, *volume, value, vertex, poly*

Input Parameters

volume — An array with three dimensions containing the dataset to be contoured. If the volume array is dimensioned (D_0, D_1, D_2), the resulting vertices range as follows:

- In X, they range between 0 and $D_0 - 1$.
- In Y, they range between 0 and $D_1 - 1$.
- In Z, they range between 0 and $D_2 - 1$.

value — A scalar containing the contour value.

Output Parameters

vertex — The name of a variable to receive the vertex array. This variable will be set to a (3, *n*) floating-point array, suitable for input to the MESH or POLYSHADE procedure.

poly — The name of a variable to receive the polygon list, an *m*-element longword array. This list describes the vertices of each polygon and is suitable for input to MESH or POLYSHADE.

Input Keywords

Low — If present and nonzero, indicates that the low side of the contour surface is to be displayed and that the contour surfaces enclose high data values. Otherwise, it is assumed that the high side of the contour surface is to be displayed and that the contour encloses low data values. If this parameter is incorrectly specified, errors in shading will result.

Shades — An array with the same dimensions as *volume*. On input, it contains the user-specified shading color index for each volume element (voxel), and is converted to byte type before use.

Output Keywords

Shades — On output, this input array is replaced by another array containing the shading value for each vertex, contained in *vertex*.

Discussion

SHADE_VOLUME computes the polygons that describe a three-dimensional contour surface. Each voxel is visited to find the polygons formed by the intersections of the contour surface and the voxel edges.

You can obtain shading from either a single light-source model or from the values you specify with *Shades*.

The surface produced by SHADE_VOLUME may then be displayed as a shaded surface with the POLYSHADE procedure.

This routine is limited to processing datasets that will fit in memory.

Example

The following procedure shades a volume passed as a parameter. It uses SURFACE to establish the viewing transformation. It then calls SHADE_VOLUME to produce the vertex and polygon lists, and POLYSHADE to draw the contour surface.

For another example demonstrating SHADE_VOLUME, see the POLYSHADE function.

```
PRO ShowVolume, vol, thresh, Low=low
    Display the contour surface of a volume.

s = SIZE(vol)
    Get the dimensions.
```

```
IF s(0) NE 3 THEN PRINT, 'Error'
```
Flag an error if s is not a 3D array.

```
SURFACE, FLTARR(2,2), /Nodata, /Save, $
   XRange=[0,s(1)-1], YRange=[0,s(2)-1],$
   ZRange=[0,s(3)-1]
```
Use SURFACE to establish 3D transformation and coordinate ranges.

```
IF N_ELEMENTS(low) EQ 0 THEN low = 0
```
Make the default be to view the high side of the contour surface.

```
SHADE_VOLUME, vol, thresh, v, p, Low=low
```
Produce the vertices and polygons.

```
TV, POLYSHADE(v, p, /T3D)
```
Produce the image of the surface and display.

```
END
```

See Also

POLYSHADE, SURFACE

For information on volume visualization, see Chapter 6, *Advanced Rendering Techniques*, in the *PV-WAVE User's Guide.*

The method used by SHADE_VOLUME is that described by Klemp, McIrvin and Boyd in "PolyPaint – A Three-Dimensional Rendering Package," *American Meteorology Society Proceedings*, Sixth International Conference on Interactive Information and Processing Systems, 1990.

This method is similar to the marching cubes algorithm described by Lorenson and Cline in "Marching Cubes: A High Resolution 3D Surface Construction Algorithm," *Computer Graphics*, Vol. 21, pp. 163-169, 1987.

SHIFT Function

Shifts the elements of a vector or array along any dimension by any number of elements.

Usage

result = SHIFT(*array, shift*$_1$, ... , *shift*$_n$)

Input Parameters

array — The array to be shifted.

shift$_i$ — The shift parameters (see Discussion below).

Returned Value

result — The shifted array.

Keywords

None.

Discussion

The SHIFT function is used to perform a circular shift upon the elements of a vector or an array. The resulting array has the same dimension and data type as the input array. Shifts are handled similarly, regardless of the number of dimensions in the input array, as detailed below:

- **Shifts on One-Dimensional Arrays** — A shift performed on a one-dimensional array (a vector) shifts the contents of each element to the right or left, depending on the number of elements specified in the second parameter: a positive number shifts elements to the right, while a negative number shifts them to the left.
- **Shifts on Two-Dimensional Arrays** — A shift performed on a two-dimensional array (such as a raster image) is done in a similar way. The contents of entire rows and/or columns are

shifted to the rows above or below, or to the columns to the right or left, depending on the number of rows and columns specified by the second and third parameters of the process, respectively.

Positive numbers for the second and third parameters shift rows in an up direction (or columns to the right), while negative numbers shift rows in a down direction (or columns to the left).

- **Shifts on Arrays with More than Two Dimensions** – For arrays of more than two dimensions, the parameter $shift_n$ specifies the shift applied to the *n*th dimension. For example, $shift_1$ specifies the shift along the first dimension. If you specify 0 for $shift_n$, this means that no shift is to be performed along that dimension.

Regardless of the number of dimensions, all shifts are circular, meaning that values that are pushed off the beginning or end of the array by the shift operation are automatically inserted back onto the opposite end of the array. No values in the array are lost.

If only one shift parameter is present and the parameter is an array, the array is treated as a vector.

Sample Usage

Typical uses of the SHIFT function include:

- To force the elements of one array to align with the elements of another array.
- To force the elements of one array to be misaligned with the elements of another array (some statistical analysis techniques require this).
- To line up (or *register*) the edges of an image to match those of another image. This can be used to compensate for an image that was initially digitized out of alignment with respect to the edges of another image.
- To shift the beginning and ending point of a color table in an image.

- To do an edge enhancement technique for images commonly known as *Shift and Difference Edge Enhancement* (see Example 2 below for more information).

Example 1 – One-dimensional Shifting

The following demonstrates using SHIFT with a vector:

```
a = INDGEN(5)
```
Make a small vector.

```
PRINT, a, SHIFT(a,1), SHIFT(a,-1)
```
Print the vector, the vector shifted one position to the right, and the vector shifted one position to the left.

Executing these statements gives the result:

```
0       1       2       3       4
4       0       1       2       3
1       2       3       4       0
```

Notice how elements of the vector that shift off the end wrap around to the other end. This "wrap around" occurs when shifting arrays of any dimension.

Example 2 – Shift and Difference Edge Enhancement

SHIFT can be used to create an edge enhancement technique for images. In this technique, a copy of an array may be shifted by one or more elements (pixels) in any direction, and then subtracted from the original image.

When performed on a binary image (containing only black and white pixels), edges that are opposite the direction of the shift are enhanced.

When performed on a gray scale or pseudocolor image, an embossing effect is created opposite the direction of the shift.

By carefully selecting the direction and amount of the shift, you can make certain details (for example, only vertical or horizontal lines) be discernible in an otherwise jumbled image.

Typically, single-element (one pixel) shifts are most pronounced, while any shift beyond ten elements (pixels) tends to start blurring the features in the image.

For example, to shift a mandril image to highlight the edges to the left of each feature, you would first run the SHIFT function and then subtract the resulting image from the original image to create a third image:

```
shift_mandril = SHIFT(mandril, 1, 0)

shift_diff_mand = mandril - shift_mandril
```

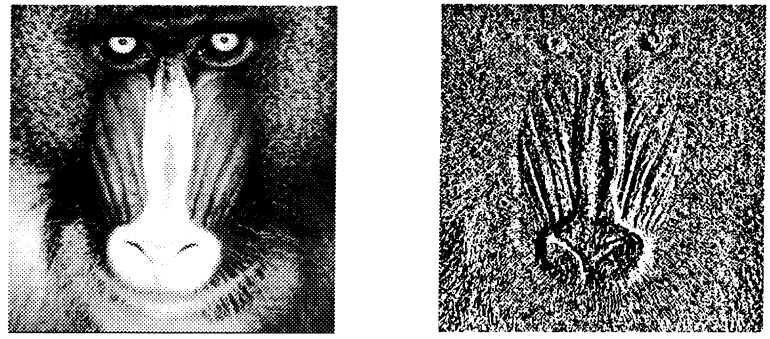


Figure 2-51 The SHIFT function described above has been used with this 512-by-512 mandril image for edge enhancement. Notice how the dark edges to the left of each feature in the image are highlighted by using SHIFT with a positive number for the first parameter (which causes the image to be shifted to the right).

To shift a mandril image to highlight the edges below and to the left of each feature:

```
shift_mandril = SHIFT(mandril, 1, 1)

shift_diff_mand = mandril - shift_mandril
```

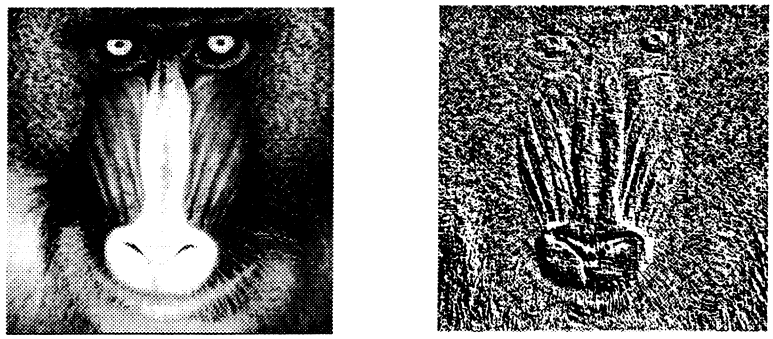


Figure 2-52 Notice how the dark edges to the southwest of each feature in the image are now highlighted by using the SHIFT function with a positive number for the first and second parameter (which causes the image to be shifted both up and to the right).

See Also

CONVOL, ISHFT, ROBERTS, SOBEL

For more information about Shift and Difference Edge Enhancement, see *Digital Image Processing*, by Gregory Baxes, Cascade Press, Denver, 1988.

SHOW3 Procedure

Standard Library procedure that displays a two-dimensional array as a combination contour, surface, and image plot. The resulting display shows a surface with an image underneath and a contour overhead.

Usage

SHOW3, *array*

Input Parameters

array — The two-dimensional array to display.

Input Keywords

Ax — The angle of rotation, in degrees, about the X axis.

Az — The angle of rotation, in degrees, about the Z axis.

C_Colors — A vector of color indices whose elements indicate which color to use in drawing the corresponding contour level.

Interp — If present and nonzero, specifies that bilinear interpolation is to be used for the pixel display. Otherwise, the nearest neighbor interpolation method is used.

Sscale — The reduction scale for the surface. If set to anything other than 1 (the default value), the image size is reduced by the specified factor. If the image dimensions are not an integral multiple of *Sscale*, the image is reduced to the next smaller multiple.

Bot_Image — The name of the image array to be used as the underneath image.

Discussion

You can modify SHOW3, if necessary, to customize the contour and surface commands to your satisfaction (e.g., use different colors, skirts, line styles, and contour levels). See the descriptions of the CONTOUR and SURFACE routines for details.

Tip When you are displaying larger images (say 50-by-50), the display produced by SHOW3 can become too "busy." If this happens, try using the SMOOTH and/or REBIN procedures to smooth the surface plot.

Caution The SHOW3 procedure is not supported on Tektronix terminals or the 4510 Rasterizer. If you try to display a SHOW3 image on such a device, PV-WAVE may abort. This is because of a limitation in the range of image coordinates available on Tektronix devices.

Example

This example uses the Pike's Peak elevation and snowpack images found in the PV-WAVE directory `wave/data` to recreate the display that appears on the cover of this manual:

```
OPENR, 1, !data_dir + 'pikeselev.dat'
```
Open the file to read.

```
pikes = FLTARR(60, 40)
```
Create the data array for the pikes elevation data.

```
READF, 1, pikes
```
Read in the formatted file.

```
CLOSE, 1
```
Close the file.

```
OPENR, 2, !data_dir + 'snowpack.dat'
```
Open the file to read.

```
snow = FLTARR(60, 40)
```
Create the data array for snow pack data.

```
READF, 2, snow
```
Read in the formatted file.

```
CLOSE, 2
```
Close the file.

```
LOADCT, 5
```
Load color table number 5.

```
SHOW3, SMOOTH(pikes, 3), Bot_image=snow, $
   /Interp
```

Produce the combined display.

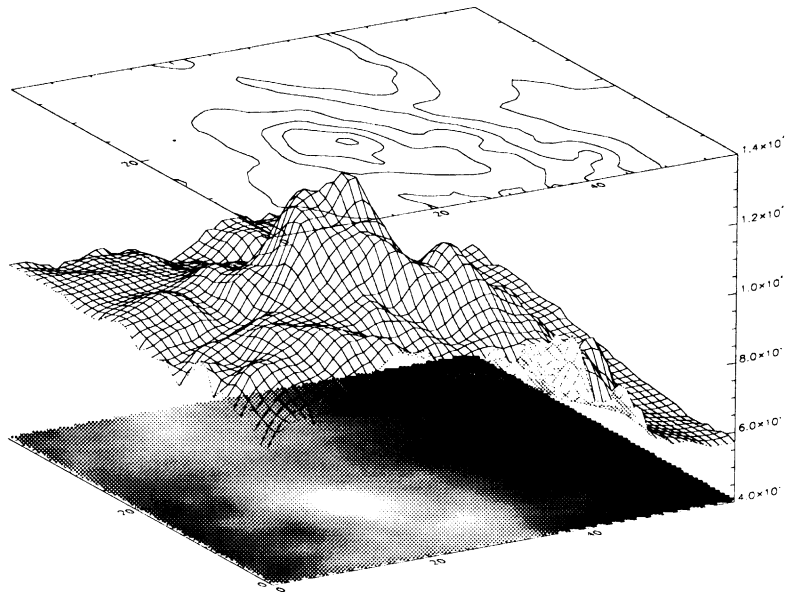


Figure 2-53 Combination image, surface, and contour produced with SHOW3.

See Also

CONTOUR, REBIN, SURFACE, SMOOTH

For information on interpolation methods, see *Efficiency and Accuracy of Interpolation* on page 170 of the *PV-WAVE User's Guide*.

SIGMA Function

Standard Library function that calculates the standard deviation value of an array. (Optionally, it can also calculate the standard deviation over one dimension of an array as a function of the other dimensions.)

Usage

result = SIGMA(*array* [, *npar*, *dim*])

Input Parameters

array — The array to be processed. Can be of any data type except string.

npar — The number of parameters (the default value is 0).

dim — The dimension over which to calculate the standard deviation.

Returned Value

result — The standard deviation of *array*, or the standard deviation over one dimension of *array* as a function of *dim*.

Keywords

None.

Discussion

The SIGMA function is useful in a variety of data and statistical analyses for estimating thresholds and evaluating the significance of variance.

The number of degrees of freedom in SIGMA is equal to the number of elements in *array* minus the value supplied in the optional *npar*. In other words:

degrees of freedom = #_of elements_in_array – npar

The degrees of freedom affects the value of the standard deviation. Specifically, the value of the standard deviation varies as one over the square root of the number of degrees of freedom.

If *dim* is used, then the result of SIGMA is an array with the same dimensions as the input array, except for the dimension specified. Each element in the resulting *array* is the standard deviation of the corresponding vector in the input *array*.

The dimension specified in a SIGMA call must be valid for the array passed; otherwise, the input array is returned as the output array.

If `array` is an array with dimensions of (3,4,5), then the command:

```
std = SIGMA(array, 2, 1)
```

is equivalent to the commands:

```
std = FLTARR(3,5)
FOR j = 0, 4 DO BEGIN
   FOR i = 0, 2 DO BEGIN
   STD(i, j) = SIGMA(array(i, *, j), 2)
   ENDFOR
ENDFOR
```

Example

```
y = [1., 5., 9., 3., 10., 4.]
std = SIGMA(y, 1)
PRINT, 'The standard deviation = ', std
   3.50238

a = FLTARR(3, 3)
a(*, 0) = [2., 2., 2.]
a(*, 1) = [4., 4., 4.]
a(*, 2) = [6., 6., 6.]
PRINT, a
```

```
PRINT, SIGMA(a, 1, 0)
   0.00000     0.00000     0.00000
```
Print the standard deviation of the column elements.

```
PRINT, SIGMA(a, 1, 1)
   2.00000     2.00000     2.00000
```
Print the standard deviation of the row elements.

See Also

STDEV

SIN Function

Returns the sine of the input variable.

Usage

result = SIN(*x*)

Input Parameters

x — The angle, in radians, that is evaluated.

Returned Value

result — The trigonometric sine of *x*.

Keywords

None.

Discussion

If *x* is of double-precision floating-point or complex data type, SIN yields a result of the same type. All other types yield a single-precision floating-point result.

SIN handles complex numbers in the following way:

$$sin(x) \equiv complex((sin(r)cosh(i), cos(r)sinh(i))$$

where r and i are the real and imaginary parts of x.

If x is an array, the result of SIN has the same data type, with each element containing the sine of the corresponding element of x.

Example

The following commands produce a dampened sine wave.

```
x = FINDGEN(200)
PLOT, 10000 * SIN(x/5) / EXP(x/100)
```

See Also

COS, COSH, SINH

For a list of other transcendental functions, see *Transcendental Mathematical Functions* on page 20, in Volume 1 of this reference.

SINDGEN Function

Returns a string array with the specified dimensions.

Usage

result = SINDGEN(dim_1, ... , dim_n)

Input Parameters

dim_i — The dimensions of the result. May be any scalar expression. Up to eight dimensions may be specified.

Returned Value

result — An initialized string array. If the resulting array is treated as a one-dimensional array, then its initialization is given by the following:

$$array\ (i)\ =\ \text{STRING}\ (i),\ \text{for}\ \ i\ =\ 0, 1, \ldots, \left(\prod_{j=1}^{n} D_j - 1\right)$$

Keywords

None.

Discussion

Each element of the array is set to the string representation of the value of its one-dimensional subscript, using the default formatting rules of PV-WAVE. These rules are described in Table 8-7 on page 164 of the *PV-WAVE Programmer's Guide*.

Example

This example creates a 4-by-2 string array.

```
a = SINDGEN(4, 2)
```

Create string array.

```
INFO, a
A       STRING      = Array(4, 2)

PRINT, a
0   1   2   3
4   5   6   7
```

See Also

BINDGEN, CINDGEN, DINDGEN, FINDGEN, INDGEN, LINDGEN

SINH Function

Returns the hyperbolic sine of the input variable.

Usage

result = SINH(x)

Input Parameters

x — The angle, in radians, that is evaluated.

Returned Value

result — The hyperbolic sine of x.

Keywords

None.

Discussion

SINH is defined by:

$$sinh(x) \equiv (e^{x} - e^{-x})/2$$

If x is of double-precision floating-point or of complex data type, SINH yields a result of the same type. All other data types yield a single-precision floating-point result.

If x is an array, the result of SINH has the same dimensions, with each element containing the hyperbolic sine of the corresponding element of x.

Example

```
x = [0.3, 0.5, 0.7, 0.9]
PRINT, SINH(x)
   0.304520    0.521095    0.758584    1.02652
```

See Also

COS, COSH, SIN, TANH

For a list of other transcendental functions, see *Transcendental Mathematical Functions* on page 20, in Volume 1 of this reference.

SIZE Function

Returns a vector containing size and type information for the given expression.

Usage

result = SIZE(*expr*)

Input Parameters

expr — The expression to be evaluated.

Returned Value

result — A vector containing size and type information for *expr.*

Keywords

None.

Discussion

The returned vector is of longword type and has the following form:

$$[D, S_1, S_2, \ldots, S_D, T, E]$$

where D is the number of dimensions of EXPRESSION (zero if EXPRESSION is scalar or undefined); S_i is the size of dimension i (not present if EXPRESSION is scalar or undefined); T is the type code, encoded as shown in the table below; and E is the number of elements in EXPRESSION.

Type Code	Data Type
0	Undefined
1	Byte
2	Integer
3	Longword integer
4	Floating point
5	Double precision floating
6	Complex floating
7	String
8	Structure

See Also

N_TAGS, N_PARAMS, TAG_NAMES, N_ELEMENTS

SKIPF Procedure

(VMS Only) Skips records or files on the designated magnetic tape unit.

Usage

SKIPF, *unit, files*
SKIPF, *unit, records, r*

Input Parameters

unit — A number between 0 and 9 specifying the magnetic tape unit to rewind. (Do not confuse this parameter with file logical unit numbers.)

files — The number of files to be skipped. If this number is positive, skipping is in the forward direction. Otherwise, files are skipped backwards.

records — The number of records to be skipped. If this number is positive, skipping is in the forward direction. Otherwise, records are skipped backwards.

r — If this third parameter is present, records are skipped; otherwise, files are skipped. (The value of *r* is never examined; its presence serves only to indicate that records are to be skipped.)

Keywords

None.

Discussion

The number of files or records actually skipped is stored in the system variable !Err. Note that when skipping records, the operation terminates immediately when the end of a file is encountered.

See Also

!Err, TAPRD, TAPWRT

For more information and sample usage, see *Accessing Magnetic Tape* on page 229 of the *PV-WAVE Programmer's Guide*.

SLICE_VOL Function

Returns a 2D array containing a slice from a 3D volumetric array.

Usage

result = SLICE_VOL(*volume, dim, cut_plane*)

Input Parameters

volume — The 3D volume of data to slice.

Tip For better results, first use VOL_PAD to preprocess the volume.

dim — The X and Y dimensions of the slice to return. Larger values for *dim* increase the slice resolution and execution time. *dim* is typically the largest of the three dimensions of *volume*.

cut_plane — A (3, 2) array defining the slicing plane. The elements in this (3, 2) array are interpreted as follows:

cut_plane(0, 0)	The plane's angle of rotation about the X axis.
cut_plane(1, 0)	The plane's angle of rotation about the Y axis.
cut_plane(2, 0)	Ignored.
cut_plane(0, 1)	The X coordinate of the center of the plane.
cut_plane(1, 1)	The Y coordinate of the center of the plane.
cut_plane(2, 1)	The Z coordinate of the center of the plane.

Note The slicing plane is rotated first about the Y axis, and then about the X axis.

Returned Value

result — A 2D array containing a slice from a 3D volumetric array.

Input Keywords

Degrees — If present and nonzero, *cut_plane(0:1,0)* is assumed to be in degrees.

Discussion

SLICE_VOL extracts a planar oblique slice from a volumetric (3D) array. The slicing plane is defined by the center point (X, Y, and Z), and the rotations about the Y and X axes. You can interactively define the slicing plane by calling the VIEWER procedure.

For best results, process volumes with VOL_PAD before slicing them with SLICE_VOL.

Examples

For demonstrations of the SLICE_VOL procedure, use the Medical Imaging and CFD/Aerospace buttons on the PV-WAVE Demonstration Gallery.

To run the Gallery, enter `wave_gallery` at the `WAVE>` prompt.

See Also

VIEWER, VOL_PAD

SMOOTH Function

Smooths an array with a boxcar average of a specified width.

Usage

result = SMOOTH(*array, width*)

Input Parameters

array — The array to be smoothed. Must have either one or two dimensions; if it has two dimensions, the algorithm is applied over each dimension.

width — The width of the smoothing window. Should be an odd number, smaller than the smallest dimension. (If *width* is even, *width* + 1 is used instead.)

Returned Value

result — A copy of *array* smoothed with a boxcar average of the specified *width*. It has the same type and dimensions as *array*.

Keywords

None.

Discussion

SMOOTH is used to selectively average the elements in an array within a moving window of a given *width*. The result generally smooths out spikes or rapid transitions in the data, and fills in valleys and dips. This is usually called a boxcar average.

The window is a one- or two-dimensional region that traverses the input array, element by element, until it reaches the end. As the window moves across the array, all values within the window are averaged. The average value is then placed at the center of the window in the output array, while the original array is kept intact.

In a one-dimensional array, the smoothing window moves from right to left; in a two-dimensional array, it moves from upper left to lower right.

Note

The window may be any size as long as it is smaller than the array itself. One-dimensional windows of 3, 5, 7, and 9 elements are common; similarly, two-dimensional windows of 9, 25, 49, and 81 elements are also typical. The value of *width* does not appreciably affect the running time of SMOOTH.

The algorithm used by SMOOTH is shown below, where n is the number of elements in A and w is the width of the smoothing window.

When $w/2 \le i < n - w$, then:

$$R_i = (1/w) \sum_{j=0}^{w-1} A_{i+j-w/2}$$

Otherwise, $R_i = A_i$.

Sample Usage

Typical uses for the SMOOTH function include:

- To remove ripples, spikes, or high frequency noise from a signal or image.
- To blur an image or set of data such that only the general trends in the data can be seen (and are thereby highlighted).
- To isolate the lower spatial frequency components in an image. By subtracting a blurred image from the original image, only the higher spatial frequency components are left. (This is sometimes referred to as unsharp masking.)
- To soften sharp transitions from one color to another in a color table. This helps reduce the banding or contouring artifact evident in color tables with rapid color changes.

Example

Here is what a mandril image looks like before and after applying the SMOOTH function. For this example, a value of 7 was used for the *width* parameter.

Figure 2-54 The SMOOTH function has been used to soften the sharp contrasts in this 512-by-512 mandril image.

See Also

CONVOL, MEDIAN, ROBERTS, SOBEL

For more information, see *Image Smoothing* on page 158 of the *PV-WAVE User's Guide*.

SOBEL Function

Performs a Sobel edge enhancement of an image.

Usage

result = SOBEL(*image*)

Input Parameters

image — The two-dimensional array containing the image to be enhanced.

Returned Value

result — A two-dimensional array of integer type containing the image that has been edge-enhanced. It has the same dimensions as *image*.

Keywords

None.

Discussion

SOBEL implements an approximation of the 3-by-3 nonlinear edge enhancement operator:

$$G(j,k) = |X| + |Y|$$

where

$$X = (A_2 + 2A_3 + A_4) - (A_0 + 2A_7 + A_6)$$

$$Y = (A_0 + 2A_1 + A_2) - (A_6 + 2A_5 + A_4)$$

and where the pixels surrounding the neighborhood of the pixel $F(j, k)$ are numbered as follows:

$$\begin{bmatrix} A_0 & A_1 & A_2 \\ A_7 & F(j,k) & A_3 \\ A_6 & A_5 & A_4 \end{bmatrix}$$

The above algorithm is a fast approximation of the SOBEL function, which is actually defined as:

$$G(j,k) = \sqrt{X^2 + Y^2}$$

Caution Because the result image is saved in integer format, large original data values will cause overflow. Overflow occurs when the absolute value of the result is larger than 32,767.

Sample Usage

SOBEL is commonly used to obtain an image that contains only the edges (rapid transitions between light and dark, or from one color to another) that were present in the original image. SOBEL can help enhance features and transitions between areas in an image (for example, a machine part photographed against a white background).

With this information, it is possible to identify and compare features or items in an image with those in another image, usually for verification or detection purposes. SOBEL and other edge-detection algorithms are used extensively for image processing and preprocessing for pattern recognition.

The image returned by SOBEL contains the edges present in the original image, with the brightest edges representing a rapid transition (well-defined features), and darker edges representing smoother transitions (blurred or blended features).

An original image can also be somewhat sharpened by adding or averaging the edge-detected image with the original image.

Example

Here is what an aerial image looks like before and after applying the SOBEL function.

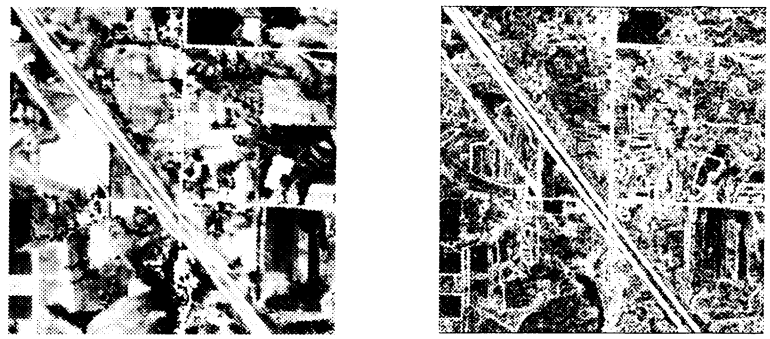


Figure 2-55 The SOBEL function has been used with this 512-by-512 aerial image to make the edges stand out with sharp contrast.

See Also

ROBERTS, CONVOL

SORT Function

Sorts the contents of an array.

Usage

result = SORT(*array*)

Input Parameters

array — The array to be sorted. Can be a vector or an array.

Returned Value

result — A vector of subscripts which allow access to the elements of *array* in ascending order.

Keywords

None.

Discussion

String arrays are sorted using the ASCII collating sequence. The result is always a vector of long integer type with the same number of elements as *array*.

Note The contents of the result are the sorted indices, not the values themselves.

Example

This example uses SORT to obtain the vector of subscripts that places the single-precision, floating-point vector a into ascending order. To obtain elements of *a* in sorted order, use the vector of subscripts returned by SORT as the subscript vector for *a*.

```
a = [4.0, 3.0, 7.0, 1.0, 2.0]
```

Create an unsorted single-precision, floating-point vector.

```
b = SORT(a)
```
Place the vector of sorting subscripts into b.

```
PRINT, b
3     4     1     0     2

PRINT, a(b)
```
Print the sorted vector by using b as the subscript vector for a.

```
1.00000 2.00000 3.00000 4.00000 7.00000
```

See Also

QUERY_TABLE, UNIQUE, WHERE, AVG, MAX, MIN, MEDIAN

SPAWN Procedure

Spawns a child process to execute a given command.

Usage

SPAWN [, *command* [, *result*]]

Input Parameters

command — The name of the command to spawn.

- If present, must be of type string. Under UNIX, *command* can be an array—each element is passed to the child process as a separate parameter. Under VMS, *command* is restricted to being a scalar.
- If not present, starts an interactive shell and PV-WAVE execution suspends until the new shell process terminates. This ability is provided primarily for compatibility with the VMS version of PV-WAVE.

Shells that handle process suspension (e.g., `/bin/csh`) offer a more efficient way to get the same effect.

Output Parameters

result — Indicates where the result is to be directed.

- If present, places the output from the child process into a string array (one line of output per array element).
- If not present, sends the output from the child shell process to the standard output stream.

Input Keywords

F77_Unformatted — (UNIX only) If set, opens a pipe to the spawned process in a mode to do unformatted FORTRAN F77 input/output.

Noclisym — (VMS only) If set, prevents the spawned process from inheriting CLI symbols from its caller. Otherwise, the subprocess inherits all currently defined CLI symbols.

You may want to specify *Noclisym* to help prevent commands redefined by symbol assignments from affecting the spawned commands.

Nologname — (VMS only) If set, prevents the spawned process from inheriting process logical names from its caller. Otherwise, the subprocess inherits all currently defined process logical names.

You may want to specify *Nologname* to help prevent commands redefined by logical name assignments from affecting the spawned commands.

Noshell — (UNIX only) If present and nonzero, specifies that *command* should execute directly as a child process without an intervening shell process. In this case, *command* must be specified as a string array in which the first element is the name of the command to execute and the following parameters are the parameters to be passed to the command.

Noshell is useful when performing many spawned operations from a program and speed is a primary concern. Since no shell is present, wildcard characters are not expanded, and other tasks normally performed by the shell do not occur.

Notify — (VMS only) If set, broadcasts a message to SYS$OUTPUT when the subprocess completes or aborts. Otherwise, no message is broadcast. This keyword should not be set unless the *Nowait* keyword is also set.

Nowait — (VMS only) If set, causes the calling process to continue executing in parallel with the subprocess. Otherwise, the calling process waits until the subprocess completes.

Sh — (UNIX only) If present and nonzero, forces the use of the Bourne shell.

Output Keywords

Count — The number of string elements returned if the output is a string variable.

Pid — A named variable for storing the process identification number of the child process.

Unit — (UNIX only) A named variable for storing the number of the file unit.

If present, causes SPAWN to create a child process in the usual manner, but instead of waiting for the specified *command* to finish, SPAWN attaches a bidirectional pipe between the child process and PV-WAVE. From the PV-WAVE session, the pipe appears as a logical file unit. The other end of the pipe is attached to the child process standard input and output.

Note If the *Unit* keyword is used, the *command* parameter must also be present, and *result* is not allowed.

Discussion

Under UNIX, the shell used (if any) is obtained from the SHELL environment variable. Under VMS, the DCL command language interpreter is used.

Once the child process is started, the PV-WAVE session can communicate with it using the normal input/output facilities. After the child process has done its task, the CLOSE procedure is used to delete the process and close the pipe.

Since SPAWN uses GET_LUN to allocate the file unit, FREE_LUN should be used to free the unit.

Example

```
SPAWN,'ps -a'
```

See Also

CLOSE, FREE_LUN, GET_LUN, CALL_UNIX, UNIX_LISTEN, UNIX_REPLY, LINKNLOAD

For background information, see Chapter 13, *Interapplication Communication*, in the *PV-WAVE Programmer's Guide*. Also see Chapter 12, *Accessing the Operating System*, in the *PV-WAVE Programmer's Guide*.

SPHERE Function

Defines a spherical object that can be used by the RENDER function.

Usage

result = SPHERE( )

Parameters

None.

Returned Value

result — A structure that defines an ellipsoidal object.

Input Keywords

Color — A 256-element double-precision floating-point vector containing the color (intensity) coefficients of the object. The default is `Color(*)=1.0`. For more information, see the sec-

tion *Defining Color and Shading* on page 198 of the *PV-WAVE User's Guide.*

Decal — A 2D array of bytes whose elements correspond to indices into the arrays of material properties. For more information, see the section *Decals* on page 201 of the *PV-WAVE User's Guide.*

Kamb — A 256-element double-precision floating-point vector containing the ambient (flat shaded) coefficients. The default is `Kamb(*)=0.0`. For more information, see the section *Ambient Component* on page 199 of the *PV-WAVE User's Guide.*

Kdiff — A 256-element double-precision floating-point vector containing the diffuse reflectance coefficients. The default is `Kdiff(*)=1.0`. For more information, see the section *Diffuse Component* on page 198 of the *PV-WAVE User's Guide.*

Ktran — A 256-element double-precision floating-point vector containing the specular transmission coefficients. The default is `Ktran(*)=0.0`. For more information, see the section *Transmission Component* on page 199 of the *PV-WAVE User's Guide.*

Transform — A 4-by-4 double-precision floating-point array containing the local transformation matrix whose default is the identity matrix. For more information, see the section *Setting Object and View Transformations* on page 201 of the *PV-WAVE User's Guide.*

Discussion

A SPHERE is used by the RENDER function to render ellipsoid objects, such as for spherical inverse mapping or molecular modeling (atoms). It is centered at the origin, with a radius of 0.5.

You can alter its diameter and orientation with the *Transform* keyword.

Examples

```
ds = 6
checks = BYTARR(ds, ds)
checks(*) = 255
```

```
FOR x=0, ds - 1 DO $
   FOR y=0, ds - 1 DO $
    IF ((x mod 2) EQ (y mod 2)) THEN $
      checks(x, y) = 128
```

Create a 6-by-6 checkerboard image.

```
two = FLTARR(256)
two(128) = 0.5 & two(255) = 1.0
```

Set checks to be full and one-half intensity.

```
s = SPHERE(Decal=checks, Color=two)
TV, RENDER(s)
```

Render the sphere with the checkerboard decal mapped on.

See Also

CONE, CYLINDER, MESH, RENDER, VOLUME

For more information, see *Ray-tracing Rendering* on page 196 of the *PV-WAVE User's Guide.*

SPLINE Function

Standard Library function that performs a cubic spline interpolation.

Usage

result = SPLINE(*x*, *y*, *t* [, *tension*])

Input Parameters

x — A vector containing the independent coordinates of the dataset. Must be monotonic and increasing.

y — A vector containing the dependent coordinates of the dataset.

t — A vector containing the independent coordinates for which the ordinates are desired. Must be monotonic and increasing.

tension — The amount of tension to be put on the spline curve. The default value is 1.0 (see Discussion below).

Returned Value

result — A vector containing interpolated ordinate values. In other words, result(i) = value of the function at T(i).

Keywords

None.

Discussion

SPLINE performs a cubic spline interpolation of the input vector in order to obtain a vector of interpolated dependent values. The dependent values are calculated at the independent values given by the vector *t*.

A tension curve always passes through each known data point. The optional *tension* parameter controls the smoothness of the fitted curve. The higher the tension, the more closely the curve

approximates the set of line segments that connect the data points. A lower tension produces a smoother curve that may deviate considerably from the straight-line path between points.

When *tension* is set close to zero (e.g., 0.01), the curve is virtually a cubic spline fit. When *tension* is set to a large value (e.g., >10.0), then the fitted curve will be similar to that obtained from a polynomial interpolation, such as POLY_FIT or POLYFITW.

The SPLINE function can be useful for those applications where you need to fit the data with a smoother or stiffer curve than that obtained with an interpolating polynomial. Splines also tend to be more stable than polynomials, with less possibility of wild oscillation between the data points.

Example 1

```
x = FINDGEN(10)
y = RANDOMN(seed, 10)
```

Create the data.

```
t = FINDGEN(100)/11.
```

Create a vector containing the independent points at which the dependent points are calculated.

```
PLOT, y
```

Plot the original data.

```
PLOT, t, SPLINE(x, y, t), Xstyle=4, Ystyle=4,$
   /Noerase, linestyle=2
```

Plot using 100 independent points and a default tension of 1.

```
PLOT, t, SPLINE(x, y, t, 8.), Xstyle=4, $
   Ystyle=4, /Noerase, Linestyle=3
```

Plot using 100 independent points and a tension of 8.

Example 2

```
x = [2.0, 3.0, 4.0]
```
X values of the original function.

```
y = (x - 3)^2
```
Y formed from a quadratic function.

```
t = FINDGEN(20) / 10. + 2
```
Twenty values from 2 to 3.90 for the interpolated points.

```
z = SPLINE(x, y, t)
```
Do the interpolation.

See Also

CURVEFIT, GAUSSFIT, POLY_FIT, POLYFITW, SVDFIT

SQRT Function

Calculates the square root of the input variable.

Usage

result = SQRT(*x*)

Input Parameters

x — The value or array of values for which the square root is desired.

Returned Value

result — The square root of *x*.

Keywords

None.

Discussion

SQRT handles complex numbers (defined by $c = a + bi$), in the following manner:

$$c^{1/2} = \frac{1}{2}(r+a)^{1/2} \pm i\frac{1}{2}(r-a)^{1/2}$$

where

$$r = \sqrt{a^2 + b^2}$$

The ambiguous sign is taken to be the same as the sign of b.

If x is of double-precision floating-point or complex data type, SQRT yields a result of the same type. All other types yield a single-precision floating-point result.

If x is an array, the result of SQRT has the same dimensions, with each element containing the square root of the corresponding element of x.

Example

```
x = [3, 5, 7, 9]
PRINT, SQRT(x)
   1.73205     2.23607     2.64575     3.00000
```

See Also

For more information, see ^ (the PV-WAVE symbol for power). For a list of other transcendental functions, see *Transcendental Mathematical Functions* on page 20, in Volume 1 of this reference.

STDEV Function

Standard Library function that computes the standard deviation and (optionally) the mean of the input array.

Usage

result = STDEV(*array* [, *mean*])

Input Parameters

array — The array to be processed. Can be of any data type except string.

Output Parameters

mean — The mean of *array*.

Returned Value

result — The standard deviation of *array*.

Keywords

None.

Discussion

Mean and standard deviation are basic statistical tools used in a variety of applications. They are computed as follows:

$$mean = \frac{\sum_{i=0}^{n} array_i}{n}$$

where n is the number of elements in *array*.

$$STD = \sqrt{\frac{\sum_{i=0}^{n} (array_i - mean)^2}{n-1}}$$

In PV-WAVE, these equations are implemented as follows:

```
mean = TOTAL(array) / N_ELEMENTS(array)

std = SQRT(TOTAL((array - mean)^2) / $
   (N_ELEMENTS(array) - 1))
```

Example

```
y = [1, 5, 9, 3, 10, 4]
```

Create a simple array.

```
std = STDEV(y, arrmean)
```

Compute the standard deviation and mean array value.

```
PRINT, std, arrmean
   3.50238    5.33333
```

Print the results.

See Also

AVG, SIGMA

STOP Procedure

Stops the execution of a running program or batch file, and returns control to the interactive mode.

Usage

STOP [, $expr_1$, ... , $expr_n$]

Input Parameters

expr$_i$ — One or more expressions whose value is printed. If no parameters are present, a brief message describing where the STOP was encountered is printed.

Keywords

None.

See Also

BREAKPOINT, RETALL, RETURN

STRARR Function

Returns a string array.

Usage

result = STRARR(dim_1, ... , dim_n)

Input Parameters

dim_i — The dimensions of the result. May be any scalar expression. Up to eight dimensions may be specified.

Returned Value

result — A string array.

Keywords

None.

Example

```
r = STRARR(2)
r(0) = 'one'
r(1) = 'two'
PRINT, r
   one   two
```

See Also

BYTARR, COMPLEXARR, DBLARR, FLTARR, INTARR, LONARR, MAKE_ARRAY, SINDGEN, STRLEN

STRCOMPRESS Function

Compresses the white space in an input string.

Usage

result = STRCOMPRESS(*string*)

Input Parameters

string — The string to be compressed.

Returned Value

result — A string with all white space (blank spaces and tabs) compressed to a single space or completely removed. If *string* is an array, the result is an array with the same structure—each element contains a compressed copy of the corresponding element of *string*.

Input Keywords

Remove_All — If nonzero, removes all white space. Otherwise, all white space is compressed to a single space (the default).

Discussion

If not of type string, *string* is converted to string using the default formatting rules of PV-WAVE CL. (These rules are described in *Free Format Output* on page 164 of the *PV-WAVE Programmer's Guide*.)

Example 1

In this example, STRCOMPRESS is used to remove the excess white space in a string.

```
s = ' This string   has     extra white space'
```

Create a string with excess white space characters.

```
PRINT, STRCOMPRESS(s)
```

Display the string with all excess white space removed.

```
This string has extra white space
```

Example 2

This example uses STRCOMPRESS to remove all white space from each element of a three-element string array.

```
s = strarr(3)
```

Create a three-element string array.

```
s(0) = 'a       b  c'
s(1) = '   d    e f'
s(2) = 'g     h    i'
```

Assign a string to each element of the array.

```
PRINT, TRANSPOSE(STRCOMPRESS(s, /Remove_All))
```

Remove all spaces from each element of the array and display the resulting array. TRANSPOSE is used to display the array as a column vector.

```
abc
def
ghi
```

See Also

STRTRIM, STRLEN, STRPOS, STRPUT

For an example, see *Removing White Space From Strings* on page 128 of the *PV-WAVE Programmer's Guide.*

STRETCH Procedure

Standard Library procedure that linearly expands the range of the color table currently loaded to cover an arbitrary range of pixel values.

Usage

STRETCH, *low, high*

Input Parameters

low — The lowest pixel value in the selected range; in other words, this is the pixel value that will be displayed with color index 0. The default value is 0.

high — The highest pixel value in the selected range; in other words, this is the pixel value that will be the highest color index available on a particular device (normally 255 on an eight-bit plane device). The default value is !D.N_Colors – 1.

Keywords

None.

Discussion

STRETCH linearly interpolates new Red, Green, and Blue color vectors between *low* and *high*, and then loads them into the image display with LOADCT. The color vectors in the PV-WAVE COLORS common block are unchanged.

For example, the command:

```
STRETCH, 100, 150
```

expands the color table so that the pixels in the range of 100 to 150 fill the entire color-intensity range.

To revert to a normal color table, call STRETCH with no parameters.

Example 1

```
mandril = BYTARR(512, 512)
OPENR, unit, !Data_dir + 'mandril.img',$
   /Get_lun
READU, unit, mandril
FREE_LUN, unit
```

Read the PV-WAVE mandril demo image.

```
WINDOW, /Free, Colors=128, XSize=512, $
   YSize=512
```

```
TVSCL, mandril
```

Display the original image using 128 colors.

```
LOADCT, 4
COLOR_PALETTE
```

Change the color palette and display it for reference.

```
!Err = 0
WHILE !Err LE 0 DO BEGIN
   CURSOR, x, y, /Change, /Normal
   range = FIX(y * 128.0 + 5.0)
   STRETCH, 64-range, 64+range
ENDWHILE
```

Use the position of the cursor to compress or expand the palette about the middle using the STRETCH function.

Example 2

A simplified version of STRETCH can be written as:

```
PRO STRETCH, lo, hi
```

Procedure definition.

```
COMMON colors, r_orig, g_orig, b_orig, $
   r_curr, g_curr, b_curr
```

Access the color table common block used by PV-WAVE procedures.

```
t = BYTSCL(INDGEN(256), Min = lo, Max = hi)
```

Make a vector of subscripts into the color table arrays.

```
TVLCT, r_orig(t), g_orig(t), b_orig(t)
    Load colors from the original tables transformed by t.

RETURN
END
```

See Also

!D.N_Colors, LOADCT, MODIFYCT, TVLCT, WgCtTool

For more information about how to access the three color variables in the color table common block, see *Retrieving Information About the Current Color Table* on page 321 of the *PV-WAVE User's Guide.*

For more information about stretching color tables, see *Stretching the Color Table* on page 319 of the *PV-WAVE User's Guide.*

STRING Function

Converts the input parameters to characters and returns a string expression.

Usage

result = STRING($expr_1$, ... , $expr_n$)

Input Parameters

expr$_i$ — The expressions to be converted to type string.

Returned Value

result — The string value for *expr.*

Input Keywords

Format — Allows the format of the output to be specified in precise detail, using a FORTRAN-style specification. FORTRAN-style formats are described in Appendix A, *FORTRAN and C Format Strings*, in the *PV-WAVE Programmer's Guide*.

Print — If present and nonzero, specifies that any special case processing should be ignored, and that STRING should behave exactly as the PRINT procedure.

Discussion

STRING can be used to convert one or more expressions to string data type. You can use the *Format* keyword to explicitly specify the format in the converted string. The format specification string used with the *Format* keyword follows this syntax:

$$"(q_1 f_1 s_1 f_2 s_2 \ldots f_n q_n)"$$

where:

- q — is an optional slash (/) record terminator. During output, each record terminator causes the output to move to a new line. During input, each record terminator causes the next line of input to be read.
- f — is a FORTRAN-style format string. Some format strings specify how data should be transferred while others control some other function related to how I/O is handled. If you do not specify a format string, the result is formatted automatically.

  For more information about the FORTRAN format codes that can be used, refer to Appendix A, *FORTRAN and C Format Strings*, in the *PV-WAVE Programmer's Guide*.
- s — is a comma (,) or a slash (/) that is used to separate input values. The only restriction on these separators is that two commas cannot occur side by side.

Note The quotation marks and parentheses surrounding the format string are required. The quotation marks can be either single or double quotation marks.

If the *Format* keyword is not present, PV-WAVE uses its default rules for formatting the output. These rules are described in Table 8-7 on page 164 of the *PV-WAVE Programmer's Guide*.

STRING is similar to the PRINT procedure, except that its output is placed in a string rather than being output to the terminal.

Example 1

The following three commands all yield the string scalar 'ABC':

```
x = STRING([65B,66B,67B])
y = STRING([byte('A'), byte('B'), byte('C')])
z = STRING('A' + 'B' + 'C')
```

In the first expression above, the input is a byte vector, and STRING converts it into a string scalar. The first parameter is 65B, which is a notation indicating that the parameter uses a byte data type, but the result is equal to the decimal ASCII code 65.

Example 2

STRING can also be used with a floating-point variable, as shown below.

```
x = 123.45
result = STRING(x)
PRINT, result
```

results in the output:

```
123.45
```

Example 3

Here are some examples using the *Format* keyword. In all three cases, the STRING command that is entered is:

```
result = STRING(numbers, Format="(I2)")
```

In these examples, the *Format* keyword instructs the STRING function to convert `numbers` to a string data type, using an integer format with a maximum field width of 2 characters.

- If `numbers = [36, 9, 72]`, and `result` is computed with the format string shown above, then entering the following command:

  ```
  PRINT, result
  ```

  results in the output:

  ```
  36  9 72
  ```

  The values are converted to strings, using a maximum field width of two characters.

- If `numbers = [5, 7, 9, 100]`, and `result` is computed with the format string shown above, then entering the following command:

  ```
  PRINT, result
  ```

  results in the output:

  ```
   5  7  9 **
  ```

  The two asterisks indicate that the integer value 100 was too big to be read with an I2 FORTRAN format.

- If `numbers = [6.12, 4.507, 4.339]`, and `result` is computed with the format string shown above, then entering the following command:

  ```
  PRINT, result
  ```

  results in the output:

  ```
   6  4  4
  ```

  As shown in this example, an integer format can be used to output floating point data, but all digits after the decimal point are lost.

See Also

PRINT, STRARR, XYOUTS

For more information on string formats, see Chapter 7, *Working with Text*, in the *PV-WAVE Programmer's Guide.*

For more information on format specification codes, see Appendix A, *FORTRAN and C Format Strings*, in the *PV-WAVE Programmer's Guide.*

STRLEN Function

Returns the length of the input parameter.

Usage

result = STRLEN(*expr*)

Input Parameters

expr — The expression for which the string length is desired.

If not of type string, *expr* is converted to string using the default formatting rules of PV-WAVE CL. (These rules are described in *Free Format Output* on page 164 of the *PV-WAVE Programmer's Guide.*)

Returned Value

result — A long integer containing the string length of *expr.* If *expr* is an array, the result is an array with the same structure, with each element containing the length of the corresponding *expr* element.

Keywords

None.

Example

This example uses STRLEN to determine the length of several different strings.

```
a = 'a b c'
```

Create a scalar string.

```
PRINT, STRLEN(a)
```

Display the length of a.

```
5
```

```
b = 45
```
Create an integer scalar variable.

```
PRINT, STRLEN(b)
```
Display the length of b converted to string type.

```
8
```

```
c = STRING(FINDGEN(4), Format = '(f3.1)')
```
Create a four-element vector of strings.

```
PRINT, TRANSPOSE(c)
```
Display the contents of c as a column vector.

```
0.0
1.0
2.0
3.0
```

```
PRINT, TRANSPOSE(STRLEN(c))
```
Display the vector of lengths of elements of c as a column vector. This vector is returned by STRLEN.

```
3
3
3
3
```

See Also

STRMID, STRPOS, STRPUT, STRTRIM

For an example, see *Determining the Length of Strings* on page 130 of the *PV-WAVE Programmer's Guide*.

STRLOWCASE Function

Converts a copy of the input string to lowercase letters.

Usage

result = STRLOWCASE(*string*)

Input Parameters

string — The string to be converted.

If not of type string, *string* is converted to string using the default formatting rules of PV-WAVE CL. (These rules are described in *Free Format Output* on page 164 of the *PV-WAVE Programmer's Guide*.)

Returned Value

result — A copy of *string* converted to lowercase letters. If *string* is an array, the result is an array with the same structure, with each element containing the substring of the corresponding *string* element.

Keywords

None.

Example

This example uses STRLOWCASE to convert uppercase characters to lowercase in several different strings.

```
a = 'A StRInG OF mIXeD CaSe'
```

Create a string with a mix of uppercase and lowercase characters.

```
PRINT, STRLOWCASE(a)
```

```
a string of mixed case
```

Convert the string in a to lowercase and display the result.

```
b = 45
```
Create an integer scalar variable.

```
INFO, STRLOWCASE(b)
```
Examine the result of STRLOWCASE applied to b. Note that b is converted to a string.

```
<Expression>      STRING    = '       45'
```

```
c = STRARR(3)
```
Create a three-element string vector.

```
c(0) = 'StrInG 0'
c(1) = 'sTrINg 1'
c(2) = 'StrinG 2'
```
Assign a string with a mix of uppercase and lowercase characters to each element of C.

```
PRINT, TRANSPOSE(STRLOWCASE(c))
```
Display the vector of strings of c after converting them to lowercase. Use Transpose to view the vector as a column.

```
string 0
string 1
string 2
```

Discussion

Only uppercase characters are modified by STRLOWCASE; lowercase and nonalphabetic characters are copied without change.

See Also

STRUPCASE, STRING, PRINT, MESSAGE, XYOUTS

For an example, see *Converting Strings to Upper or Lower Case* on page 127 of the *PV-WAVE Programmer's Guide.*

STRMESSAGE Function

Returns the text of the error message specified by the input error number.

Usage

result = STRMESSAGE(*errno*)

Input Parameters

errno — The error number for which the message text is desired.

Returned Value

result — The text of the error message specified by *errno*.

Keywords

None.

Discussion

This function is especially useful in conjunction with the !Err system variable, which always contains the error number of the last error.

However, you should take care not to make the assumption in your programs that certain error numbers always correspond to certain error messages, as this correspondence may change as PV-WAVE CL is modified over time.

Example

The following procedure uses function STRMESSAGE to display the error message associated with an input/output error trapped by procedure ON_IOERROR.

```
FUNCTION READ_DATA, file_name
```

Define a function to read, and return a 100-element, floating-point array.

```
ON_IOERROR, bad
```
Declare error label.

```
OPENR, unit, file_name, /Get_Lun
```
Open the file and use the Get_Lun keyword to allocate a logical file unit.

```
a = FLTARR(100)
```
Define data array.

```
READU, unit, a
```
Read data.

```
GOTO, DONE
```
Clean up and return.

```
bad:
```
Exception label.

```
PRINT, STRMESSAGE(!ERROR)
```
Print the error message associated with the error number in !ERROR. Note that STRMESSAGE is used to display the message.

```
DONE:
```

```
FREE_LUN, unit
```
Close and free the input/output unit.

```
RETURN, a
```
Return the result. Variable a is undefined if an error occurred.

```
END
```

See Also

!Err, !Err_String, ON_ERROR, ON_IOERROR, MESSAGE, PRINT

For more information on error handling, see Chapter 10, *Programming with PV-WAVE*, in the *PV-WAVE Programmer's Guide.*

STRMID Function

Extracts a substring from a string expression.

Usage

result = STRMID(*expr, first_character, length*)

Input Parameters

expr — The expression from which the substring is to be extracted.

If not of type string, *expr* is converted to string using the default formatting rules of PV-WAVE CL. (These rules are described in *Free Format Output* on page 164 of the *PV-WAVE Programmer's Guide.*)

first_character — The starting position within *expr* at which the substring starts. The first character position is position 0.

length — The length of the substring. If there are not enough characters left in the main string to obtain *length* characters, the substring will be truncated.

Returned Value

result — A string of *length* characters taken from *expr*, starting at character position *first_character.* If *expr* is an array, the result is an array with the same structure, with each element containing the substring of the corresponding *expr* element.

Keywords

None.

Example

In this example, STRPOS is used to locate the first occurrence of the string *a* within a larger string. Function STRMID is then used to extract a substring from that position. Function STRPOS is used to locate the second occurrence of the string *a*, and finally, STRMID is used to extract another substring from this second position within the larger string.

```
a = 'Extract a substring from a string'
```
Create a string in the variable a.

```
POS = STRPOS(a, 'a ')
```
Locate first occurrence of the string "a ".

```
PRINT, STRMID(a, pos, 11)
```
Extract 11 characters from a, starting at POS.

```
a substring
```

```
POS = STRPOS(a, 'a ', pos + 1)
```
Search for the second occurrence of the string "a " by searching from the character position that is one greater than the first occurrence of that string. Extract 8 characters from a, starting at the new POS.

```
PRINT, STRMID(a, pos, 8)

a string
```

See Also

STRLEN, STRPOS, STRPUT

For an example, see *Manipulating Substrings* on page 131 of the *PV-WAVE Programmer's Guide.*

STRPOS Function

Searches for the occurrence of a substring within an object string, and returns its position.

Usage

result = STRPOS(*object, search_string* [, *position*])

Input Parameters

object — The expression in which to search for the substring.

search_string — The substring to be searched for within *object*.

If *object* or *search_string* are not of type string, they are converted to string using the default formatting rules of PV-WAVE CL. (These rules are described in *Free Format Output* on page 164 of the *PV-WAVE Programmer's Guide*.)

position — The character position at which the search is begun. If *position* is omitted or is less than zero, the search begins at the first character (character position 0).

Returned Value

result — If *search_string* occurs in *object*, STRPOS returns the character position of the match; otherwise, it returns –1.

If *object* is an array, *result* is an array of the same structure, and each element contains the position of the substring within *object*.

If *search_string* is the null string, STRPOS returns the smaller of *position* or one less than the length of *object*.

Keywords

None.

Example

See the example for STRMID.

See Also

STRPUT, STRLEN, STRMESSAGE, STRLOWCASE, STRUPCASE

For an example, see *Manipulating Substrings* on page 131 of the *PV-WAVE Programmer's Guide.*

STRPUT Procedure

Inserts the contents of one string into another.

Usage

STRPUT, *destination, source* [, *position*]

Input Parameters

destination — The string into which *source* will be inserted. Must be a named variable of type string. Cannot be an element of an array. If *destination* is an array, *source* is inserted into every element.

source — The string to be inserted into *destination.* Must be scalar.

If not of type string, *source* is converted to string using PV-WAVE CL's default formatting rules. (These rules are described in *Free Format Output* on page 164 of the *PV-WAVE Programmer's Guide.*)

position — The character position at which the insertion is begun. If *position* is omitted or is less than zero, the search begins at the first character (character position 0).

Keywords

None.

Discussion

The *source* string is inserted into the *destination* string, starting at the given *position*. All characters in *destination* that occur either before the starting position, or after the starting position plus the length of *source,* remain unchanged.

Example

This example uses STRPUT to insert a substring into a larger string, starting at position 0 of the destination string. Clipping is then demonstrated by using STRPUT to insert a substring that would otherwise extend the length of the destination string.

```
a = 'Strings are fun'
```
Create a string in the variable a.

```
STRPUT, a, 'PV-WAVE is '
```
Insert the string "PV-WAVE is" into a, starting at position 0.

```
PRINT, a
```
Display the result.

```
PV-WAVE is  fun
```

```
STRPUT, a, 'fun to use', 12
```
Insert a string into a that would extend its length.

```
PRINT, a
```
Display the result. Note that the inserted string was clipped so the length of a did not change.

```
PV-WAVE is  fun
```

See Also

STRPOS, STRLEN, STRMESSAGE, STRLOWCASE, STRUPCASE

For an example, see *Manipulating Substrings* on page 131 of the *PV-WAVE Programmer's Guide.*

STR_TO_DT Function

Converts date and time string data to PV-WAVE Date/Time values.

Usage

result = STR_TO_DT(*date_strings* [, *time_strings*])

Input Parameters

date_strings – A string constant or string array that contains date strings.

time_strings – A string constant or string array that contains time strings.

Returned Value

result – A PV-WAVE Date/Time variable containing the converted Date/Time data.

Input Keywords

Date_Fmt – Specifies the format of the date data in the input variable. Possible values are 1, 2, 3, 4, or 5, as summarized in the following table:

Table 2-11: Valid Date Formats

Value	Format Description	Examples for May 1, 1992
1	MM*DD*[YY]YY	05/01/92
2	DD*MM*[YY]YY	01-05-92
3	ddd*[YY]YY	122,1992
4	DD*mmm[mmmmmm]*[YY]YY	01/May/92
5	[YY]YY*MM*DD	1992-05-01

where the asterisk (*) represents one of the following separators: dash (–), slash (/), comma (,), period (.), or colon (:).

Time_Fmt – Specifies the format of the time portion of the data in the input variable. Possible values are –1 or –2, as summarized in the following table:

Table 2-12: Valid Time Formats

Value	Format Description	Examples for 1:30 p.m.
–1	HH*Mn*SS[.SSSS]	13:30:35.25
–2	HHMn	1330

where the asterisk (*) represents one of the following separators: dash (–), slash (/), comma (,), or colon (:). No separators are allowed between hours and minutes for the –2 format. Both hours and minutes must occupy two spaces.

For a detailed description of the date and time formats, see *Converting Your Data into Date/Time Data* on page 229 of the *PV-WAVE User's Guide*.

Note Date and time separators are specified with the !Date_Separator and !Time_Separator system variables. The STR_TO_DT function only recognizes the standard separators listed above. If any other separator is specified, this function does not work as expected.

Discussion

You can convert just date strings, just time strings, or both. If you do not pass in a date string, the resulting date portion of the Date/Time structure defaults to the value in the system variable !DT_Base. If you do not pass in a time string, the time portion of the resulting Date/Time variable defaults to zero.

Example 1

```
x = ['3-13-92', '4-20-83', '4-24-64']
```

Create an array that contains some date strings with the MM DD YY date format.

```
y = ['1:10:34', '16:18:30', '5:07:25']
```

Create an array that contains some time strings with the HH Mn SS date format.

```
date1 = STR_TO_DT(x, y, Date_Fmt=1, $
   Time_Fmt =-1)
```

Use the formats1 and -1 to return PV-WAVE Date/Time data.

```
DT_PRINT, date1
   3/13/1992 01:10:34
   4/20/1983 16:18:30
   4/24/1964 05:07:25
```

Example 2

```
date2 = STR_TO_DT('3-13-92', Date_Fmt=1)

PRINT, date2
   { 1992 3 13 0 0 0.00000 87474.000 0 }
```

See Also

DT_TO_STR, SEC_TO_DT, VAR_TO_DT, JUL_TO_DT

For more information on using Date/Time functions, see Chapter 7, *Working with Date/Time Data*, in the *PV-WAVE User's Guide*.

STRTRIM Function

Removes extra blank spaces from an input string.

Usage

result = STRTRIM(*string* [, *flag*])

Input Parameters

string — The string that will have leading and/or trailing blanks removed.

If not of type string, *string* is converted to string using the default formatting rules of PV-WAVE CL. (These rules are described in *Free Format Output* on page 164 of the *PV-WAVE Programmer's Guide*.)

flag — Controls the action of STRTRIM:

- If zero or not present, removes trailing blanks.
- If 1, removes leading blanks.
- If 2, removes both leading and trailing blanks.

Returned Value

result — A copy of *string* with extra (leading and/or trailing) blank spaces removed. If *string* is an array, the result is an array with the same structure — each element contains a trimmed copy of the corresponding element of *string*.

Keywords

None.

Example

In this example, STRTRIM is used to trim trailing, leading, then trailing and leading blanks from a string.

```
a = '    A String    '
```
Create a string with both leading and trailing blanks.

```
INFO, a
```
Examine the contents of a. Note the presence of both leading and trailing blanks.

```
VARIABLE          STRING    = '    A String    '
```

```
b = STRTRIM(a)
```
Remove trailing blanks from a.

```
INFO, b
```
Examine the results. Note that all trailing blanks are removed.

```
VARIABLE        STRING    = '    A String'
```

```
b = STRTRIM(a, 1)
```
Remove leading blanks from a.

```
INFO, b
```
Examine the results. Note that all leading blanks are removed.

```
VARIABLE          STRING    = 'A String    '
```

```
b = STRTRIM(a, 2)
```
Remove both leading and trailing blanks from a.

```
INFO, b
```
Examine the results. Note that all leading and trailing blanks are removed.

```
VARIABLE          STRING    = 'A String'
```

See Also

STRCOMPRESS

For an example, see *Removing White Space From Strings* on page 128 of the *PV-WAVE Programmer's Guide.*

STRUCTREF Function

Returns a list of all existing references to a structure.

Usage

result = STRUCTREF({*structure*})

Input Parameters

structure — The structure name. The name can be specified as {*structure*}, "*structure*", or *x* , where *x* is a variable of type structure.

Returned Value

result — A list of the variables, structures, definitions, and common blocks that reference *structure*.

Keywords

None.

Discussion

Use STRUCTREF before you use DELSTRUCT to check if the structure you want to delete is currently referenced by any variables, common blocks, or other structure definitions.

You *cannot* delete a structure that is currently referenced.

If you want to delete a structure that is referenced, you can either:

- Delete the references (variables, structures, etc.) returned by STRUCTREF, and then use the DELSTRUCT procedure.
- Use the DELSTRUCT procedure with the *Rename* keyword. This renames the structure.

If you are trying to free memory, then you must pursue the first option. If you want to delete a structure, and memory is not a concern, then the second option is probably the best choice.

Examples

```
WAVE> x = {struct1, a:float(0)}
WAVE> PRINT, structref(x)
   <procedure $MAIN$, symbol X>
```

See Also

DELSTRUCT, DELFUNC, DELPROC, N_TAGS, TAG_NAMES

For more information on structures, see Chapter 6, *Working with Structures*, in the *PV-WAVE Programmer's Guide*.

STRUPCASE Function

Converts a copy of the input string to uppercase letters.

Usage

result = STRUPCASE(*string*)

Input Parameters

string — The string to be converted.

If not of type string, *string* is converted to string using the default formatting rules of PV-WAVE CL. (These rules are described in *Free Format Output* on page 164 of the *PV-WAVE Programmer's Guide*.)

Returned Value

result — A copy of *string* converted to uppercase letters. If *string* is an array, the result is an array with the same structure, with each element containing the substring of the corresponding *string* element.

Keywords

None.

Discussion

Only lowercase characters are modified by STRUPCASE; uppercase and nonalphabetic characters are copied without change.

Example

This example uses STRUPCASE to convert lowercase characters to uppercase in several different strings.

```
a = 'A StRInG oF miXeD caSE'
print, STRUPCASE(a)
```

```
A STRING OF MIXED CASE
```

Create a string with a mix of uppercase and lowercase characters. Convert the string in a to uppercase and display the result.

```
b = 45
```

```
INFO, STRUPCASE(b)
```

Create an integer scalar variable. Examine the result of STRUPCASE applied to b. Note that B is converted to a string.

```
<Expression>      STRING    = '       45'
```

```
c = STRARR(3)
```

Create a three-element string vector.

```
c(0) = 'StrInG 0'
c(1) = 'sTrINg 1'
c(2) = 'StrinG 2'
```

Assign a string with a mix of uppercase and lowercase characters to each element of c.

```
PRINT, TRANSPOSE(STRUPCASE(c))
```

Display the vector of strings of c after converting it to uppercase. Use TRANSPOSE to view the vector as a column.

```
STRING 0
STRING 1
STRING 2
```

See Also

STRLOWCASE. STRING, PRINT, MESSAGE, XYOUTS

For examples, see *Converting Strings to Upper or Lower Case* on page 127 of the *PV-WAVE Programmer's Guide.*

SURFACE Procedure

Draws the surface of a two-dimensional array with hidden lines removed.

Usage

SURFACE, *z* [, *x*, *y*]

Input Parameters

z — A two-dimensional array containing the values that make up the surface. If *x* and *y* are supplied, the surface is plotted as a function of the X,Y locations specified by their contents. Otherwise, the surface is generated as a function of the array index of each element of *z*.

x — A vector or two-dimensional array specifying the X coordinates for the contour surface.

- If *x* is a vector, each element of *x* specifies the X coordinate for a column of *z*. For example, *x(0)* specifies the X coordinate for z*(0, *)*.
- If *x* is a two-dimensional array, each element of *x* specifies the X coordinate of the corresponding point in *z* (x_{ij} specifies the X coordinate for z_{ij}).

y — A vector or two-dimensional array specifying the Y coordinates for the contour surface.

- If *y* is a vector, each element of *y* specifies the Y coordinate for a row of *z*. For example, *y(0)* specifies the Y coordinate for *z (*, 0)*.
- If *y* is a two-dimensional array, each element of *y* specifies the Y coordinate of the corresponding point in *z* (y_{ij} specifies the Y coordinate for z_{ij}).

Keywords

SURFACE keywords are listed below. For a description of each keyword, see Chapter 3, *Graphics and Plotting Keywords.*

Ax	Normal	XTickformat	YTitle
Az	Position	XTicklen	
Background	Save	XTickname	ZAxis
Bottom	Skirt	XTicks	ZCharsize
Channel	Subtitle	XTickv	ZGridstyle
Charsize	T3d	XTitle	ZMargin
Charthick	Thick		ZMinor
Clip	Tickformat	YCharsize	ZRange
Color	Ticklen	YGridstyle	ZStyle
Data	Title	YMargin	ZTickformat
Device	Upper_Only	YMinor	ZTicklen
Font		YRange	ZTickname
Horizontal	XCharsize	YStyle	ZTicks
Linestyle	XGridstyle	YTickformat	ZTickv
Lower_Only	XMargin	YTicklen	ZTitle
Noclip	XMinor	YTickname	ZValue
Nodata	XRange	YTicks	
Noerase	XStyle	YTickv	

Discussion

Note the following restrictions on the use of SURFACE. If the X,Y grid is not regular or nearly regular, errors in hidden line removal will occur.

If the *T3D* keyword is set, the 3D to 2D transformation matrix contained in !P.T must project the Z axis to a line parallel to the device Y axis, or errors will occur.

Example

This example displays the surface described by the function

$$f(x, y) = x\sin(y) + y\cos(x)$$

where

$$(x, y) \in \{\mathbb{R}^2 | x, y \in [-10, 10]\}$$

```
.RUN

- FUNCTION f, x, y
- RETURN, x * SIN(y) + y * COS(x)
- END
```

Define the function.

```
x = FINDGEN(101)/5-10
```

Create vector of x-coordinates.

```
y = x
```

Create vector of y-coordinates.

```
z = FLTARR(101, 101)
```

Create an array to hold the function values.

```
FOR i = 0, 100 DO FOR j = 0, 100 DO $
   z(i, j) = f(x(i), y(j))
```

Evaluate the function at the given x- and y-coordinates and place the result in z.

```
SURFACE, z, x, y, Ax = 50, XCharsize = 2, $
   YCharsize = 2, ZCharsize = 2
```

Display the surface. The Ax keyword is used to specify the angle of rotation about the x-axis. The XCharsize, YCharsize, and ZCharsize keywords are used to enlarge the characters used to annotate the axes.

```
XYOUTS, 163, 477, $
   "f(x,y) = x*sin(y) + y*cos(x)", $
   Charsize = 2, /Device
```

Place a title on the window. Note that the CURSOR procedure with the Device keyword was used to locate the proper position for the title.

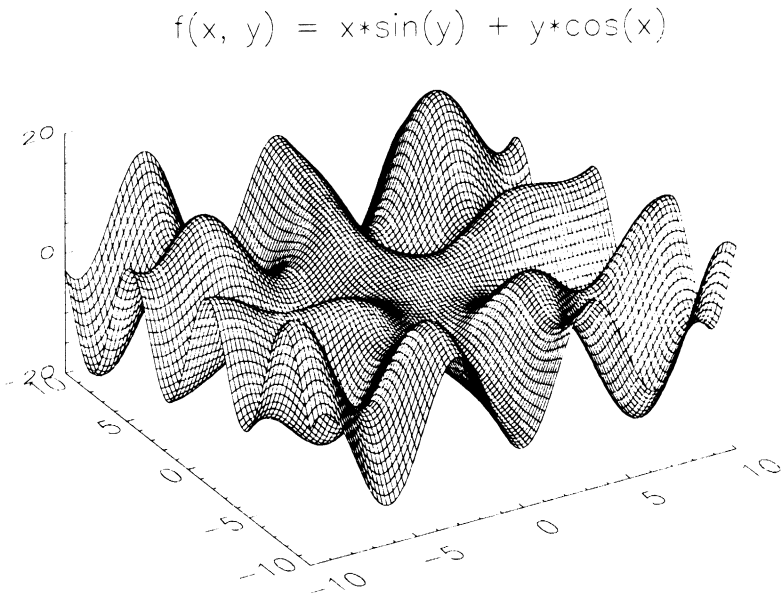


Figure 2-56 Surface with title.

See Also

!P.T, SHADE_SURF, SHADE_SURF_IRR, SURFACE_FIT, SURFR, T3D, THREED

For more information, see Chapter 4, *Displaying 3D Data*, in the *PV-WAVE User's Guide.*

SURFACE_FIT Function

Standard Library function that determines the polynomial fit to a surface.

Usage

result = SURFACE_FIT(*array, degree*)

Input Parameters

array — The two-dimensional array of data to which the surface will be fit. The two dimensions do not have to be the same size. The number of data points must be ≥ $(degree + 1)^2$.

degree — The maximum degree of the fit (in one dimension).

Returned Value

result — A two-dimensional array of values as calculated from the least-squares fit of the data.

Keywords

None.

Discussion

SURFACE_FIT first determines the coefficients of the polynomials in both directions, using the least-squares method of the POLYWARP function. It then uses these coefficients to calculate the data points of the *result* array.

Example

```
OPENR, 1, !Data_dir + 'pikeselev.dat'
data = FLTARR(60, 40)
READF, 1, data
```

Read in the data from the PV-WAVE pikes elevation file.

```
CLOSE, 1
```

Close the input file.

```
SURFACE, data
```

Show the raw data without fitting.

```
SURFACE, SURFACE_FIT(data, 1)
```

Approximate a linear least-squares fit.

```
SURFACE, SURFACE_FIT(data, 2)
```

Do a second-degree polynomial fit.

```
SURFACE, SURFACE_FIT(data, 3)
```

Do a third-degree polynomial fit.

```
SURFACE, SURFACE_FIT(data, 4)
```

Do a forth-degree polynomial fit.

```
SURFACE, SURFACE_FIT(data, 5)
```

Do a fifth-degree polynomial fit.

See Also

POLY_FIT, POLYWARP, SURFACE

SURFR Procedure

Standard Library procedure that duplicates the rotation, translation, and scaling of the SURFACE procedure.

Usage

SURFR

Parameters

None.

Input Keywords

Ax — The angle of rotation about the X axis in degrees. The default is 30 degrees.

Az — The angle of rotation about the Z axis in degrees. The default is 30 degrees.

Discussion

SURFR should be used for axonometric projections only. The 4-by-4 matrix in the system variable !P.T receives the homogeneous transformation matrix generated by this procedure.

SURFR performs the following steps:

- Translates the unit cube so that the center (.5, .5, .5) is moved to the origin.
- Rotates –90 degrees about the X axis to make the +Z axis of the data the +Y axis of the display. The +Y data axis extends from the front of the display to the back.
- Rotates about the Y axis *Az* degrees. This rotates the result counterclockwise as seen from above the page.
- Rotates about the X axis *Ax* degrees, tilting the data towards the viewer.

- Translates back to the origin and scales the data so that the data are still contained within the unit cube after the transformation. (This step uses the SCALE3D procedure.)

Example 1

```
TEK_COLOR
```
Load a color table.

```
data = HANNING(50, 50)
SURFR
```
Create the 3D spatial transformation. By default, the angle of rotation is defined as 30 degrees around the X and Y axes.

```
CONTOUR, data, Nlevels=20, /Follow, /T3D, $
   Charsize=1.5
```
Create the contour plot in the 3D space.

```
SURFR,Ax=45, Az=10
```
Now try it with different angles of rotation.

```
CONTOUR, data, Nlevels=20, /Follow, /T3D, $
   Charsize=1.5
```
Create the contour plot in the 3D space.

Tip For an informative display, the above example could be done using the SHADE_SURF or SURFACE procedures instead of SURFR, as shown below. (SURFR is not needed in this case because these two procedures themselves set up the 3D view area.)

```
SURFACE, data, /Save, Color=3
CONTOUR, data, Nlevels=20, /Follow, /T3D, $
   Charsize=1.5
```

Example 2

This example displays a cube as a shaded surface and rotates it.

```
xmin = 0 & xmax = 1
xmin = xmin - 1.5 & xmax = xmax+1.5
!x.s = [-xmin,1.0] / (xmax - xmin)
!y.s = !x.s
!z.s = !x.s
```

Set up scaling for the 3D view.

```
vert = FLTARR(3, 8)
FOR i = 1, 2   DO vert(0, i) = 1
FOR i = 5, 6   DO vert(0, i) = 1
FOR i = 2, 3   DO vert(1, i) = 1
FOR i = 6, 7   DO vert(1, i) = 1
FOR i = 4, 7   DO vert(2, i) = 1
```

Create the array of vertices.

```
poly = FLTARR(30)
poly(0:4)   = [4, 0, 3, 2, 1]
poly(5:9)   = [4, 1, 2, 6, 5]
poly(10:14) = [4, 5, 6, 7, 4]
poly(15:19) = [4, 4, 7, 3, 0]
poly(20:24) = [4, 3, 7, 6, 2]
poly(25:29) = [4, 0, 1, 5, 4]
```

Create the connectivity array.

```
SURFR
img = POLYSHADE(vert, poly, /T3D, /Data)
TV, img
```

Display the cube with the default rotations.

```
SURFR, Ax=50, Az=10
img = POLYSHADE(vert, poly, /T3D, /Data)
TV, img
```

Display the cube rotated 50 degrees around the X axis and 10 degrees around the Z axis.

Tip This example can be done more simply with the CENTER_VIEW procedure, which is available in the Advanced Rendering Library. This library is located in the `wave/demo/arl` directory. For more information, view the `.pro` file for this procedure.

See Also

!P.T, SCALE3D, SURFACE, T3D

SVBKSB Procedure

Uses "back substitution" to solve the set of simultaneous linear equations **Ax = b** , given the *u*, *w*, and *v* arrays created by the SVD procedure from the matrix *a*.

Usage

SVBKSB, *u, w, v, b, x*

Input Parameters

u — The *m*-by-*n* column matrix of the decomposition of *a*, as returned by SVD.

w — The vector of singular values, as returned by SVD.

v — The *n*-by-*n* orthogonal matrix of the decomposition of *a*, as returned by SVD.

b — The vector containing the right-hand side of the equation.

Output Parameters

x — A variable containing the result.

Keywords

None.

Discussion

Since no input quantities are destroyed, SVBKSB may be called numerous times with different *b* vectors.

Example

Here's a typical use of SVD and SVBKSB to solve the system **Ax = b** :

```
SVD, A, w, u, v
```
Decompose square matrix A.

```
small = WHERE(w LT MAX(w) * 1.0e-6, count)
```
Get subscripts of singular values, using a given threshold.

```
IF count NE 0 THEN w(small) = 0.0
```
Zero singular values less than the threshold. See the Numerical Recipes book (referred to in the See Also section) for details.

```
SVBKSB, u, w, v, b, x
```
The vector x now contains the solution.

```
PRINT, TOTAL(ABS(A # x - b))
```
The residual, **|Ax – b|** should be near 0.

See Also

SVD

SVBKSB is based on the routine of the same name in *Numerical Recipes in C: The Art of Scientific Computing*, by Flannery, Press, Teukolsky, and Vetterling, Cambridge University Press, Cambridge, MA, 1988. It is used by permission.

SVD Procedure

Performs a singular value decomposition on a matrix.

Usage

SVD, *a*, *W* [, *u* [, *v*]]

Input Parameters

a — The two-dimensional matrix to be decomposed. It has *m* rows and *n* columns, and *m* must be greater than or equal to *n*.

Output Parameters

W — An *n*-element vector of "singular values" equal to the diagonal elements of *w*: $w_{i,j} = W_j$, $w_{i,j} = 0$ for $i \neq j$.

u — The *m*-by-*n* column matrix of the decomposition of *a*.

v — The *n*-by-*n* orthogonal matrix of the decomposition of *a*.

Keywords

None.

Discussion

SVD performs a singular value decomposition on a matrix *a*. It is useful for solving linear least-squares equations. SVD is able to deal with matrices that are singular or very close to singular.

The SVD procedure function transforms an *m*-by-*n* matrix *a* to the product of an *m*-by-*n* column orthogonal matrix *u*, an *n*-by-*n* diagonal matrix *w*, and the transpose of an *n*-by-*n* orthogonal matrix *v*. In other words, *u*, *w*, and *v* are matrices that are calculated by SVD.

By definition, the product of these three matrices (*u*, *w*, *v*) is equal to *a*:

$$a = uwv^t$$

In a linear system of equations,

$$Ax = b$$

where there are at least as many equations as unknowns, the least-squares solution vector x is given by:

$$x = v \cdot [diag(1/w_j)](u^t \cdot b)$$

Example

A PV-WAVE CL function that returns x, given A and b is:

```
Function SVD_SOLVE, A, b
    Return the vector x, the solution of the system of equations
    Ax = b. A is an (m, n) matrix, where m ≥ n.

SVD, A, w, u, v
    Call SVD to decompose A.

n = N_ELEMENTS(w)
    Make the diagonal matrix W_i,i = 1/w_i.

wp = FLTARR(n,n)

FOR i=0, n-1 DO IF w(i) NE 0 THEN $
   wp(i,i) = 1./w(i)

return, v # wp # (transpose(u) # b)
    Calculate x from equation and return.

END
```

See Also

SVBKSB

The SVD function is based on the subroutine SVDCMP in *Numerical Recipes in C: The Art of Scientific Computing*, by Flannery, Press, Teukolsky, and Vetterling, Cambridge University Press, Cambridge, MA, 1988, and is used by permission.

PV-WAVE's SVD is a translation of the ALGOL procedure SVD described in *Linear Algebra, Vol. II of The Handbook for Automatic Computation*, by Wilkinson and Reinsch, Springer-Verlag, New York, NY, 1971.

For more information on SVD, also consult *Computer Models for Mathematical Computations*, by Forsythe, Malcom, and Moler, Prentice Hall, Englewood Cliffs, NJ, 1977.

SVDFIT Function

Standard Library function that uses the singular value decomposition method of least-squares curve fitting to fit a polynomial function to data.

Usage

result = SVDFIT(*x*, *y*, *m*)

Input Parameters

x — A vector containing the X (independent) coordinates of the data.

y — A vector containing the Y (dependent) coordinates of the data. Should have the same number of elements as *x*.

m — The number of coefficients in the fitted function. For polynomials, *m* is one more than the degree of the polynomial.

Returned Value

result — A vector containing the coefficients of the polynomial equation which best approximates the data. It has a length of *m*.

Input Keywords

Weight — A vector of weighting factors for determining the weighting of the least-squares fit. Must have the same number of elements as *x*.

Output Keywords

Chisq — The sum of the squared errors, multiplied by the weights, if *Weight* is specified.

Yfit — A vector containing the calculated Y values of the fitted function.

Singular — The number of singular values (i.e., the number of values that are inconsistent with the other data) encountered in evaluating the fit. Should be 0; if not, the computed polynomials probably do not accurately reflect the data.

Variance — The estimated variance (sigma squared) for each of the *m* coefficients.

Covar — The covariance matrix of the *m* coefficients.

Funct — The name of a user-supplied basis function with *m* coefficients (see *User-Supplied Basis Function* section below).

Discussion

You must define any keywords to be returned by SVDFIT before calling it. The value or structure of the variable doesn't matter, since the variable will be redefined dynamically in the function call. For example:

```
yf = 1
```
Define the output variable yf.

```
c = SVDFIT(x, y, m, Yfit=yf)
```
Do the SVD fit and return the Yfit vector in the variable yf.

User-Supplied Basis Function

If *Funct* is not supplied, a polynomial function is used as the basis function. This function is of the form:

$$result(i, j) = x(i) \hat{} j$$

The function is called with two parameters in the following fashion:

result = FUNCT(x, m)

where *x* and *m* are as defined above.

The file containing *Funct* should reside in the current working directory or in the search path defined by the system variable !Path.

If *Funct* does not have the file extension .pro, it should be compiled before it is called in SVDFIT.

See the Standard Library function `cosines.pro`, which defines a basis function of the form:

*result(i, j) = COS(j * x(i))*

Weighting is useful when you want to correct for potential errors in the data you are fitting to a curve. The weighting factor, *Weight*, adjusts the parameters of the curve so that the error at each point of the curve is minimized. For more information, see the section *Weighting Factor* on page 149, in Volume 1 of this reference.

See Also

COSINES, FUNCT, REGRESS

For more examples of basis functions, see *Numerical Recipes in C: The Art of Scientific Computing*, by Flannery, Press, Teukolsky, and Vetterling, Cambridge University Press, Cambridge, MA, 1988.

SYSTIME Function

Returns the current system time as either a string or as the number of seconds elapsed since January 1, 1970.

Usage

result = SYSTIME(*param*)

Input Parameters

param — If present and nonzero, causes the number of seconds elapsed since January 1, 1970 to be returned as a double-precision floating-point value. Otherwise, a scalar string containing the current date/time in standard system format is returned.

Returned Value

result — Either a value representing the number of seconds since January 1, 1970 or a string containing the time in the standard system time format.

Keywords

None.

Example

```
t1 = SYSTIME(1)
```
Calculate number of seconds elapsed since January 1, 1970.

```
t2 = SYSTIME(0)
```
Calculate the current date/time in standard system format.

```
PRINT, t1, t2
   6.9248465e+08 Wed Dec 11 13:48:33 1991
```

See Also

For information on other ways that PV-WAVE can handle dates and times, see Chapter 7, *Working with Date/Time Data*, in the *PV-WAVE User's Guide*.

T3D Procedure

Standard Library procedure that accumulates one or more sequences of translation, scaling, rotation, perspective, or oblique transformations and stores the result in the system variable !P.T.

Usage

T3D

Parameters

None.

Input Keywords

Reset — A scalar which, if nonzero, resets !P.T (the transformation matrix) back to the default identity matrix.

Translate — A three-element vector containing the specified translations in the X, Y, and Z directions.

Scale — A three-element vector containing the specified scaling factors in the X, Y, and Z directions.

Rotate — A three-element vector, in units of degrees, containing the specified rotations about the X, Y, and Z axes. Rotations are performed in the order of X, Y, and then Z.

Perspective — A scalar (p) indicating the Z distance to the center of the projection. Objects are projected onto the XY plane at Z=0, and the "eye" is located at point (0, 0, p).

Oblique — A two-element vector containing the oblique projection parameters. Points are projected onto the XY plane at Z=0 as follows:

$$X' = X + Z(d * cos(a))$$

$$Y' = Y + Z(d * sin(a))$$

where *Oblique(0)* = *d* and *Oblique(1)* = *a*

XYech — If nonzero, exchanges the X and Y axes.

XZech — If nonzero, exchanges the X and Z axes.

YZech — If nonzero, exchanges the Y and Z axes.

Discussion

All parameters are entered in the form of keywords. The transformation specified by each keyword is performed in the order of its description above. For example, if both *Translate* and *Scale* are specified, the translation is done first, even if *Scale* is the first keyword in the procedure call.

The 4-by-4 transformation matrix, !P.T, is updated by this procedure, but the system variable !P.T3D is not set. This means that for the transformations to take effect, you must set !P.T3D equal to 1, or use the *T3D* keyword, in any plotting procedure that will make use of this transformation. Since all the PV-WAVE CL graphic routines use the !P.T matrix for output, T3D can be used to effect the graphic output of PV-WAVE CL.

Caution It is possible to create a transformation matrix with T3D that will not work correctly with the SURFACE or SHADE_SURF procedures. The only T3D transformations allowed with these procedures are those that end up with the Z axis placed vertically on the display screen.

This procedure follows the example given in *Fundamentals of Interactive Computer Graphics*, by Foley and Van Dam, Addison Wesley Publishing Company, Reading, MA, 1982.

Note The matrix notation used in the procedure is reversed from the normal PV-WAVE CL sense in order to conform to this reference. Moreover, a right-handed system is used, meaning that positive rotations are counterclockwise when looking from a positive axis to the origin.

Example 1

```
T3D, /Reset, Rotate=[30,0,0], Perspective=-1
```

Reset transformation, rotate 30 degrees about the X axis, and then do a perspective transformation with the center of the projection at (0, 0, –1).

Example 2

Transformations may also be cascaded. For example:

```
T3D, /Reset, Translate=[-.5,-.5,0], $
   Rotate=[0,0,45]
```

Reset, translate the center (.5, .5, 0) to the origin, and rotate 45 degrees counterclockwise about the Z axis.

```
T3D, Translate=[.5,.5,0]
```

Move the origin back to the center of the viewport.

Example 3

```
b = FINDGEN(37)*10
y = SIN(b*!Dtor)/EXP(b/200)*4
sz = SIZE(y)
j = REFORM(y, sz(1), 1)
```

Create the data, and reform it into a 2D array so that it can be used with the SURFACE command.

```
SURFACE, j, /Nodata, /Save, YMargin=[0, 0], $
   ZStyle=1, ZRange=[0, 1]
```

Draw a 3D axis and set up a 3D screen.

```
T3D, /YZexch
```

Exchange the Y and Z axes so that plots are stacked one in front of the other along the usual Y axis.

```
TEK_COLOR
PLOT, b, y, /T3D, ZValue=1.0, YMargin=[0, 0],$
   /Noerase
```

Create a line plot stacked on the 3D axis.

```
POLYFILL, b, y, /T3D, Color=6, Z=1.0
```

Fill under the curve.

```
PLOT, b, y, /T3D, ZValue=0.5, YMargin=[0, 0],$
   /Noerase
POLYFILL, b, y, /T3D, Color=8, Z=0.5
```

Create and fill a second curve.

```
PLOT, b, y, /T3D, ZValue=0.0, YMargin=[0, 0],$
   /Noerase
POLYFILL, b, y, /T3D, Color=7, Z=0.0
```

Create and fill a third curve.

```
T3D, /Reset
```

See Also

!P.T, !P.T3D, SURFR

For more information and examples, see *Drawing Three-dimensional Graphics* on page 115 of the *PV-WAVE User's Guide.*

TAG_NAMES Function

Returns a string array containing the names of the tags in a structure expression.

Usage

result = TAG_NAMES(*expr*)

Input Parameters

expr — The expression for which the tag names will be returned. Must be of structure type.

Returned Value

result — The string array containing the names of the tags. If *expr* is a structure containing nested structures, only the names of tags in the outermost structure are returned (as TAG_NAMES does not search for tags recursively).

Keywords

None.

Example

This example uses TAG_NAMES to display the tag names of a structure and one of its fields, which is also a structure.

```
a = {struc1, t1: 0.0D, t2: {struct2, $
   t2_t1: INTARR(3), t2_t2: 0.0, $
   t2_t3: 0L }, t3: FLTARR(12), t4: 0L }
```

Create a structure containing four fields, the second of which is also a structure.

```
PRINT, TAG_NAMES(a)
```

Display tag names of a.

```
T1 T2 T3 T4
```

```
PRINT, TAG_NAMES(a.t2)
```

Display tag names of the structure in the second field of a.

```
T2_T1 T2_T2 T2_T3
```

See Also

DELSTRUCT, STRUCTREF, N_TAGS

TAN Function

Returns the tangent of the input variable.

Usage

result = TAN(*x*)

Input Parameters

x — The angle, in radians, that is evaluated. Cannot be a complex data type.

Returned Value

result — The tangent of *x*.

Keywords

None.

Discussion

If *x* is of double-precision floating-point, TAN yields a result of the same data type. All other data types, except complex, yield a single-precision floating-point result.

If *x* is an array, the result of TAN has the same dimensions, with each element containing the tangent of the corresponding element of *x*.

Example

```
x = [-60, -30, 0, 30, 60]
PRINT, TAN(x * !Dtor)
   -1.73205 -0.577350 0.00000 0.577350 1.73205
```

See Also

TANH, ATAN, COS, SIN

For a list of other transcendental functions, see *Transcendental Mathematical Functions* on page 20, in Volume 1 of this reference.

TANH Function

Returns the hyperbolic tangent of the input variable.

Usage

result = TANH(x)

Input Parameters

x — The angle, in radians, that is evaluated.

Returned Value

result — The hyperbolic tangent of x.

Keywords

None.

Discussion

TANH is defined by:

$$\tanh(x) = \frac{e^{x} - e^{-x}}{e^{x} + e^{-x}}$$

If x is of double-precision floating-point or of complex data type, TANH yields a result of the same type. All other data types yield a single-precision floating-point result.

If x is an array, the result of TANH has the same dimensions, with each element containing the hyperbolic tangent of the corresponding element of x.

Example

```
x = [0.3, 0.5, 0.7, 0.9]
PRINT, TANH(x)
   0.291313   0.462117   0.604368   0.716298
```

See Also

COSH, SINH, TAN, ATAN

For a list of other transcendental functions, see *Transcendental Mathematical Functions* on page 20, in Volume 1 of this reference.

TAPRD Procedure

(VMS Only) Reads the next record on the selected tape unit into the specified array.

Usage

TAPRD, *array*, *unit* [, *byte_reverse*]

Input Parameters

array — A named variable into which the data should be read. The length of *array* and the records on the tape may range from 14 to 65,235 bytes.

- If *array* is larger than the tape record, the last portion of *array* is not changed.
- If *array* is shorter than the tape record, a data overrun error occurs.

unit — A number between 0 and 9 specifying the magnetic tape unit to rewind. (Do not confuse this parameter with file logical unit numbers.)

byte_reverse — If present, causes the even and odd numbered bytes to be swapped after reading, regardless of the type of data or variables. This facilitates reading tapes written on IBM machines.

Keywords

None.

Discussion

No data or format conversion, with the exception of optional byte reversal, is performed by TAPRD. The input array must be defined with the desired type and dimensions.

If the read is successful, the system variable !Err is set to the number of bytes read.

See Also

SKIPF, TAPWRT

For more information, see *Accessing Magnetic Tape* on page 229 of the *PV-WAVE Programmer's Guide.*

TAPWRT Procedure

(VMS Only) Writes data from the input array to the selected tape unit.

Usage

TAPWRT, *array*, *unit* [, *byte_reverse*]

Input Parameters

array — The variable from which the data should be output. May be an expression. The length of *array* and the records on the tape may range from 14 to 65,235 bytes.

unit — A number between 0 and 9 specifying the magnetic tape unit to rewind. (Do not confuse this parameter with file logical unit numbers.)

byte_reverse — If present, causes the even and odd numbered bytes to be swapped on output, regardless of the type of data or variables. This facilitates writing tapes compatible with IBM machines.

Keywords

None.

Discussion

One physical record containing the same number of bytes as *array* is written each time TAPWRT is called.

See Also

SKIPF, TAPRD

For more information, see *Accessing Magnetic Tape* on page 229 of the *PV-WAVE Programmer's Guide.*

TEK_COLOR Procedure

Standard Library procedure that loads a color table, which contains 32 distinct colors and is similar to the default Tektronix 4115 color table, into the display.

Usage

TEK_COLOR

Parameters

None.

Keywords

None.

Discussion

TEK_COLOR loads the first 32 elements of the color table with the Tektronix 4115 default color map. This creates a useful color table if you desire distinctive colors.

Example 1

```
b = FINDGEN(37)
x = b * 10
y = SIN(x * !Dtor)
```

Create an array containing the values for a sine function from 0 to 360 degrees.

```
PLOT, x, y, XRange=[0,360], XStyle=1, YStyle=1
```

Plot data and set the range to be exactly 0 to 360.

```
COLOR_PALETTE
```
Put up a window containing a display of the current color table and its associated color indices.

```
TEK_COLOR
```
Load a predefined color table that contains 32 distinct colors.

```
POLYFILL, x, y, Color=6
POLYFILL, x, y/2, Color=3
POLYFILL, x, y/6, Color=4
```
Fill in areas under the curve with different colors.

```
z = COS(x * !Dtor)
```
Create an array containing the values for a COS function from 0 to 360 degrees.

```
OPLOT, x, z/8, Linestyle=2, Color=5
```
Plot the cosine data on top of the sine data.

Example 2

This example creates a contour plot of the PV-WAVE Pike's Peak elevation data file, with the area in between the contour lines filled with a solid color.

```
OPENR, 1, !Data_dir + 'pikeselev.dat'
pikes = FLTARR(60, 40)
READF, 1, pikes
```
Read in the data file.

```
CLOSE, 1

c_pikes = FLTARR(62, 42)
c_pikes(1, 1) = pikes
```
Close any open contours.

```
TEK_COLOR
```
Load a color table.

```
CONTOUR, c_pikes, $
  Levels=[5,6,7,8,9,10,11,12,13,14,15]*1000,$
  Path='path.dat', XStyle=1, YStyle=1
```
Contour the data and store the results in file path.dat.

```
POLYCONTOUR, 'path.dat'
```

Display the contour plot with contours filled with solid colors.

```
pikes = REBIN(pikes, 600, 400)
```

Resize the original data so that it will be a good size when it is displayed.

```
TV, BYTSCL(pikes, Top=10)
```

Display the plot as an image similar to a polycontour. (Displaying the plot as an image gives you access to the various image processing and analysis routines, such as DEFROI, HISTOGRAM, and PROFILES.)

See Also

ADJCT, C_EDIT, COLOR_EDIT, COLOR_PALETTE, LOADCT, PALETTE, TVLCT

THREED Procedure

Standard Library procedure that plots a two-dimensional array as a pseudo three-dimensional plot on the currently selected graphics device.

Usage

THREED, *array* [, *space*]

Input Parameters

array — The two-dimensional array to plot.

space — The spacing between lines of the plot:

- If *space* is omitted, spacing will be set to `(MAX(A) - MIN(A))/ROWS`.
- If *space* is negative, no hidden lines will be removed.

Input Keywords

Title — A string containing the main plot title.

XTitle — A string containing the title of the X axis.

YTitle — A string containing the title of the Y axis.

Discussion

The orientation of the data plotted by THREED is fixed.

Example

```
OPENR, 1, !Data_dir + 'pikeselev.dat'
data = FLTARR(60, 40)
READF, 1, data
CLOSE, 1
THREED, data
SURFACE, data
```

See Also

SURFACE, T3D

TODAY Function

Returns a Date/Time variable containing the current system date and time.

Usage

result = TODAY()

Parameters

None.

Returned Value

result — A PV-WAVE Date/Time variable containing the current system date and time.

Keywords

None.

Example

```
dttoday = TODAY()
PRINT, dttoday
   {1992 4  29  14  47  55.0000  87521.617  0}

DT_PRINT, dttoday
   04/29/1992   14:47:55
```

See Also

DTGEN

For more information, see Chapter 7, *Working with Date/Time Data*, in the *PV-WAVE User's Guide*.

TOTAL Function

Sums the elements of an input array.

Usage

result = TOTAL(*array*)

Input Parameters

array – The array that is totalled. Can be of any data type except string.

Returned Value

result – A scalar value equal to the sum of all the elements of *array*.

Keywords

None.

Discussion

If *array* is of double-precision floating-point or complex data type, the result is of the same type. If *array* is any other data type, TOTAL returns single-precision floating-point.

Example

In this example, TOTAL is used to compute the sums of all elements in various rows and columns of a 3-by-2 integer array.

```
a = INDGEN(3, 2)
```

Create a 3-by-2 integer array. Each element has a value equal to its one-dimensional subscript.

```
PRINT, a
0       1       2
3       4       5
```

```
PRINT, TOTAL(a(*, 0))
```
Display the sum of the elements in the first row.

```
3.00000
```

```
PRINT, TOTAL(a(1, *))
```
Display the sum of the elements in the second column.

```
5.00000
```

```
PRINT, TOTAL(a)
```
Display the sum of all elements in the array.

```
15.0000
```

See Also

SIZE, AVG, MIN, MAX, MEDIAN

TQLI Procedure

Uses the QL algorithm with implicit shifts to determine the eigenvalues and eigenvectors of a real, symmetric, tridiagonal matrix.

Usage

TQLI, *d, e, z*

Input Parameters

d — An *n*-element vector. On input, it contains the diagonal elements of the matrix.

e — An *n*-element vector. On input, it contains the off-diagonal elements of the matrix. e_0 is arbitrary.

Output Parameters

d — An *n*-element vector. On output, it contains the eigenvectors.

e — An *n*-element vector. On output, it is destroyed.

z — A matrix containing the *n* eigenvectors. The eigenvectors are stored by rows; for example, *z (*, 0)* contains the first eigenvector.

Keywords

None.

Discussion

The TRED2 procedure may be used to reduce a real symmetric matrix to the tridiagonal form that is suitable for input to TQLI.

If the eigenvectors of a tridiagonal matrix are desired, *z* should be input as an identity matrix. If the eigenvectors of a matrix that has been reduced by TRED2 are desired, *z* should be input as the matrix Q output by TRED2.

TQLI is based on the routine of the same name found in *Numerical Recipes in C: The Art of Scientific Computing*, by Flannery, Press, Teukolsky, and Vetterling, Cambridge University Press, Cambridge, MA, 1988. It is used by permission.

Note However, because the order of subscripts in PV-WAVE are reversed in comparison to those in *Numerical Recipes*, the *z* matrix is transposed from the result described in that book.

Example

To determine the eigenvalues and eigenvectors of a real, symmetric matrix A:

```
asave = A
```
Save original matrix, as TRED2 destroys its input.

```
TRED2, A, d, e
```
Reduce matrix A to tridiagonal form.

```
TQLI, d, e, A
```
Obtain n eigenvalues in d, and n eigenvectors in A(*, i).

To verify the operation of these routines, use the definition of eigenvalues and eigenvectors. Matrix A is said to have an eigenvector x and corresponding eigenvalue λ if:

$$A \cdot x = \lambda x$$

This is demonstrated by the following code fragment:

```
FOR i=0, N_ELEMENTS(d)-1 DO BEGIN
```

For each eigenvector/value:

```
PRINT, 'Eigenvalue', i, '=', d(i)
```

Print the eigenvalue.

```
PRINT, 'Eigenvector = ', Aa(*,i)
```

Print the computed eigenvector.

```
PRINT, 'A x / lambda = ', asave # A(*,i)/d(i)
```

Print the eigenvector again. This row vector should be equal to the eigenvector printed above.

```
ENDFOR
```

See Also

TRED2

TRANSPOSE Function

Transposes the input array.

Usage

result = TRANSPOSE(*array*)

Input Parameters

array — The array to be transposed. Must have one or two dimensions.

Returned Value

result — The transposed array.

Keywords

None.

Discussion

TRANSPOSE provides a convenient way to convert a row vector into a column vector, or the reverse. For example, it can be used to change a two-dimensional array into a one-dimensional vector, or to change an *m-by-n* array into an *n*-by-*m* array.

Example 1

For example, executing the statements:

```
a = INDGEN(10)
```
a is a 10-element row vector.

```
b = TRANSPOSE(a)
```
b is a 10-element column vector.

```
INFO, a, b
```
Show the results.

gives the result:

```
a   INT = Array(10)
b   INT = Array(1, 10)
```

Example 2

TRANSPOSE can also be used to shift the elements of a square array around the diagonal. For example, suppose you have the following array:

$$\begin{bmatrix} 1 & 2 & 2 \\ 3 & 1 & 2 \\ 3 & 3 & 1 \end{bmatrix}$$

Applying TRANSPOSE to this array will yield the following result:

$$\begin{bmatrix} 1 & 3 & 3 \\ 2 & 1 & 3 \\ 2 & 2 & 1 \end{bmatrix}$$

Example 3

Here is what an aerial image looks like before and after applying TRANSPOSE.

Figure 2-57 TRANSPOSE has been used with this 512-by-512 aerial image to flip it diagonally (rotate it and create a mirror image).

See Also

INVERT, ROT, ROTATE

TRED2 Procedure

Reduces a real, symmetric matrix to tridiagonal form, using Householder's method.

Usage

TRED2, *a* [, *d* [, *e*]]

Input Parameters

a — An *n*-by-*n* real, symmetric matrix.

Output Parameters

a — This input parameter is replaced, on output, by the orthogonal matrix Q, effecting the transformation. The TQLI procedure uses this result to find the eigenvectors of the matrix A.

d — An *n*-element vector containing the diagonal elements of the tridiagonal matrix.

e — An *n*-element vector containing the off-diagonal elements of the tridiagonal matrix.

Keywords

None.

See Also

TQLI

TRED2 is based on a routine of the same name in *Numerical Recipes in C: The Art of Scientific Computing*, by Flannery, Press, Teukolsky, and Vetterling, Cambridge University Press, Cambridge, MA, 1988. It is used by permission.

TRIDAG Procedure

Solves tridiagonal systems of linear equations.

Usage

TRIDAG, *a, b, c, r, u*

Input Parameters

a — An *n*-element vector containing $n - 1$ subdiagonal elements. a_0 is ignored.

b — An *n*-element vector containing *n* diagonal elements.

c — An *n*-element vector containing $n - 1$ superdiagonal elements. c_{n-1} is ignored.

r — An *n*-element vector containing the right-hand side of the equation $\mathbf{A}^T\mathbf{u} = \mathbf{r}$.

Output Parameters

u — An *n*-element floating-point vector containing the solution for tridiagonal systems of linear equations.

Keywords

None.

Discussion

The input vectors *a, b, c,* and *r* are not modified by TRIDAG. They contain, respectively, the subdiagonal, diagonal, and superdiagonal elements of **A**, and the right-hand side of the equation:

$$\mathbf{A}^T\mathbf{u} = \mathbf{r}$$

The solution is stored in the variable *u*.

Note Because PV-WAVE subscripts are in column-row order, the above equation is written as $\mathbf{A}^T\mathbf{u} = \mathbf{r}$, rather than as $\mathbf{Au} = \mathbf{r}$.

See Also

LUBKSB, LUDCMP, MPROVE, SVBKSB

TRIDAG is based on a routine of the same name in *Numerical Recipes in C: The Art of Scientific Computing*, by Flannery, Press, Teukolsky, and Vetterling, Cambridge University Press, Cambridge, MA, 1988, and is used by permission.

TRNLOG Function

(VMS Only) Searches the VMS name tables for a specified logical name and returns the equivalence string(s) in a PV-WAVE variable.

Usage

result = TRNLOG(*logname, value*)

Input Parameters

logname — A scalar string containing the name of the logical to be translated.

Output Parameters

value — A variable into which the equivalence string is placed. If *logname* has more than one equivalence string, the first one is used.

Note that you can use the *Full_Translation* keyword to obtain all equivalence strings.

Returned Value

result — The VMS status code associated with the translation as a longword value:

- An odd value (the least significant bit is set) indicates success.
- An even value indicates failure.

Input Keywords

Acmode — An integer specifying the access mode to be used in the translation. Valid values are listed below:

0 Kernel

1 Executive

2 Supervisor

3 User

If you use the *Acmode* keyword, all names at access modes less privileged than the specified mode are ignored.

If you don't use *Acmode*, the translation proceeds without regard to access mode. However, the search proceeds from the outermost (User) to the innermost (Kernel) mode. Thus, if two logical names with the same name but different access modes exist in the same table, the name with the outermost access mode is used.

Full_Translation — If present and nonzero, specifies that *value* should be turned into a string array. Each element of this array is one of the equivalence strings.

If *Full_Translation* is not present, *value* only receives the first equivalence string as a scalar value, when translating a multi-valued logical name.

For example, under recent versions of VMS, the `SYS$SYSROOT` logical can have multiple values. To see these values from within PV-WAVE:

```
ret = TRNLOG('SYS$SYSROOT', trans, /Full, $
   /Issue_Error)
```

Translate the logical.

```
PRINT, trans
```

View the equivalence strings.

Issue_Error — If present and nonzero, causes TRNLOG to issue an error message if the translation fails.

Table — A scalar string giving the name of the logical table in which the search for *logname* will occur. If *Table* is not specified, the standard VMS logical tables are searched until a match is found, starting with `LNM$PROCESS_TABLE` and ending with `LNM$SYSTEM_TABLE`.

Output Keywords

Result_Acmode — If present, specifies a named variable into which the access mode value of the translated logical will be placed. (The access mode values are summarized in the *Input Keywords* section.)

Result_Table — If present, specifies a named variable into which the name of the logical table containing the translated logical will be placed, as a scalar string.

See Also

DELETE_SYMBOL, DELLOG, GET_SYMBOL, SETLOG, SET_SYMBOL

TV Procedure

Displays images without scaling the intensity.

Usage

TV, *image* [, *x*, *y* [, *channel*]]

TV, *image* [, *position*]

Input Parameters

image — A vector or two-dimensional matrix to be displayed as an image.

If *image* is not already of byte type, it is converted prior to use, although the conversion may distort the data contained in the image.

To insure data integrity, use the TVSCL procedure instead, which does a byte scaling before displaying the image.

x, y — The X and Y lower-left coordinates of the displayed image.

channel — The memory channel to be written. If not specified, it is assumed to be zero. This parameter is ignored on display systems that have only one memory channel.

position — Number specifying the position of the image. Positions run from the left of the window to the right, and from the top of the window to the bottom (see Discussion below for details).

Input Keywords

Centimeters — If present, specifies that all position values (the *x y* parameters and the *XSize* and *YSize* keywords) are in centimeters from the origin. This is useful when dealing with devices that do not provide a direct relationship between image pixels and the size of the resulting image, such as PostScript printers.

If *Centimeters* is not present, position values are taken to be in device coordinates.

Channel — The memory channel to be written. This keyword is identical to the *channel* input parameter; only one needs to be used.

Data — If present, specifies that all position and size values are in data coordinates. This is useful when drawing an image over an existing plot, since the plot establishes the data scaling.

Device — If present, specifies that all position and size values are in device coordinates. This is the default.

Inches — If present, specifies that all position and size values are in inches from the origin. This is useful when dealing with devices that do not provide a direct relationship between image pixels and the size of the resulting image, such as PostScript printers.

Normal — If present, specifies that all position and size values are in normalized coordinates in the range 0.0 to 1.0. This is useful when you want to draw an image in a device-independent manner.

Order — If specified, overrides the current setting of the !Order system variable for the current image only. If nonzero, *Order* causes the image to be drawn from the top-down, instead of from the bottom-up (the default).

True — If present and nonzero, indicates that a true-color (24-bit) image is to be displayed and specifies the index of the dimension over which color is interleaved:

1. Displays pixel-interleaved images of dimensions (3, *m*, *n*).
2. Displays row-interleaved images of dimensions (*m*, 3, *n*).
3. Displays image-interleaved images of dimensions (*m*, *n*, 3). (Image interleaving is also known as band interleaving.)

Note To use *True*, the *image* parameter must have three dimensions, one of which is equal to 3.

XSize — The width of the resulting image. This keyword is intended for devices with scalable pixel size (such as PostScript),

and is ignored by pixel-based devices that are unable to change the size of their pixels (such as a Sun Workstation monitor).

YSize — The height of the resulting image, with the same limitations as *XSize*.

Z — The Z position. The value of *Z* is of use only if the three-dimensional transformation is in effect via *T3D*.

Discussion

If *position* is used instead of the *x* and *y* parameters, the position of the image is calculated based on the largest grid of images of this size that will fit on the display, numbered from left to right and top to bottom. Specifically, the position is calculated as explained below.

The starting X coordinate position is defined as:

$$x = x_{dim} \bullet position_{moduloN_x}$$

The starting Y coordinate position is defined as:

$$y = YSize - y_{dim} \bullet int(1 + (position/N_x))$$

where

YSize is the height of the display or window,

x_{dim} and y_{dim} are the dimensions of the array,

and the images across the display surface are defined as:

$$N_x = \frac{Xsize}{Ysize}$$

For example, when displaying 128-by-128 images on a 512-by-512 display, the position numbers run from 0 to 15 as follows:

$$\begin{bmatrix} 0 & 1 & 2 & 3 \\ 4 & 5 & 6 & 7 \\ 8 & 9 & 10 & 11 \\ 12 & 13 & 14 & 15 \end{bmatrix}$$

Example 1

```
mandril = BYTARR(512, 512)
OPENR, unit, !Data_dir + 'mandril.img', $
   /Get_lun
READU, unit, mandril
FREE_LUN, unit
```

Read the PV-WAVE mandril demo image.

```
WINDOW, XSize=512, YSize=512
TV, mandril
```

Display the mandril image.

```
TV, mandril, /Order
```

Display the mandril image from bottom-up instead of top-down; this inverts the image.

```
small_img = CONGRID(mandril, 100, 100)
```

Interpolate a smaller mandril image of size 100-by-100 pixels.

```
CONTOUR, small_img
TV, small_img, 0, 0, /Data
```

Create a contour plot of the data and overlay the image at the origin, specifying the image position in data coordinates.

```
FOR i=0, 24 DO TV, small_img, i
```

Tile the entire window with mandrils, using the position parameter rather than specifying X and Y locations.

Example 2

This example uses TV in conjunction with the REBIN and CONGRID procedures to enlarge small images.

```
data = BYTSCL(DIST(60))
```

Create the data.

```
TV, data
```

Display the data.

```
LOADCT, 5
```

Load a color table.

```
enlarge = REBIN(data, 480, 480)
```
Enlarge the original data.

```
TV, enlarge
```
Display the area enlarged with REBIN.

```
enlarge = REBIN(data, 480, 480, /Sample)
```

```
TV, enlarge
```
Redisplay the area enlarged with REBIN using the nearest neighbor method for the sampling.

```
enlarge = CONGRID(data, 480, 480)
```

```
TV, enlarge
```
Display the area enlarged with CONGRID.

```
enlarge = CONGRID(data, 480, 480, /Interp)
```

```
TV, enlarge
```
Redisplay the area enlarged with CONGRID using the bilinear interpolation method for the sampling.

See Also

!Order, BYTSCL, TVCRS, TVLCT, TVRD, TVSCL

For more information, see *Image Display Routines: TV and TVSCL* on page 136 of the *PV-WAVE User's Guide*.

TVCRS Procedure

Manipulates the cursor within a displayed image, allowing it to be enabled and disabled, as well as positioned.

Usage

TVCRS [, *on_off*]

TVCRS [, *x*, *y*]

Input Parameters

on_off — Specifies whether the cursor should be on or off. If present and nonzero, enables the cursor. If zero or not specified, disables the cursor.

x — The column to which the cursor will be positioned.

y — The row to which the cursor will be positioned.

Input Keywords

Centimeters — If present, specifies that all position values are in centimeters from the origin.

Data — If present and nonzero, specifies that the cursor position is in data coordinates.

Device — If present and nonzero, specifies that the cursor position is in device coordinates.

Hide — If present and nonzero, causes a disabled cursor to always be blanked out.

By default, disabling the cursor works differently for window systems than for other devices. For window systems, the cursor is restored to the standard cursor used for non-PV-WAVE windows (and remains visible), while for other devices it is complete-ly blanked out.

Inches — If present, specifies that all position values are in inches from the origin.

Normal — If present and nonzero, specifies that the cursor position is in normalized coordinates.

T3D — If present, indicates that the generalized transformation matrix in !P.T is to be used. (For a description of !P.T, see the *Save* plotting keyword in Chapter 3, *Graphics and Plotting Keywords*.)

If not present, the user-supplied coordinates are simply scaled to screen coordinates.

Z — The Z position. The value of *Z* is of use only if the three-dimensional transformation is in effect via the *T3D* keyword.

Discussion

Normally, the cursor is disabled and is not visible. Using TVCRS with one parameter allows the cursor to be enabled or disabled, while using TVCRS with two parameters enables the cursor and places it on pixel location (X, Y).

Example

To enable the image display cursor and position it at device coordinate, use the following command:

```
TVCRS, 100, 100
```

To enable the image display cursor and position it at data coordinate, use the following command:

```
TVCRS, 0.5, 3.2, /Data
```

To disable and hide the image display cursor, use the following command:

```
TVCRS, /Hide_Cursor
```

To enable the image display cursor but not set the cursor position, use the following command:

```
TVCRS, 1
```

See Also

TVRD, CURSOR

For more information, see *Image Display Routines: TV and TVSCL* on page 136 of the *PV-WAVE User's Guide.*

TVLCT Procedure

Loads the display color translation tables from the specified variables.

Usage

TVLCT, v_1, v_2, v_3 [, *start*]

Input Parameters

v_1, v_2, v_3 — Contain the three values to be used for the specified color system (HLS, HSV, or RGB, as detailed in the Discussion section below). May be either scalar or vector expressions.

start — An integer value specifying the starting point in the color translation table into which the color intensities are loaded.

If *start* is not specified, a value of zero is used, causing the tables to be loaded starting at the first element of the translation tables.

Input Keywords

Hls — Indicates that the parameters specify color using the HLS color system.

Hsv — Indicates that the parameters specify color using the HSV color system.

Output Keywords

Get — If set to 1, returns the actual RGB values loaded into the device when either the *Hls* or *Hsv* keywords are present. (The *Get* keyword has no effect when loading RGB tables.)

For example, the statements:

```
TVLCT, H, S, V, /Hsv
TVLCT, R, G, B, /Get
```

load a color table based on the HSV system, and store the equivalent RGB values into the `H`, `S`, and `V` vectors.

Discussion

Color tables may be based on the following color systems: RGB (Red Green Blue, the default), HLS (Hue Lightness Saturation), and HSV (Hue Saturation Value).

The meaning and type for the v_1, v_2, and v_3 parameters are dependent upon the color system selected, as described below. If no color-system keywords are present, the RGB color system is used.

- **HLS** – Parameters contain the Hue, Lightness, and Saturation values. All parameters are floating-point. Hue is expressed in degrees and is reduced modulo 360. v_2 and v_3 may range from 0 to 1.0.
- **HSV** – Parameters contain the Hue, Saturation, and Value (similar to intensity) values. All parameters are floating-point. Hue is expressed in degrees. The Saturation and Value may range from 0 to 1.0.
- **RGB** – Parameters contain the Red, Green, and Blue values. Values are interpreted as integers in the range of 0 to 255 (255 being full intensity). May be scalars or may contain up to 256 elements.

See Also

LOADCT, MODIFYCT, COLOR_EDIT, STRETCH, TEK_COLOR, WgCtTool

For more information, including a comparison of TVLCT and LOADCT, see *Experimenting with Different Color Tables* on page 310 of the *PV-WAVE User's Guide*.

TVMENU Function

Standard Library procedure that creates an interactive menu.

Usage

result = TVMENU(*text* [, *title*, *x*, *y*])

Input Parameters

text — A string array with each element containing the text of one menu choice.

title — A string containing the title of the menu. The default is "Menu".

x — The X location of the lower-left corner of the menu, given in number of pixels from the lower-left corner of the display screen.

y — The Y location of the lower-left corner of the menu, given in number of pixels from the lower-left corner of the display screen.

Returned Value

result — The index of the choice. Values range from 0 (the first element in *text*) to one less than the number of elements in *text*.

Keywords

None.

Discussion

TVMENU is similar to the WMENU procedure. However, TVMENU creates a menu that can be positioned with the *x* and *y* parameters, and places it in a separate window.

This menu displays, in a column, the list of strings that were input as the *text* parameter. It waits while you use the mouse to click on the string of your choice. It then stores the value of that choice in

the returned variable name. (Remember that PV-WAVE starts counting at 0, so your returned value will be one less than its position on the menu.)

Example

```
a = 5.
b = 7.
n = TVMENU(['add', 'subtract', 'multiply', $
   'divide'], 'Choose one:', 100, 100)
```

Display the menu, and then make your choice by clicking with the mouse.

```
.RUN
- CASE n OF
- 0:PRINT, 'a+b=', a+b
- 1:PRINT, 'a-b=', a-b
- 2:PRINT, 'a*b=', a*b
- 3:PRINT, 'a/b=', a/b
- ENDCASE
- END
```

Set up a case statement to perform the chosen function.

```
n = TVMENU(['add', 'subtract', 'multiply', $
   'divide'], 'Choose one:', 100, 100)
```

Display the menu again.

```
.GO
```

Rerun the saved program.

See Also

WMENU

TVRD Function

Returns the contents of the specified rectangular portion of a displayed image.

Usage

result = TVRD(x_0, y_0, n_x, n_y [, *channel*])

Input Parameters

x_0 — Starting column of data to read.

y_0 — Starting row of data to read.

n_x — Number of columns to read.

n_y — Number of rows to read.

channel — The memory channel to be read. If not specified, it is assumed to be zero. This parameter is ignored on display systems that only have one memory channel.

Returned Value

result — Byte array of dimensions n_x-by-n_y.

Note If the display is a 24-bit display, and both the *channel* parameter and *True* keyword are absent, the maximum RGB value in each pixel is returned.

Input Keywords

Channel — The memory channel to be read. This keyword is identical to the *channel* input parameter; only one needs to be specified.

Order — If specified, overrides the current setting of the !Order system variable for the current image only. If nonzero, *Order* causes the image to be drawn from the top-down, instead of from the bottom-up (the default).

True — If present and nonzero, indicates that a true-color (24-bit) image is to be read and specifies the index of the dimension over which color is interleaved:

1 Displays an array that is pixel-interleaved and has dimensions of (3, n_x, n_y).

2 Displays a line-interleaved array of dimensions (n_x, 3, n_y).

3 Displays an image-interleaved array of dimensions (n_x, n_y, 3).

Example

For an example of TVRD, see the REBIN function.

See Also

!Order, TV, TVSCL, ZOOM

For more information, see *Image Display Routines: TV and TVSCL* on page 136 of the *PV-WAVE User's Guide*.

TVSCL Procedure

Scales the intensity values of an input image into the range of the image display, usually from 0 to 255, and outputs the data to the image display at the specified location.

Usage

TVSCL, *image* [, *x*, *y* [, *channel*]]

TVSCL, *image* [, *position*]

Input Parameters

image — A vector or two-dimensional matrix to be displayed as an image. If *image* is not already of byte type, it is converted prior to use.

x*, *y — The X and Y lower-left coordinates of the displayed image.

channel — The memory channel to be written. If not specified, it is assumed to be zero. This parameter is ignored on display systems that have only one memory channel.

position — Number specifying the position of the image. Positions run from the left of the window to the right, and from the top of the window to the bottom (see Discussion below for details).

Input Keywords

Centimeters — If present, specifies that all position values (the *x* *y* parameters and the *XSize* and *YSize* keywords) are in centimeters from the origin. This is useful when dealing with devices that do not provide a direct relationship between image pixels and the size of the resulting image, such as PostScript printers.

If *Centimeters* is not present, position values are taken to be in device coordinates.

Channel — The memory channel to be written. This keyword is identical to the *channel* input parameter; only one needs to be used.

Data — If present, specifies that all position and size values are in data coordinates. This is useful when drawing an image over an existing plot, since the plot establishes the data scaling.

Device — If present, specifies that all position and size values are in device coordinates. This is the default.

Inches — If present, specifies that all position and size values are in inches from the origin. This is useful when dealing with devices that do not provide a direct relationship between image pixels and the size of the resulting image, such as PostScript printers.

Normal — If present, specifies that all position and size values are in normalized coordinates in the range 0.0 to 1.0. This is useful when you want to draw an image in a device-independent manner.

Order — If specified, overrides the current setting of the !Order system variable for the current image only. If nonzero, *Order* causes the image to be drawn from the top-down, instead of from the bottom-up (the default).

True — If present and nonzero, indicates that a true-color image is to be displaced and specifies the index of the dimension over which color is interleaved:

1. Displays pixel-interleaved images of dimensions (3, *m*, *n*).
2. Displays row-interleaved images of dimensions (*m*, 3, *n*).
3. Displays image-interleaved images of dimensions (*m*, *n*, 3). (Image interleaving is also known as band interleaving.)

Note To use *True*, the *image* parameter must have three dimensions, one of which is equal to 3.

XSize — The width of the resulting image. This keyword is intended for use by devices with scalable pixel size (such as PostScript), and is ignored by pixel-based devices that are unable to change the size of their pixels.

YSize — The height of the resulting image, with the same limitations as *XSize*.

Discussion

If *position* is used instead of the *x* and *y* parameters, the position of the image is calculated based on the largest grid of images of this size that will fit on the display, numbered from left to right and top to bottom. Specifically, the position is calculated as explained below.

The starting X coordinate position is defined as:

$$x = x_{dim} \bullet position_{moduloN_x}$$

The starting Y coordinate position is defined as:

$$y = YSize - y_{dim} \bullet int(1 + (position/N_x))$$

where

YSize is the height of the display or window,

x_{dim} and y_{dim} are the dimensions of the array,

and the images across the display surface are defined as:

$$N_x = \frac{Xsize}{Ysize}$$

For example, when displaying 128-by-128 images on a 512-by-512 display, the position numbers run from 0 to 15 as follows:

$$\begin{bmatrix} 0 & 1 & 2 & 3 \\ 4 & 5 & 6 & 7 \\ 8 & 9 & 10 & 11 \\ 12 & 13 & 14 & 15 \end{bmatrix}$$

Example

This example uses TVSCL and TV to exhibit the difference between images whose intensity values are scaled into the full range of the image display and images that have not been scaled.

```
OPENR, unit, FILEPATH('aerial_demo.img', $
   Subdir='data'), /Get_Lun
```

Open the file containing the image.

```
img = BYTARR(512, 512)
```

Create an array large enough to hold the image.

```
READU, unit, img
```

Read the image data.

```
FREE_LUN, unit
```

Close the file and free the file unit number.

```
WINDOW, 0, Xsize = 1024, Ysize = 512
```

Create a window large enough to hold two 512-by-512 images.

```
TV, img
```

Display the original image in the left half of the window.

```
TVSCL, img, 1
```

Use TVSCL to display the scaled image in the right half of the window.

Figure 2-58 Unscaled image (left); scaled image (right).

See Also

!Order, BYTSCL, TVCRS, TVLCT, TVRD, TV

For more information, see *Image Display Routines: TV and TVSCL* on page 136 of the *PV-WAVE User's Guide.*

UNIQUE Function

Returns a vector (one-dimensional array) containing the unique elements from another vector.

Usage

result = UNIQUE(*vec*)

Input Parameters

vec — A vector containing duplicate values.

Returned Value

result — A new vector containing the unique elements of the original vector.

Keywords

None.

Discussion

This function works on any vector (one-dimensional array) variable.

Example 1

For a very simple example, suppose you have a vector defined as:

```
vec = [1,1,2,2,3,3,4,4,5,5]
```

The following command produces a new vector containing only the unique elements of `vec`:

```
result = UNIQUE(vec)

print, result
   1   2   3   4   5
```

Example 2

With UNIQUE, you can determine the unique values in any column of a table.

For example, a table called `phone_data` contains information on phone calls made during a three-day period. This table contains eight columns of phone information: the date, time, caller's initials, phone extension, area code of call, number of call, duration, and cost. (For more information on the structure of this table, see Chapter 8, *Creating and Querying Tables*, in the *PV-WAVE User's Guide*.)

To obtain a list of the dates on which calls were made.

```
dates = UNIQUE(phone_data.DATE)
```

Note that tables are represented internally in PV-WAVE as an array of structures. In this command, `phone_data.DATE` represents the `DATE` field of the structure called `phone_data`.

The result is a one-dimensional variable called `dates` that contains a list of the dates on which calls were made:

```
PRINT, dates
   901002  901003  901004
```

Example 3

In some applications, it may be possible to generate the text for menu buttons from the unique elements in a table column. For example, the following commands display a menu of dates. The menu selection is then passed into the QUERY_TABLE function where the total cost of calls is calculated for that date.

```
unique_date = UNIQUE(phone_data.DATE)
```

Find the unique dates in the phone_data table.

```
date_pick = unique_date $
   (WMENU(STRING(unique_date)))
```

Display a menu of unique dates. The menu selection returns the selected date to the variable date_pick. Note that the parameter passed to WMENU must be type string.

```
total_cost = QUERY_TABLE(phone_data, $
   'DATE, SUM(COST) Where DATE = ' +$
   'date_pick Group By DATE')
```

Find the total cost of calls made on the selected date.

See Also

QUERY_TABLE, BUILD_TABLE

UNIX_LISTEN Function

Standard Library function that allows PV-WAVE to be called by external routines written in C.

Usage

result = UNIX_LISTEN ( )

Parameters

None.

Returned Value

result — The number of parameters returned to UNIX_LISTEN.

Input Keywords

Procedure — A string that is set by the client and retrieved by UNIX_LISTEN. Its intended use is to control program flow within the server (PV-WAVE).

User — A string that is set by the client and retrieved by UNIX_LISTEN. Its intended use is for controlling access to the server, as an authentication mechanism.

Program — An integer used as an identifier for the external routines. If an external routine (or client) calls `call_wave`, UNIX_LISTEN checks if the value of *Program* matches the value

of the program parameter in `call_wave` sent by the client. The client's program identifier is set by the program parameter in the `call_wave` function call.

Discussion

UNIX_LISTEN waits until an external routine calls the function `call_wave`, and then returns the number of parameters passed to UNIX_LISTEN.

Parameters are passed into PV-WAVE through the common block UT_COMMON. A maximum of thirty parameters can be passed to PV-WAVE.

The common block UT_COMMON is included in the server routine with the command `@UT_COMMON`. The first of the thirty available parameters is `ut_param0`, the second is `ut_param1`, and the thirtieth parameter is `ut_param29`.

As well as being returned by UNIX_LISTEN, the number of parameters is also contained in the variable `ut_num_params` in the UT_COMMON common block.

See Also

CALL_UNIX, LINKNLOAD, SPAWN, UNIX_REPLY

For more information and an example, see IntChapter 13, *Interapplication Communication*, in the *PV-WAVE Programmer's Guide*.

UNIX_REPLY Function

Standard Library function that allows PV-WAVE to return a value or values that it has calculated to an external routine written in C.

Usage

result = UNIX_REPLY(*reply*)

Input Parameters

reply — A variable of any data type, except of type structure, representing the result of an operation that PV-WAVE, as a server, has performed.

Returned Value

result — A number indicating the status of the reply operation. A return value of –1 indicates an error. Errors can also be trapped by the ON_IOERROR routine.

Output Keywords

Return_Params — If present and nonzero, causes UNIX_REPLY to return the modified parameters to the client. The number of parameters to be sent back is the same as the number that came in with UNIX_LISTEN. This number is tracked internally by PV-WAVE.

See Also

CALL_UNIX, LINKNLOAD, ON_IOERROR, SPAWN, UNIX_LISTEN

For more information and an example, see Chapter 13, *Interapplication Communication*, in the *PV-WAVE Programmer's Guide*.

USERSYM Procedure

Lets you create a custom symbol for marking plotted points.

Usage

USERSYM, *x* [, *y*]

Input Parameters

x, *y* — Vectors containing the X,Y vertices of the symbol to be created. *x* and *y* are offsets from the data point, in units of approximately the size of a character. In other words, a value of 1 corresponds to the actual X or Y size of a character, while a value of .5 is equal to one-half the character size.

In the case of vector-drawn symbols, these vertices are connected, in order, with vectors forming the symbol.

If only *x* is specified, it must be a (2, *n*) array of vertices, with element (0, *i*) containing the X coordinate of the vertex, and element (1, *i*) containing the Y coordinate.

Input Keywords

Color — An integer specifying the color used to draw the symbols, or used to fill the polygon. The default is the line color.

Fill — A flag which, if set, fills the polygon defined by the vertices. If *Fill* is not set, lines are drawn connecting the vertices.

Thick — The thickness of the lines drawn in constructing the symbol. The default is 1.0.

Discussion

Symbols may be drawn with vectors or may be filled. Symbols may be of any size and may have up to 50 vertices. To use a user-defined symbol, set the value of the *Psym* plotting keyword or the !Psym system variable to +8 or –8.

Example

This example uses USERSYM to define a plotting symbol that resembles a house. The *Fill* keyword is used to fill the interior of the polygon defining the house. Six random points are then plotted using the house symbol to mark the data points.

The *Psym* keyword, in the call to PLOT, is given a value of -8 so that the data points are connected by lines. Also, the *Symsize* keyword is used with a value of 6 to increase the size of the plotting symbols. This example uses PV-WAVE Advantage procedures RANDOMOPT and RANDOM.

```
x = [0, -0.5, -0.5, 0.5, 0.5, 0]
```

```
y = [0.5, 0, -1, -1, 0, 0.5]
```

Define the x- and y-coordinates of the vertices.

```
USERSYM, x, y, /Fill
```

Create the filled symbol.

```
RANDOMOPT, Set = 12542
```

Generate six random points.

```
pts = RANDOM(6)
```

```
PLOT, pts, Psym = -8, Symsize = 6, $
   Xrange = [-0.1, 5.1]
```

Plot the points, using the new user-defined symbol.

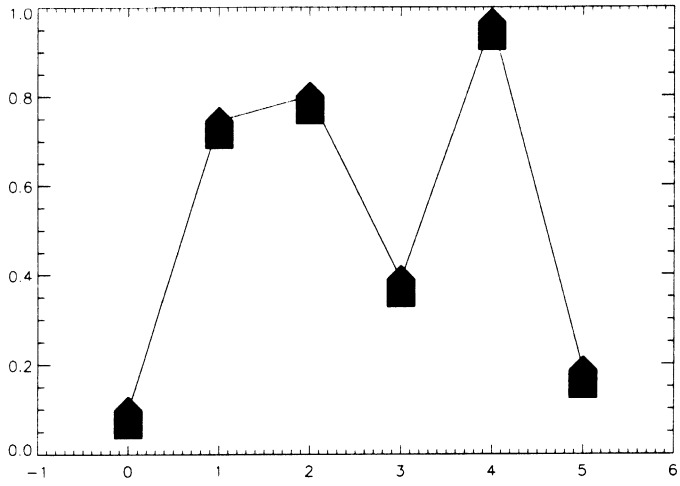


Figure 2-59 Scattered data plot with user-defined markers for data points.

See Also

!P.Psym system variable

Psym and Symsize plotting keywords

VAR_TO_DT Function

Converts scalar or array values representing dates and times to PV-WAVE Date/Time variables.

Usage

result = VAR_TO_DT (*yyyy*, *mm*, *dd*, *hh*, *mn*, *ss*)

Input Parameters

yyyy — A scalar or array containing year number(s).

mm — A scalar or array containing month number(s) (1 – 12).

dd — A scalar or array containing day number(s) (1 – 31).

hh — A scalar or array containing hour number(s) (0 – 23). If zero or not specified, *hh* is 0 hours.

mn — A scalar or array containing minute number(s) (0 – 59). If zero or not specified, *mn* is 0 minutes.

ss — A scalar or array containing second number(s) (0.0000 – 59.9999). If zero or not specified, *ss* is 0.0 seconds.

Returned Value

result — A PV-WAVE Date/Time variable containing the converted values.

Keywords

None.

Discussion

Use this function to create Date/Time variables from time stamp data that does not conform to a format used by the STR_TO_DT function. For example, you can read the date and time data into atomic PV-WAVE variables representing each of the date and time elements (i.e., year, month, day, etc.). Then the variables can be converted to Date/Time variables using VAR_TO_DT.

If the year, month, and day values are all zero, then the value of the !DT_Base system variable is used for the date portion of the resulting Date/Time variable.

The parameters can be arrays of any numeric values, but all parameters must have the same dimension; that is, the parameters must be either all scalars or all arrays of the same size. Also you can only omit parameters from the end of the parameter list.

Example 1

This example illustrates how to convert a single date value into PV-WAVE Date/Time variable.

```
z = VAR_TO_DT(1992, 11, 22, 12, 30)
```

Note that seconds have been omitted. This command creates a Date/Time variable containing November 22, 1992 at 12:30.

```
PRINT, z
   { 1992 11 22 12 30 0.00000 87728.521 0}

DT_PRINT, z
   11/22/1992   12:30:00
```

Example 2

This example illustrates how to return a PV-WAVE Date/Time variable for an array containing values representing dates.

```
years = [1992,1993]
months = [3,4]
days = [17,18]
```

Create arrays that contain Date/Time information for two days.

```
y = VAR_TO_DT(years, months, days)
```
Convert the Date/Time arrays to a Date/Time structure variable.

```
DT_PRINT, y
   03/17/1992
   04/18/1993
```

See Also

DT_TO_VAR, STR_TO_DT, SEC_TO_DT, JUL_TO_DT

For more information, see the Chapter 7, *Working with Date/Time Data*, in the *PV-WAVE User's Guide*.

VECTOR_FIELD3 Procedure

Plots a 3D vector field from three arrays.

Usage

VECTOR_FIELD3, *vx, vy, vz, n_points*

Input Parameters

vx — A 3D array containing the X component of the vector field, or an *n*-element vector containing the X component of the vector field.

vy — A 3D array containing the Y component of the vector field, or an *n*-element vector containing the Y component of the vector field.

vz — A 3D array containing the Z component of the vector field, or an *n*-element vector containing the Z component of the vector field.

Note The arrays *vx, vy,* and *vz* must be the same size.

n_points — If v*x, vy,* and *vz* are all 3D arrays and *n_points* is a (3, *n*) array, then *n_points* is used to specify where the vectors are plotted.

If *vx*, *vy*, and *vz* have the dimensions (*i,j,k*), then:

n_points(0,)* should range between 0 and i – 1

n_points(1,)* should range between 0 and j – 1

n_points(2,)* should range between 0 and k – 1

If *vx*, *vy*, and *vz* are all 3D arrays and *n_points* is a single positive value n, then *n* vectors are plotted with random starting locations.

If *vx*, *vy*, and *vz* are all 3D arrays and *n_points* is zero or negative, then one vector is plotted for each element in *vx*.

If *vx*, *vy*, and *vz* are *n*-element vectors and *n_points* is a (3, *n*) array, then the starting locations for each vector are taken from *n_points*.

Input Keywords

Axis_Color – The color to use when plotting the axis. To suppress the axis, set *Axis_Color* to –1.

Mark_Color – The color index to use when plotting the markers.

Mark_Size – The marker size.

Mark_Symbol – A number ranging from 1 to 7 defining the marker symbol to use. The default is 3 (a period). Markers are plotted at the tail of each vector. For a list of symbols, see the description of !Psym in Chapter 4, *System Variables*.

Max_Color – The highest color index to use when plotting.

Min_Color – The lowest color index to use when plotting. The color of each vector ranges from *Min_Color* to *Max_Color*.

Max_Length – A scalar value for the maximum plotted length of each vector. Each vector ranges from zero to *Max_Length*.

Thick – The line thickness (in pixels) to use when plotting vectors.

Vec_Color – A 3D array (with the same dimensions as *vx*) containing the data for the vector colors.

A vector plotted where *Vec_Color* is at its maximum has the color *Max_Color*, while a vector plotted at a location where *Vec_Color* is minimum has the color *Min_Color*.

If *Vec_Color* is not supplied, then the color of each vector is determined by its length.

Discussion

VECTOR_FIELD3 plots a 3D velocity vector field from volumetric or 3D data.

Examples

```
PRO vec_demo1
```
This program displays a 3D vector field from X, Y, Z data.

```
winx = 800
winy = 600
```
Specify the window size.

```
v_num = 1000
```
Specify the number of vectors.

```
xvec = FLTARR(v_num)
yvec = FLTARR(v_num)
zvec = FLTARR(v_num)
points = FLTARR(3, v_num)
```
Create the arrays for the vectors and their starting points.

```
FOR k=0, 9 DO BEGIN
   FOR j=0, 9 DO BEGIN
      FOR i=0, 9 DO BEGIN
      ind = i + (j * 10) + (k * 10 * 10)
        xvec(ind) = COS(!PI * FLOAT(i)/10.0)
        yvec(ind) = SIN(!PI * FLOAT(j)/10.0)
        zvec(ind) = SIN(!PI * FLOAT(k)/10.0)$
          + COS(!PI * FLOAT(i)/10.0)
        points(*, ind) = [i, j, k]
      ENDFOR
```

```
   ENDFOR
ENDFOR
```

Create the data for the vectors and their starting points.

```
T3D, /Reset
T3D, Translate=[-0.5, -0.5, -0.5]
T3D, Scale=[0.5, 0.5, 0.5]
T3D, Rotate=[0.0, 0.0, -30.0]
T3D, Rotate=[-60.0, 0.0, 0.0]
T3D, Translate=[0.5, 0.5, 0.5]
```

Set up the transformation matrix for the view.

```
WINDOW, 0, XSize=winx, YSize=winy, $
   XPos=256, YPos=128, Colors=128, $
   Title='3-D Velocity Vector Field'
LOADCT, 4
```

Set up the viewing window and load the color table.

```
VECTOR_FIELD3, xvec, yvec, zvec, points, $
   Max_Length=0.5, Min_Color=32, $
   Max_Color=127, Axis_Color=100, $
   Mark_Symbol=3, Mark_Color=127, $
   Mark_Size=0.5, thick=2
```

Plot the vector field with the vector directions defined by *xvec*, *yvec*, and *zvec*, and the vector starting points defined by *points*.

```
END
```

For other examples, see the `vec_demo2` and `vol_demo1` demonstration programs in `$WAVE_DIR/demo/arl`.

See Also

VOL_MARKER

VEL Procedure

Standard Library procedure that draws a graph of a velocity field with arrows pointing in the direction of the field. The length of an arrow is proportional to the strength of the field at that point.

Usage

VEL, *u*, *v*

Input Parameters

u — The X component of the velocity field at each point. Must be a two-dimensional array.

v — The Y component of the velocity field at each point. Must have the same dimensions as *u*.

Input Keywords

Nvecs — The number of arrows to draw. The default is 200.

Xmax — The aspect ratio (the X axis size as a fraction of the Y axis size). The default is 1.0.

Length — The length of each arrow segment, expressed as a fraction of the longest arrow divided by *Nsteps*. *Length* is used to calculate the proportional length of each arrow segment. The default is 0.1.

Nsteps — The number of segments in each arrow. The default is 10.

Discussion

VEL selects *Nvecs* random points within the boundary of the (*u*, *v*) arrays. At each point, the field is bilinearly interpolated from the (*u*, *v*) arrays and a vector of the correct proportional length is drawn.

The field is recalculated at the endpoint of this vector and a new vector is iteratively drawn, until an arrow with *Nsteps* number of segments is drawn.

An arrowhead is drawn at the end of this arrow, and the procedure moves on to another random point to initiate the loop again. The graph is plotted with the title "Velocity Field".

Caution 

Extra care must be taken if you run the PLOT_FIELD and VEL procedures in the same PV-WAVE session. Each procedure calls a routine named ARROWS, but the ARROWS routines are slightly different. If you get an error in the ARROWS routine when you are using VEL, recompile VEL (by typing `.RUN VEL`), and then try again.

Example

```
u = FLTARR(21, 21)
v = FLTARR(21, 21)
```

Create the arrays.

```
.RUN
```

After you type .RUN, the WAVE prompt changes to a dash (–) to indicate that you may enter a complete program unit.

```
- FOR j = 0, 20 DO BEGIN
- FOR i = 0, 20 DO BEGIN
- x = 0.05 * FLOAT(i)
- z = 0.05 * FLOAT(j)
- u(i, j) = -SIN(!Pi*x) * COS(!Pi*z)
- v(i, j) = COS(!Pi*x) * SIN(!Pi*z)
- ENDFOR
- ENDFOR
- END
```

This procedure stuffs values into the arrays; the last END exits the programming mode, compiles and executes the procedure, and then returns you to the WAVE prompt.

```
VEL, u, v
```

Display the velocity field with default values.

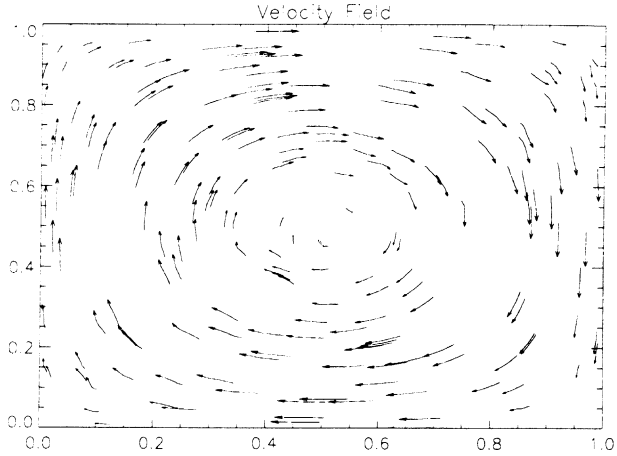


Figure 2-60 Velocity field displayed with default values.

```
VEL, u, v, Nvecs=400
```

Display the velocity field using 400 arrows.

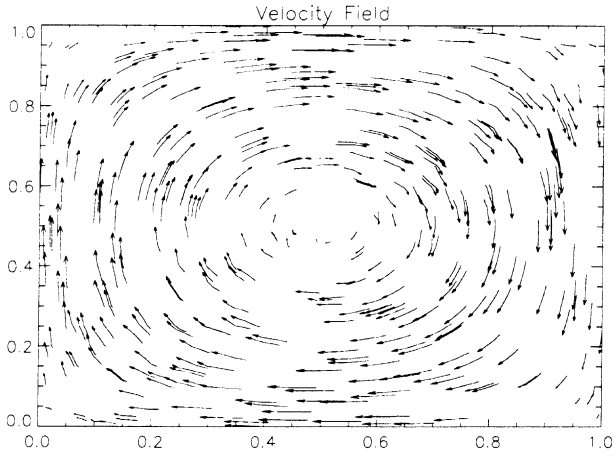


Figure 2-61 Velocity field displayed with 400 arrows.

```
VEL, u, v, Nvecs=40, Xmax=.7, Length=.4, $
   Nsteps=20
```

Display the velocity field with individual modifications.

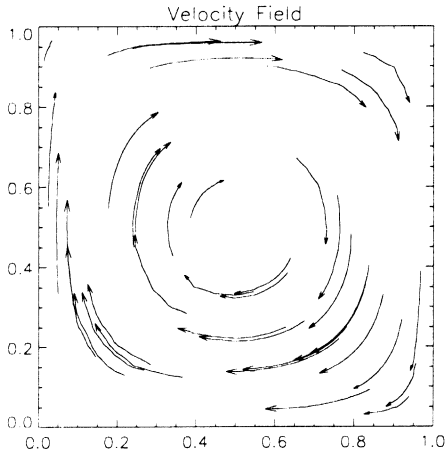


Figure 2-62 Velocity field displayed using various keywords.

See Also

PLOT_FIELD, VELOVECT

VELOVECT Procedure

Standard Library procedure that draws a two-dimensional velocity field plot, with each directed arrow indicating the magnitude and direction of the field.

Usage

VELOVECT, *u*, *v* [, *x*, *y*]

Input Parameters

u — The X component of the two-dimensional field. Must be a two-dimensional array.

v — The Y component of the two-dimensional field. Must be a two-dimensional array of the same size as *u*.

x — The abscissa values. Must be a vector. The size of *x* must equal the first dimension of *u* and *v*.

y — The ordinate values. Must be a vector. The size of *y* must equal the second dimension of *u* and *v*.

Input Keywords

Dots — If present and nonzero, places a dot at the position of the missing data. Otherwise, nothing is drawn for missing points. *Dots* is only valid if the *Missing* keyword is also specified.

Length — A length factor. The default value is 1.0, which makes the longest (*u*, *v*) vector have a length equal to the length of a single cell.

Missing — A two-dimensional array with the same size as the *u* and *v* arrays. It is used to specify that specific points have missing data.

If the magnitude of the vector at (*i*, *j*) is less than the corresponding value in *Missing*, then the data is considered to be valid. Otherwise, the data is considered to be missing.

Thus, one way to set up a *Missing* array is to initialize all elements to some large value:

```
missing_array = FLTARR(n, m) + 1.0E30
```

Then, if point (*i, j*) is a missing point, set the corresponding element to a negative value:

```
missing_array(i, j) = -missing_array(i, j)
```

Discussion

VELOVECT draws a two-dimensional velocity field plot. The arrows indicate the magnitude and the direction of the field.

If missing values are present, you can use the *Missing* keyword to specify that they be ignored during the plotting, or the *Dots* keyword to specify that they be marked with a dot.

The system variables !X.Title, !Y.Title, and !P.Title may be used to title the axes and the main plot.

Example

```
u = FLTARR(21, 21)
v = FLTARR(21, 21)
```

Create the arrays.

```
.RUN
```

After you type .RUN, the WAVE prompt changes to a dash (–) to indicate that you may enter a complete program unit.

```
- FOR j = 0, 20 DO BEGIN
- FOR i = 0, 20 DO BEGIN
- x = 0.05 * FLOAT(i)
- z = 0.05 * FLOAT(j)
- u(i, j) = -SIN(!Pi*x) * COS(!Pi*z)
- v(i, j) = COS(!Pi*x) * SIN(!Pi*z)
- ENDFOR
- ENDFOR
- END
```

This procedure stuffs values into the arrays; the last END exits the programming mode, compiles and executes the procedure, and then returns you to the WAVE prompt.

```
VELOVECT, u, v
```

Display the velocity field with default values.

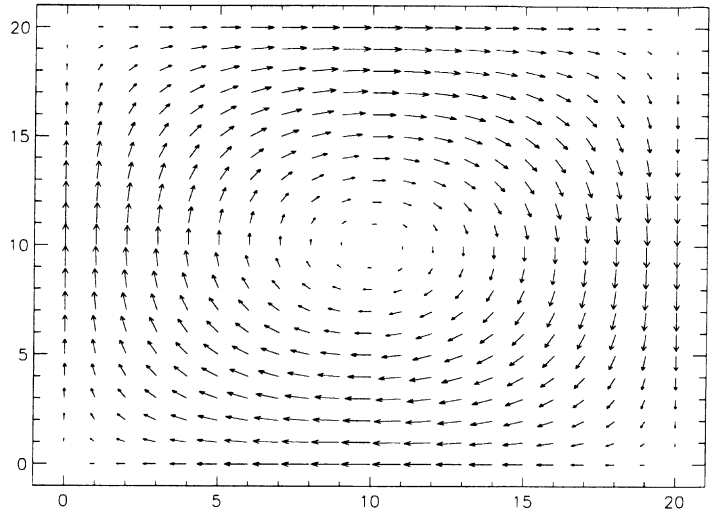


Figure 2-63 Velocity field displayed using default values.

```
VELOVECT, u, v, Length=2
```

Display the velocity field using arrows twice the length of a single cell.

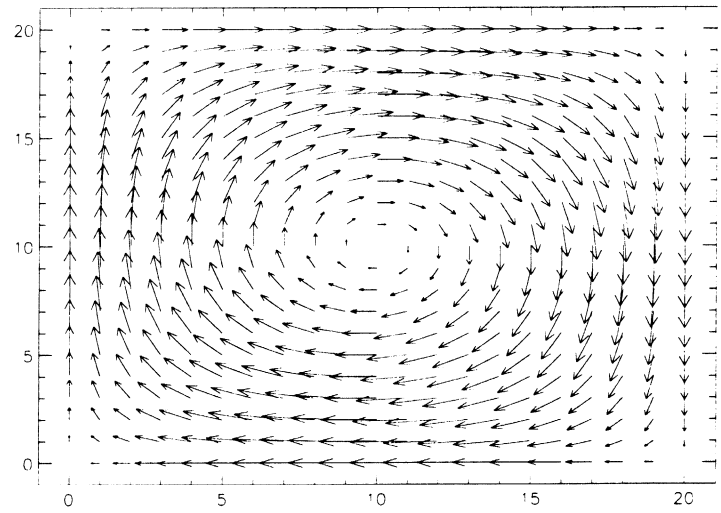


Figure 2-64 Velocity field displayed using arrows twice the length of a single cell.

```
missing = FLTARR(21, 21) + 1.e30
missing(4:6, 7:9) = -1.e30
missing(15:17, 16:19) = -1.e30
VELOVECT, u, v, Missing=missing, /Dots
```

Display the velocity field that contains missing data.

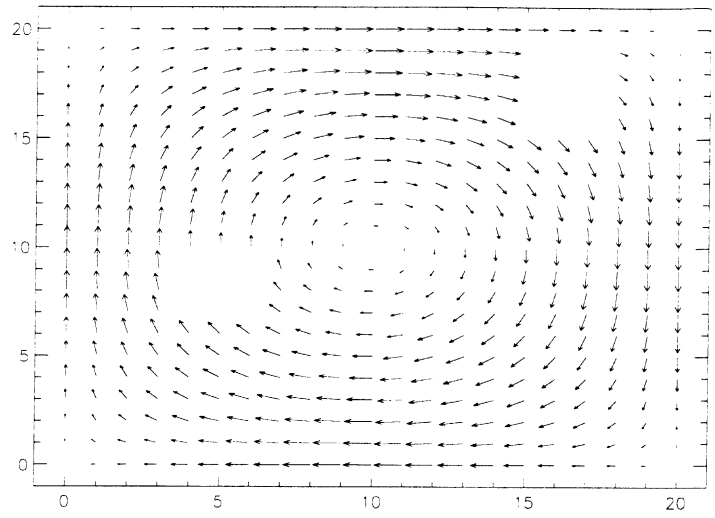


Figure 2-65 Velocity field that contains missing data.

See Also

PLOT_FIELD, VEL

VIEWER Procedure

Lets users interactively define a 3D view, a slicing plane, and multiple cut-away volumes for volume rendering. (Creates a View Control and a View Orientation window in which to make these definitions.)

Usage

VIEWER, *win_num, xsize, ysize, size_fac, xpos, ypos, colors, retain, xdim, ydim, zdim*

Input Parameters

win_num — The number of the PV-WAVE window to use for the View Orientation window. Since this window is left on the screen when VIEWER returns, it is up to the calling program to delete it when desired. (The View Control window is automatically deleted when VIEWER returns.)

xsize, ysize — The X and Y dimensions, respectively, of the PV-WAVE window that VIEWER is setting up the view for.

size_fac — A factor controlling the size of the View Orientation window. The X dimension of the View Orientation window is (*size_fac* * *xsize*) and the Y dimension is (*size_fac* * *ysize*). Typically, *size_fac* should be in the range 0.5 to 1.0.

xpos, ypos — The location (X and Y positions, respectively) for the View Orientation and View Control windows.

If the View Orientation window is near the bottom of the screen, then the View Control window is created above the View Orientation window. Otherwise, the View Control window is created below the View Orientation window.

colors — The value (number of colors to allocate) to use as the *Colors* keyword value in the WINDOW procedure call. A typical value for an 8-bit color system is 128 or 256.

retain — The value (flag) to use as the *Retain* keyword value in the WINDOW procedure call. Typically this is the value 1 or 2.

For more information on *colors* and *retain*, see the description of the WINDOW procedure in the *PV-WAVE Reference*.

xdim, ydim, zdim — The size (first, second, and third dimension, respectively) of the array containing the data that is displayed using the view specified by VIEWER.

For example, if a 20-by-30-by-40 array is to be displayed using SHADE_VOLUME and POLYSHADE, then *xdim* should be 20, *ydim* should be 30, and *zdim* should be 40.

If a 20-by-30 array is to be displayed using the SURFACE or CONTOUR procedures, then *xdim* should be 20, *ydim* should be 30, and *zdim* should be `(MAX(array)+1.0)`.

Input Keywords

Ax — On input, if this keyword is omitted, or if the variable passed to *Ax* is undefined, then no controls for setting the view rotation about the X axis are displayed.

If a valid value is passed to *Ax*, then this value is the initial (default) view rotation about the X axis.

Ay — The view rotation about the Y axis (similar to *Ax*).

Az — The view rotation about the Z axis (similar to *Ax*).

Bg_Color — The window background color. The default is 0.

Bot_Color — The bottom shadow color for buttons. The default is 0.

Cut_Plane — On input, if this keyword is omitted, or if the variable passed to *Cut_Plane* is undefined, then no controls for setting the slicing plane are displayed.

For the cut-away controls to be displayed, a previously-defined variable must be passed to *Cut_Plane*. If this variable is a valid (3, 2) integer array, then it is assumed to contain the initial (default) slicing plane.

If `cut_plane` is a valid array, then its contents are interpreted as follows:

cut_plane(0, 0)	The plane's angle of rotation about the X axis.
cut_plane(1, 0)	The plane's angle of rotation about the Y axis.
cut_plane(2, 0)	Ignored.
cut_plane(0, 1)	The X coordinate of the center of the plane.
cut_plane(1, 1)	The Y coordinate of the center of the plane.
cut_plane(2, 1)	The Z coordinate of the center of the plane.

Note The slicing plane is rotated about the Y axis first, then about the X axis. If the variable passed to *Cut_Plane* is defined but is not a valid (3, 2) array, then controls to set the slicing plane are displayed, the initial (default) slicing plane is defined with no rotation about the X or Y axes, and the center point of the plane is at (*xdim*/2, *ydim*/2, *zdim*/2).

Cut_Vol — On input, if this keyword is omitted, or if the variable passed to *Cut_Vol* is undefined, then no controls for setting the cut-away volume(s) are displayed.

For the cut-away controls to be displayed, a previously-defined variable must be passed to *Cut_Vol*. If this variable is a valid (6, *n*) integer array, then it is assumed to contain the initial (default) cutting volumes. This (6, *n*) array contains the subscript ranges in the display array that are to be cut away.

For example, if a (6, 2) array called `ca` is passed in, then two initial cutting volumes are defined. In this case, the contents of `ca` are interpreted as follows:

ca(0, 0)	X dimension of the first cut-away.
ca(1, 0)	Y dimension of the first cut-away.
ca(2, 0)	Z dimension of the first cut-away.
ca(3, 0)	X position of the first cut-away.

ca(4, 0)	Y position of the first cut-away.
ca(5, 0)	Z position of the first cut-away.
ca(0:5, 1)	Defines second cut-away (similar to ca(0:5, 0)).

If the variable passed to *Cut_Vol* is defined, but is not a valid (6, *n*) array, then no initial cut-aways are defined, although the controls to define cut-aways are displayed.

Fg_Color — The foreground color. Used for buttons and for the current cut-away volume. The default is !P.Color.

HL_Color — The color to use when highlighting buttons and for drawing the slicing plane. The default is !P.Color.

Out_Mode — If present and nonzero, then users are not allowed to exit VIEWER until they have specified a view in which all the vertices of the view cube lie completely within the View Orientation window.

Setting *Out_Mode* to 1 ensures that VIEWER always sets up a view that is compatible with POLYSHADE. (POLYSHADE will not work properly if one or more polygon vertices lie outside the window.)

Persp — On input, if this keyword is omitted, or if the variable passed to *Persp* is undefined, then no controls for setting the view perspective projection distance are displayed.

If a valid value is passed to *Persp*, then this value is used as the initial (default) setting for the perspective projection, and controls for setting the perspective are displayed.

Top_Color — The top shadow color for buttons. Also used to draw the view cube. The default is !P.Color.

Zoom — On input, if this keyword is omitted, or if the variable passed to *Zoom* is not a valid scalar or three-element vector, then no controls for setting the *Zoom* factor(s) are displayed.

If the variable passed to *Zoom* is a single value, then this value is used as the initial (default) setting for the zoom factor and a single

control is provided for zooming the view equally in all three dimensions (X, Y, and Z).

If the variable passed to *Zoom* is a three-element vector, then these three values are the initial (default) values for the zoom factors and three controls are provided for zooming the view independently in the X, Y, and Z directions.

Output Keywords

Ax, Ay, Az – On output, these input keywords each return a single floating-point value containing the X, Y, and Z rotation, respectively, that was selected.

The calling program does not need to do anything with the returned values *Ax*, *Ay*, and *Az*, since VIEWER automatically calls CENTER_VIEW to set the system view transformation !P.T, as well as !P.T3D, !X.S, !Y.S, and !Z.S. The calling program may, however, use these returned values in subsequent calls to VIEWER to let users "pick up where they left off."

Cut_Plane – On output, the variable passed to *Cut_Plane* is always a valid (3, 2) single-precision floating-point array in the form described above under *Input Keywords*.

You can use the array returned from *Cut_Plane* as input to the SLICE_VOL procedure to extract the slice, or in subsequent calls to VIEWER.

Cut_Vol – On output, the variable passed to *Cut_Vol* is always a valid (6, *n*) integer array of the form described above under *Input Keywords*. If you do not define any cut-aways, then this variable is returned as a (6, 1) array containing all zeroes.

Typically, after the cut-away information is returned to the calling program, the array of data to be displayed is modified by the calling program using the cut-away information. This modification usually involves setting portions of the display array to zero before using the display array with other commands, such as RENDER, SHADE_VOLUME, VOL_REND, and VECTOR_FIELD3.

For example, if the display array is a 20-by-30-by-40 array (`xdim=20, ydim=30, zdim=40`) and the variable returned from *Cut_Vol* is a (6, 1) array containing the values:

```
[19, 10, 13, 0, 6, 24]
```

then the portions of the display array `da` to set to zero are as follows:

```
da(0:(0+19), 6:(6+10), 24:(24+13)) = 0
```

You may use the array returned from *Cut_Vol* in subsequent calls to VIEWER.

Persp — On output, this input keyword returns the perspective projection distance that was selected.

The calling program does not need to do anything with the returned values for *Zoom* or *Persp*, since VIEWER automatically sets the view. However, you may use the returned value(s) in subsequent calls to VIEWER.

Zoom — On output, this input keyword returns the *Zoom* value(s) that was selected.

Discussion

VIEWER returns the view parameters, slicing plane parameters, and cut-away volume coordinates to the calling program.

VIEWER automatically defines the view by calling the procedure CENTER_VIEW, but it is up to the calling program to decide what to do with any slicing plane or cut-away information returned to it. It is also up to the calling program to perform the rendering.

Note This procedure sets the system variables !P.T, !P.T3D, !X.S, !Y.S, and !Z.S, overriding any values you may have previously set. (These system variables are described in the *PV-WAVE Reference*.)

Due to the large amount of code in this procedure, the following command must be entered (once per PV-WAVE session) before any procedure that calls VIEWER can be run:

```
WAVE> .size 32766 32766
```

Interactive Usage

When VIEWER is called, a View Control and a View Orientation window are created that let users interactively define 3D viewing parameters. These windows are shown below in Figure 2-66 and Figure 2-67.

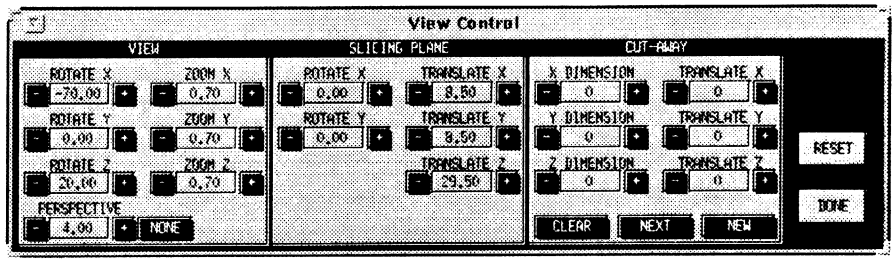


Figure 2-66 The View Control window contains buttons used for setting the view, slicing plane, and cut-away volume parameters.

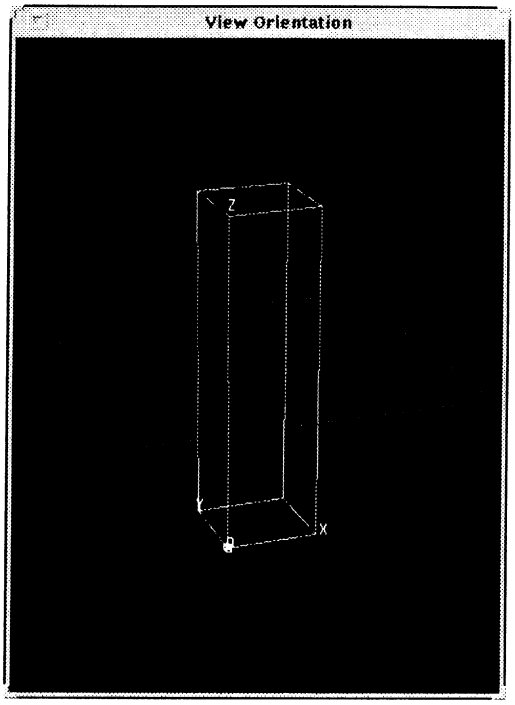


Figure 2-67 The View Orientation window displays a cube representing the current state of the parameters set in the View Control window.

The controls (buttons) provided for the user depend on the keywords supplied to VIEWER. For example, if you do not wish the user to be able to set the Y rotation parameter, then do not use the *Ay* keyword.

Note It is advisable to use only the *Ax*, *Az*, and *Zoom* keywords when setting up a view for SURFACE or SHADE_SURF, since these procedures are limited in the type of viewing transformation they can utilize. (Other commands, such as PLOTS, POLYFILL, POLY_PLOT, and POLYSHADE, are compatible with most view transformations; therefore, you may freely use the *Ay* and *Persp* keywords when setting up the view for these routines.)

The available buttons in the View Control window are for X rotation, Y rotation, Z rotation, Perspective, and Zoom. Depending on how VIEWER is called, the *Zoom* keyword may consist of a single control, in which case the view is zoomed equally in the X, Y, and Z dimensions. There may also be three zoom controls provided, in which case the zoom factors for the X, Y, and Z dimensions may be set independently. There is also a NONE button provided for turning off the perspective projection.

If the zoom factor is large, or the perspective parameter is small, then the cube display in the View Orientation window may be erroneous. To cure the problem, reduce the zoom or increase the perspective (or set the perspective to NONE).

All of the parameters can be changed by clicking on the plus [+] or minus [–] button for that parameter. The [+] button increases the value of that parameter and the [–] button decreases it. For rapid (coarse) control, use the left mouse button. For fine control, use the middle mouse button. For extra-fine control, use the right mouse button.

If the *Cut_Plane* keyword is supplied to VIEWER, then controls are provided for setting the slicing plane. The rotation and position of the slicing plane can be set. The center of the slicing plane can not be located outside the original volume. The slicing plane is visible in the View Orientation window.

If the *Cut_Vol* keyword is supplied to VIEWER, then controls are provided for setting the cut-away volume(s). The X size, Y size, Z size, X position, Y position, and Z position for each cut-away volume can be set. The size of the cut-away can not be larger than the original volume. No part of any cut-away volume may be positioned outside the original volume.

Three additional buttons, CLEAR, NEXT, and NEW, are also provided in the View Control window:

- To create a new cut-away, click on the NEW button. This creates a small new cut-away near the coordinate origin. This cut-away is visible in the View Orientation window. You can then set the size and position of this cut-away by using the [+] and [–] buttons.

- If multiple cut-aways have been defined, the NEXT button allows users to toggle between them to modify their size and position.
- The CLEAR button removes all the cut-away volumes.

When you have finished setting the parameters, click the DONE button to set the view and return the parameters to the calling program.

If the *Out_Mode* keyword has been set, then clicking the DONE button does not cause a return to the calling program unless users have specified a view in which all the vertices of the view cube lie completely within the View Orientation window. In this case, users then need to change the view parameters (rotation, zoom, and/or perspective) before they could exit.

When VIEWER returns to the calling program, the View Control window is deleted, but the View Orientation window is left on the screen.

The RESET button can be used to reset all the parameters to their initial state.

Examples

For demonstrations of the VIEWER procedure, use the 4-D Data, Medical Imaging, Oil/Gas Exploration, and CFD/Aerospace buttons on the PV-WAVE Demonstration Gallery. To run the Gallery, enter `wave_gallery` at the `WAVE>` prompt.

See Also

CENTER_VIEW

VOL_MARKER Procedure

Displays colored markers scattered throughout a volume.

Usage

VOL_MARKER, *vol, n_points*

Input Parameters

vol — A 3D volume of data to plot markers in.

n_points — The number of markers to plot.

Input Keywords

Axis_Color — The color to use when plotting the axis. To suppress the axis, set *Axis_Color* to –1.

Mark_Size — The maximum marker size.

Mark_Symbol — A number specifying the marker symbol to use. The number should be between 1 and 7. The default is 2 (an asterisk). For a list of symbols, see the description of !Psym in Chapter 4, *System Variables*.

Mark_Thick — The maximum line thickness to use when plotting markers. Typically, this is an integer between 1 and 7. (A thickness of 1.0 is normal, 2.0 is twice as wide, and so on.)

Discussion

VOL_MARKER plots a polymarker field from volumetric data. The color of each marker displayed by VOL_MARKER is determined by the value of the volumetric data at the point where the marker is plotted.

Examples

```
PRO vol_demo2
```

This program displays an MRI scan of a human head using three different display techniques.

```
volx = 115
voly =  75
volz = 105
```

Specify the size of the volumes.

```
winx = 512
winy = 512
```

Specify the window size.

```
head = BYTARR(volx, voly, volz)
OPENR, 1, !Data_Dir + 'man_head.dat'
READU, 1, head
CLOSE, 1
```

Read in the volumetric data.

```
band = 5
head = VOL_PAD(head, band)
head = SMOOTH(head, band)
```

Pad the volume with zeroes and smooth it.

```
CENTER_VIEW, Xr=[0, 124], Yr=[0, 84], $
   Zr=[0, 114], Az=60.0, Ax=(-60.0), $
   Winx=512, Winy=512, Zoom=0.9
WINDOW, 0, XSize=winx, YSize=winx, $
   XPos=16, YPos=384, Colors=128
LOADCT, 9
```

Set up the viewing window and load the color table.

```
VOL_MARKER, head, 6000, Axis_Color=100, $
   Mark_Symbol=2, Mark_Size=2, Mark_Thick=2
```

Render the data using a 3D polymarker field.

```
WINDOW, 1, XSize=winx, YSize=winx, $
   XPos=496, YPos=324, Colors=128
```

Create a second window for plotting.

```
SET_SHADING, Light=[-1.0, 1.0, 0.5], $
   /Gouraud, /Reject
```
Change the direction of the light source for shading.

```
SHADE_VOLUME, head, 18, vertex_list, $
   polygon_list, /Low
```
Compute the 3D contour surface as a list of polygons.

```
TVSCL, POLYSHADE(vertex_list, $
   polygon_list, XSize=winx, YSize=winy, $
   /Data, /T3d)
```
Display the polygon list with light source shading.

```
WINDOW, 2, XSize=winx, YSize=winx, $
   XPos=256, YPos=48, Colors=128
```
Create another window for plotting.

```
head = VOL_TRANS(head, 128, !P.T)
```
Transform the volumetric data to the current view.

```
TVSCL, VOL_REND(head, winx, winy, Depth_Q=0.4)
```
Display a translucent image of the data.

```
END
```

See Also

VECTOR_FIELD3

VOL_PAD Function

Returns a 3D volume of data padded on all six sides with zeroes.

Usage

result = VOL_PAD(*volume, pad_width*)

Input Parameters

volume — On input, volume contains the 3D volume of data to pad.

pad_width — The width of the padding around the volume. The size of the resulting volume increases by (2 * *pad_width*) in all three dimensions.

Returned Value

result — The padded *volume* data.

Keywords

None.

Discussion

For best results, process volumes with VOL_PAD before transforming them with VOL_TRANS or slicing them with SLICE_VOL. For more information, see *Volume Manipulation* on page 192 of the *PV-WAVE User's Guide.*

Examples

See the Examples section in the description of the VOL_MARKER routine.

For other examples, see the following demonstration programs in `$WAVE_DIR/demo/arl`: `vol_demo3`, `vol_demo4`, and `grid_demo4`.

See Also

VOL_TRANS

VOL_REND Function

Renders volumetric data in a translucent manner.

Usage

result = VOL_REND(*volume, imgx, imgy*)

Input Parameters

volume — A 3D array containing volumetric data. *volume* is normally scaled into the range {0 ... 255}.

imgx — The X dimension of the image to return.

imgy — The Y dimension of the image to return.

Returned Value

result — An 8-bit image of the volumetric data.

Input Keywords

Depth_q — A scalar depth queuing factor. *Depth_q* should be between 0.0 and 1.0:

- A factor of 1.0 causes voxels in the back to be just as bright as the voxels in the front.
- A factor of 0.5 causes voxels in the back to be half as bright as those in front.

Opaque — A 3D array (with the same dimensions as volume) containing the translucency values for each voxel. *Opaque* is normally scaled into the range {0 ... 255}, where 0 is clear and 255 is completely opaque.

If *Opaque* is not specified, then the default is 0 (clear).

Discussion

If no keywords are used, the final intensity value produced at a given pixel with VOL_REND is the brightest value along the Z dimension of the volume. This default behavior can be enhanced, however, by using the *Opaque* and *Depth_q* keywords.

- If *Opaque* is set to 0, the resulting value will be unaffected; if *Opaque* is set to 255, then values behind that position in the opaque array will be completely blocked.
- If *Depth_q* is set to a value less than 1.0, a bright spot in the back will be dimmed in proportion to the distance it is from the viewpoint. (A bright spot in the front will remain bright.)

Typically, you would first process a volume of data with VOL_PAD and VOL_TRANS, and then render it with VOL_REND.

Examples

```
PRO vol_demo3
```

This program displays 3D fluid data using two display techniques.

```
volx = 17
voly = 17
volz = 59
```

Specify the size of the volumes.

```
winx = 512
winy = 512
```

Specify the window size.

```
flow_axial = FLTARR(volx, voly, volz)
OPENR, 1, !Data_Dir + 'cfd_axial.dat', /Xdr
READU, 1, flow_axial
CLOSE, 1
flow_axial = VOL_PAD(flow_axial, 1)
```

Read in the data and pad with zeroes.

```
CENTER_VIEW, Xr=[0.0, 18.0], $
   Yr=[0.0, 18.0], Zr=[0.0, 60.0], $
   Az=210.0, Ay=120.0, Ax=0.0, Winx=512, $
   Winy=512, Zoom=0.85
```

Set up the view.

```
SET_SHADING, Light=[-1.0, 1.0, 0.5], $
   /Gouraud, /Reject
```

Change the direction of the light source for shading.

```
SHADE_VOLUME, flow_axial, 110, vertex_list, $
   polygon_list, /Low
```

Compute the 3D contour surface as a list of polygons.

```
WINDOW, 1, XSize=winx, YSize=winx, XPos=16, $
   YPos=256, Colors=128
LOADCT, 3
```

Set up the viewing window and load the color table.

```
img1 = POLYSHADE(vertex_list, polygon_list, $
   XSize=winx, YSize=winy, /Data, /T3d)
TVSCL, img1
```

Construct the shaded surface representation of the data as a list of polygons and display it.

```
WINDOW, 2, XSize=winx, YSize=winx, $
   XPos=496, YPos=324, Colors=128
```

Create a new window for plotting.

```
vol_dim = MAX([volx, voly, volz])
flow_axial = BYTSCL(flow_axial)
```

Scale the data into the range of bytes 0 – 255.

```
vol2 = VOL_TRANS(flow_axial, vol_dim, !P.T)
```

Transform the volume of data into the current view.

```
img2 = VOL_REND(vol2, winx, winy, Depth_q=0.4)
```

Render the data as a translucent image.

```
TVSCL, img2
```

Display the image.

```
END
```

For other examples, see the following demonstration programs in `$WAVE_DIR/demo/arl`: `vol_demo2` and `vol_demo4`.

See Also

VOL_TRANS

VOL_TRANS Function

Returns a 3D volume of data transformed by a 4-by-4 matrix.

Usage

result = VOL_TRANS(*volume, dim, trans*)

Input Parameters

volume — The 3D volume of data to transform.

dim — A scalar value specifying the X, Y, and Z dimensions of the transformed volume to return. Normally, *dim* is the largest of the three dimensions of the original volume. Generally, the original volume should "fit" inside the transformed volume.

trans — The 4-by-4 transformation matrix to use for the transformation. *trans* is often the system viewing transformation matrix !P.T. (For more information, see *Geometric Transformations* on page 167 of the *PV-WAVE User's Guide.*

Returned Value

result — A 3D volume of data transformed by a 4-by-4 matrix.

Keywords

None.

Discussion

The returned volume is scaled into the range of bytes. For best results, the volume to transform should first be processed using the VOL_PAD function. For more information, see *Volume Manipulation* on page 192 of the *PV-WAVE User's Guide*.

Examples

See the Examples sections in the description of the VOL_MARKER and VOL_REND routines.

For another example, see the `vol_demo4` demonstration program in `$WAVE_DIR/demo/arl`.

See Also

VOL_PAD, VOL_REND

VOLUME Function

Defines the volumetric data that can be used by the RENDER function.

Usage

result = VOLUME(*voxels*)

Input Parameters

voxels — A 3D byte array containing voxel data.

Returned Value

result — A structure that defines a volumetric object.

Input Keywords

Color — A 256-element double-precision floating-point vector containing the color (intensity) coefficients of the object. The default is `Color(*)=1.0`. For more information, see the section *Defining Color and Shading* on page 198 of the *PV-WAVE User's Guide.*

Kamb — A 256-element double-precision floating-point vector containing the ambient (flat shaded) coefficients. The default is `Kamb=FINDGEN(256)/255.` For more information, see the section *Ambient Component* on page 199 of the *PV-WAVE User's Guide.*

Kdiff — A 256-element double-precision floating-point vector containing the diffuse reflectance coefficients. The default is `Kdiff(*)=0.0`. For more information, see the section *Diffuse Component* on page 198 of the *PV-WAVE User's Guide.*

Ktran — A 256-element double-precision floating-point vector containing the specular transmission coefficients. The default is `Ktran(*)=0.0`. For more information, see the section *Transmission Component* on page 199 of the *PV-WAVE User's Guide.*

Transform — A 4-by-4 double-precision floating-point array containing the local transformation matrix whose default is the identi-ty matrix. For more information, see the section *Setting Object and View Transformations* on page 201 of the *PV-WAVE User's Guide.*

Discussion

A VOLUME is used by the RENDER function to render volumetric data. You must specify a 3D array of bytes that represent this data in the call to VOLUME. Each byte in the voxel array corresponds to an index into the material properties associated with the volume.

For example, the material properties used for shading the point `(x,y,z)` in some data are `Color(voxels(x,y,z))`, `Kamb(voxels(x,y,z))`, etc. The surface normal at `(x,y,z)` is calculated using a 3D Sobel gradient operator on the actual voxel values. The default orientation of a volume is an origin-centered unit cube. For more information, see *Defining Object Material Properties* on page 200 of the *PV-WAVE User's Guide.*

If the voxels are not cubic, you may adjust the scaling of the dimensions with the *Transform* keyword by using a matrix generated by the T3D procedure with the *Scale* keyword.

Volumetric data is applicable to any voxel processing domain, such as for the visualization of astronomical, geological, and medical data.

Example

```
voxels = BYTARR(16, 16, 16)
voxels(*) = 255
diffuse = FLTARR(256)
T3D, /Reset, Rotate=[15, 30, 45]
cube = VOLUME(voxels, Transform=!P.T, $
   Kdiff=diffuse, Kamb=FLTARR(256))
TV, RENDER(cube)
```

See Also

CONE, CYLINDER, MESH, RENDER, SPHERE

For more information, see *Ray-tracing Rendering* on page 196 of the *PV-WAVE User's Guide.*

For details on the SHADE_VOLUME routine, see its description in the *PV-WAVE Reference.*

WAIT Procedure

Suspends execution of a PV-WAVE program for a specified period.

Usage

WAIT, *seconds*

Input Parameters

seconds — The duration of the wait, in seconds.

Keywords

None.

Discussion

WAIT is useful in interactive programs that repetitively read cursor positions.

Note that because of other activity on the system, the duration of program suspension may be longer than requested.

See Also

TVCRS, HAK, MESSAGE

WDELETE Procedure

Deletes the specified window.

Usage

WDELETE [, *window_index*]

Input Parameters

window_index — The window index of the window to be deleted. If not specified, deletes the current window, and the system variable !D.Window is set to the index of the first open window (or to –1 if no other windows are open).

Input Keywords

X_No_Close — If present and nonzero, allows the window to be deleted for PV-WAVE, but remain active for the X Window System server. Otherwise, the window is deleted for both systems.

See Also

WINDOW, WSHOW, WSET, ERASE

WEOF Procedure

(VMS Only) Writes an end-of-file mark on the designated unit at the current position.

Usage

WEOF, *unit*

Input Parameters

unit – An integer between 0 and 9 specifying the magnetic tape unit on which the end-of-file mark will be written. (Do not confuse this parameter with file logical unit numbers.)

Keywords

None.

Discussion

To use WEOF, you must mount the tape as a foreign volume. The end-of-file mark is also sometimes called a tape mark.

See Also

TAPWRT, TAPRD, SKIPF

For more information, see *Accessing Magnetic Tape* on page 229 of the *PV-WAVE Programmer's Guide.*

WgAnimateTool Procedure

Creates a window for animating a sequence of images.

Usage

WgAnimateTool, *image_data* [, *parent* [, *shell*]]

Input Parameters

image_data — A 3D array of images. The dimensions of the array are (*m, n, n_frames*), where (*m,n*) is the size of an individual image, and *n_frames* is the total number of frames in the sequence.

parent — (optional) The widget or shell ID of the parent widget (long). If *parent* is not specified, WgAnimateTool runs on its own (i.e., in its own event loop).

Output Parameters

shell — (optional) The ID of the newly created widget. If the procedure fails, zero (0) is returned.

Input Keywords

Title — A string containing the title that appears in the header of the AnimateTool window. Default value is "Animate Tool".

Cmap — The index of the color table to load when the widget is created; a positive integer in the range {0...15}.

Position — A two-element vector specifying the X and Y coordinates of the upper-left corner of the AnimateTool window (long integer). The elements of the vector are [*x, y*], where *x* (horizontal) and *y* (vertical) are specified in pixels. These coordinates are measured from the upper-left corner of the screen.

Order — The order in which the image is drawn. If present and nonzero, the image is inverted. In other words, the image is drawn from bottom to top instead of from top to bottom.

Pixmap — 1 indicates that pixmaps should be used for the animation; 0 indicates that the data is stored in a PV-WAVE variable. Using pixmaps dramatically improves the speed of the animation, but requires more memory from the X Window System's X server than when data stored in variables is used.

Do_tvscl — 1 indicates that TVSCL should be used to scale the image values to the current color table; 0 indicates that TV will be used instead (no scaling).

Delay — The minimum elapsed time between displayed images, specified in milliseconds (floating point).

File — A string containing the name of the file from which the image data is read. When using the *File* keyword, the *Dims* keyword must also be supplied. If present, the input variable *image_data* is ignored.

Dims — A three-element vector specifying the size of the images to be read from the file, and the number of images to read. The elements of the vector are [*m, n, n_frames*], where (*m,n*) is the size of an individual image, and *n_frames* is the total number of frames in the sequence.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide.*

Background — Specifies the background color name.

Basecolor — Specifies the base color.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Discussion

WgAnimateTool is an interactive window that lets you use the mouse to control the pace and direction of an animated series of images.

Note Using the WgAnimateTool window is similar in many ways to using the WgMovieTool window, but WgAnimateTool is intended to be used as a standalone utility widget, while WgMovieTool is designed so that it can be included inside larger layout widgets.

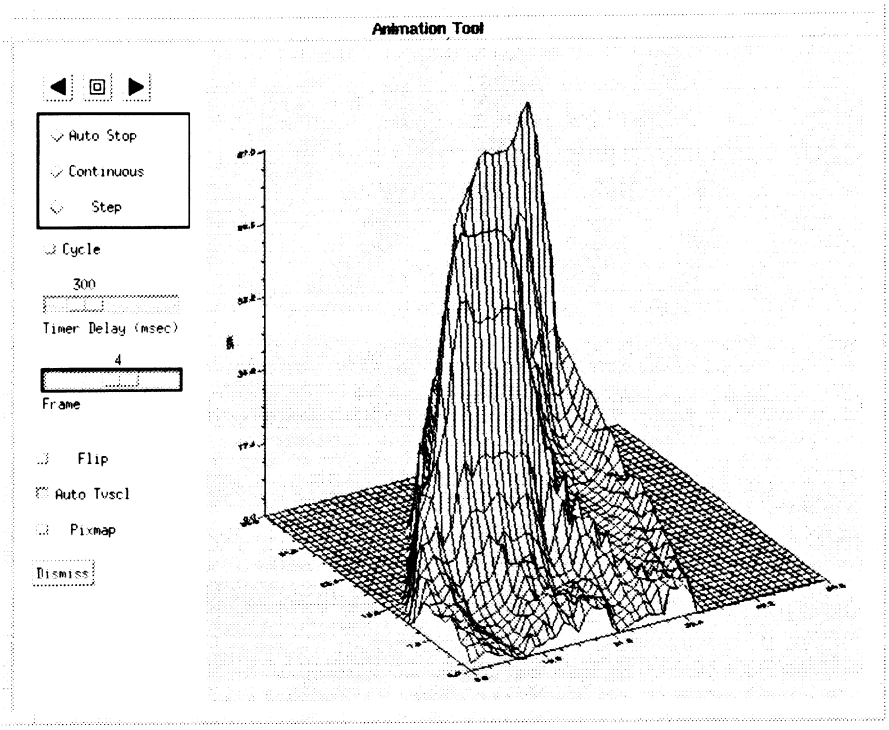


Figure 2-68 WgAnimateTool creates an interactive window that lets you use the mouse to control the orientation, pace, and direction of an animated series of images.

Contents of the Window

The AnimateTool window has two main parts — the display area and the control area.

AnimateTool Display Area

The display area is the largest area of the window; it is where the animation sequence takes place.

AnimateTool Control Area

Use the following controls to operate the AnimateTool window:

- **Reverse button** – Cycle through the images from last to first.
- **Stop button** – Freeze display at the current image.
- **Forward button** – Cycle through the images from first to last.
- **Mode** – Select Step to have the sequence proceed only when you click on one of the arrow buttons. Select Continuous to have AnimateTool move through the images in a non-stop manner, pausing only when you click the Stop button. Select Auto Stop to have AnimateTool stop sequencing when it reaches either end of the data.
- **Cycle** – When enabled, the animation sequences repeatedly through the data, alternating between forward and reverse. When disabled, the animation returns to the first (or last) image in *image_data* after every image in the sequence has been displayed.
- **Timer delay** – Decrease or increase the rate of display. The number shown above the slider is the number of milliseconds delay between contiguous images in the animation sequence.
- **Frame** – The ordinal number of the currently displayed image is displayed above this slider. If you wish, use the left mouse button to drag the slider and display a different image.
- **Flip** – When enabled, the first data value is used to draw the pixel in the upper-left corner of the image. When disabled, the first data value is used to draw the pixel in the lower-left corner of the image.

- **Auto Tvscl** – By determining whether the TV or TVSCL is used to draw the images, controls whether the input image data is automatically scaled to use the full range of available colors. Selecting this option may increase the contrast of the displayed images. Auto Tvscl does not affect the actual data; it only affects the display of the data.
- **Pixmap** – When enabled, the data is stored in pixmaps; when disabled, the data is taken directly from the PV-WAVE variable.
- **Dismiss** – Destroy the AnimateTool window and erase it from the screen.

Input Data Requirements

The animation can use data from either pixmaps or a PV-WAVE variable. Although the animation will run faster using pixmaps, it does require more memory to store the data as a pixmap than as a variable.

When reading the data from a file, the file containing the data must be a binary file containing the images in sequential order.

Event Handling

You can use the AnimateTool widget in one of the following two ways:

- **From the WAVE> prompt** – Enter the procedure name at the WAVE> prompt to display the AnimateTool widget. The AnimateTool widget handles its own event loop by calling WwLoop.
- **Standalone widget in its own window created by another application** – The AnimateTool widget has its own Main window, but the application (not the AnimateTool widget) handles the event loop by calling WwLoop.

The output parameter *shell* can be returned only if you also supply the input parameter *parent*.

Example

Enter the commands shown below into a file, and compile the procedure with the .RUN command. If the variable `parent` is defined, WgAnimateTool is created as a child of `parent`; otherwise, WgAnimateTool runs on its own (i.e., in its own event loop).

When you are finished interacting with the WgAnimateTool window, close it by clicking the Dismiss button.

```
PRO Sample_wganimatetool, parent, tool_shell
heart = BYTARR(256, 256, 15)
```

Define a variable to hold the data.

```
IF !Version.platform EQ 'VMS' THEN $
   OPENR, u, GETENV('WAVE_DIR')+$
   '[data]heartbeat.dat', /Get_lun $

ENDIF ELSE BEGIN
OPENR, u, !Dir+'/data/heartbeat.dat', $
   /Get_lun
ENDELSE
READU, u, heart
```

Read the PV-WAVE heartbeat.dat demo file that contains images showing a beating human heart.

```
CLOSE, u
FREE_LUN, u
```

Close the file and free the LUN.

```
IF N_ELEMENTS(parent) NE 0 THEN BEGIN
WgAnimateTool, heart, parent, tool_shell, $
   /Do_tvscl, /Pixmap
```

Create WgAnimateTool as a child of the widget known as "parent". The window of the newly created widget is returned via the optional output parameter "tool_shell".

```
ENDIF ELSE BEGIN

WgAnimateTool, heart, /Do_tvscl, /Pixmap
```

Create WgAnimateTool and display it as its own Main window. In other words, the WgAnimateTool window runs on its own (i.e., in its own event loop).

```
ENDELSE
END
```

See Also

MOVIE, WgMovieTool

For more information about how the UNIX environment variable `$WAVE_GUI` or the VMS logical `WAVE_GUI` affects whether the AnimateTool window is implemented using the Motif or the OLIT look-and-feel, refer to *Specifying the Desired Toolkit* on page 411 of the *PV-WAVE Programmer's Guide.*

For more information about how to transfer image data to PV-WAVE variables, refer to *Input and Output of Image Data* on page 189 of the *PV-WAVE Programmer's Guide.*

For more information about pixmaps, refer to *Using Pixmaps to Improve Application Performance* on page A-85 of the *PV-WAVE User's Guide.*

For more information about color table indices, refer to *Experimenting with Different Color Tables* on page 310 of the *PV-WAVE User's Guide.*

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide.* For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide.*

WgCbarTool Procedure

Creates a simple color bar that can be used to view and interactively shift a PV-WAVE color table.

Usage

WgCbarTool [, *parent* [, *shell* [, *windowid* [, *movedCallback*], [, *range*]]]]]

Input Parameters

parent — (optional) The widget or shell ID of the parent widget (long). If *parent* is not specified, WgCbarTool runs on its own (i.e., in its own event loop).

movedCallback — (optional) A string containing the name of the PV-WAVE callback routine that is executed when the color bar is shifted to the left or right.

range — (optional) The range of colors to be displayed in the color bar. The default is to display the entire range of colors, as defined in the system variable !D.Table_Size.

Output Parameters

shell — (optional) The ID of the newly created widget. If the procedure fails, zero (0) is returned.

windowid — (optional) The window ID of the PV-WAVE graphics window. (For information on window IDs, see the description for the WINDOW procedure.)

Input Keywords

Title — A string containing the title that appears in the header of the CbarTool window. Default value is "Color Bar".

Cmap — The index of the color table to load when the widget is created; a positive integer in the range {0...15}.

Position — A two-element vector specifying the X and Y coordinates of the upper-left corner of the CbarTool window (long integer). The elements of the vector are [*x*, *y*], where *x* (horizontal) and *y* (vertical) are specified in pixels. These coordinates are either: 1) if *parent* is present and the *Popup* keyword is not specified or has a value of zero, measured from the upper-left corner of a layout (container) widget or 2) if the *Popup* keyword is present and nonzero (regardless of whether *parent* is present and/or nonzero), measured from the upper-left corner of the screen.

Popup — If present and nonzero, the color bar widget is displayed in its own Main window.

Size — A two-element vector specifying the width and height of the color bar (long integer). If not specified, the default size of the color bar is 30-by-256 pixels.

Vertical — If present and nonzero, the color bar is oriented vertically (default).

Horizontal — If present and nonzero, the color bar is oriented horizontally.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide*.

Background — Specifies the background color name.

Basecolor — Specifies the base color.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Attachment Keywords

For additional information on attachment keywords, see *Form Layout: Attachments* on page 422 of the *PV-WAVE Programmer's Guide.*

Bottom — If a widget ID is specified (for example, `Bottom=wid`), then the bottom of the color bar widget is attached to the top of the specified widget. If no widget ID is specified (for example, `/Bottom`), then the bottom of the color bar widget is attached to the bottom of the parent widget.

Left — If a widget ID is specified (for example, `Left=wid`), then the left side of the color bar widget is attached to the right side of the specified widget. If no widget ID is specified (for example, `/Left`), then the left side of the color bar widget is attached to the left side of the parent widget.

Right — If a widget ID is specified (for example, `Right=wid`), then the right side of the color bar widget is attached to the left side of the specified widget. If no widget ID is specified (for example, `/Right`), then the right side of the color bar widget is attached to the right side of the parent widget.

Top — If a widget ID is specified (for example, `Top=wid`), then the top of the color bar widget is attached to the bottom of the specified widget. If no widget ID is specified (for example, `/Top`), then the top of the color bar widget is attached to the top of the parent widget.

Discussion

The color bar lets you display the colors of the current color table and "rotate" them.

To rotate the color table using the color bar, press and drag the left mouse button inside the color bar. As you "slide" colors into different color table indices, the colors that "scroll off" the end of the color table are added to the opposite end.

Note Use the window manager menu of the window frame to dismiss the CbarTool window from the screen.

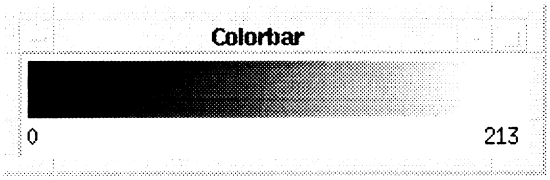


Figure 2-69 WgCbarTool creates an array of colors that match the colors in the current colortable. This color bar widget has been created using the /Horizontal option; the default is for the color bar to be displayed in a vertical orientation.

Event Handling

You can use the color bar widget in one of the following three ways:

- **From the WAVE> prompt** – Enter the procedure name at the WAVE> prompt to display the color bar widget. The color bar widget handles its own event loop by calling WwLoop.
- **Standalone widget in its own window created by another application** – If the *Popup* keyword is present and nonzero, the color bar widget has its own Main window. The application (not the color bar widget) handles the event loop by calling WwLoop.
- **Combined with other widgets in a layout widget** – Another application combines the color bar widget with other widgets inside a layout widget. The application (not the color bar widget) handles the event loop by calling WwLoop.

When the input parameter *parent* is present and nonzero, the widget operates in either the second or third mode listed, depending on the value of the *Popup* keyword. The output parameter *shell* can be returned only if you also supply the input parameter *parent*.

You can use the output parameter *windowid* to keep track of the PV-WAVE window ID that is assigned to the color bar. You can create multiple instances of the color bar; each one will be assigned a different PV-WAVE window ID.

The Colors Common Block

This procedure modifies the PV-WAVE internal color table, as well as the color table variables in the `Colors` common block.

Most color table procedures maintain the current color table in a common block called `Colors`, defined as follows:

```
COMMON Colors, r_orig, g_orig, b_orig, $
   r_curr, g_curr, b_curr
```

The variables are integer vectors of length equal to the number of color indices. Your program can access these variables by declaring the common block. The modifications you make to the color table by interacting with the CbarTool widget are stored in `r_curr`, `g_curr`, and `b_curr`.

Example

Enter the commands shown below into a file, and compile the procedure with the .RUN command. If the variable `parent` is defined, WgCbarTool is created as a child of `parent`; otherwise, WgCbarTool runs on its own (i.e., in its own event loop).

When you are finished interacting with the WgCbarTool window, close it using the window manager menu.

```
PRO Sample_wgcbartool, parent, tool_shell

IF N_ELEMENTS(parent) NE 0 THEN BEGIN
WgCbarTool, parent, tool_shell, /Horizontal, $
   /Popup
```

Create WgCbarTool as a child of the widget known as "parent". The window of the newly created widget is returned via the optional output parameter "tool_shell".

```
ENDIF ELSE BEGIN
WgCbarTool, /Horizontal
```

Create WgCbarTool and display it as its own Main window. In other words, the WgCbarTool window runs on its own (i.e., in its own event loop).

```
ENDELSE
END
```

See Also

WgCeditTool

For more information about how the UNIX environment variable `$WAVE_GUI` or the VMS logical `WAVE_GUI` affects whether the CbarTool window is implemented using the Motif or the OLIT look-and-feel, refer to *Specifying the Desired Toolkit* on page 411 of the *PV-WAVE Programmer's Guide.*

For more information about color table indices, refer to *Experimenting with Different Color Tables* on page 310 of the *PV-WAVE User's Guide.*

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide.* For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide.*

WgCeditTool Procedure

Creates a full-featured set of menus and widgets enclosed in a window; this window allows you to edit the values in PV-WAVE color tables in many different ways.

Usage

WgCeditTool [, *parent* [, *shell*]]

Input Parameters

parent — (optional) The widget or shell ID of the parent widget (long). If *parent* is not specified, WgCeditTool runs on its own (i.e., in its own event loop).

Output Parameters

shell — (optional) The ID of the newly created widget. If the procedure fails, zero (0) is returned.

Input Keywords

Cmap — The index of the color table to load when the widget is created; a positive integer in the range {0...15}.

Position — A two-element vector specifying the X and Y coordinates of the upper-left corner of the CeditTool window (long integer). The elements of the vector are [*x*, *y*], where *x* (horizontal) and *y* (vertical) are specified in pixels. These coordinates are measured from the upper-left corner of the screen.

Title — A string containing the title that appears in the header of the CeditTool window. Default value is "Color Editor".

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide*.

Background – Specifies the background color name.

Basecolor – Specifies the base color.

Font – Specifies the name of the font used for text.

Foreground – Specifies the foreground color name.

Discussion

Using the features of this window, you can edit individual color table values, or you can change ranges of values. (Range of colors can be selected and linearly interpolated.) You can use either sliders or a color wheel to adjust the current color.

You use a palette of color cells to select the current color – point to the color that interests you and click the left mouse button to select it. In this sense, the CeditTool window is like an artist's palette, where basic colors are mixed to produce different colors.

You can use either the RGB, HLS, or the HSV color system to create a new color table, and you can view the result as a color bar or as a set of three intensity graphs. You can store color tables you have modified as custom color tables, and they will be available for your later use.

In some ways, the WgCeditTool window is similar to the WgCtTool window, in that it provides easy ways to interactively modify color tables. For example, with just a few clicks, you can use the WgCeditTool window to edit individual colors in the color table. Or you can use the **Options** menu to open several other utility widgets. But if you do not need all the options of the WgCeditTool window, or if you just need a quick way to stretch or reverse a color table, then use the WgCtTool window, instead.

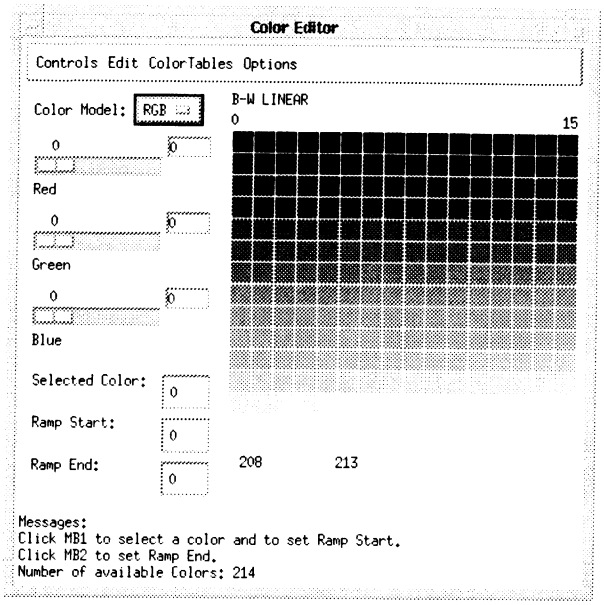


Figure 2-70 The WgCeditTool window lets you use the mouse to create a new color table based on either the HLS, HSV, or RGB color systems.

What is a Color Table?

On workstations that support color, the specific colors that are used depend on the current *color table.* A color table maps data values into colors. Many workstations support thousands of different colors, but only some number, usually 256, can be displayed at any one time.

By default, WgCeditTool uses as many colors in the color table as are currently available in the workstation's colormap. This number depends on the colors that have already been allocated by other applications running on that workstation.

The Colors Common Block

This procedure modifies the PV-WAVE internal color table, as well as the color table variables in the COLORS common block.

Most color table procedures maintain the current color table in a common block called `Colors`, defined as follows:

```
COMMON Colors, r_orig, g_orig, b_orig, $
   r_curr, g_curr, b_curr
```

The variables are integer vectors of length equal to the number of color indices. Your program can access these variables by declaring the common block. The modifications you make to the color table by interacting with the CeditTool widget are stored in `r_curr`, `g_curr`, and `b_curr`.

Custom Color Table File

The names of custom color tables that have been saved are stored in a file named `.wg_colors`. This file is placed in your home directory, which in UNIX is defined by `$HOME`, and in VMS is defined by `SYS$LOGIN`.

Caution  Do not attempt to edit the `.wg_colors` file — doing so could lead to unpredictable results.

Contents of the Window

The CeditTool window has three main parts — the color palette area, the control area, and the message area. The options provided by the menu bar are discussed in a later section.

CeditTool Color Palette Area

An array of cells, one for each color index from the colormap. A message near the bottom of the window informs you how many colors were available to PV-WAVE, and thus how many color cells could be displayed.

CeditTool Control Area

The window's control area contains sliders, a menu, and text fields that are used to manipulate colors:

- **Color Model (menu)** – Choose a color system from the menu. By default, the CeditTool uses the RGB color system. For more information about color systems, refer to *Understanding Color Systems* on page 305 of the *PV-WAVE User's Guide*.
- **Color Cell Text Fields and Sliders** – These controls allow you to modify the three basic components of any color in the color table. The labels on the text fields and sliders change to coincide with the current color system. First, select a color to modify by clicking on one of the color cells in the display area, or by entering its index number in the Selected Color text field. To modify the selected color, either enter a new color value in one of the text fields, or use the slider to change the value. If you enter a new color value into a text field, press <Return> to apply the new value to the slider and the color cell that corresponds to the selected color. If you use the sliders, the change is applied immediately as the slider moves.
- **Selected Color** – The index number of the currently selected color in the color table. Once a color is selected, other sliders and text fields in the tool control area can be used to modify its composition. Select a color by clicking the left mouse button on a color cell in the palette of cells, or by entering the color's index number in this text field and pressing <Return>.
- **Ramp Start and End** – Two text fields where you can enter color table indices between which the CeditTool will perform a linear color interpolation; this is an easy way to edit the current color table. Either enter the beginning and ending color indices in the Ramp Start and Ramp End text fields or use the mouse to select the ramp's starting and ending colors. (To use the mouse, click the left mouse button on the starting color cell and the middle mouse button on the ending color cell.) Select **Edit=>Ramp** on the CeditTool window. The affected cells in

the displayed color table are updated immediately, although no permanent change is made until you save the color table as a custom color table.

CeditTool Menu Bar

The CeditTool menu bar consists of four menu buttons located near the top of the window:

Controls Menu

- **Save Custom** – Save the current set of color indices using the same custom color table name as before.
- **Save As Custom** – Save the current set of color indices as a new custom color table with a unique name.
- **Rename Custom** – Rename a custom color table. You must select the custom color table from the Custom Color Table option menu (select **ColorTables=>Custom**) before you can rename it.
- **Delete Custom** – Delete one of the custom color tables from the list. For details about where this list of color tables is stored, refer to *Custom Color Table File* on page 293.
- **Exit** – Destroy the CeditTool window and all its children.

Edit Menu

- **Ramp** – Create a color ramp between the start ramp color and the end ramp color. See the description of Ramp Start and Ramp End on the previous page for more information about choosing start and end ramp colors.
- **Restore** – Restore the original color map for the selected color table.

ColorTables Menu

- **System** – Display a list of system color tables. System color tables are provided with PV-WAVE and cannot be modified.
- **Custom** – Display a list of custom color tables. These are color tables that you have created using **Controls=>Save Custom** or **Controls=>Save As Custom** (from the **Controls** menu).

Options Menu

- **Color Wheel** – Select the HLS or HSV components for a particular color by interacting with a dial and a slider; the color wheel is shown in Figure 2-71.

  The characteristics you can adjust in the dial are: 1) hue (azimuth of mouse from the center), and 2) saturation (distance from the center).

  The characteristics you can adjust in the vertical slider are value (in the HSV color system) or lightness (in the HLS color system).

Tip

The farther you click from the center of the wheel (with the left mouse button), the more saturated the color (for that particular hue).

- **Intensity Graphs** – The value of each of the three color system parameters (HLS or HSV) is plotted versus pixel value in a separate line graph. This results in three line graphs showing the current values of the three parameters for the current color table, as shown in Figure 2-71.
- **Color Bar** – Display a vertical color bar; this color bar displays every one of the colors in the current color table; a full-range color bar is shown in Figure 2-71.

  The color bar feature lets you display the colors of the current color table and "rotate" them. To rotate the color table using the color bar, press and drag the left mouse button up or down in the color bar.

If you have any other CeditTool options displayed on your screen, like the intensity graphs or the color wheel, you will see immediate effects as the color table shifts in relation to the mouse's movement.

Note

As you "slide" colors into different color table indices, the colors that "scroll off" the end of the color table are added to the opposite end.

- **Color Bar Range** – Display a vertical color bar displaying only the range of selected colors; a partial-range color bar is shown in Figure 2-71. The range of selected colors is the same as the range chosen for the linear interpolation in the text fields Ramp Start and Ramp End.

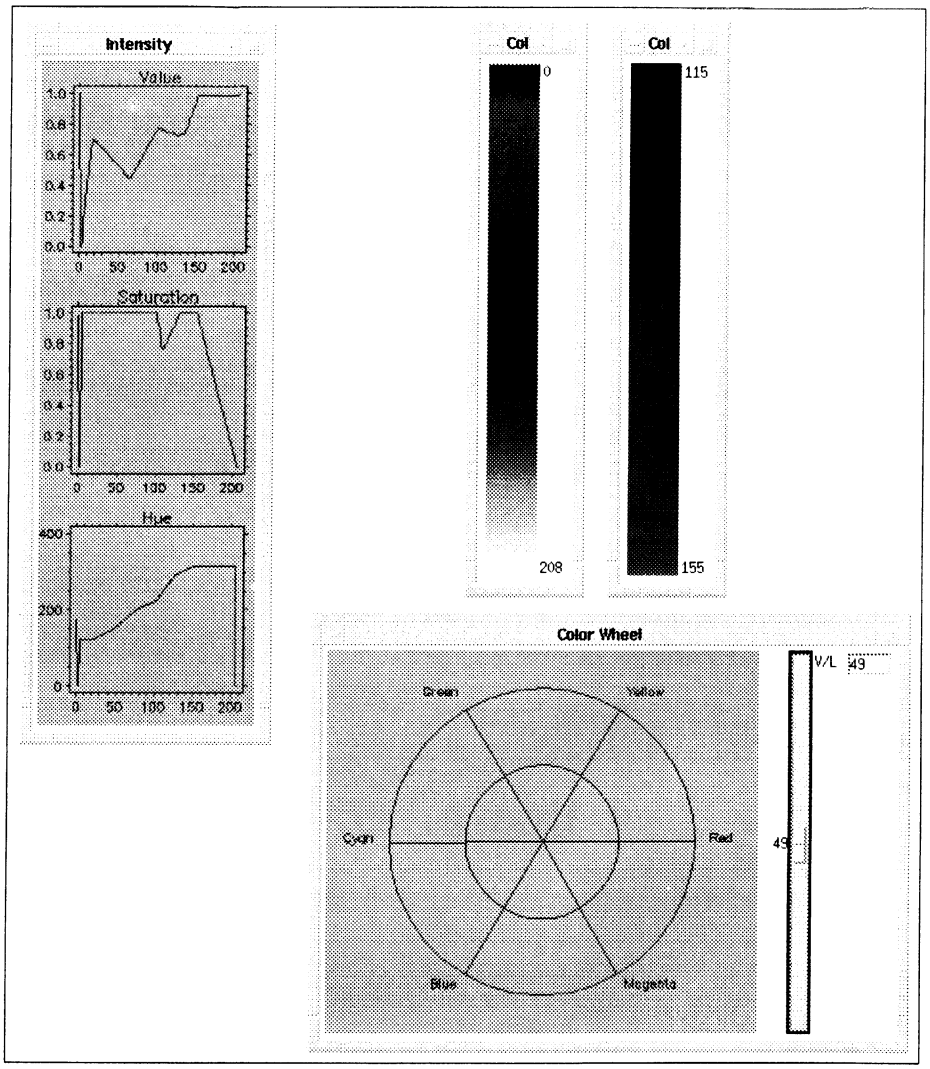


Figure 2-71 Utility widgets accessible via WgCeditTool's Options menu. The four utility widgets are (starting from the upper left, proceeding clockwise): 1) intensity graphs, 2) a color bar showing the entire range of the color table, 3) a color bar showing only a selected range of the color table (range modifiable by user), and 4) a color wheel and slider that can be used to interactively modify the current color. For more information about any of these utility widgets, refer to the *Options Menu* section.

Event Handling

You can use the CeditTool widget in one of the following two ways:

- **From the WAVE> prompt** — Enter the procedure name at the WAVE> prompt to display the CeditTool widget. The CeditTool widget handles its own event loop by calling WwLoop.
- **Standalone widget in its own window created by another application** — The CeditTool widget has its own Main window, but the application (not the CeditTool widget) handles the event loop by calling WwLoop.

The output parameter *shell* can be returned only if you also supply the input parameter *parent.*

Example

Enter the commands shown below into a file, and compile the procedure with the .RUN command. If the variable `parent` is defined, WgCeditTool is created as a child of `parent`; otherwise, WgCeditTool runs on its own (i.e., in its own event loop).

When you are finished interacting with the WgCeditTool window, close it by selecting **Controls=>Exit** from the menus of the CeditTool window.

```
PRO Sample_wgcedittool, parent, tool_shell

IF N_ELEMENTS(parent) NE 0 THEN BEGIN
WgCeditTool, parent, tool_shell
    Create WgCeditTool as a child of the widget known as "parent".
    The window of the newly created widget is returned via the
    optional output parameter "tool_shell".

ENDIF ELSE BEGIN

WgCeditTool
    Create WgCeditTool and display it as its own Main window.
    In other words, the WgCeditTool window runs on its own (i.e., in
    its own event loop).

ENDELSE
END
```

See Also

WgCtTool, COLOR_PALETTE, COLOR_EDIT

For more information about how the UNIX environment variable `$WAVE_GUI` or the VMS logical `WAVE_GUI` affects whether the CeditTool window is implemented using the Motif or the OLIT look-and-feel, refer to *Specifying the Desired Toolkit* on page 411 of the *PV-WAVE Programmer's Guide.*

For more information about color table indices, refer to *Experimenting with Different Color Tables* on page 310 of the *PV-WAVE User's Guide.*

For more information about color systems, refer to *Understanding Color Systems* on page 305 of the *PV-WAVE User's Guide.*

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide.* For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide.*

WgCtTool Procedure

Creates a simple widget that can be used interactively to modify a PV-WAVE color table.

Usage

WgCtTool [, *parent* [, *shell*]]

Input Parameters

parent — (optional) The widget or shell ID of the parent widget (long). If *parent* is not specified, WgCtTool runs on its own (i.e., in its own event loop).

Output Parameters

shell — (optional) The ID of the newly created widget. If the procedure fails, zero (0) is returned.

Input Keywords

Title — A string containing the title that appears in the header of the window. Default value is "Color Table Tool".

Cmap — The index of the color table to load when the widget is created; a positive integer in the range {0...15}.

Position — A two-element vector specifying the X and Y coordinates of the upper-left corner of the CtTool window (long integer). The elements of the vector are [*x*, *y*], where *x* (horizontal) and *y* (vertical) are specified in pixels. These coordinates are measured from the upper-left corner of the screen.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide.*

Background — Specifies the background color name.

Basecolor — Specifies the base color.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Discussion

The WgCtTool window allows you to interactively modify system color tables by stretching, rotating, and reversing them.

In some ways, the WgCtTool window is similar to the WgCeditTool window, in that it provides easy ways to interactively modify color tables. For example, with a single click, you can reverse the color table using the WgCtTool window. But if you need to edit individual colors in the color table, or save your changes for future use, then use the WgCeditTool window, instead.

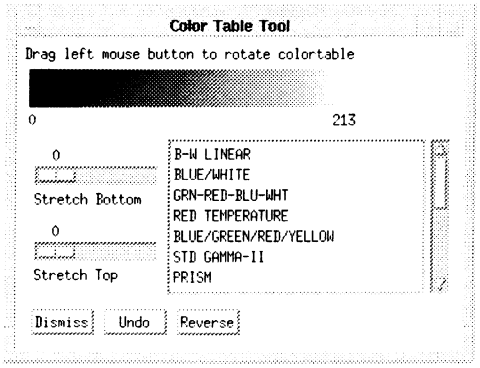


Figure 2-72 The WgCtTool window lets you interactively modify system color tables by stretching, rotating, and reversing them.

The Colors Common Block

This procedure modifies the PV-WAVE internal color table, as well as the color table variables in the COLORS common block.

Most color table procedures maintain the current color table in a common block called `Colors`, defined as follows:

```
COMMON Colors, r_orig, g_orig, b_orig, $
   r_curr, g_curr, b_curr
```

The variables are integer vectors of length equal to the number of color indices. Your program can access these variables by declaring the common block. The modifications you make to the color table by interacting with the CtTool widget are stored in `r_curr`, `g_curr`, and `b_curr`.

Contents of the Window

The CtTool window has three main parts — the color bar area, the control area, and the system color table list.

CtTool Color Bar Area

The built-in color bar lets you display the colors of the current color table and "rotate" them. To rotate the color table using the color bar, press and drag the left mouse button to the left or to the right in the color bar. As you "slide" colors into different color table indices, the colors that "scroll off" the end of the color table are added to the opposite end.

CtTool Control Area

Use the following controls to operate the CtTool window:

- **Stretch Bottom** — Select the lower limit for the stretched color table.
- **Stretch Top** — Select the upper limit for the stretched color table.

- **Undo** – Discard color table modifications you have made using the CtTool window, and return to the color table that CtTool was using when it was first created.
- **Reverse** – Swap the color table (as currently defined), end for end.
- **Dismiss** – Destroy the CtTool window and erase it from the screen.

The CtTool window uses the STRETCH procedure to linearly expand a range of color table indices. The Stretch Bottom number is used for the first parameter to the STRETCH command, and the Stretch Top number is subtracted from the number of colors available in the color table to determine the second parameter to the STRETCH command. For more information about the STRETCH command, refer the description for STRETCH in the *PV-WAVE Reference*.

System Color Table List

This area lists the 16 system color tables that are provided as part of PV-WAVE. Use the left mouse button to select one. The color table you select from the list will immediately be displayed in the color bar area.

Because system color tables are "read-only", no system color table will be permanently altered by any changes you make with the CtTool window. For this reason, the changes you make with CtTool are temporary and can be overwritten by any other PV-WAVE routine writing to the `Colors` common block.

Note To save color table changes for later use, you can use another utility widget, WgCeditTool.

Event Handling

You can use the CtTool widget in one of the following two ways:

- **From the WAVE> prompt** – Enter the procedure name at the WAVE> prompt to display the CtTool widget. The CtTool widget handles its own event loop by calling WwLoop.
- **Standalone widget in its own window created by another application** – The CtTool widget has its own Main window, but the application (not the CtTool widget) handles the event loop by calling WwLoop.

The output parameter *shell* can be returned only if you also supply the input parameter *parent*.

Example

Enter the commands shown below into a file, and compile the procedure with the .RUN command. If the variable `parent` is defined, WgCtTool is created as a child of `parent`; otherwise, WgCtTool runs on its own (i.e., in its own event loop).

When you are finished interacting with the WgCtTool window, close it by clicking the Dismiss button.

```
PRO Sample_wgcttool, parent, tool_shell

IF N_ELEMENTS(parent) NE 0 THEN BEGIN
WgCtTool, parent, tool_shell
```

Create WgCtTool as a child of the widget known as "parent". The window of the newly created widget is returned via the optional output parameter "tool_shell".

```
ENDIF ELSE BEGIN

WgCtTool
```

Create WgCtTool and display it as its own Main window. In other words, the WgCtTool window runs on its own (i.e., in its own event loop).

```
ENDELSE

END
```

See Also

WgCeditTool, COLOR_PALETTE, COLOR_EDIT

For more information about how the UNIX environment variable `$WAVE_GUI` or the VMS logical `WAVE_GUI` affects whether the CtTool window is implemented using the Motif or the OLIT look-and-feel, refer to *Specifying the Desired Toolkit* on page 411 of the *PV-WAVE Programmer's Guide.*

For more information about color table indices, refer to *Experimenting with Different Color Tables* on page 310 of the *PV-WAVE User's Guide.*

For more information about color systems, refer to *Understanding Color Systems* on page 305 of the *PV-WAVE User's Guide.*

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide.* For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide.*

WgIsoSurfTool Procedure

Creates a window with a built-in set of controls; these controls allow you to easily view and modify an iso-surface taken from a three-dimensional block of data.

Usage

WgIsoSurfTool, *surface_data* [, *parent* [, *shell*]]

Input Parameters

surface_data — A 3D variable containing volumetric surface data. The dimensions of *surface_data* define the size of the cube that you see when the IsoSurfTool window is first opened.

parent — (optional) The widget or shell ID of the parent widget (long). If *parent* is not specified, WgIsoSurfTool runs on its own (i.e., in its own event loop).

Output Parameters

shell — (optional) The ID of the newly created widget. If the procedure fails, zero (0) is returned.

Input Keywords

Title — A string containing the title that appears in the header of the IsoSurfTool window. Default value is "Isosurface Tool".

Cmap — The index of the color table to load when the widget is created; a positive integer in the range {0...15}.

Cube_color — The color in which the rotatable cube is drawn; a positive integer in the range {0...255}. The number that is provided for *cube_color* is used as an index into the current color table.

Position — A two-element vector specifying the X and Y coordinates of the upper-left corner of the IsoSurfTool window (long integer). The elements of the vector are [*x*, *y*], where *x* (horizontal) and *y* (vertical) are specified in pixels. These coordinates are measured from the upper-left corner of the screen.

View_rot — A three-element vector specifying the initial view rotation, in degrees. If not supplied, the initial rotation of the cube and the iso-surface is [30, 30, 0] — in other words, 30 degrees rotation around the X axis, 30 degrees rotation around the Y axis, and 0 degrees rotation around the Z axis.

View_zoom — The initial zoom factor; default value is 0.5.

View_persp — The initial perspective distance. If *View_persp* is zero, then the initial setting on the Perspective Distance slider is 0.5, but the Perspective pushbutton is initially deselected. If *View_persp* is nonzero, then the initial setting on the Perspective Distance slider is the value specified by *View_persp* and the Perspective pushbutton is selected.

Note Using no perspective to draw the cube is equivalent to having the eyepoint an infinite distance away from the cube, and will produce a cube with sides that all appear to be parallel to one another.

Thresh_range — The range of values to display in the threshold slider. The default is to use the entire range of values defined by *surface_data*, or in other words, the range:

{*min_surface_data*...*max_surface_data*}

Thresh_value — The initial position of the threshold slider. By default, the movable portion of the slider is positioned in the middle of the threshold range.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide.*

Background — Specifies the background color name.

Basecolor — Specifies the base color.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Discussion

WgIsoSurfTool is an interactive window that lets you use the mouse to view and modify iso-surfaces; you can view any iso-surface contained within the three-dimensional input dataset, *surface_data.*

If the zoom factor is large, or the perspective parameter is small, then the cube display in the View Orientation window may be erroneous. To cure the problem, reduce the zoom or increase the perspective (or disable the perspective entirely).

Some iso-surfaces can be time-consuming to render, especially those that compose many polygons. PV-WAVE will display its "wait cursor" while it is performing the calculations necessary to display the iso-surface.

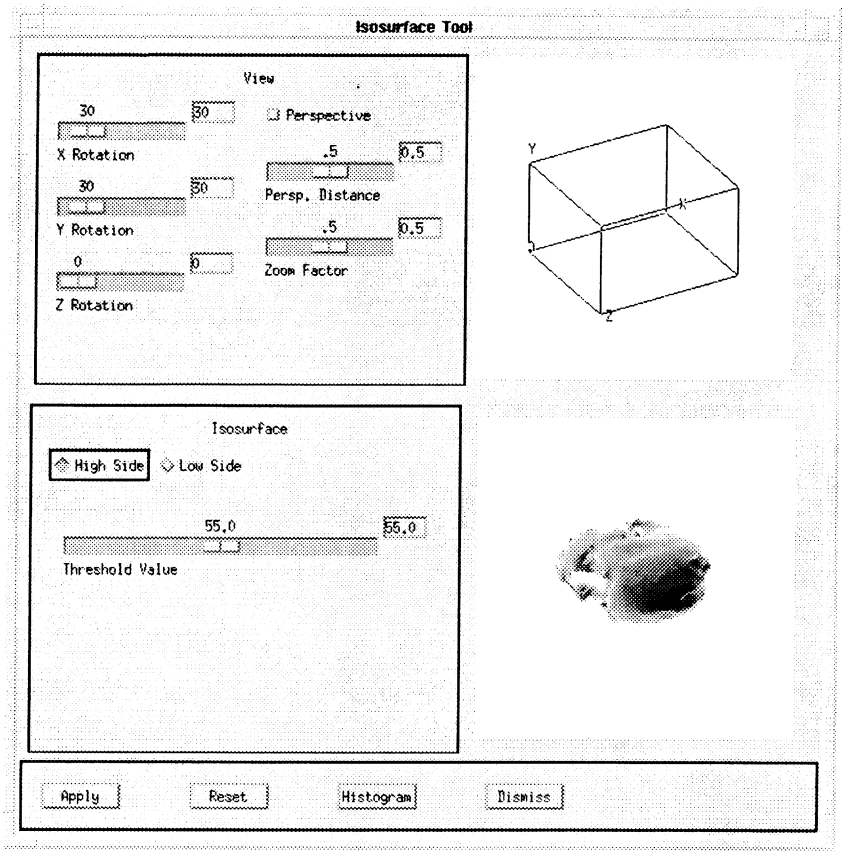


Figure 2-73 WgIsoSurfTool creates an interactive window that lets you use the mouse to easily view and modify an iso-surface taken from a three-dimensional block of data. An iso-surface is a pseudo-surface of constant density within a volumetric data set.

Contents of the Window

The IsoSurfTool window has two main parts — the display area and the control area.

IsoSurfTool Display Area

The display area is towards the right of the window; it is divided into an upper and lower region:

- **View orientation area** — The cube establishes a frame of reference for viewing the iso-surface.
- **Iso-surface area** — This region contains an image displaying an iso-surface; the iso-surface shows similarities in whatever property the data is measuring.

Note The orientation of the iso-surface is copied from the orientation of the cube.

IsoSurfTool Control Area

Use the following controls to operate the IsoSurfTool window:

- **X, Y, and Z Rotation** — These controls allow you to rotate the cube (counter-clockwise around the desired axis) a specified number of degrees. The current rotation is shown in the text field to the right of the slider. To modify the rotation, either enter a new value in one of the text fields, or use the left mouse button to drag one of the sliders. If you enter a new value into a text field, press <Return> to apply the new value to the slider and the surface. If you use the sliders, the change is applied immediately as the slider moves.
- **Perspective** — If enabled, the cube is drawn with perspective; if disabled, the cube is drawn without perspective.
- **Perspective Distance** — Controls the amount of perspective used when drawing the cube; in other words, how close the eyepoint is to the cube. The closer the eyepoint gets to the cube, the greater the amount of perspective exaggeration that is used to draw the cube.

- **Zoom Factor** – Controls the amount of magnification used to draw the cube.
- **High side/low side** – If High Side is enabled, only data values above the threshold value are highlighted on the surface; if Low Side is enabled, only data values below the threshold value are highlighted.

  For more information about High Side/Low Side, refer to the description of the *Low* keyword for the SHADE_VOLUME procedure in the *PV-WAVE Reference*.
- **Threshold Value** – Only data values above or below this value are highlighted on the surface, depending on whether High Side or Low Side is enabled.
- **Apply** – Redraw the iso-surface with the specified viewing parameters.
- **Reset** – Return to the default viewing parameters and the initial threshold value.
- **Histogram** – Draw a histogram of *surface_data* in the iso-surface display area. Viewing this histogram can be useful in determining where to place the threshold value.
- **Dismiss** – Destroy the IsoSurfTool window and erase it from the screen.

Note When you click Apply, the graphics you see being redrawn in the iso-surface portion of the display area are being sent to this window via the Z-buffer virtual graphics device. This reduces the time required to redraw the iso-surface by about fourfold. For more information on the Z-buffer graphics device, refer to *Z-buffer Output* on page A-99 of the *PV-WAVE User's Guide*.

Event Handling

You can use the IsoSurfTool widget in one of the following two ways:

- **From the WAVE> prompt** – Enter the procedure name at the WAVE> prompt to display the IsoSurfTool widget. The

IsoSurfTool widget handles its own event loop by calling WwLoop.

- **Standalone widget in its own window created by another application** – The IsoSurfTool widget has its own Main window, but the application (not the IsoSurfTool widget) handles the event loop by calling WwLoop.

The output parameter *shell* can be returned only if you also supply the input parameter *parent*.

Example

Enter the commands shown below into a file, and compile the procedure with the .RUN command. If the variable `parent` is defined, WgIsoSurfTool is created as a child of `parent`; otherwise, WgIsoSurfTool runs on its own (i.e., in its own event loop).

When you are finished interacting with the WgIsoSurfTool window, close it by clicking the Dismiss button.

```
PRO Sample_wgisosurftool, parent, tool_shell
head = BYTARR(115, 75, 105)
```

Define a variable to hold the data.

```
IF !Version.platform EQ 'VMS' THEN $
   OPENR, u, GETENV('WAVE_DIR')+$
   '[data]man_head.dat', /Get_lun $

ELSE $
OPENR, u, '$WAVE_DIR/data/man_head.dat', $
   /Get_lun
READU, u, head
```

Read the PV-WAVE man_head.dat demo file that contains three-dimensional volumetric data.

```
CLOSE, u
FREE_LUN, u
```

Close the file and free the LUN.

```
reduced_head = REBIN(head, 23, 15, 21)
```
Sample the data so fewer data points are passed in to WgIsoSurfTool. Doing this improves performance significantly, because WgIsoSurfTool has fewer polygons to process.

```
IF N_ELEMENTS(parent) NE 0 THEN BEGIN
WgIsoSurfTool, reduced_head, parent, $
   tool_shell
```
Create WgIsoSurfTool as a child of the widget known as "parent". The window of the newly created widget is returned via the optional output parameter "tool_shell".

```
ENDIF ELSE BEGIN

WgIsoSurfTool, reduced_head
```
Create WgIsoSurfTool and display it as its own Main window. In other words, the WgIsoSurfTool window runs on its own (i.e., in its own event loop).

```
ENDELSE
END
```

See Also

SHADE_VOLUME, RENDER

For more information about how the UNIX environment variable `$WAVE_GUI` or the VMS logical `WAVE_GUI` affects whether the IsoSurfTool window is implemented using the Motif or the OLIT look-and-feel, refer to *Specifying the Desired Toolkit* on page 411 of the *PV-WAVE Programmer's Guide.*

For information about drawing iso-surfaces using voxel data, see Chapter 6, *Advanced Rendering Techniques*, in the *PV-WAVE User's Guide*. This chapter includes a number of examples showing iso-surfaces that have been drawn using the RENDER function.

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*. For more information about how to write an application program based on PV-WAVE's

Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide*.

WgMovieTool Procedure

Creates a window that cycles through a sequence of images.

Usage

WgMovieTool, *image_data* [, *parent* [, *shell* [, *windowid* [, *rate*]]]]

Input Parameters

image_data — A 3D array of images (byte). The dimensions of the array are (*m, n, n_frames*), where (*m,n*) is the size of an individual image, and *n_frames* is the total number of frames in the sequence.

parent — (optional) The widget or shell ID of the parent widget (long). If *parent* is not specified, WgMovieTool runs on its own (i.e., in its own event loop).

rate — (optional) Minimum cycling speed, specified in frames per second; the exact cycling speed varies depending on system load. (This number corresponds to the numeral "1" underneath the speed slider.) By default, under "optimum" conditions, the rate is 30 frames per second (if *Pixmap* is present and nonzero) or 3 frames per second (if *Pixmap* is not supplied or is equal to zero).

Output Parameters

shell — (optional) The ID of the newly created widget. If the procedure fails, zero (0) is returned.

windowid — (optional) The window ID of the PV-WAVE graphics window. (For information on window IDs, see the description for the WINDOW procedure.)

Input Keywords

Title — A string containing the title that appears in the header of the MovieTool window. Default value is "Movie Tool".

Cmap — The index of the color table to load when the widget is created; a positive integer in the range {0...15}.

Position — A two-element vector specifying the X and Y coordinates of the upper-left corner of the MovieTool window (long integer). The elements of the vector are [*x*, *y*], where *x* (horizontal) and *y* (vertical) are specified in pixels. These coordinates are either: 1) if *parent* is present and the *Popup* keyword is not specified or has a value of zero, measured from the upper-left corner of a layout (container) widget or 2) if the *Popup* keyword is present and nonzero (regardless of whether *parent* is present and/or nonzero), measured from the upper-left corner of the screen.

Order — The order in which the image is drawn. If present and nonzero, the image is inverted. In other words, the image is drawn from bottom to top instead of from top to bottom.

Pixmap — 1 indicates that pixmaps should be used for the animation; 0 indicates that the data is stored in a PV-WAVE variable. Using pixmaps dramatically improves the speed of the animation, but requires more memory from the X Window System's X server than when data stored in variables is used.

Do_tvscl — 1 indicates that TVSCL should be used to scale the image values to the current color table; 0 indicates that TV will be used instead (no scaling).

Maximum — Maximum cycling speed, specified in frames per second; the exact cycling speed varies depending on system load. (This number corresponds to the label to the right of the speed slider.) If *Maximum* is not specified, the maximum rate is 100 frames per second (if *Do_tvscl* is not supplied or is equal to zero) or 10 frames per second (if *Do_tvscl* is present and nonzero).

File — A string containing the name of the file from which the image data is read. When using the *File* keyword, the *Dims* keyword must also be supplied. If present, the input variable *image_data* is ignored.

Dims — A three-element vector specifying the size of the images to be read from the file, and the number of images to read. The elements of the vector are [*m, n, n_frames*], where (*m,n*) is the size of an individual image, and *n_frames* is the total number of frames in the sequence.

Popup — If present and nonzero, the MovieTool widget is displayed in its own Main window.

Size — A two-element vector specifying the width and height of the display area (long integer). If not specified, the default size of the display area is *m*-by-*n* pixels, where *m* and *n* are defined by *image_data*.

View — A two-element vector specifying the width and height of the viewport onto the display area (long integer). If not specified, the default size of the viewport is *m*-by-*n* pixels, where *m* and *n* are defined by *image_data*.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide*.

Background — Specifies the background color name.

Basecolor — Specifies the base color.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Attachment Keywords

For additional information on attachment keywords, see *Form Layout: Attachments* on page 422 of the *PV-WAVE Programmer's Guide*.

Bottom — If a widget ID is specified (for example, `Bottom=wid`), then the bottom of the color bar widget is attached to the top of the specified widget. If no widget ID is specified (for example, `/Bottom`), then the bottom of the movie widget is attached to the bottom of the parent widget.

Left — If a widget ID is specified (for example, `Left=wid`), then the left side of the movie widget is attached to the right side of the specified widget. If no widget ID is specified (for example, `/Left`), then the left side of the movie widget is attached to the left side of the parent widget.

Right — If a widget ID is specified (for example, `Right=wid`), then the right side of the movie widget is attached to the left side of the specified widget. If no widget ID is specified (for example, `/Right`), then the right side of the movie widget is attached to the right side of the parent widget.

Top — If a widget ID is specified (for example, `Top=wid`), then the top of the movie widget is attached to the bottom of the specified widget. If no widget ID is specified (for example, `/Top`), then the top of the movie widget is attached to the top of the parent widget.

Discussion

WgMovieTool is an interactive window that lets you use the mouse to control the pace and direction of an animated series of images.

Note Using the WgMovieTool window is similar in many ways to using the WgAnimateTool window, but WgMovieTool is designed so that it can be included inside larger layout widgets, while WgAnimateTool is intended to be used as a standalone utility widget. Be sure to familiarize yourself with the attachment keywords if you plan to place WgMovieTool inside a larger layout widget.

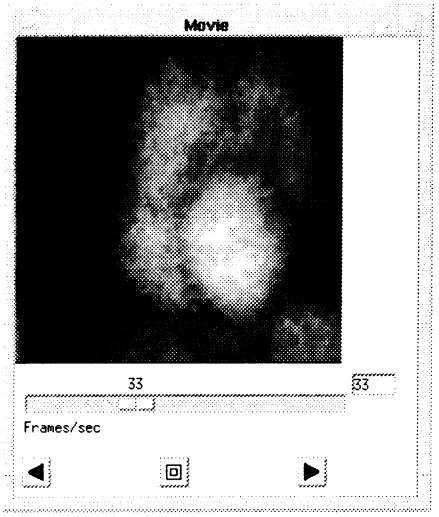


Figure 2-74 WgMovieTool creates an interactive window that lets you use the mouse to control the pace and direction of an animated series of images.

MovieTool provides a graphical user interface (GUI) to a Standard Library procedure, `movie.pro`. Unlike the blocking behavior that you encounter with movie.pro, you can interact with other windows while MovieTool is open and running.

Contents of the Window

The MovieTool window has two main parts — the display area and the control area.

MovieTool Display Area

The display area is the largest area of the window; it is where the animation sequence takes place.

MovieTool Control Area

Use the following controls to operate the MovieTool window:

- **Movie speed slider** — Decrease or increase the rate of display.

  The number shown to the left of the slider is the minimum cycling speed for the animation sequence; this number is controlled with the *Rate* keyword. The number shown to the right of the slider is the maximum cycling speed for the animation sequence; this number is controlled with the *Maximum* keyword.

- **Left-pointing arrow** — Cycle through the images from last to first.
- **Stop button** — Freeze display at the current image.
- **Right-pointing arrow** — Cycle through the images from first to last.

Use the window manager menu of the window frame to dismiss the MovieTool window from the screen.

Event Handling

You can use the MovieTool widget in one of the following three ways:

- **From the WAVE> prompt** — Enter the procedure name at the WAVE> prompt to display the MovieTool widget. The MovieTool widget handles its own event loop by calling WwLoop.
- **Standalone widget in its own window created by another application** — If the *Popup* keyword is present and nonzero, the MovieTool widget has its own Main window. The application (not the MovieTool widget) handles the event loop by calling WwLoop.
- **Combined with other widgets in a layout widget** — Another application combines the MovieTool widget with other widgets inside a layout widget. The application (not the

MovieTool widget) handles the event loop by calling WwLoop.

When the input parameter *parent* is present and nonzero, the widget operates in either the second or third mode listed, depending on the value of the *Popup* keyword. The output parameter *shell* can be returned only if you also supply the input parameter *parent*.

You can use the output parameter *windowid* to keep track of the PV-WAVE window ID that is assigned to the MovieTool. You can create multiple instances of the MovieTool; each one will be assigned a different PV-WAVE window ID.

Example

Enter the commands shown below into a file, and compile the procedure with the .RUN command. If the variable `parent` is defined, WgMovieTool is created as a child of `parent`; otherwise, WgMovieTool runs on its own (i.e., in its own event loop).

When you are finished interacting with the WgMovieTool window, close it using the window manager menu.

```
PRO Sample_wgmovietool, parent, tool_shell
heart = BYTARR(256, 256, 15)
```

Define a variable to hold the data.

```
IF !Version.platform EQ 'VMS' THEN $
   OPENR, u, GETENV('WAVE_DIR')+$
   '[data]heartbeat.dat', /Get_lun $

ENDIF ELSE BEGIN
OPENR, u, !Dir+'/data/heartbeat.dat', $
   /Get_lun
ENDELSE
READU, u, heart
```

Read the PV-WAVE heartbeat.dat demo file that contains images showing a beating human heart.

```
CLOSE, u
FREE_LUN, u
```

Close the file and free the LUN.

```
IF N_ELEMENTS(parent) NE 0 THEN BEGIN
WgMovieTool, heart, parent, tool_shell, $
   /Do_tvscl, /Pixmap, /Popup
```

Create WgMovieTool as a child of the widget known as "parent". The window of the newly created widget is returned via the optional output parameter "tool_shell".

```
ENDIF ELSE BEGIN

WgMovieTool, heart, /Do_tvscl, /Pixmap
```

Create WgMovieTool and display it as its own Main window. In other words, the WgMovieTool window runs on its own (i.e., in its own event loop).

```
ENDELSE
END
```

See Also

MOVIE, WgAnimateTool

For more information about how the UNIX environment variable `$WAVE_GUI` or the VMS logical `WAVE_GUI` affects whether the MovieTool window is implemented using the Motif or the OLIT look-and-feel, refer to *Specifying the Desired Toolkit* on page 411 of the *PV-WAVE Programmer's Guide.*

For more information about how to transfer image data to PV-WAVE variables, refer to *Input and Output of Image Data* on page 189 of the *PV-WAVE Programmer's Guide.*

For more information about pixmaps, refer to *Using Pixmaps to Improve Application Performance* on page A-85 of the *PV-WAVE User's Guide.*

For more information about color table indices, refer to *Experimenting with Different Color Tables* on page 310 of the *PV-WAVE User's Guide.*

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide.* For more information about how to write an application program based on PV-WAVE's

Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide*.

WgSimageTool Procedure

Creates two windows: 1) a scrolling image window and 2) an optional smaller window that shows a reduced view of the entire image.

Usage

WgSimageTool, *image_data* [, *parent* [, *shell*]]

Input Parameters

image_data — A 2D variable containing image data for a single image (byte).

parent — (optional) The widget or shell ID of the parent widget (long). If *parent* is not specified, WgSimageTool runs on its own (i.e., in its own event loop).

Output Parameters

shell — (optional) The ID of the newly created widget. If the procedure fails, zero (0) is returned.

Input Keywords

Title — A string containing the title that appears in the header of the window that is used to display the scrolled image. Default value is "Full Size Image".

Rtitle — A string containing the title that appears in the header of the small window that is used to display the entire image. Default value is "Reduced Image".

Position — A two-element vector specifying the X and Y coordinates of the upper-left corner of the SimageTool window (long

integer). The elements of the vector are [*x*, *y*], where *x* (horizontal) and *y* (vertical) are specified in pixels. These coordinates are measured from the upper-left corner of the screen.

Order — The order in which the image is drawn. If present and nonzero, the image is inverted. In other words, the image is drawn from bottom to top instead of from top to bottom.

Do_tvscl — 1 indicates that TVSCL should be used to scale the image data before it is displayed; 0 indicates that TV will be used to display the data, unscaled.

Noreduce — If present and nonzero, the reduced size window that is used to display the entire image is not displayed. Only the larger of the two windows is displayed.

Reduced_size — A two-element vector specifying the width and height of the image display area of the reduced size window that displays the entire image (long integer). The reduced size image is computed using CONGRID; if *Reduced* is not specified, the default size of the reduced image is 256-by-256. This keyword is ignored if *Noreduce* is present and nonzero.

Wsize — A two-element vector specifying the width and height of the image display area of the scrolled image window (long integer). Default display area size is either: 1) 512-by-512, or 2) the size of *image_data*, whichever is less.

Dsize — A two-element vector specifying the width and height of the image to be displayed in the scrolling area (long integer). Default is for *Dsize* to be the same as *image_data* in both directions. If *Dsize* is larger than *Wsize*, you will be able to use scroll bars to move the image around in the display window. An error occurs if *Dsize* is smaller than the size of *image_data* in either direction.

Note When *Dsize* is greater than *Wsize*, and scroll bars are placed on the right and at the bottom of the scrolled image window, then 12 pixels are subtracted in each direction (from the displayed image area) to allow room for the scroll bars.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide.*

Background — Specifies the background color name.

Basecolor — Specifies the base color.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Discussion

WgSimageTool provides a convenient way to view images, either full-size or reduced-size. Scroll bars are provided for viewing large images when they are viewed at full size.

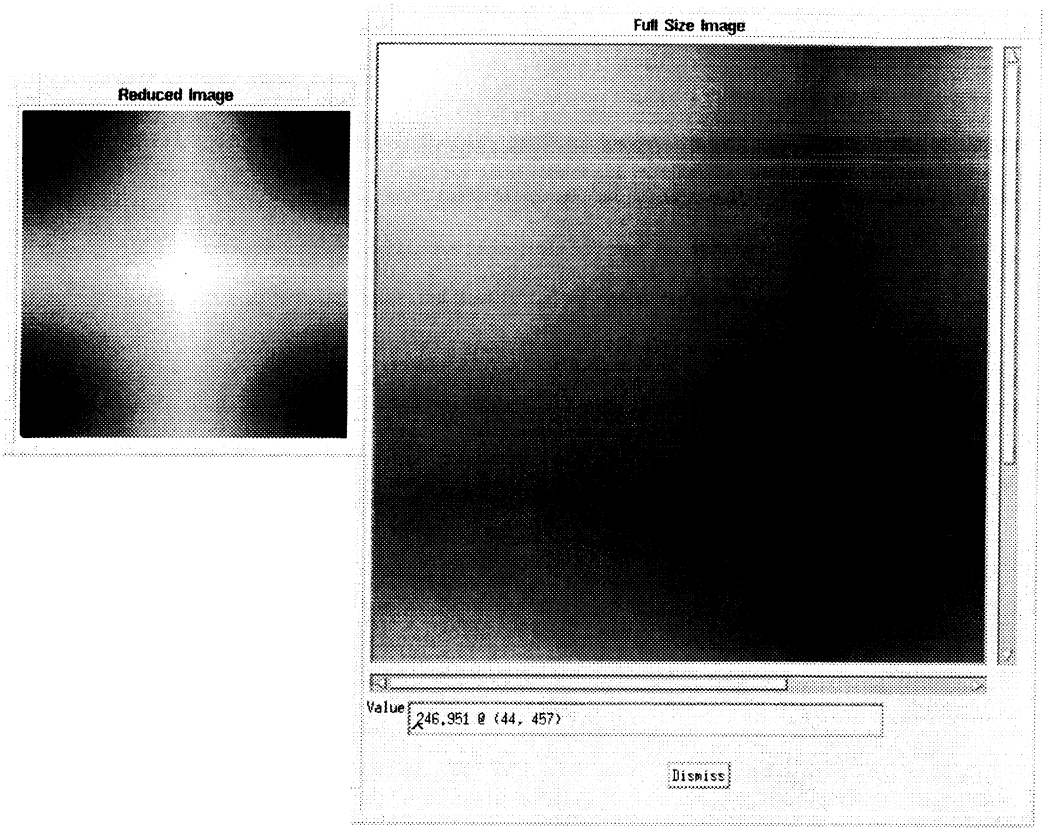


Figure 2-75 By default, WgSimageTool displays two windows. One window displays the image at full-size, and adds scroll bars to the right and bottom for viewing other portions of the image. The other window displays the image at a reduced size (256-by-256 by default) and does not offer the option of scroll bars. Use the *Noreduce* keyword to suppress the reduced-size window and display only the larger window.

Contents of the Window

The larger of the two SimageTool windows has two main parts — the display area and the control area.

SimageTool Display Area

The display area is the largest area of the window; it is where the full-size image is displayed.

SimageTool Control Area

Use the following controls to operate the SimageTool window:

- **Value** — If the pointer is within the boundaries of the image, its location is echoed in this area, along with the value of the image data directly underneath the pointer.
- **Dismiss** — Destroy the SimageTool window(s) and erase it (them) from the screen.

Event Handling

You can use the SimageTool widget in one of the following two ways:

- **From the WAVE> prompt** — Enter the procedure name at the WAVE> prompt to display the SimageTool widget. The SimageTool widget handles its own event loop by calling WwLoop.
- **Standalone widget in its own window created by another application** — The SimageTool widget has its own Main window, but the application (not the SimageTool widget) handles the event loop by calling WwLoop.

The output parameter *shell* can be returned only if you also supply the input parameter *parent*.

Example

Enter the commands shown below into a file, and compile the procedure with the .RUN command. If the variable `parent` is defined, WgSimageTool is created as a child of `parent`; otherwise, WgSimageTool runs on its own (i.e., in its own event loop).

When you are finished interacting with the WgSimageTool window, close it by clicking on the Dismiss button.

```
PRO Sample_wgsimagetool, parent, tool_shell
x = dist(7000)
```

Create a "dummy" variable to use as data for WgSimageTool.

```
IF N_ELEMENTS(parent) NE 0 THEN BEGIN
WgSimageTool, x, parent, tool_shell, /Do_tvscl
```

Create WgSimageTool as a child of the widget known as "parent". The window of the newly created widget is returned via the optional output parameter "tool_shell".

```
ENDIF ELSE BEGIN

WgSimageTool, x, /Do_tvscl
```

Create WgSimageTool and display it as its own Main window. In other words, the WgSimageTool window runs on its own (i.e., in its own event loop).

```
ENDELSE
END
```

See Also

TV, TVSCL

For more information about how the UNIX environment variable `$WAVE_GUI` or the VMS logical `WAVE_GUI` affects whether the SimageTool window is implemented using the Motif or the OLIT look-and-feel, refer to *Specifying the Desired Toolkit* on page 411 of the *PV-WAVE Programmer's Guide.*

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide.* For more information

about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide*.

WgSliceTool Procedure

Creates a window with a built-in set of controls; these controls allow you to easily select and view "slices" from a three-dimensional block of data.

Usage

WgSliceTool, *block_data* [, *parent* [, *last_slice* [, *shell*]]]

Input Parameters

block_data — A 3D variable containing volumetric data. The dimensions of *block_data* define the size of the cube that you see when the SliceTool window is first opened.

parent — (optional) The widget or shell ID of the parent widget (long). If *parent* is not specified, WgSliceTool runs on its own (i.e., in its own event loop).

Output Parameters

last_slice — (optional) The two-dimensional set of values describing the most recent slice that was displayed. The data type of *last_slice* is the same as the data type for *block_data*.

shell — (optional) The ID of the newly created widget. If the procedure fails, zero (0) is returned.

Input Keywords

Title — A string containing the title that appears in the header of the SliceTool window. Default value is "Slicer Tool".

Cmap — The index of the color table to load when the widget is created; a positive integer in the range {0...15}.

Cube_color — The color in which the rotatable cube is drawn; a positive integer in the range {0...255}. The number that is provided for *cube_color* is used as an index into the current color table.

Slice_color — The color in which the slice is drawn; a positive integer in the range {0...255}. The number that is provided for *slice_color* is used as an index into the current color table.

Position — A two-element vector specifying the X and Y coordinates of the upper-left corner of the SliceTool window (long integer). The elements of the vector are [*x*, *y*], where *x* (horizontal) and *y* (vertical) are specified in pixels. These coordinates are measured from the upper-left corner of the screen.

View_rot — A three-element vector specifying the initial view rotation, in degrees. If not supplied, the initial rotation of the cube is [30, 30, 0] — in other words, 30 degrees rotation around the X axis, 30 degrees rotation around the Y axis, and 0 degrees rotation around the Z axis.

View_zoom — The initial zoom factor; default value is 0.5.

View_persp — The initial perspective distance. If *View_persp* is zero, then the initial setting on the Perspective Distance slider is 0.5, but the Perspective pushbutton is initially deselected. If *View_persp* is nonzero, then the initial setting on the Perspective Distance slider is the value specified by *View_persp* and the Perspective pushbutton is selected.

Note Using no perspective to draw the cube is equivalent to having the eyepoint an infinite distance away from the cube, and will produce a cube with sides that all appear to be parallel to one another.

Slice_rot — A three-element vector specifying the XYZ slicing plane rotation, in degrees. If not supplied, the initial rotation is [0, 0, 0] — in other words, no rotation.

Slice_trans — A three-element vector specifying the initial slicing plane translation, in degrees. If not supplied, the initial translation is [0, 0, 0] — in other words, no translation.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide.*

Background — Specifies the background color name.

Basecolor — Specifies the base color.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Discussion

WgSliceTool is an interactive window that lets you use the mouse to view and modify the location of a slice that bisects a volume of data; you can position the slice anywhere within the three-dimensional input dataset, *surface_data.*

If the zoom factor is large, or the perspective parameter is small, then the cube display in the View Orientation area may be erroneous. To cure the problem, reduce the zoom or increase the perspective (or disable the perspective entirely).

To select a slice, adjust the sliders that control perspective, zoom, and orientation of the slice in relationship to the cube. When you are satisfied with your selections, click the Apply button.

Note Slices of data are displayed "head-on". In other words, the data slice is not projected into 3D space — the data displayed is the actual 2D slice that you selected.

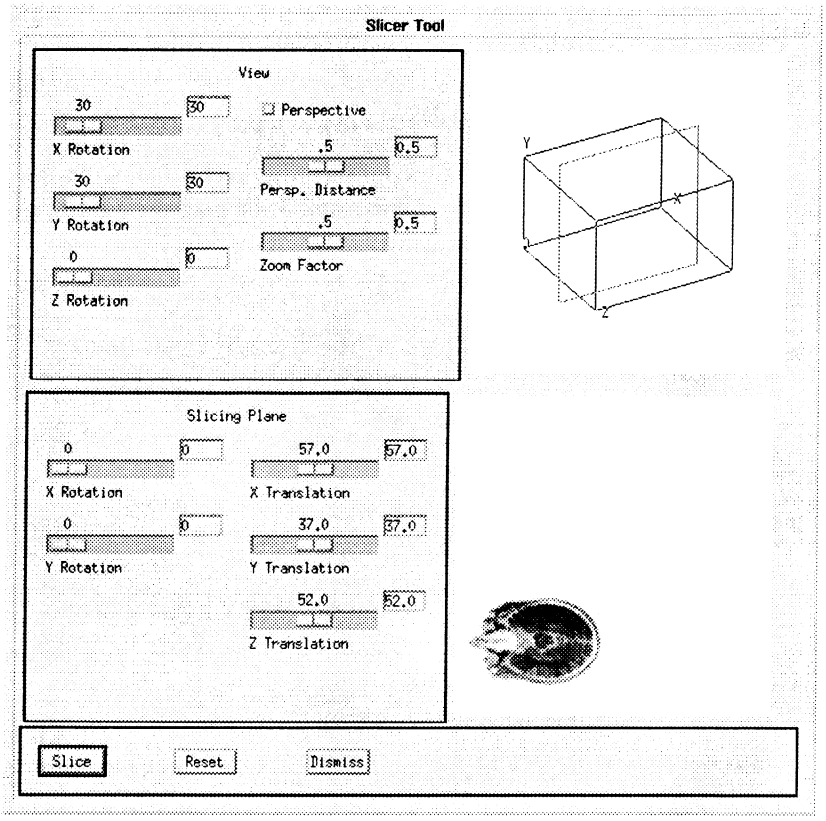


Figure 2-76 WgSliceTool is an interactive window that lets you use the mouse to view and modify the location of a slice that bisects a volume of data; your selections in the lower left part of the window affect the position of the slice.

SliceTool Display Area

The display area is towards the right of the window; it is divided into an upper and lower region:

- **View orientation area** — The cube establishes a frame of reference for positioning the slice of data.
- **Data slice area** — This region contains an image displaying the actual slice of data that you have selected for viewing.

Note The orientation of the cube provides a frame of reference for selecting and understanding the slice of data that you have chosen to view.

SliceTool Control Area

Use the following controls to operate the SliceTool window:

- **X, Y, and Z Rotation** – These controls allow you to rotate the cube (counter-clockwise around the desired axis) a specified number of degrees. The current rotation is shown in the text field to the right of the slider. To modify the rotation, either enter a new value in one of the text fields, or use the left mouse button to drag one of the sliders. If you enter a new value into a text field, press <Return> to apply the new value to the slider and the surface. If you use the sliders, the change is applied immediately as the slider moves.
- **Perspective** – If enabled, the cube is drawn with perspective; if disabled, the cube is drawn without perspective.
- **Perspective Distance** – Controls the amount of perspective used when drawing the cube; in other words, how close the eyepoint is to the cube. The closer the eyepoint gets to the cube, the greater the amount of perspective exaggeration that is used to draw the cube.
- **Zoom Factor** – Controls the amount of magnification used to draw the cube.
- **Apply** – Redraw the cube and the data slice with the specified viewing parameters.
- **Reset** – Return to the default viewing parameters and the initial orientation and positioning of the slice.
- **Dismiss** – Destroy the SliceTool window and erase it from the screen.

Event Handling

You can use the SliceTool widget in one of the following two ways:

- **From the WAVE> prompt** – Enter the procedure name at the WAVE> prompt to display the SliceTool widget. The SliceTool widget handles its own event loop by calling WwLoop.
- **Standalone widget in its own window created by another application** – The SliceTool widget has its own Main window, but the application (not the SliceTool widget) handles the event loop by calling WwLoop.

The output parameter *shell* can be returned only if you also supply the input parameter *parent*.

Example

Enter the commands shown below into a file, and compile the procedure with the .RUN command. If the variable `parent` is defined, WgSliceTool is created as a child of `parent`; otherwise, WgSliceTool runs on its own (i.e., in its own event loop).

When you are finished interacting with the WgSliceTool window, close it by clicking on the Dismiss button.

```
PRO Sample_wgslicetool, parent, tool_shell
head = BYTARR(115, 75, 105)
   Define a variable to hold the data.
IF !Version.platform EQ 'VMS' THEN $
   OPENR, u, GETENV('WAVE_DIR')+$
   '[data]man_head.dat', /Get_lun $

ELSE $
OPENR, u, '$WAVE_DIR/data/man_head.dat', $
   /Get_lun
READU, u, head
   Read the PV-WAVE man_head.dat demo file that contains
   three-dimensional volumetric data.

CLOSE, u
```

```
FREE_LUN, u
```
Close the file and free the LUN.

```
IF N_ELEMENTS(parent) NE 0 THEN BEGIN
WgSliceTool, head, slice, parent, tool_shell
```
Create WgSliceTool as a child of the widget known as "parent". The window of the newly created widget is returned via the optional output parameter "tool_shell".

```
ENDIF ELSE BEGIN
```

```
WgSliceTool, head, slice
```
Create WgSliceTool and display it as its own Main window. In other words, the WgSliceTool window runs on its own (i.e., in its own event loop).

```
ENDELSE
END
```

See Also

VIEWER, SLICE_VOL

For more information about how the UNIX environment variable `$WAVE_GUI` or the VMS logical `WAVE_GUI` affects whether the SliceTool window is implemented using the Motif or the OLIT look-and-feel, refer to *Specifying the Desired Toolkit* on page 411 of the *PV-WAVE Programmer's Guide.*

For information about other approaches to slicing volumes, see Chapter 6, *Advanced Rendering Techniques*, in the *PV-WAVE User's Guide.* This chapter includes an example showing how to render selected slices from a large amount of volume data.

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide.* For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide.*

WgStripTool Procedure

Creates a window that displays data in a style that simulates a real-time, moving strip chart.

Usage

WgStripTool [, *x*, y_1, y_2, ... , y_{10}, *parent* [, *shell*]]

WgStripTool [, *x* [, y_1 [, y_2
[, y_3 [, y_4 [, y_5 [, y_6 [, y_7 [, y_8 [, y_9 [, y_{10}]]]]]]]]]]

Input Parameters

x — (optional) A vector specifying the X values (horizontal) of each strip chart. If not specified, or set equal to zero, monotonically increasing values, starting with 0 (zero) are automatically provided along the X axis. Must have the same number of elements as the *y* vectors.

y_n — (optional) Up to ten vectors containing data in the Y direction (vertical); each vector is displayed in a separate strip chart. The number of *y* variables specified determines the number of strip charts that are displayed. All *y* vectors should contain the same number of elements.

parent — (optional) The widget or shell ID of the parent widget (long). If *parent* is not specified, WgStripTool runs on its own (i.e., in its own event loop).

Output Parameters

shell — (optional) The ID of the newly created widget. If the procedure fails, zero (0) is returned.

Input Keywords

Title — A string containing the title that appears in the header of the window. Default value is "Stripchart Tool".

Position — A two-element vector specifying the X and Y coordinates of the upper-left corner of the WgStripTool window (long integer). The elements of the vector are [*x*, *y*], where *x* (horizontal) and *y* (vertical) are specified in pixels. These coordinates are measured from the upper-left corner of the screen.

Delay — The minimum interval for updating the strip chart, specified in milliseconds (floating point). The default is to have 0 milliseconds of delay.

Size — A two-element vector specifying the width and height of the display area (long integer); the display area is divided equally between the strip charts for all specified *y* variables. If not specified, the default size of the display area is 512-by-512 pixels.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide*.

Background — Specifies the background color name.

Basecolor — Specifies the base color.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Discussion

The WgStripTool window allows you to view data in moving strip charts; you can adjust the display width in the strip charts to create the effect of zooming in and out. You can also adjust the rate and the manner with which the strip charts progress through the data.

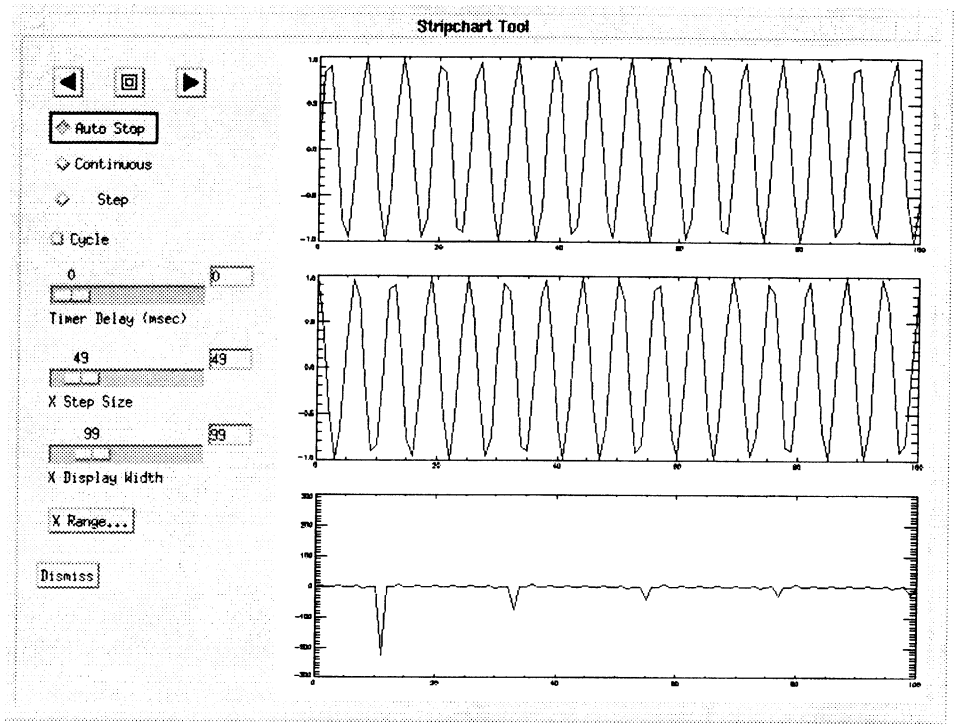


Figure 2-77 The WgStripTool window lets you interactively view data in moving strip charts; up to ten strip charts can be simultaneously displayed by the WgStripTool window. You can adjust the display width in the strip charts to create the effect of zooming in and out. You can also adjust the rate and the manner with which the strip charts progress through the data.

Contents of the Window

The StripTool window has two main parts — the display area and the control area.

StripTool Display Area

The display area is the largest area of the window; it is where the data strip charts are displayed. The number of strip charts you see

in this area is determined by the number of *y* variables that were included in the call that invoked the WgStripTool window.

StripTool Control Area

Use the following controls to operate the WgStripTool window:

- **Reverse button** – Cycle through the data in a reverse direction.
- **Stop button** – Freeze strip chart display at current location.
- **Forward button** – Cycle through the data in a forward direction.
- **Mode** – Select Auto Stop to have WgStripTool stop whenever it reaches the beginning or the end of the data in the *y* variable(s). Select Continuous to have WgStripTool move through the data in a non-stop manner, pausing only when you click the Stop button. Select Step to have the strip chart proceed only when you click on one of the arrow buttons.
- **Timer Delay** – Decrease or increase the rate of display. The number shown to the right of the slider is the number of milliseconds delay between contiguous frames of the strip chart.
- **X Step Size** – The amount by which the strip charts are moved forward or back when the strip charts are updated.
- **X Display Width** – The range of data displayed in the horizontal direction. A small value for display width has the effect of "zooming in" to view a narrow range of data; a large value for display width has the effect of "zooming out" to view a broader range of data.
- **X Range** – A more precise way to specify X Display Width. Click this button to display another dialog box containing text fields where you can type precise values for the minimum and maximum values you wish to have displayed along the X axis.

  This other dialog box is shown in Figure 2-78.
- **Dismiss** – Destroy the WgStripTool window and erase it from the screen.

Note The selections you make in the control area affect all displayed strip charts. This way, you can be assured that the data in one strip chart is in "sync" with the data in any other strip chart.

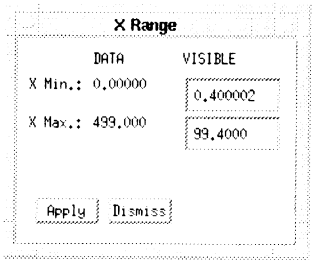


Figure 2-78 Use this dialog box to precisely control the range of the X axis in the WgStripTool window. This dialog box is displayed if you click the X Range button in the WgStripTool control area.

Event Handling

You can use the WgStripTool widget in one of the following two ways:

- **From the WAVE> prompt** — Enter the procedure name at the WAVE> prompt to display the WgStripTool widget. The WgStripTool widget handles its own event loop by calling WwLoop.
- **Standalone widget in its own window created by another application** — The WgStripTool widget has its own Main window, but the application (not the WgStripTool widget) handles the event loop by calling WwLoop.

The output parameter *shell* can be returned only if you also supply the input parameter *parent*.

Example

Enter the commands shown below into a file, and compile the procedure with the .RUN command. If the variable `parent` is defined, WgStripTool is created as a child of `parent`; otherwise, WgStripTool runs on its own (i.e., in its own event loop).

When you are finished interacting with the WgStripTool window, close it by clicking on the Dismiss button.

```
PRO Sample_wgstriptool, parent, tool_shell
x = indgen(500)
y1 = sin(x)
y2 = cos(x)
y3 = tan(x)
```

Create an independent variable and three dependent variables describing sinusoidal curves to use as data for WgStripTool.

```
IF N_ELEMENTS(parent) NE 0 THEN BEGIN
WgStripTool, x, y1, y2, y3, $
   0, 0, 0, 0, 0, 0, 0, parent, tool_shell
```

Create WgStripTool as a child of the widget known as "parent". The window of the newly created widget is returned via the optional output parameter "tool_shell".

```
ENDIF ELSE BEGIN

WgStripTool, x, y1, y2, y3
```

Create WgStripTool and display it as its own Main window. In other words, the WgStripTool window runs on its own (i.e., in its own event loop). Notice how the zeroes are not needed as placeholders, since the optional parameters "parent" and "tool_shell" are not being used in this procedure call.

```
ENDELSE
END
```

See Also

For more information about how the UNIX environment variable `$WAVE_GUI` or the VMS logical `WAVE_GUI` affects whether the WgStripTool window is implemented using the Motif or the OLIT look-and-feel, refer to *Specifying the Desired Toolkit* on page 411 of the *PV-WAVE Programmer's Guide.*

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*. For more information about how to write an application program based on PV-WAVE's

Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide*.

WgSurfaceTool Procedure

Creates a surface window with a built-in set of controls: these controls allow you to interactively modify surface parameters and view the result of those modifications.

Usage

WgSurfaceTool, *surface_data* [, *parent* [, *shell*]]

Input Parameters

surface_data — A 2D variable containing surface data.

parent — (optional) The widget or shell ID of the parent widget (long). If *parent* is not specified, WgSurfaceTool runs on its own (i.e., in its own event loop).

Output Parameters

shell — (optional) The ID of the newly created widget. If the procedure fails, zero (0) is returned.

Input Keywords

Title — A string containing the title that appears in the header of the SurfaceTool window. Default value is "Surface Tool".

Cmap — The index of the color table to load when the widget is created; a positive integer in the range {0...15}.

Position — A two-element vector specifying the X and Y coordinates of the upper-left corner of the SurfaceTool window (long integer). The elements of the vector are [*x*, *y*], where *x* (horizontal) and *y* (vertical) are specified in pixels. These coordinates are measured from the upper-left corner of the screen.

Nogrid — If present and nonzero, no grid is drawn on the surface.

Lines — If present and nonzero, lines are drawn instead of a grid.

Upper — If present and nonzero, only the upper portion of the grid is drawn. *Upper* and *Lower* are mutually exclusive keywords.

Lower — If present and nonzero, only the lower portion of the grid is drawn. *Lower* and *Upper* are mutually exclusive keywords.

Skirt — If present and nonzero, a skirt is drawn connecting the surface to the X and Y axes. Refer to Figure 2-80 for an example of a surface with and without a skirt.

Gouraud — If present and nonzero, the surface is drawn using Gouraud shading. *Gouraud* and *Elevation* are mutually exclusive.

Elevation — If present and nonzero, the surface is drawn using simple elevation shading. *Elevation* and *Gouraud* are mutually exclusive.

Xrot — The initial counter-clockwise rotation of the surface around the X axis, measured in degrees.

Zrot — The initial counter-clockwise rotation of the surface around the Z axis, measured in degrees.

Auto_redraw — If present and nonzero, the surface is automatically redrawn any time one of the surface parameters is adjusted.

Auto_congrid — If present and nonzero, the Z variable is resized to 50-by-50 (with CONGRID) prior to drawing the surface. This enables PV-WAVE to draw the surface much faster, although there is a chance that some surface detail is lost.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide.*

Background — Specifies the background color name.

Basecolor — Specifies the base color.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Discussion

WgSurfaceTool is an interactive window that lets you use the mouse to control the orientation and appearance of a displayed surface.

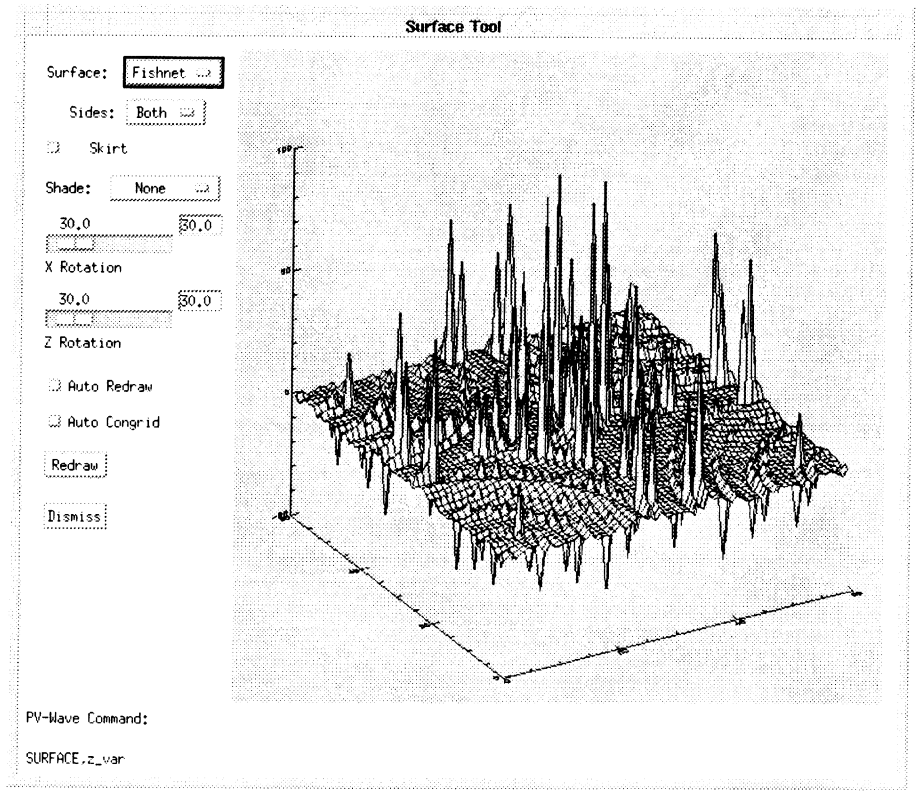


Figure 2-79 WgSurfaceTool creates an interactive window that lets you use the mouse to control the orientation and appearance of a displayed surface.

Contents of the Window

The SurfaceTool window has three main parts — the display area, the control area, and the message area.

SurfaceTool Display Area

The display area is the largest area of the window; it is where the surface is displayed.

SurfaceTool Control Area

Use the following controls to operate the SurfaceTool window:

- **Surface (menu)** — From the menu, choose the method by which the surface is drawn. The choices are: Fishnet (mesh), Lines (lines in one direction only), and None (no lines appear superimposed on a shaded surface).
- **Sides (menu)** — From the menu, choose the representation of the top and bottom sides of the surface. The choices are: Both (lines on both top and bottom), Upper (lines on upper surface only), and Lower (lines on lower surface only).
- **Skirt** — Controls whether a skirt is added to the surface. A skirt helps establish a frame of reference between the surface and the X, Y, and Z axes. Refer to Figure 2-80 for an example of a surface with and without a skirt.
- **Shade (menu)** — From the menu, select the algorithm by which the surface is shaded. The choices are: None (no shading), Gouraud, and Elevation.
- **X and Z Rotation** — These controls allow you to rotate the surface (counter-clockwise around the X or Z axis) a specified number of degrees. The current rotation is shown in the text field to the right of the slider. To modify the rotation, either enter a new value in one of the text fields, or use either slider. If you enter a new value into a text field, press <Return> to apply the new value to the slider and the surface. If you use the sliders, the change is applied immediately as the slider moves.

- **Auto Redraw** — Controls whether the contents of the display area are redrawn every time a modification is made to one of the controls in the SurfaceTool control area.
- **Auto Congrid** — The surface is resized to 50-by-50 (with CONGRID) prior to drawing the surface, for faster display of large datasets. The default is for Auto Congrid to be enabled. Auto Congrid does not affect the actual data; it only affects the display of the data.
- **Redraw** — Causes the contents of the SurfaceTool display area to be redrawn.
- **Dismiss** — Destroy the SurfaceTool window and erase it from the screen.

SurfaceTool Message Area

The message area displays the PV-WAVE command that is being used to display the surface.

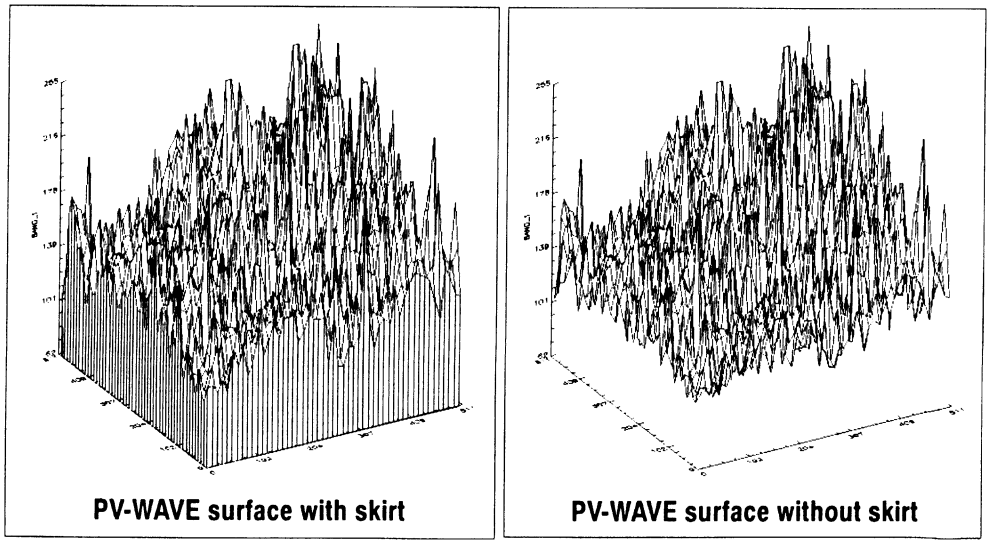


Figure 2-80 A surface with and without a skirt.

Event Handling

You can use the SurfaceTool widget in one of the following two ways:

- **From the WAVE> prompt** – Enter the procedure name at the WAVE> prompt to display the SurfaceTool widget. The SurfaceTool widget handles its own event loop by calling WwLoop.
- **Standalone widget in its own window created by another application** – The SurfaceTool widget has its own Main window, but the application (not the SurfaceTool widget) handles the event loop by calling WwLoop.

The output parameter *shell* can be returned only if you also supply the input parameter *parent*.

Example

Enter the commands shown below into a file, and compile the procedure with the .RUN command. If the variable `parent` is defined, WgSurfaceTool is created as a child of `parent`; otherwise, WgSurfaceTool runs on its own (i.e., in its own event loop).

When you are finished interacting with the WgSurfaceTool window, close it by clicking on the Dismiss button.

```
PRO Sample_wgsurfacetool, parent, tool_shell
x = dist(75)
```

Create a "dummy" variable to view as view as a surface using WgSurfaceTool.

```
IF N_ELEMENTS(parent) NE 0 THEN BEGIN
WgSurfaceTool, x, parent, tool_shell
```

Create WgSurfaceTool as a child of the widget known as "parent". The window of the newly created widget is returned via the optional output parameter "tool_shell".

```
ENDIF ELSE BEGIN
```

```
WgSurfaceTool, x
```
Create WgSurfaceTool and display it as its own Main window. In other words, the WgSurfaceTool window runs on its own (i.e., in its own event loop).

```
ENDELSE
END
```

See Also

SURFACE, SHADE_SURF

For more information about how the UNIX environment variable `$WAVE_GUI` or the VMS logical `WAVE_GUI` affects whether the SurfaceTool window is implemented using the Motif or the OLIT look-and-feel, refer to *Specifying the Desired Toolkit* on page 411 of the *PV-WAVE Programmer's Guide.*

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*. For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide.*

WgTextTool Procedure

Creates a scrolling window for viewing text from a file or character string.

Usage

WgTextTool [, *parent* [, *shell*]]

Input Parameters

parent — (optional) The widget or shell ID of the parent widget (long). If *parent* is not specified, WgTextTool runs on its own (i.e., in its own event loop).

Note Either the *File* or the *Text* keyword must be supplied to identify the text that WgTextTool will display.

Output Parameters

shell — (optional) The ID of the newly created widget. If the procedure fails, zero (0) is returned.

Input Keywords

Title — A string containing the title that appears in the header of the TextTool window. If not specified, either the name of the file is used for the title, or when TextTool is displaying a string, the value of the title defaults to "Scrolling Window".

Position — A two-element vector specifying the X and Y coordinates of the upper-left corner of the TextTool window (long integer). The elements of the vector are [*x*, *y*], where *x* (horizontal) and *y* (vertical) are specified in pixels. These coordinates are measured from the upper-left corner of the screen.

File — The name of the file to display. The *File* and *Text* keywords are mutually exclusive, and one of them must be used.

Text — A string containing the text that will be displayed. The *Text* and *File* keywords are mutually exclusive, and one of them must be used.

Rows — The number of text rows to display when the window is first created.

Cols — The number of text columns to display when the window is first created.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide.*

Background — Specifies the background color name.

Basecolor — Specifies the base color.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Discussion

WgTextTool is a window that lets you view text from a string or from a file.

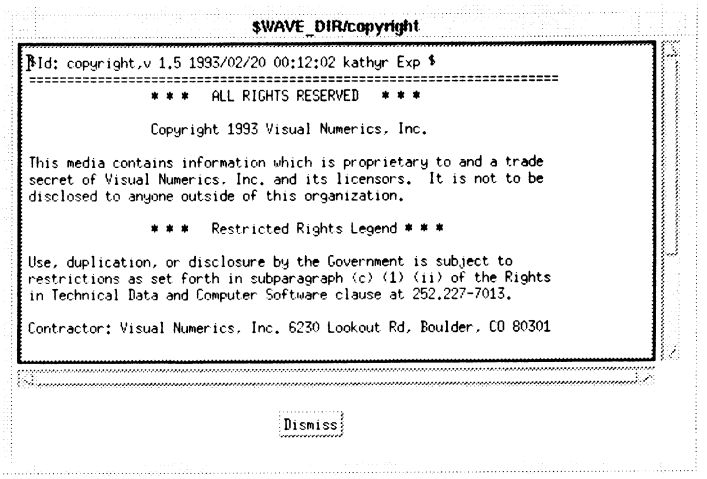


Figure 2-81 WgTextTool displays either: 1) text from a file, or 2) text from an input string. In this illustration, WgTextTool is displaying text from the copyright file that is distributed with every copy of PV-WAVE.

Note The text displayed in the window is read only; it cannot be edited.

Interacting with the Window

The standard text editing functions are available. In Motif, this means the left mouse button and the middle mouse button can be used to copy text. In OPEN LOOK, this means that the text edit popup menu is available. However, in the text edit popup menu, only the Copy function will be sensitized, because the text is read-only.

Use the Dismiss button (or the TextTool window's window manager menu) to destroy the window when you are finished viewing the text.

Event Handling

You can use the TextTool widget in one of the following two ways:

- **From the WAVE> prompt** – Enter the procedure name at the WAVE> prompt to display the TextTool widget. The TextTool widget handles its own event loop by calling WwLoop.
- **Standalone widget in its own window created by another application** – The TextTool widget has its own Main window, but the application (not the TextTool widget) handles the event loop by calling WwLoop.

The output parameter *shell* can be returned only if you also supply the input parameter *parent*.

Example

Enter the commands shown below into a file, and compile the procedure with the .RUN command. If the variable `parent` is defined, WgTextTool is created as a child of `parent`; otherwise, WgTextTool runs on its own (i.e., in its own event loop).

When you are finished interacting with the WgTextTool window, close it by clicking the Dismiss button.

```
PRO Sample_wgtexttool, parent, tool_shell
IF !Version.platform EQ 'VMS' THEN BEGIN
filename = GETENV('WAVE_DIR')+'copyright'
    Specify the pathname and filename using VMS notation.
ENDIF ELSE BEGIN
filename = '$WAVE_DIR/copyright'
    Specify the pathname and filename using UNIX notation.
ENDELSE

IF N_ELEMENTS(parent) NE 0 THEN BEGIN
WgTextTool, File=filename, parent, tool_shell
    Create WgTextTool as a child of the widget known as "parent".
    The window of the newly created widget is returned via the
    optional output parameter "tool_shell".

ENDIF ELSE BEGIN
```

`WgTextTool, File=filename`

Create WgTextTool and display it as its own Main window. In other words, the WgTextTool window runs on its own (i.e., in its own event loop).

```
ENDELSE
END
```

See Also

WwText

For more information about how the UNIX environment variable `$WAVE_GUI` or the VMS logical `WAVE_GUI` affects whether the TextTool window is implemented using the Motif or the OLIT look-and-feel, refer to *Specifying the Desired Toolkit* on page 411 of the *PV-WAVE Programmer's Guide.*

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide.* For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide.*

WHERE Function

Returns a longword vector containing the one-dimensional subscripts of the nonzero elements of the input array.

Usage

result = WHERE(*array_expr* [, *count*])

Input Parameters

array_expr — The array to be searched. May be of any data type except string. Both the real and imaginary parts of complex numbers must be zero for the number to be considered zero.

Output Parameters

count — If present, *count* is converted into a longword integer containing the number of nonzero elements found in *array_expr*. Must be a named variable.

Returned Value

result — A longword vector containing the one-dimensional subscripts of the nonzero elements of *array_expr*. The length is equal to the number of nonzero elements in *array_expr*.

Keywords

None.

Discussion

Frequently the result of WHERE is used as a vector subscript to select elements of an array using given criteria.

As a side effect, the system variable !Err is set to the number of nonzero elements. This is for compatibility with previous versions of PV-WAVE. Therefore, it is recommended that the *Count* keyword be used in all new programs, rather than !Err.

Example 1

The WHERE function can be used to select a range of values in an array. For example:

```
index = WHERE ((array GT 50) AND $
   (array LT 100))
```

Get the subscripts of those elements greater than 50 and less than 100.

```
result = array(index)
```

Put the selected values into result.

Example 2

If all the elements of *array_expr* are zero, WHERE returns a scalar integer with a value of –1. If you attempt to use this result as an index into another array, you will get an error message about the subscripts being out of bounds. In some situations, code similar to the following can be used to avoid errors:

```
index = WHERE(array, count)
```

Use count to get the number of nonzero elements.

```
IF (count GT 0) THEN result = array(index)
```

Only subscript the array if it's safe to do so.

See Also

!Err, QUERY_TABLE, SORT

For more information, see Chapter 5, *Using Subscripts and Matrices*, in the *PV-WAVE Programmer's Guide*.

WINDOW Procedure

Creates a window for the display of graphics or text.

Usage

WINDOW [, *window_index*]

Input Parameters

window_index — An integer between 0 and 31 specifying the window index for the newly created window.

- If *window_index* is omitted, 0 is used.
- If the value of *window_index* specifies an existing window, the existing window is deleted and a new window is created.

Input Keywords

Colors — The maximum number of color table indices to be used. This keyword has effect only if it is supplied when the first window is created. Otherwise, PV-WAVE uses all of the available color indices.

PV-WAVE maintains one color table for all of its windows. To use monochrome windows on a color display, use `Colors=2` when creating the first window.

If the X Window System is being used, a negative value for *Colors* specifies that all but the given number of colors from the shared color table should be allocated.

Free — If nonzero, creates a window using the largest unused window index. This keyword can be used instead of specifying the *window_index* parameter. The default position of the new window is opposite the current window.

Noretain — An obsolete keyword (see the *Retain* keyword below).

Pixmap — If the current graphics device is the X Window System, this keyword specifies that the window being created is actually an invisible portion of the display memory called a pixmap.

Retain — Specifies how backing store for the window should be handled. Possible values for this keyword are listed below:

0 No backing store (same as *Noretain* keyword).

1 The server or window system is requested to make the window retained.

2 PV-WAVE should provide a backing pixmap and handle the backing store directly (X Window System only).

Set_Xpix_ID — (X Window System only) Uses the X pixmap associated with the X Pixmap ID assigned to this keyword for the PV-WAVE pixmap. This keyword forces the *Pixmap* keyword to be set. For example:

```
WINDOW, Set_Xpix_ID=1234567L
```

Set_Xwin_ID — (X Window System only) Uses the X Window associated with the X Window ID assigned to this keyword for the PV-WAVE window. For example:

```
WINDOW, Set_Xwin_ID=1234567L
```

Title — A scalar string specifying the window's label. If not specified, the window is given a label of the form "WAVE *n*", where *n* is the index number of the window.

For example, to create a window with a label of `PV-WAVE CL Graphics`:

```
WINDOW, Title='PV-WAVE CL Graphics'
```

Xpos, Ypos — The X and Y positions of the lower-left corner of window, specified in device coordinates.

If no position is specified, the position of the window is determined from the value of *window_index*, using the following rules of thumb:

- Window 0 is placed in the upper right-hand corner.

- Even numbered windows are placed on the top half of the screen and odd numbered windows are placed on the bottom half.
- Windows 0, 1, 4, 5, 8, 9, 12, 13, 16, 17, 20, 21, 24, 25, 28, and 29 are placed on the right side of the screen and windows 2, 3, 6, 7, 10, 11, 14, 15, 18, 19, 22, 23,26, 27, 30, 31 are placed on the left.

XSize — The width of the window, in pixels. The default is 640.

YSize — The height of the window, in pixels. The default is 512.

Output Keywords

Get_Xpix_ID — (X Window System only) Returns the X pixmap ID for the pixmap just created. You must use the *Pixmap* keyword to set this ID. For example:

```
WINDOW, Get_Xpix_ID=New_Xpix_ID, /Pixmap
```

Get_Xwin_ID — (X Window System only) Returns the X Window ID for the window just created. For example:

```
WINDOW, Get_Xwin_ID=New_Xwin_ID
```

Discussion

You only need to use WINDOW if you want to display more than one PV-WAVE window simultaneously, because a window is created automatically the first time any display procedure attempts to access the window system.

The newly created window becomes the current PV-WAVE window, and the system variable !D.Window is set to the window index associated with it. (See the WSET procedure for a discussion of the current PV-WAVE window.)

The behavior of WINDOW varies slightly depending on the window system in effect.

See Also

!D.Window, WDELETE, WSET, WSHOW, ERASE

For additional information on PV-WAVE graphics devices, see Appendix A, *Output Devices and Window Systems*, in the *PV-WAVE User's Guide*.

WMENU Function

Displays a menu inside the current window whose choices are given by the elements of a string array and which returns the index of the user's response.

Usage

result = WMENU(*strings*)

Input Parameters

strings — Must be a string array, with each element containing the text of one menu choice. Both the maximum number of elements and the maximum element length are constrained by how large a display area will be used.

Returned Value

result — Returns –1 if the user did not select a menu item. Otherwise, the returned value ranges from 0 to the number of elements in *strings* minus one.

Input Keywords

Initial_Selection — The index of the initial selection.

- If this keyword is specified and within the range of *strings* indices, the initial menu display is made with the designated item selected.

- If this keyword is not specified, the menu is initially displayed with the mouse cursor at the immediate left of the first (top) selection.

Title — The index of the *strings* element that is the title, normally 0. The title element is not selectable and is displayed reversed and centered. If this keyword is omitted, all items are selectable.

Xpos — (X Window System only) The position on the X axis of the display device where the menu is to be placed.

Ypos — (X Window System only) The position on the Y axis of the display device where the menu is to be placed.

Discussion

WMENU can be used only with X Window System displays.

To use, select a menu item with the mouse and click the left mouse button.

Example

The following statement displays a menu containing the selections `Yes` and `No` and entitled `Do you wish to continue?:`

```
i = WMENU(['Do you wish to continue?', 'Yes',$
   'No'], Title=0, Init=1)
```

The menu is displayed with `Yes` initially selected. The result is as follows:

1 if the user clicks on `Yes`.

2 if the user clicks on `No`.

–1 if the user clicks the left mouse button outside the menu.

See Also

TVMENU

WRITEU Procedure

Writes binary (unformatted) data from an expression into a file.

Usage

WRITEU, *unit*, $expr_1$, ... , $expr_n$

Input Parameters

unit — The file unit to which the output will be sent.

$expr_i$ — Expressions to be output. For nonstring variables, the number of bytes contained in *expr* is output. For string variables, the number of bytes contained in the existing string is output.

Keywords

None.

Discussion

WRITEU performs a direct transfer, with no processing of any kind being done to the data.

Example

In this example, WRITEU is used to write some data to a file. The READU procedure could then be used to read the data from the file.

```
d = BYTSCL(REFORM(FIX(100 * RANDOM(40000)), $
   200, 200))
```

Create some data. Argument d contains a 200-by-200 byte array.

```
OPENW, unit, 'wuex.dat', /Get_Lun
```

Open the file wuex.dat for writing.

```
WRITEU, unit, d
```

Write the data in d to the wuex.dat file.

`FREE_LUN, unit`
Close the file and free the file unit number.

See Also

READU, OPENR

For more information and examples, see *READU and WRITEU* on page 193 of the *PV-WAVE Programmer's Guide.*

WSET Procedure

Used to select the current window to be used by the graphics and imaging routines.

Usage

WSET [, *window_index*]

Input Parameters

window_index — The window index of the new current window.

Keywords

None.

Discussion

WSET can be used only on displays with window systems.

Most PV-WAVE graphics routines do not explicitly require the PV-WAVE window to be specified. Instead, they use the window known as the current window. The window index number of the current window is given by the read-only system variable !D.Window.

See Also

WDELETE, WINDOW, WSHOW, !D.Window

WSHOW Procedure

Exposes or hides the designated window. It does not automatically make the designated window the active window.

Usage

WSHOW [, *window_index* [, *show*]]

Input Parameters

window_index — The window index of the window to be hidden or exposed. If not specified, the current window is used.

show — A flag indicating whether a window is hidden or exposed:

0 Hides the window.

1 Exposes the window.

Input Keywords

Iconic — If present and nonzero, turns the window into an icon.

Discussion

The definition of "hidden" is machine-dependent. On Sun Workstations, for example, the window disappears, although it can still be written to if it is the active window.

On machines supporting the X Window System server, the window is simply pushed to the back of the window display list so that it appears to be located behind other windows on the display.

See Also

WDELETE, WINDOW, WSET, !D.Window

WtAddCallback Function

Registers a PV-WAVE callback routine for a given widget.

Usage

status = WtAddCallback(*widget*, *reason*, *callback* [, *client_data*])

Input Parameters

widget — The widget ID of the widget to add the callback to (long).

reason — A string containing the callback reason. This parameter is GUI-dependent. See the *Discussion* section below for more information.

callback — A string containing the name of the PV-WAVE callback routine.

client_data — A PV-WAVE variable. The value of this variable is passed to the callback routine.

Returned Value

status — One (1) indicates success; zero (0) indicates failure.

Keywords

Noparams — If present and nonzero, the callback is called with two parameters: *wid* and *data*. All other parameters, as discussed in Appendix C, *Motif and OLIT Callback Parameters*, in the *PV-WAVE Programmer's Guide*.

Discussion

Callback reasons are listed throughout the *OSF/Motif Programmer's Reference* and the *OLIT Programmer's Reference*. To use a Motif or OLIT callback reason in PV-WAVE, remove the XmN or XtN prefix. For example:

Motif	OLIT	PV-WAVE Widget Set
XmNdestroyCallback	XtNdestroyCallback	destroyCallback

The application can optionally use the *client_data* parameter to specify some application-defined data to be passed to the callback procedure when the callback is invoked. If *client_data* is a local variable (defined only in the current procedure), a copy of that variable is created and passed (passed by value). If the *client_data* is a global variable (defined in a Common Block), it is passed by reference.

Example

This example creates a Motif button labeled Done. When you select the button, the widget is destroyed. To run the example, enter the callback and the example procedures in a file and run them with .RUN.

Callback Procedure Example: Motif

This is the callback routine. Note that the callback routine for the pushbutton widget class requires six parameters. The required callback parameters for Motif widget classes are discussed in *Motif Widget Classes* on page B-1, in the *PV-WAVE Programmer's Guide*.

```
PRO CancelHelp, wid, data, npar, reason,$
   event, count
   COMMON block, top
   status=WtClose(top)
END
```

Example Procedure

```
PRO example
   COMMON block, top
   @wtxmclasses.pro
   top=WtInit('wt_ex1', 'Examples')
   widget=WtCreate('Done', $
      xmPushButtonWidgetClass, top)
   status=WtAddCallback(widget, $
      'activateCallback', 'CancelHelp')
   status=WtSet(top, /Realize)
   WtLoop
END
```

Note The nonstandard callback reason XtNdefaultAction has been added to the OLIT widget scrollingListWidgetClass. This reason was added to support the default action of a double-click to select an item.

See Also

For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide*.

WtAddHandler Function

Registers the X event handler function for a given widget.

Usage

status = WtAddHandler(*widget*, *eventmask*, *handler*
[, *client_data*])

Input Parameters

widget — The ID of the widget to add the event handler to (long).

eventmask — The value of the X Event mask (long). See the `wtxlib.pro` file in the PV-WAVE Standard Library and the *Xlib Reference Manual* (O'Reilly & Associates, Inc., 1989) for more information on this parameter.

handler — A string containing the PV-WAVE X event handler procedure name.

client_data — A PV-WAVE variable. The value of this variable is passed to the callback routine.

Returned Value

status — One (1) indicates success; zero (0) indicates failure.

Keywords

Nonmaskable — If present and nonzero, nonmaskable events are intercepted by the event handler. Such events include GraphicsExpose, NoExpose, SelectionClear, SelectionRequest, SelectionNotify, ClientMessage, and MappingNotify.

Discussion

An event handler is a PV-WAVE procedure that is executed when a specific type of event occurs within a widget. Some, all, or no X events can be handled using one or more event handlers.

For information on the requirements for writing event handler procedures, see *Adding Event Handlers* on page 487 of the *PV-WAVE Programmer's Guide.*

Example

The following code fragments demonstrate the use of WtAddHandler.

```
.
.
pane=WtCreate('menu', PopupMenuWidget, $
   parent)

status = WtAddHandler(pane, ButtonPressMask, $
   'PostMenu', parent)

.
.

PRO PostMenu, wid, parent, nparams, mask,event
   @wtxlib
   status=WtPointer("GetLocation", wid,state)
   if (Button3Mask AND state(6)) ne 0 then $
   status=WtSet(pane,POPUP=event)

END
```

X Event Handler Procedure Example

```
PRO handler, widget, data, nparams, mask, $
   event
   ...

END
```

See Also

For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide.*

WtClose Function

Closes the current Xt (OLIT or Motif) session, and destroys all children of the top-level widget created in WtInit. This routine can also be used to destroy additional widget trees.

Usage

status = WtClose(*widget*)

Parameters

widget — The widget ID of the top-level shell (long).

Returned Value

status — One (1) indicates success; zero (0) indicates failure.

Discussion

This function is usually called in a PV-WAVE callback routine to destroy a popup shell (dialog, etc.).

Example

This example creates a Motif button labeled Done. When you select the button, the widget is destroyed. To run the example, enter the callback and the example procedures in a file and run them with .RUN.

Callback Procedure Example: Motif

This is the callback routine. Note that the callback routine for the pushbutton widget class requires six parameters. The required callback parameters for Motif widget classes are discussed in Appendix B, *Motif and OLIT Widget Classes*, in the *PV-WAVE Programmer's Guide*.

```
PRO CancelHelp, wid, data, npar, reason,$
   event, count
   COMMON block, top
   status=WtClose(top)

END
```

Example Procedure

```
PRO example
   common block, top
   @wtxmclasses.pro
   top=WtInit('wt_ex2', 'Examples')
   widget=WtCreate('Done', $
      xmPushButtonWidgetClass, top)
   status=WtAddCallback(widget, $
      'activateCallback', 'CancelHelp')
   status=WtSet(top, /Realize)
   WtLoop
END
```

See Also

For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide*.

WtCreate Function

Creates a widget or shell instance specified by widget class.

Usage

widget = WtCreate(*name*, *class*, *parent* [, *argv*])

Parameters

name — A string containing the name of the widget or shell to be created.

class — A constant value specifying the widget or shell class (long). See Appendix B, *Motif and OLIT Widget Classes*, in the *PV-WAVE Programmer's Guide* for a list of Motif and OLIT widget classes.

parent — The widget or shell ID of the parent (long).

argv — A structure that contains the arguments or resources for the widget or shell.

Returned Value

widget — A newly created widget. If the function fails, zero (0) is returned.

Keywords

Multi — Used with the OLIT scrollingList widget class only. Allows selection of multiple items.

Note For OLIT flat widgets use *argv* to specify the attributes of sub-items. Use tag names of the *argv* structure as the resource names.

Example

```
items=REPLICATE({FLATNON,label:'', $
   mnemonic:''},3)
items(0)={FLATNON,'Bold','B'}
items(1)={FLATNON,'Italic','I'}
items(2)={FLATNON,'Underline','U'}

fargs = {,items:items}

widget=WtCreate('fnon', $
   flatNonexclusivesWidgetClass, parent,$
   fargs)
```

Note All widgets are managed when created. To unmanage them after creation use `WtSet(wid,/Unmanage)`.

See Also

WtSet

For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide*.

WtCursor

Sets or changes the cursor.

Usage

status = WtCursor(*function*, *widget* [, *index*])

Parameters

function:

`'Default'` — The default is the system cursor.

`'System'` — Sets the default system cursor.

`'Wait'` — Sets the wait cursor.

`'Set'` — Sets the specified cursor. If `'Set'` is specified, the *index* parameter follows:

- *index* — The cursor index (e.g., XC_X_cursor). See Appendix D, *Widget Toolbox Cursors*, in the *PV-WAVE Programmer's Guide* for a list of cursors.

widget — The ID of the widget for which the cursor is being set.

Returned Value

status — One (1) indicates success; zero (0) indicates failure.

Discussion

This routine changes the current cursor for a given widget to a new cursor defined by *index*. The following cursors are available:

- All XC_* cursor types are listed in Appendix D, *Widget Toolbox Cursors*, in the *PV-WAVE Programmer's Guide*. For additional information on these cursors, see Appendix I of the *Xlib Reference Manual, Volume 2*, (O'Reilly & Associates, Inc., 1989).
- A set of custom cursors designed by Visual Numerics listed in Appendix D, *Widget Toolbox Cursors*, in the *PV-WAVE Programmer's Guide*.

Example

This example demonstrates a callback called to display the `heartbeat.dat` file with the WgMovieTool procedure. Because it takes a while to read the data file into PV-WAVE, the wait cursor is set before the file is read to notify the user that the file is being read:

```
PRO MovieCB, wid, index

@wtcursor

top = WwGetValue(wid, /Userdata)
CASE index OF
   1: BEGIN
   status = WtCursor('WAIT', top)
   heart = BYTARR(256, 256, 15)

   IF !Version.platform EQ 'vms' THEN $
       OPENR, u, getenv('WAVE_DIR')+ $
          '[data]heartbeat.dat', /Get_Lun $
       ELSE $
       OPENR, u, $
          '$WAVE_DIR/data/heartbeat.dat',$
          /Get_Lun
       READU, u, heart
```

```
            CLOSE, u
            WgMovieTool, heart, top, movie, $
              widx, 1, /Popup, /Do_tvscl
            status = WtCursor('DEFAULT', top)
         END

      2: BEGIN
         status = WwSetValue(top, /Close)
         END
      ENDCASE

      END
```

See Also

For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide*.

WtGet Function

Retrieves widget resources.

Usage

value = WtGet(*widget* [, *resource*])

Parameters

widget — The widget ID.

resource — A string containing the name of the requested resource. This parameter is GUI-dependent. See the *Discussion* section below for more information.

Returned Value

value — A PV-WAVE variable in which the value of the resource is returned. The data type of *value* depends on the requested resource.

Keywords

Child=child — (Motif only) Returns the ID of the child widget in a composite widget, such as a Command or FileSelection widget:

Legal values for a Command widget:

- XmDIALOG_COMMAND_TEXT
- XmDIALOG_PROMPT_LABEL
- XmDIALOG_HISTORY_LIST

Legal values for a FileSelection widget:

- XmDIALOG_APPLY_BUTTON
- XmDIALOG_CANCEL_BUTTON
- XmDIALOG_DEFAULT_BUTTON
- XmDIALOG_DIR_LIST

- XmDIALOG_DIR_LIST_LABEL
- XmDIALOG_FILTER_LABEL
- XmDIALOG_FILTER_TEXT
- XmDIALOG_HELP_BUTTON
- XmDIALOG_LIST
- XmDIALOG_LIST_LABEL
- XmDIALOG_OK_BUTTON
- XmDIALOG_SELECTION_LABEL
- XmDIALOG_SEPARATOR
- XmDIALOG_TEXT
- XmDIALOG_WORK_AREA

For a MessageBox widget:

- XmDIALOG_CANCEL_BUTTON
- XmDIALOG_DEFAULT_BUTTON
- XmDIALOG_HELP_BUTTON
- XmDIALOG_MESSAGE_LABEL
- XmDIALOG_OK_BUTTON
- XmDIALOG_SEPARATOR
- XmDIALOG_SYMBOL_LABEL

For a SelectionBox widget:

- XmDIALOG_APPLY_BUTTON
- XmDIALOG_CANCEL_BUTTON
- XmDIALOG_DEFAULT_BUTTON
- XmDIALOG_HELP_BUTTON
- XmDIALOG_LIST
- XmDIALOG_LIST_LABEL
- XmDIALOG_OK_BUTTON
- XmDIALOG_SELECTION_LABEL

- XmDIALOG_SEPARATOR
- XmDIALOG_TEXT
- XmDIALOG_WORK_AREA

Child — Returns a long integer array of child widget IDs.

Class — Returns the widget class for the given widget.

Count=count — Specifies the number of items for resources containing an array of strings, such as a list or command.

Managed — Returns 1 if the given widget is managed; returns 0 if the widget is unmanaged.

Name — Returns the name of the given widget.

Name=name — Returns the ID of the named widget and its parent.

Ncols — Specifies the number of columns of the two-dimensional resource to be retrieved. A two-dimensional resource is a resource whose value is a two-dimensional array of strings. Currently, two-dimensional resources are used in the table widget.

Nrows — Specifies the number of rows of the two-dimensional resource to be retrieved.

Parent — Returns the widget ID of the parent of the given widget.

Realized — Returns 1 if the given widget is realized (displayed); returns 0 if it is unrealized.

Sensitive — Returns 1 if the given widget is sensitive; returns 0 if it is not sensitive.

Shell — Returns 1 if the given widget is a shell (top-level widget); returns 0 if it is not a shell.

Userdata — Returns the user data (any variable or structure) for the given widget formally stored by the WtSet function.

Value — Returns the value for a scale, scroll bar, or toggle button.

Widget — Returns 1 if the given widget is a widget (not a shell); returns 0 if it is not a widget.

Window — Returns the window ID of the given widget.

Window=window — Returns the widget ID of the given window.

Discussion

See the *OSF/Motif Programmer's Reference* or the *OLIT Programmer's Reference* for a list of resource names. The resource name for a Widget Toolbox widget is derived from the Motif or OLIT widget set resource name. If you have a Motif toolkit, remove the XmN prefix from the Motif resource name. If you have an OLIT toolkit, remove the XtN prefix from the OLIT resource name. For example:

Motif	OLIT	PV-WAVE Widget Set
XmNwidth	XtNwidth	width
XmNx	XtNx	x

The data type of a resource's value depends on the type of the resource.

Example

```
window = WtGet(wid, /Window)
```
Returns the window ID of the specified widget (wid).

```
wid = WtGet(wid, Window=win(2))
```
Returns the widget ID of window win(2) for the specified widget (wid).

```
widget = WtGet(wid, /Widget)
```
Returns 1 if the given widget is not a shell, or 0 if it is a shell.

```
name = WtGet(wid, /Name)
```
Returns the name of the specified widget (wid).

```
child = WtGet(wid, Child=XmDIALOG_DIR_LIST)
```
Returns the ID of the XMDIALOG_DIR_LIST component the FileSelection widget (wid).

See Also

For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide*.

WtInit Function

Initializes the Widget Toolbox and the Xt toolkit, opens the display, and creates the first top-level shell.

Usage

topshell = WtInit(*app_name*, *appclass_name* [, *Xserverargs* ...])

Parameters

app_name — A string containing the name of the application as used in the resource file.

appclass_name — A string containing the application class name (name of the resource file).

Xserverargs — A string containing X server arguments (font, display, synchronize, etc.). See the *OSF/Motif Programmer's Reference* or the *OLIT Programmer's Reference* for more information.

Returned Value

topshell — Returns the widget ID of the top application shell.

Discussion

Call this routine before the first use of any Widget Toolbox routines, or to reinitialize Widget Toolbox after closing the top-level shell(s).

Example

This example creates a Motif button labeled Done. When you select the button, the widget is destroyed. To run the example, enter the callback and the example procedures in a file and run them with .RUN.

Callback Procedure Example: Motif

```
PRO CancelHelp, wid, data, npar, reason,$
   event, count
   COMMON block, top
   status=WtClose(top)

END
```

Example Procedure

```
PRO example
   COMMON block, top
   @wtxmclasses.pro
   top=WtInit('wt_ex3', 'Examples')
   widget=WtCreate('Done', $
      xmPushButtonWidgetClass, top)
   status=WtAddCallback(widget, $
      'activateCallback', 'CancelHelp')
   status=WtSet(top, /Realize)
   WtLoop
END
```

See Also

For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide*.

WtInput Function

Registers a PV-WAVE input source handler procedure.

Usage

status = WtInput(*function* [, *parameters*])

Input Parameters

function:

`'Add'` — Add input to the source of events. If this function is specified, provide the following parameters:

- *file_lun* — LUN of the input source file (or pipe).
- *handler* — (optional) A PV-WAVE procedure that is called when input is available.
- *client_data* — (optional) User data to be passed to the handler procedure.

`'Remove'` — Remove a previously registered input source. If this function is specified, provide the following parameter:

- *input_id* — ID of the input source being removed.

Returned Value

For `'Add'`:

status — The input source ID, or zero (0) to indicate failure.

For `'Remove'`:

status — One (1) indicates success; zero (0) indicates failure.

Keywords

If the `'Add'` function is specified, the following keywords can be used:

Read — If specified and nonzero, the Xt Intrinsic condition XtInputReadMask is used to define the input source (default).

Write — If specified and nonzero, the Xt Intrinsic condition XtInputWriteMask is used to define the input.

Except — If specified and nonzero, the Xt Intrinsic condition XtInputExceptMask is used to define the input source.

Discussion

While most GUI applications are driven only by events, some applications need to incorporate other sources of input into the X Toolkit event handling mechanism. WtInput supports input or output gathering from files. The application registers an input source handler procedure and a file with the X Toolkit. When input is pending on the file, the registered handler is invoked.

Note In this context a "file" should be loosely interpreted to mean any sink (destination of output) or pipe (source of data).

For information on the requirements for writing input handler procedures, see *Adding Input Handler Procedures* on page 492 of the *PV-WAVE Programmer's Guide*.

Example

The following application accepts and processes data from another application that gathers the data.

```
PRO Server, top, client_data, nparams, id, $
   lun, source
   READU, lun, data
       Process received data here.
END

PRO ButtonCB, wid, index
    COMMON ProcessComm, top, inputid
       Handle buttons here.
   CASE index OF
    1: ; Store
    2: ; Display
    3: BEGIN ; Close application
    status = WtInput('REMOVE', inputid)
```

```
      status = WwSetValue(top, /Close)
      END
      ENDCASE
    END

PRO ProcessData
    COMMON ProcessComm, top, inputid
        Spawn data gathering application
    SPAWN, 'getdata', unit = lun
        Initialize the application.
    top = WwInit('processdata','Test', layout)
    buttons = WwButtonBox(layout, $
    ['Store','Display','Close'],'ButtonCB')

        Register input source handler and start the application.
    inputid = WtInput('ADD', lun, 'Server')
    status = WwSetValue(top, /Display)
    WwLoop

 FREE_LUN, lun

END
```

See Also

For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide*.

WtList Function

Controls the characteristics of scrolling list widgets.

Usage

status = WtList(*function*, *widget* [, *parameters*])

Parameters

function:

- `'Add'` – Add specified item(s) to the list.
- `'Delete'` – Delete specified item(s) from the list.
- `'DeleteAll'` – Delete all items from the list.
- `'Deselect'` – Deselect specified item(s) in the list.
- `'DeselectAll'` – Deselect all items in the list.
- `'ItemCount'` – Number of items in the list.
- `'Items'` – Get items in the list.
- `'Menu'` – (OLIT) Defines a popup menu for a scrolling list widget.
- `'Select'` – Select specified item(s) from the list.
- `'SelectAll'` – Select all items from the list.
- `'SelectCount'` – Number of selected items.
- `'Selected'` – Get selected items.
- `'Replace'` – Replace specified item(s) in the list.

widget – The list widget ID.

parameters:

- For `'Add'` – (p_1) A string or array of strings; (p_2) a long integer representing the position at which to add the item. This optional parameter is used with Motif only. The default is the end position.

- For `'Delete'` — (p_1) A string or array of strings.
- For `'Deselect'` — (p_1) A string or array of strings.
- For `'ItemCount'` — (p_1) Number of items in the list (long, output).
- For `'Items'` — (p_1) Items in the list. Array of strings (output).
- For `'Menu'` — (p_1) Menu shell ID (long).
- For `'Select'` — (p_1) A string or array of strings.
- For `'SelectCount'` — (p_1) Number of selected items (long, output).
- For `'Selected'` — (p_1) Selected items. Array of strings (output).
- For `'Replace'` — (p_1) A string or array of strings; (p_2) position of first items to be replaced.

Keywords

Notify — If specified, a PV-WAVE callback is called during Select or Deselect operations.

Discussion

The list utility lets users choose an action from a list of actions. For detailed information on the list utility, see the description of XmList in the *OSF/Motif Programmer's Reference*. The scrolling list implemented for OLIT users is not the standard OLIT scrolling list widget. A nonstandard OLIT scrolling list was implemented for greater compatibility with the Motif scrolling list. The Widget Toolbox scrolling list for OLIT works much like the Motif scrolling list.

Example

```
.
.
items = ['Presidents Day','St.Patricks Day', $
```

```
    'Easter', 'Memorial Day', '4th of July', $
    'Labor Day', 'Halloween', 'Thanksgiving', $
    'Hanukkah', 'Christmas', 'New Years Eve']
status = WtList("Add", list, items)
.
.
```

See Also

For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide*.

WtLoop Function

Handles the dispatching of events and calling of PV-WAVE call-back routines.

Usage

WtLoop

Parameters

None.

Returned Value

None.

Discussion

WtLoop causes PV-WAVE to loop indefinitely, processing the events and dispatching callbacks, handlers, and timers.

Motif Example

This example creates a Motif button labeled Done.

```
PRO example
   COMMON block, top
   @wtxmclasses.pro
   top=WtInit('wt_ex4', 'Examples')
   widget=WtCreate('Done', $
      xmPushButtonWidgetClass, top)
   status=WtAddCallback(widget, $
      'activateCallback', 'CancelHelp')
   status=WtSet(top, /Realize)
   WtLoop
END
```

WtMainLoop Function

Handles the dispatching of events.

Usage

status = WtMainLoop

Input Parameters

None.

Output Parameters

None.

Returned Value

status — One (1) indicates success; zero (0) indicates failure.

Discussion

The WtLoop function can be called to accomplish the same result as WtMainLoop. WtMainLoop has been retained to provide upward compatibility with an earlier release of PV-WAVE, but it is recommended that you use WtLoop, instead.

See Also

WtLoop

For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide*.

WtPointer Function

The pointer utility function.

Usage

status = WtPointer(*function*, *widget* [, *parameters*])

Parameters

function:

- `'GetLocation'` — Get the current location of the pointer.
- `'GetControl'` — Get the control attributes of the pointer.
- `'GetMapping'` — Get the current mapping of the pointer.
- `'SetLocation'` — Set the location of the pointer.
- `'SetControl'` — Set the control attributes of the pointer.
- `'SetMapping'` — Set the mapping of the pointer.

widget — The current widget.

parameters:

- `'GetLocation'` — A seven-element array of long integers:

  0 Root window

  1 Child window where the pointer is located

  2 X coordinate in root

  3 Y coordinate in root

  4 X coordinate in current window

  5 Y coordinate in current window

  6 Modifier keys and buttons state mask

- `'GetControl'` — A three-element array of long integers:

  0 accel_numerator

1 accel_denominator

2 threshold

- `'GetMapping'` — An array of up to ten long integers:

  0–9 Pointer button mapping

- `'SetLocation'` — A two element array of long integers:

  0 X coordinate in current window

  1 Y coordinate in current window

- `'SetControl'` — A three-element array of long integers:

  0 accel_numerator

  1 accel_denominator

  2 threshold

- `'SetMapping'` — An array of up to ten long integers:

  0–9 Pointer button mapping

Returned Value

status — One (1) indicates success; zero (0) indicates failure.

Discussion

See the *Xlib Reference Manual* (O'Reilly & Associates, Inc., 1989) for details on XQueryPointer, XGetPointerControl, XGetPointerMapping, XWarpPointer, XChangePointerControl, and XSetPointerMapping.

Example

```
.
.
status=WtPointer("GetLocation", wid, state)
.
.
```

See Also

For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide*.

WtSet Function

Sets widget resources.

Usage

status = WtSet(*widget*, *argv*)

Parameters

widget — The widget ID.

argv — A PV-WAVE unnamed structure specifying the resources for the widget or shell.

Returned Value

status — One (1) indicates success; zero (0) indicates failure.

Keywords

Append=com — (Motif only) Appends a command to the command widget.

Callback=reason — Calls all defined callbacks for the specified reason for this widget.

Destroy — Destroys the widget and all children of the widget.

Error=errmsg — (Motif only) Displays an error message in the history area of the command widget.

Manage — Manages the given widget (WtCreate manages widgets by default).

Map — Maps the given widget.

Mappedwhen — Sets mapped to true for managed attributes.

Nonsensitive — Sets the given widget to nonsensitive.

Popup=event — Pops up the given menu (*event* specifies the location).

Realize — Realizes (displays) the given widget.

Realize=grab — Realizes the given shell with one of these grab values:

Xtgrabnone

Xtgrabnonexclusive

Xtgrabexclusive

Remove_callback = name — If the *name* of a PV-WAVE callback routine is specified, this keyword removes the named callback. If *name* is not specified, all callbacks for the specified widget are removed.

Remove_handler = name — If the *name* of a PV-WAVE event handler is specified, this keyword removes the named event handler. If *name* is not specified, all event handlers for the specified widget are removed.

Search=dir — (Motif only) Sets the search context for a file selection widget.

Sensitive — Sets the given widget to sensitive.

Unmanage — Unmanages the given widget.

Unmap — Unmaps the given widget.

Unmappedwhen — Sets mapped to false for managed attributes.

Unrealize — If present and nonzero, unrealizes a widget, or pops down (undisplays) a shell.

Userdata — Stores a copy of the value of a PV-WAVE variable.

Value=value — (Motif only) Sets the value for a command, scale, scroll bar, or toggle button.

Discussion

Resources are passed as an unnamed structure, where tag names correspond to resource names and tag definitions are resource values. Resource names are given without the XtN (OLIT) or XmN (Motif) prefix.

An unnamed structure has the following general definition:

$$x = \{, tag\_name_1: tag\_def_1, tag\_name_n: tag\_def_n\}$$

See the *Creating Unnamed Structures* on page 105 of the *PV-WAVE Programmer's Guide* for detailed information on unnamed structures.

For a list of resources for the specified widget or shell, see the appropriate *OSF/Motif Programmer's Reference* or the *OLIT Programmer's Reference.*

Note If the color, font, or bitmap (called an "image" in OLIT and a "pixmap" in Motif) resource value is of type string, it is assumed to be the value of the color/font name or bitmap file name, and the appropriate resources are loaded.

Example

```
.
.
args={,x:100,y:100,label:'Enter File:',$
   string:'/usr/home/myfile.pro'}
        Resources are defined in an unnamed structure.
status=WtSet(w,args)
.
.
status=WtSet(top,/Realize)
.
.
```

See Also

For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide*.

WtTable Function

Modifies an xbaeMatrix class widget.

Usage

status = WtTable(*function*, *widget* [, *parameters*])

Input Parameters

function:

`'AddColumns'` — Add columns to the table. If this function is specified, also provide the following parameters:

- *columns* — Two-dimensional string array of column values.
- *num_columns* — Number of columns to be added.
- *width* — One-dimensional array of column widths.
- *labels* — (optional) One-dimensional array of column labels.
- *max_lengths* — (optional) One-dimensional array of column maximum lengths.
- *alignments* — (optional) One-dimensional array of column alignments. Valid values are:

  0 Align cell contents to cell's left edge (left justify).

  1 Center cell contents (center justify).

  2 Align cell contents to cell's right edge (right justify).

- *label_alignments* — (optional) One-dimensional array of column label alignments. Valid values are:
  - 0 Align cell contents to cell's left edge (left justify).
  - 1 Center cell contents (center justify).
  - 2 Align cell contents to cell's right edge (right justify).
- *colors* — (optional) Two-dimensional array of column cell colors.

`'AddRows'` — Add rows to the table. If this function is specified, also provide the following parameters:

- *rows* — Two-dimensional string array of row values.
- *num_rows* — Number of rows to be added.
- *labels* — (optional) One-dimensional array of row labels.
- *colors* — (optional) Two-dimensional array of row cell colors.

`'DeleteCols'` — Delete columns from the table. If this function is specified, also provide the following parameter:

- *num_columns* — Number of columns to delete.

`'DeleteRows'` — Delete rows from the table. If this function is specified, also provide the following parameter:

- *num_rows* — Number of rows to delete.

`'DeselectAll'` — Deselect all cells in the table.

`'DeselectCell'` — Deselect the specified cell in the table. If this function is specified, also provide the following parameter:

- *row* — Row index of the cell to deselect.
- *column* — Column index of the cell to deselect.

`'DeselectCol'` — Deselect the specified column in the table. If this function is specified, also provide the following parameter:

- *column* — Index of column to deselect.

`'DeselectRow'` — Deselect the specified row in the table. If this function is specified, also provide the following parameter:

- *row* — Index of row to deselect.

`'SelectCell'` — Select the specified cell in the table. If this function is specified, also provide the following parameters:

- *row* — Row of the cell to select.
- *column* — Column of the cell to select.

`'SelectCol'` — Select the specified column in the table. If this function is specified, also provide the following parameter:

- *column* — Column to select.

`'SelectRow'` — Select the specified row in the table. If this function is specified, also provide the following parameter:

- *row* — Row to deselect.

`'EditCell'` — Edit the specified cell in the table. If this function is specified, also provide the following parameters:

- *row* — Row of the cell to edit.
- *column* — Column of the cell to edit.

`'CancelEdit'` — Cancel the edit of the currently edited cell. If this function is specified, also provide the following parameter:

- *unmap* — (optional) If specified and nonzero, the currently edited cell is unmapped.

`'CommitEdit'` — Commit the edit of the currently edited cell. If this function is specified, also provide the following parameter:

- *unmap* — (optional) If specified and nonzero, the currently edited cell is unmapped.

`'GetCell'` — Get the value of a cell in the table. If this function is specified, also provide the following parameters:

- *row* — Row of the cell to get.
- *column* — Column of the cell to get. Returns the value of the specified cell.

`'SetCell'` — Set the value of a cell in the table. If this function is specified, also provide the following parameters:

- *row* — Row of the cell to set.
- *column* — Column of the cell to set.

- *value* — New value of the specified cell.

`'SetColor'` — Set the color value for a cell in the table. If this function is specified, also provide the following parameters:

- *row* — Row of the cell whose color you want to set.
- *column* — Column of the cell whose color you want to set.
- *color* — New colormap index of the specified cell.

`'SetColColor'` — Set the color value for a column in the table. If this function is specified, also provide the following parameters:

- *position* — Column at which to start setting colors.
- *colors* — Two-dimensional array of new colormap indexes for columns.
- *num_colors* — The number of elements in the *colors* array.

`'SetRowColor'` — Set the color value for a row in the table. If the `'SetRowColor'` function is specified, also provide the following parameters:

- *position* — Row at which to start setting colors.
- *colors* — 2D array of new colortable indexes for rows.
- *num_colors* — The number of colors in the *colors* array.

widget — Widget ID of the table (xbaeMatrix class) widget.

Discussion

The XbaeMatrix widget creates an editable 2D array of string data (cells) similar to a spreadsheet. All values must be converted to string type before being set with WtTable.

XbaeMatrix Widget Documentation

The Motif version of the XbaeMatrix widget was originally developed by Andrew Wason of Bellcore. This widget was enhanced and an OLIT version was developed by Visual Numerics, Inc. Complete documentation for the XbaeMatrix widget is available in `$WAVE_DIR/docs/widgets`:

- `matrix_motif.ps` — A PostScript file containing the documentation for the Motif version of XbaeMatrix widget. You can print this file on any PostScript printer.
- `matrix_olit.ps` — A PostScript file containing the documentation for the OLIT version of XbaeMatrix widget. You can print this file on any PostScript printer.

XbaeMatrix Widget Callbacks

See Appendix C, *Motif and OLIT Callback Parameters* in the *PV-WAVE Programmer's Guide* for information on the required parameters for all PV-WAVE widget callbacks. In addition, the XbaeMatrix widget's callback routines and their parameters are documented in the files `matrix_motif.ps` and `matrix_olit.ps` discussed in the previous section. Refer to those documents for information on the table widget's callbacks.

Example

In this example, values in the table are modified (set) through a call to WtTable.

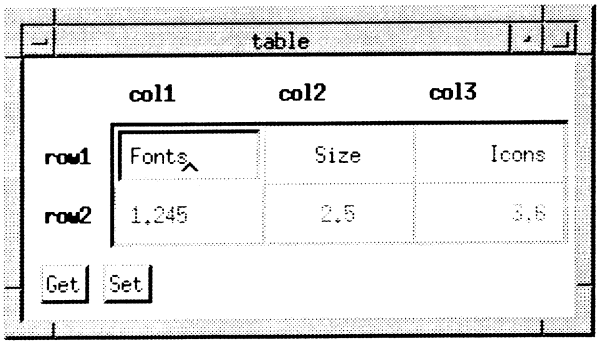


Figure 2-82 Editable table based on the XbaeMatrix widget.

```
   PRO ButtonCB, w, which
COMMON Widgets, table
```

When a button is pressed, modify the table with a call to WtTable.

```
CASE which OF
    1: PRINT, WtGet(table,'cells',Nrows = 2, $
      Ncols = 3)
    2: status = WtTable('SetCell', table, 0, $
      0, 'New Font')
ENDCASE

    END

    PRO LeaveCellCB, w, data, n, reason, event, r,
       c, $
       value, doit
```

This callback is called just before an edit to a cell is committed. For more information on XbaeMatrix widget callbacks and their parameters, see the previous section "XbaeMatrix Widget Callbacks".

```
 PRINT, "leaveCellCallback ", r, c, value

    END

    PRO ModifyVerifyCB, w, data, n,reason, event,$
       r, c, doit, ci, cn, sp, ep, txt, len, fmt
```

This callback is called while a cell is being edited. For more information on XbaeMatrix widget callbacks and their parameters, see the previous section "XbaeMatrix Widget Callbacks".

```
     print, "modifyVerifyCallback ", r, c, doit,
       ci, cn, $ sp, ep, txt, len, fmt

    END

    PRO Table

    @wtxmclasses

    @wtxmconsts

    COMMON Widgets, table
```

Initialize the Widgets Toolkit.

```
 top = WwInit('table','Test', layout, $
   /Vertical)
```

Load color table.

```
loadct, 5
```

Set cell contents, display table.

```
cells = [['Fonts','Size','Icons'], $
 ['1.245','2.5','3.6']]
 args = {, rows:2, columns:3, cells:cells,$
   columnWidths:[10, 10, 10], $
 columnLabels:['col1','col2','col3'],$
   rowLabels:['row1','row2'], $
   boldLabels:TRUE, $
   colors:[[40, 50, 60], [100, 110, 120]], $
 columnAlignments:[XmALIGNMENT_BEGINNING, $
   XmALIGNMENT_CENTER, XmALIGNMENT_END]}
 table = WtCreate('table', xbaeMatrixWidgetClass,
   layout, args)
status = WtAddCallback(table, "leaveCellCallback",$
   'leaveCellCB')

      status = WtAddCallback(table, "modifyVerify-
         Callback",$ 'modifyVerifyCB')

      buttons = WwButtonBox(layout,['Get','Set'],'-
         ButtonCB')

      status = WwSetValue(top, /Display)

      WwLoop

      END
```

See Also

WwTable

For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide*.

WtTimer Function

Registers a callback function for a given timer.

Usage

status = WtTimer(*function*, *params*, [*client_data*])

Parameters

function:

- 'Add' — If Add is specified, the also provide the following three parameters:

  time — A long integer specifying the time interval in milliseconds.

  timer — A string containing a PV-WAVE timer function name.

  client_data — (optional) A PV-WAVE variable.

- 'Remove' — If Remove is specified, also provide the following parameter:

  ID — The timer ID.

Returned Value

status — For Add, returns the timer ID or zero (0) to indicate failure. For Remove, one (1) indicates success; zero (0) indicates failure.

Keywords

Once_only — If present and nonzero, the PV-WAVE timer function is called only once.

Discussion

This timer, unlike the XtIntrinsics XtTimeOut function, restarts itself. To stop the timer, use the command:

```
WtTimer("REMOVE", id)
```

in the timer callback. The new timer ID is returned in the timer callback parameter `timer_id`.

If you need to keep a copy of the timer ID in a common block, copy the `timer_id` parameter of the timer callback routine to your timer ID variable in the COMMON block, as shown in the following example.

For information on the requirements for writing timer procedures, see *Adding Timers* on page 489 of the *PV-WAVE Programmer's Guide.*

Example

```
COMMON timer, tid
.
.
id=WtTimer("ADD", 100, 'TimerCallback', $
   my_data)

PRO TimerCallback, wid, client_data, $
   timer_id, interval
   COMMON timer, tid
   tid = timer_id
   .
   .
END
```

See Also

For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide.*

WtWorkProc Function

Registers a PV-WAVE work procedure for background processing.

Usage

status = WtWorkProc(*function*, *parameters*)

Parameters

function:

- `'Add'` — Registers the specified work procedure.
- `'Remove'` — Removes the previously registered work procedure.

parameters:

- If `'Add'` is specified, also provide the following two parameters:

  workproc — A PV-WAVE work procedure name (string).

  client_data — (optional) A PV-WAVE variable.

- If `'Remove'` is specified, also provide the following parameter:

  id — The ID of the work procedure to be removed.

Returned Value

For `'Add'`:

status — The work procedure ID; zero (0) indicates failure.

For `'Remove'`:

status — One (1) indicates success; zero (0) indicates failure.

Discussion

A work procedure is useful if you need to execute a time-consuming operation from a callback procedure. While a callback procedure normally blocks events until the operation is finished, a work procedure lets you execute a callback while the toolkit is idle.

For information on the requirements for writing work procedures, see *Adding Work Procedures* on page 491 of the *PV-WAVE Programmer's Guide*.

Example

```
PRO ButtonCB
    This callback is called when a button is selected. Do not initiate
    the selected operation here, because it is too time-consuming.
    Instead, schedule a work procedure.

id=WtWorkProc("ADD", 'MyWorkProc', my_data)
    .
    .
END

PRO MyWorkProc, wid, client_data, workproc_id
    .
    .
IF done THEN status = WtWorkProc("REMOVE", $
   workproc_id)

END
```

See Also

For more information about how to write an application program based on PV-WAVE's Widget Toolbox, refer to Chapter 16, *Using the Widget Toolbox*, in the *PV-WAVE Programmer's Guide*.

WwButtonBox Function

Creates a horizontally or vertically oriented box containing push buttons.

Usage

bbox = WwButtonBox(*parent, labels, callback*)

Input Parameters

parent — The parent widget's ID.

labels — A string or an array of strings containing the text that is to appear on the buttons.

callback — A string containing the name of the PV-WAVE callback routine.

Returned Value

bbox — The ID of the button box widget.

Input Keywords

Border — Specifies the width in pixels of the button box and button borders.

Horizontal — If present and nonzero, creates a horizontally aligned row of buttons.

Measure — Specifies the number of columns of buttons (for a vertical box) or rows (for a horizontal box).

Position — If the button box widget is to be placed in a bulletin board layout, use this keyword to specify the *x, y* coordinates of the button box widget within the bulletin board.

Vertical — When present and nonzero, creates a vertically aligned column of buttons.

Spacing — Specifies the space in pixels between buttons.

Output Keywords

Buttons — Returns an array of push button widget IDs.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide.*

Background — Specifies the background color name. Background color is the color of the button.

Basecolor — Specifies the base color of the container widget.

Font — Specifies the name of the font used for button text.

Foreground — Specifies the foreground color name. Foreground color is the color of the button text.

Attachment Keywords

For additional information on attachment keywords, see *Form Layout: Attachments* on page 422 of the *PV-WAVE Programmer's Guide.*

Bottom — If a widget ID is specified (for example, `Bottom=wid`), then the bottom of the button box widget is attached to the top of the specified widget. If no widget ID is specified (for example, `/Bottom`), then the bottom of the button box widget is attached to the bottom of the parent widget.

Left — If a widget ID is specified (for example, `Left=wid`), then the left side of the button box widget is attached to the right side of the specified widget. If no widget ID is specified (for example, `/Left`), then the left side of the button box widget is attached to the left side of the parent widget.

Right — If a widget ID is specified (for example, `Right=wid`), then the right side of the button box widget is attached to the left side of the specified widget. If no widget ID is specified (for example, `/Right`), then the right side of the button box widget is attached to the right side of the parent widget.

Top — If a widget ID is specified (for example, `Top=wid`), then the top of the button box widget is attached to the bottom of the specified widget. If no widget ID is specified (for example, `/Top`), then the top of the button box widget is attached to the top of the parent widget.

Get/Set Value

For information on Get and Set values, see *Setting and Getting Widget Values* on page 466 of the *PV-WAVE Programmer's Guide*.

getvalue — Gets the label of the selected button.

setvalue — Sets the label of the selected button.

Callback Parameters

Any button box callback procedure must have the following two parameters:

wid — The button widget ID.

index — Index of the button pushed ($1 - n$).

Discussion

The "button box" is a special widget in which individual buttons are arranged. If only one button is requested, that button's widget ID is returned. By default, the buttons are arranged in a row/column format. See the WwLayout function for information on row/column format.

Example

This example creates a button box containing three buttons, Quit, Dialog, and Message. The callback `ButtonCB` is executed when one of the buttons in the button box is selected.

Enter the callback procedure into a file, and compile the procedure with the .RUN command. Then, enter the widget commands at the `WAVE>` prompt. To dismiss the button box, select the appropriate function (such as **Close**) from the window manager menu.

Callback Procedure

```
PRO ButtonCB, wid, data
CASE data OF
   1: PRINT,'Quit Selected'
   2: PRINT,'Dialog Selected'
   3: PRINT,'Message Selected'
   ENDCASE
END
```

Widget Commands

```
labels = ['Quit','Dialog','Message']
top=WwInit('ww_ex20', 'Examples', layout)
bbox=WwButtonBox(layout, labels,'ButtonCB', $
   /Horizontal, Spacing=20)
status=WwSetValue(top, /Display)
WwLoop
```

See Also

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwCommand Function

Creates a command window.

Usage

command = WwCommand(*parent, enteredCallback, doneCallback*)

Input Parameters

parent — The parent widget's ID.

enteredCallback — A string containing the name of the PV-WAVE callback routine that is executed when a command is entered and confirmed (the user presses <Return>).

doneCallback — A string containing the name of the callback routine that is executed when the command window is destroyed.

Returned Value

command — The widget ID of the command window.

Keywords

Maximum — Specifies the maximum number of items that can be placed in the command history list.

Position — Specifies the position of the upper-left corner of the command window on the screen.

Prompt — Specifies a string containing the command prompt.

Title — Specifies a string containing the command window title.

Visible — Specifies the maximum number of command history items that are visible.

Width — Specifies the width of the command window.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide.*

Background – Specifies the background color name.

Font – Specifies the name of the font used for text.

Foreground – Specifies the foreground color name.

Get/Set Value

For information on Get and Set values, see *Setting and Getting Widget Values* on page 466 of the *PV-WAVE Programmer's Guide.*

getvalue – Gets a string array containing the list of commands entered, from the oldest to newest command.

setvalue – Sets a new command in the text input field.

Callback Parameters

Any command widget callback procedure must have the following two parameters:

container – Container widget ID.

wid – Popup window widget ID.

Discussion

A command window is a *popup* window. This means that it cannot be the child of the top-level shell or the layout widget. Usually, a command widget is activated by a pushbutton or menu button, as in the example below.

A command window provides:

- A text input field where the user can enter text, such as a command or a label.
- A scrolling command-history list. Whenever the user enters a command in the text input field and presses <Return>, a callback is executed and the command text is placed on the history list. The user can re-enter a previously entered command by clicking on it in the command history list.

  If the user double-clicks on a command in the command history list, the callback is automatically executed and appended to the end of the list.
- A label for the text input field.

Example

This example creates a button labeled Command. When this button is selected, the `CbuttonCB` callback is activated and a command window is created. When a user enters text in the text input field and presses <Return>, the callback `CommandOK` is executed. When the user exits the command box, the `CommandDone` callback is executed.

Enter the callback procedures into a file, and compile the procedures with the .RUN command. Then, enter the widget commands at the `WAVE>` prompt. To dismiss the widgets, select the appropriate function (such as **Close**) from the window manager menu of the Command button (the parent widget).

Callback Procedures

```
PRO CbuttonCB, wid, data
   command = WwCommand(wid, 'CommandOK', $
      'CommandDone', Position=[300,300], $
      Title='Command Entry Window')
END

PRO CommandOK, wid, shell
   value = WwGetValue(wid)
   PRINT, value
END

PRO CommandDone, wid, shell
   status = WwSetValue(shell, /Close)
END
```

Widget Commands

```
top=WwInit('example2', 'Examples', layout)

button=WwButtonBox(layout, 'Command', $
   'CbuttonCB')

status=WwSetValue(top, /Display)

WwLoop
```

See Also

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwControlsBox Function

Creates a box containing sliders.

Usage

controls = WwControlsBox(*parent, labels, range, changedCallback*)

Input Parameters

parent — The widget ID of the parent widget.

labels — A string or array of strings containing the text used to label the slider ranges.

range — An array of values specifying the minimum and maximum slider values.

changedCallback — A string containing the name of the callback routine that is executed when the value of a slider changes.

Returned Value

controls — The widget ID of the controls box widget.

Input Keywords

Border — Specifies the width in pixels of the controls box and slider borders.

Drag — If present and nonzero, the callback procedure is called while the slider is being dragged.

Float — Lets you display a floating-point slider, with ranges that include implied decimal numbers. This keyword specifies the number of digits that appear after the decimal point. For example, to display a floating-point slider with the range 0.5 to 12.5, use:

```
controls=WwControlsBox(parent, 'myslider',$
   [5, 125], 'mycallback', Float=1)
```

The decimal point is implied in that it is used for display purposes only. If the user choses a slider value of 5.7, the value returned to the callback is 57. The value of *Float* can be obtained through the *Userdata* keyword of the WwGetValue function. Thus, you can obtain the implied decimal position that was used in a WwControlsBox function. For example:

```
PRO mycallback, wid, which
   ndec = WwGetValue(wid, /Userdata)
   value = WwGetValue(wid)
   PRINT, 'User Selected Value: ', $
   Float(value)/10.0^ndec
```

Height — Specifies the height of the slider(s).

Horizontal — When present and nonzero, creates a horizontally aligned row of sliders.

Hslider — When present and nonzero, creates horizontally-oriented slider(s).

Measure — Specifies the number of columns of sliders (for a vertical box) or rows (for a horizontal box).

Position — If the controls box widget is to be placed in a bulletin board layout, use this keyword to specify the *x*, *y* coordinates of the controls box widget within the bulletin board.

Spacing — Specifies the space between sliders.

Text — When present and nonzero, an input text field is created for each slider.

Vertical — When present and nonzero, creates a vertically aligned column of sliders.

Vslider — When present and nonzero, creates vertically-oriented slider(s).

Width — Specifies the width of the slider(s).

Output Keywords

Sliders — Returns an array of slider widget IDs.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide.*

Background — Specifies the background color name.

Basecolor — Specifies the base color.

Font — Specifies the name of the font used for slider text.

Foreground — Specifies the foreground color name.

Attachment Keywords

For additional information on attachment keywords, see *Form Layout: Attachments* on page 422 of the *PV-WAVE Programmer's Guide.*

Bottom — If a widget ID is specified (for example, `Bottom=wid`), then the bottom of the controls box widget is attached to the top of the specified widget. If no widget ID is specified (for example, `/Bottom`), then the bottom of the controls box widget is attached to the bottom of the parent widget.

Left — If a widget ID is specified (for example, `Left=wid`), then the left side of the controls box widget is attached to the right side of the specified widget. If no widget ID is specified (for example, `/Left`), then the left side of the controls box widget is attached to the left side of the parent widget.

Right — If a widget ID is specified (for example, `Right=wid`), then the right side of the controls box widget is attached to the left side of the specified widget. If no widget ID is specified (for example, `/Right`), then the right side of the controls box widget is attached to the right side of the parent widget.

Top — If a widget ID is specified (for example, `Top=wid`), then the top of the controls box widget is attached to the bottom of the specified widget. If no widget ID is specified (for example, `/Top`), then the top of the controls box widget is attached to the top of the parent widget.

Get/Set Value

For information on Get and Set values, see *Setting and Getting Widget Values* on page 466 of the *PV-WAVE Programmer's Guide*.

getvalue — Gets the value of the selected slider.

setvalue — Sets the value of the selected slider.

Callback Parameters

Any controls box callback procedure must have the following two parameters:

wid — Slider widget ID.

index — Index value of the slider that has changed ($1 - n$).

Discussion

A "controls box" is a special widget in which individual sliders are arranged. If only one slider is requested, that slider's widget ID is returned. By default, the sliders are placed in a row/column format.

A slider allows the user to change a value interactively by moving the slider handle back and forth within a predefined range. You have the option of including a text input field with each slider. The text input field lets the user enter an exact value for the slider.

Example

This example creates a box with three sliders labeled Pressure, RPM, and Temperature. Whenever the user moves one of the sliders, the callback procedure is executed.

Enter the callback procedure into a file, and compile the procedure with the .RUN command. Then, enter the widget commands at the `WAVE>` prompt. To dismiss the controls box, select the appropriate function (such as **Close**) from the window manager menu.

Callback Procedure

```
PRO SliderCB, wid, which
CASE which OF
   1: PRINT,'First Slider Moved'
   2: PRINT,'Second Slider Moved'
   3: PRINT,'Third Slider Moved'
   ENDCASE
value = WwGetValue(wid)
PRINT, value
END
```

Widget Commands

```
top=WwInit('ww_ex22', 'Examples', layout)
labels=['Pressure','RPM','Temperature']
ranges=[0,100,2000,4000,50,150]
controls = WwControlsBox(layout, labels, $
   ranges, 'SliderCB',/Vertical,/Text, $
   Foreground='gray',Background='white', $
   Basecolor='blue')
status=WwSetValue(top, /Display)
WwLoop
```

See Also

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwDialog Function

Creates a blocking or nonblocking dialog box.

Usage

wid = WwDialog(*parent, label, OKCallback, CancelCallback, HelpCallback*)

Input Parameters

parent — The widget ID of the parent widget.

label — A string containing the label for the input field.

OKCallback — A string containing the name of the callback that is executed when the OK (Motif) or Apply (OPEN LOOK) button is selected.

CancelCallback — A string containing the name of the callback that is executed when the Cancel button is selected.

HelpCallback — A string containing the name of the callback that is executed when the Help button is selected. If you are running under OPEN LOOK, this parameter is ignored.

Returned Value

wid — The ID of the dialog widget.

Keywords

Block — If this keyword is present and nonzero, the dialog box is blocking (the default).

Cols — Specifies the number of columns in the text input field.

Nonblock — If this keyword is present an nonzero, the dialog box is not blocking.

Text — Specifies a string containing the initial text in the text input field.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide.*

Background — Specifies the background color name.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Get/Set Value

For information on Get and Set values, see *Setting and Getting Widget Values* on page 466 of the *PV-WAVE Programmer's Guide.*

getvalue — Gets a string containing the text entered in the text input field.

setvalue — Sets a string in the text input field.

Callback Parameters

Any dialog box callback procedure must have the following two parameters:

wid — Command widget ID.

text — Text input field widget ID.

Discussion

A dialog box is a *popup* window. This means that it cannot be the child of the top-level shell or the layout widget. Usually, a dialog box widget is activated by a pushbutton or menu button, as in the example below.

Example

This example creates a button labeled Dialog Box. When the user selects this button, a dialog box appears. When the user enters text in the dialog box and presses <Return>, `DialogOK` is executed. When the user cancels the dialog box, the second callback routine, `DialogCancel`, is executed.

Enter the callback procedure into a file, and compile the procedure with the .RUN command. Then, enter the widget commands at the `WAVE>` prompt. To dismiss both widgets, select the appropriate function (such as **Close**) from the window manager menu of the Dialog Box button (the parent widget).

Callback Procedures

```
PRO DbuttonCB, wid, data
   select=WwDialog(wid,'Type something:',$
      'DialogOK','DialogCancel',Title='Type')
END

PRO DialogOK, wid, text
   PRINT,'Dialog OK'
   value = WwGetValue(text)
   PRINT, value
END

PRO DialogCancel, wid, data
   PRINT,'Dialog Cancel'
END
```

Widget Commands

```
top=WwInit('ww_ex23', 'Examples', layout)
button=WwButtonBox(layout, 'Dialog Box', $
   'DbuttonCB')
status=WwSetValue(top, /Display)
WwLoop
```

See Also

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwDrawing Function

Creates a drawing area, which allows users to display graphics generated by PV-WAVE.

Usage

wid = WwDrawing(*parent, windowid, drawCallback, wsize, dsize*)

Input Parameters

parent — The widget ID of the parent widget.

windowid — The window ID of the PV-WAVE graphics window. When the window index is undefined or between zero and 31, the first free window index (ascending) is used and returned as *windowid*. (For information on window IDs, see the WINDOW procedure.)

drawCallback — A string containing the name of the PV-WAVE callback routine that is executed when the drawing area is exposed to display the graphics.

wsize — A vector containing two long integers that represent the width and height of the drawing area window.

dsize — A vector containing two long integers that represent the width and height of the image to be displayed in the drawing area. If this is larger than *wsize*, you can use the scroll bars to move the image around in the display window.

Returned Value

wid — The ID of the drawing area widget.

Input Keywords

Border — Specifies the width of the borders in pixels for the parent widget and the child widgets. The default is 0.

Noscroll — If present and nonzero, the drawing area does not use scroll bars. The drawing area window is created the same size as the drawing area. In other words, the value of *dsize* equals *wsize*.

Position — If the drawing box widget is to be placed in a bulletin board layout, use this keyword to specify the *x*, *y* coordinates of the drawing box widget within the bulletin board.

Output Keywords

Area — Returns the drawing area widget's ID.

Color Keywords

For additional information on the color keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide*.

Background — Specifies the background color name.

Foreground — Specifies the foreground color name.

Attachment Keywords

For additional information on attachment keywords, see *Setting and Getting Widget Values* on page 466 of the *PV-WAVE Programmer's Guide*.

Bottom — If a widget ID is specified (for example, `Bottom=wid`), then the bottom of the drawing box widget is attached to the top of the specified widget. If no widget ID is specified (for example, `/Bottom`), then the bottom of the drawing box widget is attached to the bottom of the parent widget.

Left — If a widget ID is specified (for example, `Left=wid`), then the left side of the drawing box widget is attached to the right side of the specified widget. If no widget ID is specified (for example, `/Left`), then the left side of the drawing box widget is attached to the left side of the parent widget.

Right — If a widget ID is specified (for example, `Right=wid`), then the right side of the drawing box widget is attached to the left side of the specified widget. If no widget ID is specified (for example, `/Right`), then the right side of the drawing box widget is attached to the right side of the parent widget.

Top — If a widget ID is specified (for example, `Top=wid`), then the top of the drawing box widget is attached to the bottom of the specified widget. If no widget ID is specified (for example, `/Top`), then the top of the drawing box widget is attached to the top of the parent widget.

Get/Set Value

For information on Get and Set values, see *Setting and Getting Widget Values* on page 466 of the *PV-WAVE Programmer's Guide.*

getvalue — Gets the window ID of the drawing area widget.

setvalue — Sets a two-element vector containing the width and height of the drawing area.

Callback Parameters

Any drawing area widget callback procedure must have the following two parameters:

wid — Drawing area widget ID.

index — PV-WAVE window index.

Example

This example creates a widget that displays a PV-WAVE image. Whenever the drawing area widget is displayed, the callback is executed. In this case, the callback opens and reads an image file.

Enter the callback procedure into a file, and compile the procedure with the .RUN command. Then, enter the widget commands at the WAVE> prompt. To dismiss the drawing area widget, select the appropriate function (such as **Close**) from the window manager menu.

Callback Procedure

```
PRO DrawCB, wid, data
   common draw, img
   print, 'Draw'
   tv, img
END
```

Widget Commands

```
top=WwInit('ww_ex24', 'Examples', layout)
COMMON draw, img
LOADCT, 5, /SILENT
img=BYTARR(512,512)
OPENR,1,'$WAVE_DIR/data/head.img'
   Note: Under VMS, enter: WAVE_DIR:[DATA]head.img
READU,1,img
CLOSE, 1
draw=WwDrawing(layout, 1,'DrawCB', $
   [256,256], [512,512])
status=WwSetValue(top, /Display)
WwLoop
```

See Also

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwFileSelection Function

Creates a file selection widget, which lets the user display the contents of directories and select files.

Usage

wid = WwFileSelection(*parent, OKCallback, CancelCallback, HelpCallback*)

Input Parameters

parent — The widget ID of the parent widget.

OKCallback — A string containing the name of the callback that is executed when the OK button is selected.

CancelCallback — A string containing the name of the callback procedure that is called when the file selection widget is dismissed.

HelpCallback — A string containing the name of the callback routine that is called when the Help button is selected. If you are running under OPEN LOOK, this parameter is ignored.

Returned Value

wid — The file selection widget ID.

Keywords

Block — Creates a blocking file selection window (the default).

Dir — Specifies a string containing the directory path.

File — Specifies a string containing the default file selection.

NonBlock — Creates a nonblocking file selection window.

Pattern — (Motif only) Specifies the search pattern used in combination with the directory in determining files to be displayed.

Position — Specifies the position of the upper-left corner of the file selection window on the screen in pixels.

Title — Specifies a string containing the file selection widget's title.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide.*

Background — Specifies the background color name.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Get/Set Value

For information on Get and Set values, see *Setting and Getting Widget Values* on page 466 of the *PV-WAVE Programmer's Guide.*

getvalue — Gets the selected file specification.

setvalue — Sets a three-element array of strings:

0 Determines the files and directories displayed in the directory list. For example, `/usr/home/mydir/*.c`. Ignored in OLIT.

1 Directory: specifies the base directory.

2 Pattern: specifies the search pattern to be used to select files.

Callback Parameters

Any file selection widget callback procedure must have the following two parameters:

wid — File selection widget ID.

shell — The ID of the top-level shell.

Discussion

A file selection widget is a *popup* window. This means that it cannot be the child of the top-level shell or the layout widget. Usually, a file selection widget is activated by a pushbutton or menu button, as in the example below.

Example

This example creates a button labeled File Selection. When the user selects this button, a file selection widget appears. When the user selects a file, the callback is executed.

Enter the callback procedure into a file, and compile the procedure with the .RUN command. Then, enter the widget commands at the WAVE> prompt. To dismiss the widget, select the appropriate function (such as **Close**) from the window manager menu of the File Selection button (the parent widget).

Callback Procedure

```
PRO FbuttonCB, wid, data
   file = WwFileSelection(wid,'FileOK',$
      'FileCancel', Title='Search')
END

PRO FileOK, wid, shell
   value = WwGetValue(wid)
   PRINT, value
   status = WwSetValue(shell, /Close)
END

PRO FileCancel, wid, shell
   PRINT, 'File Cancel'
END
```

Widget Commands

```
top=WwInit('ww_ex25', 'Examples', layout)
button=WwButtonBox(layout, 'File Tool', $
   'FbuttonCB')
status=WwSetValue(top, /Display)
WwLoop
```

See Also

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwGetValue Function

Returns a specific value for a given widget.

Usage

value = WwGetValue(*widget*)

Input Parameters

widget — The widget for which you want the value.

Returned Value

value — The value returned from the *widget*.

Keywords

Sensitive — Returns 1 if the widget is sensitive, or 0 if the widget is not sensitive.

Shown — Returns 1 if the widget is shown, or 0 if the widget is not visible.

Userdata — Returns the value of the *Userdata* variable that was previously stored with the WwSetValue function.

Discussion

See the *Get Value* section under each WAVE Widget function description to find out what WwGetValue returns by default for each function. For example, WwGetValue called with the ID of a list widget returns a string array containing the selected item(s) in the list.

Example

The following example demonstrates WwGetValue with the WwCommand function. WwGetValue returns a string array containing the commands entered in the Command window. The

callback routine CommandOK prints the value returned by WwGetValue whenever the user enters a command in the Command window and presses <Return>.

Enter the callback procedures into a file, and compile the procedure with the .RUN command. Then, enter the widget commands at the WAVE> prompt. To dismiss the widget, select the appropriate function (such as **Close**) from the window manager menu of the command window.

Callback Procedures

```
PRO CbuttonCB, wid, data
   command = WwCommand(wid, 'CommandOK', $
      'CommandDone', Position=[300,300], $
      Title='Command Entry Window')
END

PRO CommandOK, wid, shell
   value = WwGetValue(wid)
   print, value
END

PRO CommandDone, wid, shell
   status = WwSetValue(shell, /Close)
END
```

Widget Commands

```
top=WwInit('ww_ex26', 'Examples', layout)
button=WwButtonBox(layout, 'Command', $
   'CbuttonCB')
status=WwSetValue(top, /Display)
WwLoop
```

See Also

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwInit Function

Initializes the WAVE Widgets environment, opens the display, creates the first top-level shell, and creates a layout widget.

Usage

topshell = WwInit(*app_name*, *appclass_name*, *workarea* [, *destroyCallback*])

Input Parameters

app_name — A string containing the name of the application. This name can be referenced in a resource file.

appclass_name — A string containing the application class name, which can be the name of a resource file.

destroyCallback — (optional) A string containing the name of the callback that is executed when the top-level shell is destroyed.

Output Parameters

workarea — The widget ID of the layout widget that is created inside of the top-level shell.

Returned Value

topshell — The widget ID of the top-level application shell.

Keywords

Board — If present and nonzero, a bulletin board layout is created inside the top-level shell.

Border — Specifies the width in pixels of the borders for the layout widget and its child widgets. Default is 0.

Form — If present and nonzero, a form layout is created inside the top-level shell.

Horizontal — If present and nonzero, orients child widgets horizontally within the layout widget (the default). Used with row/column layouts only. For more information on layout widgets, see the WwLayout function.

Position — Specifies the position of the upper-left corner of the main window on the screen.

Spacing — Specifies the amount of space between child widgets inside the layout. Used with row/column layouts only. Default is 0. For more information on layout widgets, see the WwLayout function.

Title — A string specifying a title for the shell.

Vertical — If present and nonzero, orients child widgets vertically within the layout widget. Used with row/column layouts only. For more information on layout widgets, see the WwLayout function.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide.*

Background — Specifies the default background color name for an application.

Font — Specifies the name of the default font used for text in an application.

Foreground — Specifies the default foreground color name for an application.

Discussion

Call this routine before the first use of a WAVE Widgets routine.

Example

For examples showing the use of WwInit, see any of the WAVE Widgets widget-creation routines, such as WwButtonBox, WwCommand, WwControlsBox, WwList, and so on.

See Also

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwLayout Function

Creates a layout widget that is used to control the arrangement of other widgets.

Usage

layout = WwLayout(*parent*)

Input Parameters

parent — The widget ID of the parent widget.

Returned Value

layout — The widget ID of the layout widget.

Keywords

Board — If present and nonzero, the layout that is created is a "bulletin board".

Border — Specifies the width of the borders in pixels for the parent widget and the child widgets. The default is 0.

Form — If present and nonzero, the layout that is created is a "form".

Horizontal — If present and nonzero, aligns child widgets horizontally within the layout widget (the default). This keyword is only used for row/column layouts.

Position — If the layout widget is to be placed in a bulletin board layout, use this keyword to specify the *x*, *y* coordinates of the layout widget within the bulletin board.

Scroll — If present and nonzero, places scroll bars on the layout widget. Specify a width and height (e.g., `Scroll=[w,h]`) to set the width and height of the scrolled window.

Spacing — Specifies the amount of space in pixels between child widgets in the layout. The default is 0. This keyword is only used for row/column layouts.

Vertical — If present and nonzero, aligns child widgets vertically within the parent widget. This keyword is only used for row/column layouts.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide*.

Background — Specifies the background color name.

Foreground — Specifies the foreground color name.

Attachment Keywords

For additional information on attachment keywords, see *Form Layout: Attachments* on page 422 of the *PV-WAVE Programmer's Guide*.

Bottom — If a widget ID is specified (for example, `Bottom=wid`), then the bottom of the layout widget is attached to the top of the specified widget. If no widget ID is specified (for example, `/Bottom`), then the bottom of the layout widget is attached to the bottom of the parent widget.

Left — If a widget ID is specified (for example, `Left=wid`), then the left side of the layout widget is attached to the right side of the specified widget. If no widget ID is specified (for example, `/Left`), then the left side of the layout widget is attached to the left side of the parent widget.

Right — If a widget ID is specified (for example, `Right=wid`), then the right side of the layout widget is attached to the left side of the specified widget. If no widget ID is specified (for example, `/Right`), then the right side of the layout widget is attached to the right side of the parent widget.

Top — If a widget ID is specified (for example, `Top=wid`), then the top of the layout widget is attached to the bottom of the specified widget. If no widget ID is specified (for example, `/Top`), then the top of the layout widget is attached to the top of the parent widget.

Get/Set Value

For information on Get and Set values, see *Setting and Getting Widget Values* on page 466 of the *PV-WAVE Programmer's Guide*.

getvalue — Gets the *x, y* position of the contents of the scrolled window.

setvalue — Sets the *x, y* position of the contents of the scrolled window.

Callback Parameters

None.

Discussion

A layout widget is a container that holds other widgets. The layout widget provides different methods of arranging widgets, such as buttons, menus, sliders, and even other layout widgets, inside the "container." The three layout types are:

- Row/column — Widgets are arranged in rows and/or columns (the default).

- Form — Widgets are "attached" to one another inside the layout. Specified with the *Form* keyword.
- Bulletin board — Widgets are positioned in the layout with *x*, *y* coordinates. Specified with the *Board* keyword.

The layout widget can be the parent widget for each "child" widget it contains. If a border is not specified with the *Border* keyword, the layout widget itself is not visible to the user; only the widgets inside the layout are visible.

For more detailed information on layouts, see *Arranging Widgets in a Layout* on page 419 of the *PV-WAVE Programmer's Guide.*

Examples

The following example creates a simple layout widget containing a button box and a radio box widget. Note that WwLayout does not use callbacks, as it primarily creates a "container" that holds other widgets.

Enter the callback procedures into a file, and compile them with the .RUN command. Then, enter the widget commands at the WAVE> prompt (or enter them in a command file and run them with the @ command). To dismiss the layout box, select the appropriate function (such as **Close**) from the window manager menu.

Callback Procedures

```
PRO RadioCB, wid, which
CASE which OF
   1: PRINT,'First Toggle Selected'
   2: PRINT,'Second Toggle Selected'
   3: PRINT,'Third Toggle Selected'
   ENDCASE
value = WwGetValue(wid)
PRINT, value
END

PRO ButtonCB, wid, data
CASE data OF
```

```
   1: PRINT,'Quit Selected'
   2: PRINT,'Dialog Selected'
   3: PRINT,'Message Selected'
   ENDCASE
END
```

Widget Commands

```
top=WwInit('ww_ex27', 'Examples', layout,$
   /Vertical, Spacing=30, Border=10)

blabels = ['Quit','Dialog','Message']
bbox=WwButtonBox(layout, blabels,'ButtonCB',$
   /Horizontal, Spacing=20)

rlabels=['System','Owner','Group']
rbox=WwRadioBox(layout,rlabels, 'RadioCB', $
   /Vertical, Border=2, Spacing=20, $
   Top=controls)

status=WwSetValue(top, /Display)
WwLoop
```

See Also

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwList Function

Creates a scrolling list widget.

Usage

list = WwList(*parent, items, selectedCallback, defaultCallback*)

Input Parameters

parent — The widget ID of the parent widget.

items — A string array containing the items to appear on the list.

selectedCallback — A string containing the name of the callback that is executed when an item is selected.

defaultCallback — A string containing the name of the callback that is executed when a user double-clicks on an item.

Returned Value

list — The widget ID of the list widget.

Keywords

Multi — If present and nonzero, the list widget uses multiple selection mode. The default is single selection mode.

Position — If the scrolling list widget is to be placed in a bulletin board layout, use this keyword to specify the *x*, *y* coordinates of the scrolling list widget within the bulletin board.

Visible — Specifies the number of items that are visible in the list widget.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide*.

Background — Specifies the background color name.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Attachment Keywords

For additional information on attachment keywords, see *Form Layout: Attachments* on page 422 of the *PV-WAVE Programmer's Guide*.

Bottom — If a widget ID is specified (for example, `Bottom=wid`), then the bottom of the scrolling list widget is attached to the top of the specified widget. If no widget ID is specified (for example, `/Bottom`), then the bottom of the scrolling list widget is attached to the bottom of the parent widget.

Left — If a widget ID is specified (for example, `Left=wid`), then the left side of the scrolling list widget is attached to the right side of the specified widget. If no widget ID is specified (for example, `/Left`), then the left side of the scrolling list widget is attached to the left side of the parent widget.

Right — If a widget ID is specified (for example, `Right=wid`), then the right side of the scrolling list widget is attached to the left side of the specified widget. If no widget ID is specified (for example, `/Right`), then the right side of the scrolling list widget is attached to the right side of the parent widget.

Top — If a widget ID is specified (for example, `Top=wid`), then the top of the scrolling list widget is attached to the bottom of the specified widget. If no widget ID is specified (for example, `/Top`), then the top of the scrolling list widget is attached to the top of the parent widget.

Get/Set Value

For information on Get and Set values, see *Setting and Getting Widget Values* on page 466 of the *PV-WAVE Programmer's Guide*.

getvalue — Returns an array of the selected items (string).

setvalue — Replaces current items with the new items (array of strings).

Callback Parameters

Any list widget callback procedure must have the following two parameters:

wid — List widget ID.

parent — Parent widget ID.

Discussion

A scrolling list allows users to select one or more items from a group of choices. Items are selected from the list with the mouse. An additional callback can be defined for the default action. This callback is executed when the user double-clicks on an item.

Example

This example creates a scrolling list containing the items defined in the string array `items`. When the user selects an item (clicks it with the mouse), the first callback `ListCB` is executed. If the user double-clicks on an item, the callback `DefaultCB` is executed.

Enter the callback procedures into a file, and compile them with the .RUN command. Then, enter the widget commands at the WAVE> prompt. To dismiss the list box, select the appropriate function (such as **Close**) from the window manager menu.

Callback Procedures

```
PRO ListCB, wid, data
   PRINT,'Item Selected'
```

```
   value = WwGetValue(wid)
   PRINT, value
END

PRO DefaultCB, wid, data
   PRINT,'Default Item Selected'
   value = WwGetValue(wid)
   PRINT, value
END
```

Widget Commands

```
top=WwInit('ww_ex28', 'Examples', layout)
items = ['Presidents Day','St.Patricks Day', $
   'Easter', 'Memorial Day', '4th of July', $
   'Labor Day', 'Halloween', 'Thanksgiving', $
   'Hanukkah', 'Christmas', 'New Years Eve']
list=WwList(layout, items, 'ListCB', $
   'DefaultCB', Visible=7, /Multi)
status=WwSetValue(top, /Display)
WwLoop
```

WwLoop Function

Handles the dispatching of events and calling of PV-WAVE callbacks.

Usage

WwLoop

Parameters

None.

Returned Value

None.

Discussion

WwLoop causes PV-WAVE to loop indefinitely, processing the events and dispatching callbacks. WwLoop is always the last WAVE Widgets command in a WAVE Widgets procedure.

Example

For examples showing the use of WwLoop, see any of the WAVE Widgets widget-creation routines, such as WwButtonBox, WwCommand, WwControlsBox, WwList, and so on.

See Also

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwMainWindow Function

Creates a top-level window and a layout widget.

Usage

shell = WwMainWindow(*parent, workarea,* [*destroyCallback*])

Input Parameters

parent — The widget ID of the parent widget.

destroyCallback — A string containing the name of the callback that is executed when the main window is destroyed.

Output Parameters

workarea — The widget ID of the layout widget that is created inside of the top-level shell.

Returned Value

shell — The widget ID of the top-level shell.

Keywords

Board — If present and nonzero, a bulletin board layout is created inside the main window shell. See WwLayout for more information.

Border — Specifies the width in pixels of the borders for the layout widget and its child widgets. Default is 0.

Form — If present and nonzero, a form layout is created inside the shell. See WwLayout for more information.

Horizontal — If present and nonzero, aligns child widgets horizontally within the layout widget (the default). Used with row/column layouts only. For more information on layout widgets, see the WwLayout function.

Position — Specifies the *x*, *y* position of the upper-left corner of the main window on the screen.

Spacing — Specifies the amount of space in pixels between child widgets inside the layout. Used with row/column layouts only. Default is 0. For more information on layout widgets, see the WwLayout function.

Title — A string specifying a title for the shell.

Vertical — If present and nonzero, aligns child widgets vertically within the layout widget. Used with row/column layouts only. For more information on layout widgets, see the WwLayout function.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide*.

Background — Specifies the background color name.

Font — Specifies the name of the font used for text (not supported for OLIT).

Foreground — Specifies the foreground color name.

Get/Set Value

Not supported.

Callback Parameters

Any main window callback procedure must have the following two parameters:

shell — Main window shell widget ID.

layout — Layout widget ID.

Discussion

The WwInit function creates one main window, and for many applications, this is sufficient. WwMainWindow gives you the ability to create additional main windows and layout widgets.

By default, the WwMainWindow creates a row/column layout widget. For more information on layout widgets, see WwLayout.

Example

This example shows a call to the WwMainWindow function. No callback is specified.

```
shell = WwMainWindow(parent,form, destroyCB, $
   /Vertical, Title='Topics')
```

See Also

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwMenuBar Function

Creates a menu bar.

Usage

menubar = WwMenuBar(*parent, items*)

Input Parameters

parent — The widget ID of the parent widget.

items — An unnamed structure containing the menu bar items. For more information, see *Creating and Handling Menus* on page 425 of the *PV-WAVE Programmer's Guide.*

Returned Value

menubar — The widget ID of the menu bar widget.

Input Keywords

Position — If the menu bar widget is to be placed in a bulletin board layout, use this keyword to specify the *x, y* coordinates of the menu bar widget within the bulletin board.

Spacing — Specifies the amount of space in pixels between child widgets.

Output Keywords

Menus — Returns an array of menu pane widget IDs in the order in which the menus were created. A menu pane is a special menu widget that serves as a container for a menu item. Menu pane widget IDs can be used in the WwMenuItem function to add, modify, or delete menu items.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide.*

Background — Specifies the background color name.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Attachment Keywords

For additional information on attachment keywords, see *Form Layout: Attachments* on page 422 of the *PV-WAVE Programmer's Guide.*

Bottom — If a widget ID is specified (for example, `Bottom=wid`), then the bottom of the menu bar widget is attached to the top of the specified widget. If no widget ID is specified (for example, `/Bottom`), then the bottom of the menu bar widget is attached to the bottom of the parent widget.

Left — If a widget ID is specified (for example, `Left=wid`), then the left side of the menu bar widget is attached to the right side of the specified widget. If no widget ID is specified (for example, `/Left`), then the left side of the menu bar widget is attached to the left side of the parent widget.

Right — If a widget ID is specified (for example, `Right=wid`), then the right side of the menu bar widget is attached to the left side of the specified widget. If no widget ID is specified (for example, `/Right`), then the right side of the menu bar widget is attached to the right side of the parent widget.

Top — If a widget ID is specified (for example, `Top=wid`), then the top of the menu bar widget is attached to the bottom of the specified widget. If no widget ID is specified (for example, `/Top`), then the top of the menu bar widget is attached to the top of the parent widget.

Get/Set Value

For information on Get and Set values, see *Setting and Getting Widget Values* on page 466 of the *PV-WAVE Programmer's Guide.*

getvalue — Gets the button label or icon pixmap ID for the selected menu button. Or, if the button is a toggle, determines if the button is selected or unselected (selected = 1, unselected = 0).

setvalue — Sets the button label or icon pixmap ID for the selected menu button. Or, if the button is a toggle, selects or unselects the toggle button (select = 1, unselect = 0).

Callback Parameters

Any menu bar callback procedure must have the following two parameters:

wid — Widget ID of the selected menu item.

index — Index of the selected menu item ($1 - n$).

Example

First, this example creates a menu bar with three menus: **Fonts**, **Size**, and **Icons**. The unnamed structure `menus` contains all of the information used to create the menus.

Enter the callback procedure into a file, and compile the procedure with the .RUN command. Then, enter the widget commands at the `WAVE>` prompt (or enter them in a command file and run them with the @ command). To dismiss the menu bar, select the appropriate function (such as **Close**) from the window manager menu.

Callback Procedure

```
PRO MenuCB, wid, index
   PRINT, 'Menu Item', index, 'selected.'
   value = WwGetValue(wid)
   PRINT, value
END
```

```
top=WwInit('ww_ex29', 'Examples', layout)

menus={,callback:'MenuCB', $
   menubutton:'Fonts', $
   menu:{,callback:'MenuCB', $
      menubutton:'Adobe', $
      menu:{,callback:'MenuCB', $
         toggle:'Normal', $
         toggle:'Bold', $
         toggle:'Italic'}, $
      button:'Helvetica', $
      button:'Courier'}, $
      menubutton:'Size', $
      menu:{,callback:'MenuCB', $
         button:'8', $
         button:'10', $
         button:'12'}, $
   menubutton:'Icons', $
   menu:{,callback:'MenuCB', $
      title:'Help', $
icon:getenv('WAVE_DIR')+ $
   '/src/help/app/xres/wxbm_btn_help_search.', $
icon:getenv('WAVE_DIR')+ $
   '/src/help/app/xres/wxbm_btn_help_toc.', $
icon:getenv('WAVE_DIR')+ $
   '/src/help/app/xres/wxbm_btn_help_topics.', $
separator:1, $
icon:getenv('WAVE_DIR')+ $
   '/src/help/app/xres/wxbm_btn_help_quit.'}}

bar=WwMenuBar(layout, menus)
status=WwSetValue(top, /Display)
WwLoop
```

See Also

WwMenuItem, WwOptionMenu, WwPopupMenu

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwMenuItem Function

Adds, modifies, or deletes specified menu items.

Usage

status = WwMenuItem(*parent*, *item*, *value* [, *callback*])

Input Keywords

parent — The menu pane widget ID acquired using the *Menus* keyword from the WwMenuBar, WwOptionMenu, or WwPopupMenu functions. A menu pane is a special menu widget that serves as a container for a menu item.

item — The index of the menu item; the index of the first menu item is one (1). Used for an Update or Delete operation.

value — The value (string) of the menu item. Used for an Update or Add operation.

callback — The PV-WAVE callback procedure that is executed when the menu item is selected. Used for an Add operation.

Returned Value

status — Returns one (1) if the function is successful, or zero (0) if the function is not successful.

Keywords

Update — Modifies the value of the item specified by the index of *item*.

Add — Appends the specified *item*. The type of the item is specified by additional keywords:

- *Button* — A push button item is added.
- *Toggle* — A toggle (radio) button is added.
- *Icon* — A graphic (icon) button is added.

Delete — Deletes the item specified by *index*.

Discussion

WwMenuItem lets you dynamically update menus that have already been created. All menu items are placed inside a parent menu pane, and the widget ID of the appropriate menu pane can be acquired using the *Menus* keyword of the WwMenuBar, WwPopupMenu, or WwOptionMenu functions.

To update (*Update* keyword) or remove (*Delete* keyword) a menu item, use the appropriate menu item index; the index of the first menu item is one (1). To add a menu item to the bottom of the menu use the *Add* keyword.

Example

The following fragment shows how a callback might be written that uses WwMenuItem to modify the contents of a menu pane.

```
PRO ButtonCB, wid, index
   COMMON Menus, menupane, item_no, new_name
   CASE index OF
   1: BEGIN ; Add new item
   status = WwMenuItem(menupane, item_no,$
      new_name, /Add)
      END
   2: BEGIN: ; Update last selected item
   status = WwMenuItem(menupane, item_no, $
      new_name, /Update)
      END
```

```
      3: BEGIN ; Remove last selected item
      status = WwMenuItem(menupane, item_no, $
         /Delete)
         END
      ENDCASE
   END
```

See Also

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwMessage Function

Creates a blocking or nonblocking message box.

Usage

wid = WwMessage(*parent, label, OKCallback, CancelCallback, HelpCallback*)

Input Parameters

parent — The widget ID of the parent widget.

label — A string containing the message text.

OKCallback — A string containing the name of the callback routine that is called when the OK (Motif) or Confirm (OPEN LOOK) button is selected.

CancelCallback — A string containing the name of the callback routine that is executed when the Cancel button is selected.

HelpCallback — A string containing the name of the callback that is executed when the Help button is selected. If you are running under OPEN LOOK, this parameter is ignored.

Keywords

Block — If present and nonzero, creates a blocking message box (the default).

Info — If present and nonzero, creates an "information" message box (the default, Motif only).

Nonblock — If present and nonzero, creates a nonblocking message box.

Question — If present and nonzero, creates a "question" message box (Motif only).

Title — Specifies a string containing the message box title.

Warning — If present and nonzero, creates a "warning" message box (Motif only).

Working — If present and nonzero, creates a "working" message box (Motif only).

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide*.

Background — Specifies the background color name.

Font — Specifies the name of the font used for message text.

Foreground — Specifies the foreground color name.

Returned Value

wid — The message box widget ID.

Get/Set Value

Not supported.

Callback Parameters

Any message box callback procedure must have the following two parameters:

wid — Message widget ID.

shell — Shell widget ID.

Discussion

A message window is a *popup* window. This means that it cannot be the child of the top-level shell or the layout widget. Usually, a message widget is activated by a pushbutton or menu button, as in the example below.

Example

This example creates a button box with four buttons. If you are running under Motif, each button activates one of the four types of message windows: information, working, warning, or question. (Under OPEN LOOK, the four message boxes will look the same.) The callback `MessageOK` is executed when the user clicks on the OK or Confirm button. The callback `MessageCancel` is executed when the user clicks on the Cancel button.

Enter the callback procedures into a file, and compile them with the .RUN command. Then, enter the widget commands at the `WAVE>` prompt. To dismiss the widgets, select the appropriate function (such as **Close**) from the window manager menu of the menu bar.

Callback Procedures

```
PRO MbuttonCB, wid, data
 CASE data OF
   1: message=WwMessage(wid, $
      'This is a Test Message','MessageOK', $
      'MessageCancel',Title='Information')
   2: message=WwMessage(wid, $
      'This is a Test Message','MessageOK', $
```

```
        'MessageCancel', /Working, $
        Title='Working')
    3: message=WwMessage(wid, $
        'This is a Test Message','MessageOK', $
        'MessageCancel', /Warning, $
        Title='Warning')
    4: message=WwMessage(wid, $
        'This is a Test Message','MessageOK', $
        'MessageCancel', /Question, $
        Title='Question')
  ENDCASE
END

PRO MessageOK, wid, data
   PRINT,'Message OK'
END

PRO MessageCancel, wid, data
   PRINT,'Message Cancel'
END
```

Widget Commands

```
top=WwInit('ww_ex30', 'Examples', layout)
button=WwButtonBox(layout, ['Information', $
   'Working', 'Warning', 'Question'], $
   'MbuttonCB')
status=WwSetValue(top, /Display)
WwLoop
```

See Also

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwOptionMenu Function

Creates an option menu.

Usage

option = WwOptionMenu(*parent, label, items*)

Input Parameters

parent — The widget ID of the parent widget.

label — A string containing the text of the option menu label.

items — An unnamed structure specifying the option menu items. For more information, see *Creating and Handling Menus* on page 425 of the *PV-WAVE Programmer's Guide.*

Returned Value

option — The widget ID of the option menu box.

Input Keywords

Position — If the option menu widget is to be placed in a bulletin board layout, use this keyword to specify the *x*, *y* coordinates of the option menu widget within the bulletin board.

Output Keywords

Menus — Returns an array of menu pane widget IDs in the order in which the menus were created. A menu pane is a special menu widget that serves as a container for a menu item. Menu pane widget IDs can be used in the WwMenuItem function to add, modify, or delete menu items.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide*.

Background — Specifies the background color name.

Font — Specifies the name of the font used for label and button text.

Foreground — Specifies the foreground color name.

Attachment Keywords

For additional information on attachment keywords, see *Form Layout: Attachments* on page 422 of the *PV-WAVE Programmer's Guide*.

Bottom — If a widget ID is specified (for example, `Bottom=wid`), then the bottom of the option menu widget is attached to the top of the specified widget. If no widget ID is specified (for example, `/Bottom`), then the bottom of the option menu widget is attached to the bottom of the parent widget.

Left — If a widget ID is specified (for example, `Left=wid`), then the left side of the option menu widget is attached to the right side of the specified widget. If no widget ID is specified (for example, `/Left`), then the left side of the option menu widget is attached to the left side of the parent widget.

Right — If a widget ID is specified (for example, `Right=wid`), then the right side of the option menu widget is attached to the left side of the specified widget. If no widget ID is specified (for example, `/Right`), then the right side of the option menu widget is attached to the right side of the parent widget.

Top — If a widget ID is specified (for example, `Top=wid`), then the top of the option menu widget is attached to the bottom of the specified widget. If no widget ID is specified (for example, `/Top`), then the top of the option menu widget is attached to the top of the parent widget.

Get/Set Value

For information on Get and Set values, see *Setting and Getting Widget Values* on page 466 of the *PV-WAVE Programmer's Guide.*

getvalue — The button label or icon pixmap ID for the selected menu button. Or, if the button is a toggle, returns whether it is selected or unselected (selected = 1, unselected = 0).

setvalue — The button label or icon pixmap ID for the selected menu button. Or, if the button is a toggle, selects or unselects the toggle button (select = 1, unselect = 0).

Callback Parameters

Any option menu callback procedure must have the following two parameters:

wid — Widget ID of the selected menu item.

index — Index of the selected menu item (1 – *n*).

Discussion

An option menu is a button that, when selected, displays a menu. The current selection is always displayed on the option menu button. When the user makes a selection, the option menu button is updated to reflect the change.

Pullright menus are not allowed in an option menu.

Example

This example creates an option menu. The menu information is defined in an unnamed structure called `fonts`. The callback routine, `MenuCB`, is called whenever a menu item is selected.

Enter the callback procedure into a file, and compile the procedure with the .RUN command. Then, enter the widget commands at the `WAVE>` prompt. To dismiss the option menu, select the appropriate function (such as **Close**) from the window manager menu.

Callback Procedure

```
PRO MenuCB, wid, index
   PRINT, 'Menu Item', index, 'selected.'
   value = WwGetValue(wid)
   PRINT, value
END
```

Widget Commands

```
top=WwInit('ww_ex31', 'Examples', layout)
fonts={,callback:'MenuCB', $
    button:'Adobe',$
    button:'Helvetica',$
    button:'Courier'}
opmenu=WwOptionMenu(layout, 'Fonts:', $
   fonts, Position=[0,150])
status=WwSetValue(top, /Display)
WwLoop
```

See Also

WwMenuItem, WwMenuBar, WwPopupMenu

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwPopupMenu Function

Creates a popup menu.

Usage

popup = WwPopupMenu(*parent, items*)

Input Parameters

parent — The widget ID of the parent widget.

items — An unnamed structure specifying the menu bar items. For more details, see *Creating and Handling Menus* on page 425 of the *PV-WAVE Programmer's Guide.*

Returned Value

popup — The widget ID of the popup menu widget.

Input Keywords

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide.*

Background — Specifies the background color name.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Output Keywords

Menus — Returns an array of menu pane widget IDs in the order in which the menus were created. A menu pane is a special menu widget that serves as a container for a menu item. Menu pane wid-

get IDs can be used in the WwMenuItem function to add, modify, or delete menu items.

Get/Set Value

For information on Get and Set values, see *Setting and Getting Widget Values* on page 466 of the *PV-WAVE Programmer's Guide*.

getvalue — The button label or icon pixmap ID for the selected menu button. Or, if the button is a toggle, returns whether it is selected or unselected (selected = 1, unselected = 0).

setvalue — The button label or icon pixmap ID for the selected menu button. Or, if the button is a toggle, selects or unselects the toggle button (select = 1, unselect = 0).

Callback Parameters

Any popup menu callback procedure must have the following two parameters:

wid — Widget ID of the selected menu item.

index — Index of the selected menu item (1 – *n*).

Discussion

A popup menu is a menu that appears when the user presses a mouse button (usually the right button) when the pointer is in the popup menu's parent widget. Thus, the popup menu is not tied to any menu button or menu bar.

Tip Avoid creating popup menus that have a multi-line text widget as a parent. The system editing menu may appear over the popup menu that you have defined.

Example

This example creates a drawing widget that serves as the parent for a popup menu. The popup menu is activated when the right mouse button is pressed while the pointer is over the drawing widget. The callback procedure is executed when a menu button is selected.

Enter the callback procedures into a file, and compile the procedures with the .RUN command. Then, enter the widget commands at the WAVE> prompt (or enter them in a command file and run them with the @ command). To dismiss the button box, select the appropriate function (such as **Close**) from the window manager menu.

Callback Procedures

```
PRO DrawCB, wid, data
   COMMON draw, img
   PRINT, 'Draw'
   TV, img
END

PRO MenuCB, wid, index
   PRINT, 'Menu Item', index, 'selected.'
   VALUE = WwGetValue(wid)
   PRINT, value
END
```

Widget Commands

```
top=WwInit('ww_ex32', 'Examples', layout)
COMMON draw, img
LOADCT, 5, /SILENT
img=BYTARR(512,512)
OPENR,1,'$WAVE_DIR/data/head.img'
   Note: Under VMS, enter: WAVE_DIR:[DATA]head.img
READU,1,img
CLOSE, 1
draw=WwDrawing(layout, 1,'DrawCB', $
   [256,256], [512,512])
status=WwSetValue(top, /Display)

menus={,callback:'MenuCB', $
   menubutton:'Fonts', $
   menu:{,callback:'MenuCB', $
```

```
      menubutton:'Adobe', $
      menu:{,callback:'MenuCB', $
         toggle:'Normal', $
         toggle:'Bold', $
         toggle:'Italic'}, $
      button:'Helvetica', $
      button:'Courier'}, $
   menubutton:'Size', $
   menu:{,callback:'MenuCB', $
      button:'8', $
      button:'10', $
      button:'12'}}

menu=WwPopupMenu(draw, menus)
status=WwSetValue(top, /Display)
WwLoop
```

See Also

WwMenuItem, WwMenuBar, WwOptionMenu

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwRadioBox Function

Creates a box containing radio buttons.

Usage

radio = WwRadioBox(*parent, labels, callback*)

Input Parameters

parent — The widget ID of the parent widget.

labels — A string array of button labels.

callback — A string containing the name of the PV-WAVE callback that is executed when a radio button is selected or unselected.

Returned Value

radio — The widget ID of the radio box widget. If only one button is requested, that radio button's widget ID is returned.

Input Keywords

Border — Specifies the width in pixels of the radio box and button borders.

Horizontal — When present and nonzero, creates a horizontally aligned row of radio buttons.

Measure — Specifies the number of columns of radio buttons (for a vertical box) or rows (for a horizontal box).

Nofmany — When present and nonzero, creates nonexclusive radio buttons, where any number of buttons can be selected at once.

Oneofmany — When present and nonzero, creates exclusive radio buttons, where only one button can be selected at a time.

Position — If the radio box widget is to be placed in a bulletin board layout, use this keyword to specify the *x*, *y* coordinates of the radio box widget within the bulletin board.

Spacing — Specifies the space in pixels between radio buttons.

Vertical — When present and nonzero, creates a vertically aligned column of radio buttons.

Output Keywords

Toggles — Returns an array of toggle button widget IDs.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide.*

Background — Specifies the background color name.

Basecolor — Specifies the base color.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Attachment Keywords

For additional information on attachment keywords, see *Form Layout: Attachments* on page 422 of the *PV-WAVE Programmer's Guide.*

Bottom — If a widget ID is specified (for example, `Bottom=wid`), then the bottom of the radio box widget is attached to the top of the specified widget. If no widget ID is specified (for example, `/Bottom`), then the bottom of the radio box widget is attached to the bottom of the parent widget.

Left — If a widget ID is specified (for example, `Left=wid`), then the left side of the radio box widget is attached to the right side of the specified widget. If no widget ID is specified (for example, `/Left`), then the left side of the radio box widget is attached to the left side of the parent widget.

Right — If a widget ID is specified (for example, `Right=wid`), then the right side of the radio box widget is attached to the left side of the specified widget. If no widget ID is specified (for example, `/Right`), then the right side of the radio box widget is attached to the right side of the parent widget.

Top — If a widget ID is specified (for example, `Top=wid`), then the top of the radio box widget is attached to the bottom of the specified widget. If no widget ID is specified (for example, `/Top`), then the top of the radio box widget is attached to the top of the parent widget.

Get/Set Value

For information on Get and Set values, see *Setting and Getting Widget Values* on page 466 of the *PV-WAVE Programmer's Guide*.

getvalue — Gets the state of the selected radio button. Set = 1; unset = 0.

setvalue — Sets the state of the selected radio button. Set = 1; unset = 0.

Callback Parameters

Any radio button callback procedure must have the following two parameters:

wid — Toggle button widget ID.

index — Index of the toggle button changed (1 – *n*).

Discussion

This function creates a box containing a specified number of rows or columns of labeled toggle buttons. If only one button is created, a box is not created; instead, only a single button widget is created.

Example

This example creates a box containing radio buttons. The callback is executed whenever the user clicks on a button.

Enter the callback procedure into a file, and compile the procedure with the .RUN command. Then, enter the widget commands at the WAVE> prompt. To dismiss the radio button box, select the appropriate function (such as **Close**) from the window manager menu.

Callback Procedure

```
PRO RadioCB, wid, which
 CASE which OF
   1: PRINT,'First Toggle Selected'
   2: PRINT,'Second Toggle Selected'
```

```
    3: PRINT,'Third Toggle Selected'
  ENDCASE
  value = WwGetValue(wid)
  PRINT, value
END
```

Widget Commands

```
top=WwInit('ww_ex33', 'Examples', layout)
labels=['System','Owner','Group']
rbox=WwRadioBox(layout,labels, 'RadioCB', $
   /Vertical, Border=2, Spacing=20)
status=WwSetValue(top, /Display)
WwLoop
```

See Also

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwSetValue Function

Sets the specified value for a given widget.

Usage

status = WtSetValue(*widget*, [*value*])

Input Parameters

widget — The ID of the widget whose value you want to set.

value — The value of the widget (optional when keywords are specified).

Returned Value

status — Returns 1 if the function is successful, or 0 if the function is not successful.

Keywords

Close — If present and nonzero, closes the widget hierarchy from the top-level shell down.

Display — If present and nonzero, displays the widget hierarchy from the top-level shell down.

Hide — If present and nonzero, hides the specified widget or group of widgets (layout).

Nonsensitive — If present and nonzero, sets the widget to nonsensitive.

Position — If the widget is to be placed in a bulletin board layout, use this keyword to specify the *x*, *y* coordinates of the widget within the bulletin board.

Show — If present and nonzero, shows the specified widget or group of widgets (layout).

Sensitive — If present and nonzero, sets the widget to sensitive.

Userdata — Stores the specified PV-WAVE variable with the widget. You can retrieve this value later with WwGetValue.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide*.

Background — Specifies the background color name.

Basecolor — Specifies the base color.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Attachment Keywords

For additional information on attachment keywords, see *Form Layout: Attachments* on page 422 of the *PV-WAVE Programmer's Guide.*

Bottom — If a widget ID is specified (for example, `Bottom=wid`), then the bottom of the widget is attached to the top of the specified widget. If no widget ID is specified (for example, `/Bottom`), then the bottom of the widget is attached to the bottom of the parent widget.

Left — If a widget ID is specified (for example, `Left=wid`), then the left side of the widget is attached to the right side of the specified widget. If no widget ID is specified (for example, `/Left`), then the left side of the widget is attached to the left side of the parent widget.

Right — If a widget ID is specified (for example, `Right=wid`), then the right side of the widget is attached to the left side of the specified widget. If no widget ID is specified (for example, `/Right`), then the right side of the widget is attached to the right side of the parent widget.

Top — If a widget ID is specified (for example, `Top=wid`), then the top of the widget is attached to the bottom of the specified widget. If no widget ID is specified (for example, `/Top`), then the top of the widget is attached to the top of the parent widget.

Discussion

See the *Get/Set Value* section under each WAVE Widget function description to find out what value is set by WwSetValue for each function. For example, WwSetValue called with the ID of a list widget sets the current list of items to a specified string array of new items.

Example

The following example demonstrates two common uses of WwSetValue: displaying and closing widgets. In the callback rou-

tine CommandDone, WwSetValue is called to close the widget when the user selects the **Close** function from the window manager menu. In the *Widget Commands* section, WwSetValue is used to display the button box widget.

```
PRO CbuttonCB, wid, data
   command = WwCommand(wid, 'CommandOK', $
      'CommandDone', Position=[300,300], $
      Title='Command Entry Window')
END

PRO CommandOK, wid, shell
   value = WwGetValue(wid)
   PRINT, value
END

PRO CommandDone, wid, shell
   status = WwSetValue(shell, /Close)
END
```

Widget Commands

```
top=WwInit('ww_ex34', 'Examples', layout)
button=WwButtonBox(layout, 'Command', $
   'CbuttonCB')
status=WwSetValue(top, /Display)
WwLoop
```

See Also

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide.*

WwTable Function

Creates an editable 2D array of cells containing string data, similar to a spreadsheet.

Usage

table = WwTable(*parent*, *callback* [, *variable*])

Input Parameters

parent — The widget ID of the parent widget.

callback — A PV-WAVE procedure that is called when the contents of a cell are modified.

Note It is the calling routine's responsibility to modify the appropriate PV-WAVE variables when a table cell has been modified.

variable — (optional) A PV-WAVE variable used to initialize the table cells. When this parameter is not supplied, the cells are initially empty, and the size of the table is set to the size specified by the *Cols* and *Rows* keywords. You can use the following types of variables with WwTable:

- scalar
- vector
- 2D array
- structure with scalar fields or date/time structure field

All values are converted to type string within WwTable.

Returned Value

table — The widget ID of the table widget.

Keywords

Alignments — A one-dimensional array (0, ..., *cols*–1) of column alignments. Valid values are:

0 Align cell contents to cell's left edge (left justify).

1 Center cell contents (center justify).

2 Align cell contents to cell's right edge (right justify).

Clabels — A one-dimensional string array (0, ..., *cols*–1) of column labels.

Note It is recommended that you specify row/column labels. Clicking MB2 on a row label selects the whole row; clicking MB2 on a column label selects the whole column.

Colors — A two-dimensional array (0, ..., *rows*–1, 0, ..., *cols*–1) of color indexes for table cells. This enables you to highlight particular groups of cells.

Cols — The number of columns in the table. If the *Cols* keyword is not specified, and the *variable* parameter is specified, the number of columns is calculated from the dimensions of *variable*. If neither *Cols* nor *variable* are specified, the size of the table is set to one column.

Cwidth — A one-dimensional array (0, ..., *cols*–1) of column widths. If not specified, the default column width is 10 characters.

Fixrows — The number of fixed rows in the table. Fixed rows are non-scrollable, non-editable cells that can serve as labels.

Fixcols — The number of fixed columns in the table. Fixed columns are non-scrollable, non-editable cells that can serve as labels.

Note You can specify *Fixrows* or *Fixcols* for a table, but not both.

Horizontal — If this keyword is present and nonzero, the contents of *variable* are displayed in natural fashion, i.e., *variable* rows are horizontal and columns are vertical. *Horizontal* is enabled by default. The *Horizontal* and *Vertical* keywords are mutually exclusive.

Position — If the widget is to be placed in a bulletin board layout, use this keyword (a two-element vector) to specify the *x*, *y* coordinates of the widget within the bulletin board.

Rlabels — A one-dimensional string array (0, ..., *rows*–1) of row labels.

Rows — The number of rows in the table. If the *Rows* keyword is not specified, and the *variable* parameter is specified, the number of rows is calculated from the dimensions of *variable*. If neither *Rows* nor *variable* are specified, the size of the table is set to one row.

Setcelldata — A copy of any PV-WAVE variable to be passed as client data to the *Setcells* function.

Setcells — Allows you to name a PV-WAVE function that is responsible for setting the values of the exposed cells. This function is called, like a callback, whenever cells are exposed (for example, as the user scrolls through the table). The function returns a string that is used to set the cell's new value. The function's input parameters are the table widget ID, a vector [*row*, *column*] specifying the exposed cell, and client data specified with the *Setcelldata* keyword. If this function is specified, the *variable* parameter is ignored.

Using *Setcells* can improve performance when a large table is created. Ordinarily, when the table's cells are populated by values taken from a single variable (the *variable* parameter), WwTable actually copies this variable first. When *Setcells* is used, only the values currently displayed are held in memory. See *Example 2* on page 479 for more information on *Setcells*.

Vertical — If this keyword is present and nonzero, the contents of *variable* are displayed as transposed (*variable* rows are vertical and columns are horizontal). The *Horizontal* and *Vertical* keywords are mutually exclusive.

Visible — A two-element vector specifying the number of rows and columns displayed. If the table size is bigger than the number of visible rows and columns, scrollbars are placed at the right and bottom edges of the window, so that you can view different portions of the table. If this keyword is not specified, four rows and four columns are displayed.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide*.

Background — Specifies the background color name.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Attachment Keywords

For additional information on attachment keywords, see *Form Layout: Attachments* on page 422 of the *PV-WAVE Programmer's Guide*.

Bottom — If a widget ID is specified (for example, `Bottom=wid`), then the bottom of the widget is attached to the top of the specified widget. If no widget ID is specified (for example, `/Bottom`), then the bottom of the widget is attached to the bottom of the parent widget.

Left — If a widget ID is specified (for example, `Left=wid`), then the left side of the widget is attached to the right side of the specified widget. If no widget ID is specified (for example, `/Left`), then the left side of the widget is attached to the left side of the parent widget.

Right — If a widget ID is specified (for example, `Right=wid`), then the right side of the widget is attached to the left side of the specified widget. If no widget ID is specified (for example, `/Right`), then the right side of the widget is attached to the right side of the parent widget.

Top — If a widget ID is specified (for example, `Top=wid`), then the top of the widget is attached to the bottom of the specified widget. If no widget ID is specified (for example, `/Top`), then the top of the widget is attached to the top of the parent widget.

Get/Set Value

getvalue — Gets the Boolean array (0...*rows*–1, 0...*cols*–1) of selected cells. For information on cell selection, see the *Discussion* section.

setvalue — A two-element vector [*row, column*] the indices of which select the cell to be set.

Callback Parameters

Any table widget callback procedure must have the following three parameters:

wid — The table widget ID.

cell — A two-element vector [*row, column*] specifying the modified cell.

value — A string containing the new contents of the modified cell.

Discussion

This section discusses how to select table cells for editing and for other operations.

Selecting Cells for Editing

When a cell is selected for editing, it is considered the current cell. You can delete and add characters in the current cell using the keys on your keyboard.

- To edit a cell, select it by clicking the left mouse button in the cell.
- To edit the cell to the left of the current cell, press the <Shift>+<Tab> key.
- To edit the cell to the right of the current cell, press the <Tab> key.
- To edit the cell above the current cell, press the up arrow key.
- To edit the cell on the bottom of the current cell, press the down arrow key.

Selecting One or More Cells

This section describes how to select cells for operations other than editing.

- To select a single cell, click the middle mouse button on the cell.
- To extend the selection, press the <Shift> key and click the middle mouse button.
- To deselect the cell, press the <Shift>+<Control> keys and click the middle mouse button.
- To toggle the selection press the <Control> key and click the middle mouse button.
- To select a rectangular region of cells, press the middle mouse button, drag the mouse, and then release the middle mouse button.

- To select, deselect, extend, or toggle the selection of an entire row or column, click the middle mouse button (with appropriate key(s) listed above pressed) on the row or column label.

Example 1

The following example displays data stored in the phone_data variable in the save file:

```
$WAVE_DIR/data/phone_example.sav
```

To restore this file, enter the following commands:

```
.RUN
RESTORE, !Dir+'/data/phone_example.sav'
COMMON Tablecomm, phone_data
END
```

Callback Procedures

```
PRO tableCB, wid, which, text

COMMON Tablecomm, phone_data
   PRINT, 'Table', which, text
   status = WwSetValue(wid, which)
   PRINT, WwGetValue(wid)
END

PRO ButtonCB, wid, data
COMMON Tablecomm, phone_data
   PRINT, 'Table Selected'
   shell = WwMainWindow(wid, form, /Vertical, $
      TITLE = 'Table')
   clrs = INTARR(N_TAGS(phone_data), $
      N_ELEMENTS(phone_data))
   FOR i = 0, N_ELEMENTS(phone_data)-1 DO $
      clrs(*, i) = INDGEN(N_TAGS(phone_data)) * 20
   rlabs = $
   STRTRIM(STRING(INDGEN(N_ELEMENTS(phone_data))), 2)
```

```
   table = WwTable(form,'tableCLBK',phone_data, $
      Colors=clrs,Visible=[10,N_TAGS(phone_data)-4], $
      Clabels=TAG_NAMES(phone_data), Rlabels = rlabs, $
      /Vertical)
   status = WwSetValue(shell, /Display)
END
```

Widget Commands

```
top=WwInit('tble_ex', 'Examples', layout)

label = ['Table']

button=WwButtonBox(layout, label, 'ButtonCB')

status=WwSetValue(top, /Display)

WwLoop
```

Example 2

This example demonstrates the use of the *Setcells* and *Setcelldata* keywords. In this program fragment, the contents of table cells are set to the value of the row number times the column number.

Callback Procedures

```
FUNCTION settableCLBK, wid, data, n, r, c
   RETURN, STRTRIM(STRING(r * c), 2)
      Return the string value of the product of row times column.
END


PRO buttonCB, wid, data
  COMMON Tablecomm, phone_data
   PRINT, 'Table Selected'
   shell = WwMainWindow(wid, form, /VERTICAL, $
      TITLE = 'Table')
```

```
  table = WwTable(form, 'tableCLBK', Visible=[10,5], $
   Rows=40, Cols=50, Setcells = 'settableCLBK', $
   Setcelldata='any var')

  status = WwSetValue(shell, /Display)
END
```

Widget Commands

```
top=WwInit('tble_ex20', 'Examples', layout)

label = ['Table']

button=WwButtonBox(layout, label, 'buttonCB')

status=WwSetValue(top, /Display)

WwLoop
```

See Also

WtTable

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwText Function

Creates a text widget that can be used for both single-line text entry or as a full text editor. In addition, this function can create a static text label.

Usage

text = WwText(*parent, verifyCallback*)

Input Parameters

parent — The widget ID of the parent widget.

verifyCallback — A string containing the name of a callback routine that is executed when the contents of the text field changes.

Keywords

Cols — Specifies the number of columns in the text field (in characters).

File — Specifies a name of a file containing text.

Label — If present and nonzero, the widget is a label (static text). The value of the label is set using the *Text* keyword. If the *Label* keyword is set to a string value, the text field (single line) or text edit (multi-line) widget is preceded by this string.

Pixmap — Specifies a filename containing a pixmap or bitmap file to be displayed as a label. This keyword is used in conjunction with the *Label* keyword.

Position — If the text widget is to be placed in a bulletin board layout, use this keyword to specify the *x, y* coordinates of the text widget within the bulletin board.

Read — If present and nonzero, the text widget is read only.

Note Because OLIT does not support read-only text fields, the staticText OLIT widget is used for the OLIT version of the read-only text field widget.

Rows — Specifies the number of rows in the text field.

Text — Specifies a label for the text field.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide.*

Background — Specifies the background color name.

Font — Specifies the name of the font used for text.

Foreground — Specifies the foreground color name.

Attachment Keywords

For additional information on attachment keywords, see *Form Layout: Attachments* on page 422 of the *PV-WAVE Programmer's Guide.*

Bottom — If a widget ID is specified (for example, `Bottom=wid`), then the bottom of the text widget is attached to the top of the specified widget. If no widget ID is specified (for example, `/Bottom`), then the bottom of the text widget is attached to the bottom of the parent widget.

Left — If a widget ID is specified (for example, `Left=wid`), then the left side of the text widget is attached to the right side of the specified widget. If no widget ID is specified (for example, `/Left`), then the left side of the text widget is attached to the left side of the parent widget.

Right — If a widget ID is specified (for example, `Right=wid`), then the right side of the text widget is attached to the left side of the specified widget. If no widget ID is specified (for example, `/Right`), then the right side of the text widget is attached to the right side of the parent widget.

Top — If a widget ID is specified (for example, `Top=wid`), then the top of the text widget is attached to the bottom of the specified widget. If no widget ID is specified (for example, `/Top`), then the top of the text widget is attached to the top of the parent widget.

Returned Value

text — The text widget ID.

Get/Set Value

For information on Get and Set values, see *Setting and Getting Widget Values* on page 466 of the *PV-WAVE Programmer's Guide.*

getvalue — A string containing the displayed text.

setvalue — A string containing the displayed text.

Callback Parameters

Any text widget callback procedure must have the following two parameters:

wid — Text widget ID.

parent — Parent widget ID.

Example 1: Single-line Text Field and Label

This example creates a layout widget containing a single-line text field and a label. The callback is executed when the user enters text in the text field and presses <Return>.

Enter the callback procedure into a file, and compile the procedure with the .RUN command. Then, enter the widget commands at the `WAVE>` prompt (or enter them in a command file and run it with the @ command). To dismiss the button box, select the appropriate function (such as **Close**) from the window manager menu.

Callback Procedure

```
PRO TextCB, wid, data
```

```
   PRINT, 'Text done'
   value = WwGetValue(wid)
   PRINT, value
END
```

Widget Commands

```
top=WwInit('ww_ex35', 'Examples', layout, $
   /Form)
```

Initialize WAVE Widgets and create the form layout widget.

```
label=WwText(layout, /Label, $
   Text='This is Label')
```

Create the label widget.

```
text=WwText(layout, 'TextCB', Cols=40, $
   left=label)
```

Create the single-line text field widget, attaching it to the right edge of the label widget.

```
status=WwSetValue(top, /Display)
WwLoop
```

Example 2: Multi-line Text Window

This example creates a multi-line text window. Because the *Read* keyword is used, the text is read-only.

Callback Procedure

```
PRO TextCB, wid, data
   PRINT, 'Text done'
   value = WwGetValue(wid)
   PRINT, value
END
```

Widget Commands

```
top=WwInit('ww_ex36', 'Examples', layout)
filename = getenv('WAVE_DIR')+ $
   '/Tips'
```

```
text=WwText(layout, 'TextCB', /Read, $
   File=filename, Cols=40, Rows=20)
status=WwSetValue(top, /Display)
WwLoop
```

See Also

WgTextTool

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide*.

WwToolBox Function

Creates an array of graphic buttons (icons).

Usage

toolb = WwToolBox(*parent, labels, callback*)

Input Parameters

parent — The widget ID of the parent widget.

labels — A string array of icon file names.

callback — A string containing the name of the PV-WAVE callback routine that is executed when a button is selected.

Returned Value

toolb — The ID of the tool box widget. If only one button is requested, that button's widget ID is returned.

Input Keywords

Border — Specifies the width in pixels of the tool box and icon borders. The default is 0.

Horizontal — When present and nonzero, creates a horizontally aligned row of buttons (the default).

Measure — If you create a horizontal box, then measure specifies the number of rows into which the buttons will be divided. For a vertical box, this keyword specifies the number of columns in which to divide the buttons.

Position — If the tool box widget is to be placed in a bulletin board layout, use this keyword to specify the *x*, *y* coordinates of the tool box widget within the bulletin board.

Spacing — Specifies the space in pixels between buttons. The default is 0.

Vertical — When present and nonzero, creates a vertically aligned column of buttons.

Output Keywords

Tools — Returns an array of graphical button (icon) widget IDs.

Color/Font Keywords

For additional information on the color and font keywords, see *Setting Colors and Fonts* on page 463 of the *PV-WAVE Programmer's Guide*.

Background — Specifies the background color name.

Basecolor — Specifies the base color.

Font — Specifies the name of the font used for button text.

Foreground — Specifies the foreground color name.

Attachment Keywords

For additional information on attachment keywords, see *Form Layout: Attachments* on page 422 of the *PV-WAVE Programmer's Guide*.

Bottom — If a widget ID is specified (for example, `Bottom=wid`), then the bottom of the tool box widget is attached to the top

of the specified widget. If no widget ID is specified (for example, `/Bottom`), then the bottom of the tool box widget is attached to the bottom of the parent widget.

Left — If a widget ID is specified (for example, `Left=wid`), then the left side of the tool box widget is attached to the right side of the specified widget. If no widget ID is specified (for example, `/Left`), then the left side of the tool box widget is attached to the left side of the parent widget.

Right — If a widget ID is specified (for example, `Right=wid`), then the right side of the tool box widget is attached to the left side of the specified widget. If no widget ID is specified (for example, `/Right`), then the right side of the tool box widget is attached to the right side of the parent widget.

Top — If a widget ID is specified (for example, `Top=wid`), then the top of the tool box widget is attached to the bottom of the specified widget. If no widget ID is specified (for example, `/Top`), then the top of the tool box widget is attached to the top of the parent widget.

Get/Set Value

For information on Get and Set values, see *Setting and Getting Widget Values* on page 466 of the *PV-WAVE Programmer's Guide*.

getvalue — Icon (pixmap) ID.

setvalue — The icon file name.

Callback Parameters

Any toolbox callback procedure must have the following two parameters:

wid — Button widget ID.

index — Index of the button pushed ($1 - n$).

Discussion

This function creates a box containing iconic buttons arranged in rows and/or columns. If you only create a single button, then the box widget is not created — only the button widget is created.

Example

This example creates a box containing graphical buttons (a toolbox). The callback routine, `PickedCB`, is executed when one of the toolbox buttons is selected.

Enter the callback procedure into a file, and compile the procedure with the .RUN command. Then, enter the widget commands at the `WAVE>` prompt (or enter them in a command file and run them with the @ command. To dismiss the tool box, select the appropriate function (such as **Close**) from the window manager menu.

Callback Procedure

```
PRO PickedCB, wid, which
CASE which OF
   1: PRINT,'Search Selected'
   2: PRINT,'Toc Selected'
   3: PRINT,'Topics Selected'
   4: PRINT,'Quit Selected'
   ENDCASE
END
```

Widget Commands

```
top=WwInit('ww_ex37', 'Examples', layout)
pixmaps = [GETENV('WAVE_DIR')+ $
   'src/help/app/xres/wxbm_btn_help_search.',$
    getenv('WAVE_DIR')+ $
   'src/help/app/xres/wxbm_btn_help_toc.',$
    getenv('WAVE_DIR')+ $
   'src/help/app/xres/wxbm_btn_help_topics.',$
    getenv('WAVE_DIR')+ $
   'src/help/app/xres/wxbm_btn_help_quit.']
dbox=WwToolBox(layout, pixmaps, 'PickedCB', /Vertical, $
   Spacing=20, Measure=2)
status=WwSetValue(top, /Display)
WwLoop
```

See Also

For more information about how to write an application program based on WAVE Widgets, refer to Chapter 15, *Using WAVE Widgets*, in the *PV-WAVE Programmer's Guide.*

XYOUTS Procedure

Draws text on the currently selected graphics device starting at the designated data coordinate.

Usage

XYOUTS, *x*, *y*, *string*

Input Parameters

x, *y* — *x* is the column, and *y* is the row, at which the output string should start. *x* and *y* are normally taken to be in data coordinates; however, the *Device* and *Normal* keywords can be used to change this unit.

Output Parameters

string — The scalar string containing the text that is to be output to the display surface. If not of string type, it is converted prior to use.

Keywords

XYOUTS keywords are listed below. For a description of each keyword, see Chapter 3, *Graphics and Plotting Keywords*.

Alignment	Color	Noclip	Text_Axes
Channel	Data	Normal	Thick
Charsize	Device	Orientation	Width
Charthick	Font	Size	Z
Clip	Linestyle	T3d	

Discussion

XYOUTS is machine-dependent when you are using hardware fonts. This means that on two different machines, the same PV-WAVE commands may produce text that does not appear the same. To guarantee similar appearance, use software fonts.

Note 

You may notice that under X Windows the size of the software fonts varies from device to device. When you start PV-WAVE, the PV-WAVE hardware font is set to the current hardware font of the X server. Not all X servers will have the same default font size because users can reconfigure the default font and the default font can differ between X servers. Therefore, you may discover that the hardware font size, and therefore the software font size, may vary across different workstations. You can avoid this by explicitly setting the X font using the DEVICE procedure. For example:

```
DEVICE, font='-adobe-courier-medium-r-normal-
   -14-*'
```

Example

In this example, XYOUTS is used to label a plot of random data. Procedure XYOUTS also is used to place a title on the plot. Text placement is relative to the *x* and *y* coordinates of the plot, which is the default for XYOUTS. Note that the CURSOR procedure was used to determine the proper coordinates at which to place labels. This example uses PV-WAVE Advantage procedure RANDOMOPT.

```
RANDOMOPT, Set = 1234567

x = RANDOM(5)
```

Create a 5-element vector of random data.

```
PLOT, x, Xrange = [-0.5, 4.5]
```

Plot the data.

```
XYOUTS, 0.1, 0.65, "Point 1"
```

Label the first data point.

```
XYOUTS, 1.1, 0.20, "Point 2"
```

Label the second data point.

```
XYOUTS, 2.0, 0.425, "Point 3"
```
Label the third data point.

```
XYOUTS, 3.1, 0.30, "Point 4"
```
Label the fourth data point.

```
XYOUTS, 4.1, 0.825, "Point 5"
```
Label the fifth data point.

```
XYOUTS, 1.25, 0.9, "Random Data", Charsize = 2
```
Place a title on the plot. Make the title twice the default character size using the Charsize keyword.

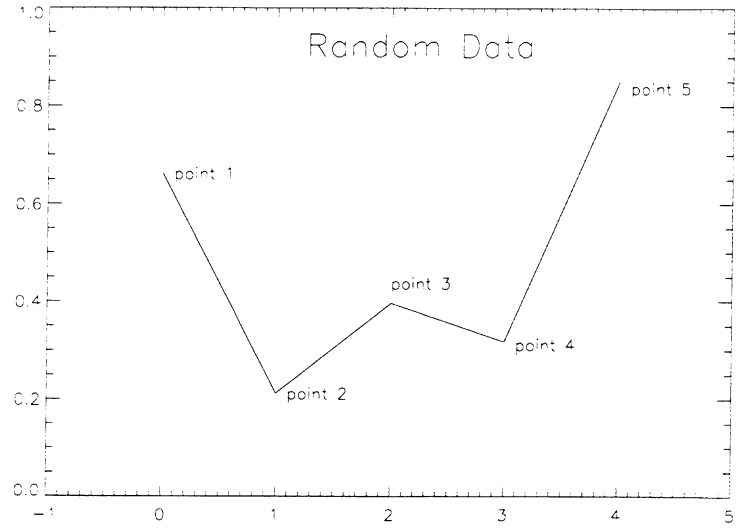


Figure 2-83 Example of plot labeling using XYOUTS.

See Also

LEGEND, PLOT

For more information, see *Using XYOUTS to Annotate Plots* on page 69 of the *PV-WAVE User's Guide*.

ZOOM Procedure

Expands and displays part of an image (or graphic plot) from the current window in a second window.

Usage

ZOOM

Parameters

None.

Input Keywords

Fact – The zoom expansion factor. The default is 4.

Interp – Specifies the interpolation method to be used. If non-zero, uses the bilinear interpolation method. Otherwise, uses the nearest neighbor method (the default).

XSize – The X size of the new window. The default is 512.

YSize – The Y size of the new window. The default is 512.

Continuous – If set to 1, causes the zoom window to track the mouse cursor. This obviates the need to press the left mouse button to mark the center of the zoom. Note that *Continuous* works well only on fast computers.

Discussion

ZOOM works only on windowing systems. It provides a quick way to get a close look at your image.

ZOOM lets you click with your mouse button on the center point of a region in a previously displayed image to bring up an enlarged view of this region in a new window. Then use your mouse buttons as follows:

- Use the left mouse button to choose the center point of the region to be zoomed in on from the original image.

- Use the middle mouse button to display a window letting you choose the zoom factor to use.
- Use the right button to quit out of ZOOM.

Example

```
OPENR, 1, !Data_dir + 'mandril.img'
mandril = BYTARR(512, 512)
READU, 1, mandril
```

Read in the PV-WAVE mandril demo image file.

```
TVSCL, mandril
```

Display the image file.

```
ZOOM
```

Use ZOOM with the default values; the mouse button functions will be described in the original window.

```
ZOOM, Fact=2
```

Use ZOOM with the zoom factor set to 2.

```
ZOOM, Interp=0
```

Use ZOOM with the zoomed region displayed using nearest neighbor sampling.

```
ZOOM, Interp=1
```

Use ZOOM with the zoomed region displayed using bilinear interpolation.

```
ZOOM, XSize=200, YSize=200
```

Display the new image in a window that is 200-by-200 pixels.

```
ZOOM, /Continuous
```

Run ZOOM where it continually samples the cursor; there is no need to click.

See Also

TVRD, ROT, ROT_INT

For details on interpolation methods. see *Efficiency and Accuracy of Interpolation* on page 170 of the *PV-WAVE User's Guide.*

ZROOTS Procedure

Finds the roots of the *m*-degree complex polynomial, using Laguerre's method.

Usage

ZROOTS, *a, roots* [, *polish*]

Input Parameters

a — A vector containing the *m* + 1 coefficients of the polynomial. May be either real or complex.

polish — Specifies whether polishing is to be done. Set to 0 if you want to prevent polishing of the roots. If set to 1 or omitted, roots are polished.

Output Parameters

roots — The result of ZROOTS, which is set to an *m*-element complex vector on exit.

Keywords

None.

Discussion

ZROOTS returns the roots of the *m*-degree complex polynomial:

$$\sum_{i=0}^{m} a_i x^i$$

See Also

POLY

ZROOTS is based on a routine of the same name in *Numerical Recipes in C: The Art of Scientific Computing*, by Flannery, Press, Teukolsky, and Vetterling, Cambridge University Press, Cambridge, MA, 1988. It is used by permission.

3

CHAPTER

Graphics and Plotting Keywords

This chapter describes the keywords that can be used with the PV-WAVE graphics and plotting system routines. For information on the corresponding system variables that are listed for some keywords, see Chapter 4, *System Variables*.

Alignment Keyword

Used With Routines: XYOUTS

Corresponding System Variable: None.

Specifies the horizontal alignment of the text in relation to the point *x*, *y*, which is specified as input to the XYOUTS procedure.

An alignment of 0.0 (the default) places the left edge of the text on the given (X, Y) coordinate (left-justifies). An alignment of 1.0 right-justifies the text, while 0.5 centers the text over point (X, Y).

Ax Keyword

Used With Routines: SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: None.

Specifies the angle of rotation about the X axis, in degrees, towards the viewer.

The *Ax* keyword parameter defaults to +30 degrees if omitted and !P.T3d is 0.

Note This keyword is effective only if !P.T3d is *not* set. If !P.T3d is set, the three-dimensional to two-dimensional transformation used by SURFACE is contained in the 4-by-4 array !P.T.

The surface represented by the two-dimensional array is first rotated, *Az* (see the next section) degrees about the Z axis, then by *Ax* degrees about the X axis, tilting the surface towards the viewer (*Ax* > 0), or away from the viewer.

The three-dimensional to two-dimensional transformation represented by *Ax* and *Az* can be saved in !P.T by including the *Save* plotting keyword.

Az Keyword

Used With Routines: SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: None.

Specifies the counterclockwise angle in degrees of rotation about the Z axis (when looking down the Z axis toward the origin).

This keyword is effective only if !P.T3d is *not* set. The order of rotation is *Az* first, then *Ax*.

Background Keyword

Used With Routines: CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !P.Background.

The background color index to which the screen is set when the ERASE procedure is called.

Note Not all devices support erasing the background to a color index.

Example

To produce a black plot with a white background on a color display:

```
PLOT, y, Background = 255, Color = 0
```

Bottom Keyword

Used With Routines: SURFACE

Corresponding System Variable: None.

The color index used to draw the lower part of the surface. If not specified, the bottom is drawn with the same color as the top.

Box Keyword

Used With Routines: PLOT

Corresponding System Variable: !PDT.Box

Places a box around the labels in a Date/Time axis. If you set the keyword to a value of 1, boxes are drawn around all the labels of the Date/Time axis. The default is for no boxes to be drawn.

C_Annotation Keyword

Used With Routines: CONTOUR

Corresponding System Variable: None.

Sets the label that will be drawn on each contour.

Usually, contours are labeled with their value. This parameter, a vector of strings, allows any text to be specified. The first label is used for the first contour drawn, and so forth. If the *Levels* keyword is specified, the elements of *C_Annotation* correspond directly to the levels specified, otherwise, they correspond to the default levels chosen by the CONTOUR procedure. If there are more contour levels than elements in *C_Annotation*, the remaining levels are labeled with their values.

Example

To produce a contour plot with three levels labeled "low", "medium", and "high":

```
CONTOUR, Z, Levels = [0.0, 0.5, 1.0], $
   C_Annotation = ["low", "medium", "high"]
```

Use of this keyword implies use of the *Follow* keyword.

C_Charsize Keyword

Used With Routines: CONTOUR

Corresponding System Variable: None.

Sets the size of the characters used to annotate contour labels.

Normally, contour labels are drawn at three-fourths the size used for the axis labels (specified by the *Charsize* keyword or !P.Charsize system variable). This keyword allows the contour label size to be specified independently. Use of this keyword implies use of the *Follow* keyword.

C_Colors Keyword

Used With Routines: CONTOUR

Corresponding System Variable: None.

A vector of color indices used to set the color index used to draw each contour.

This parameter is a vector, converted to integer type if necessary. If there are more contour levels than elements in *C_Colors*, the elements of the color vector are cyclically repeated.

Example

If *C_Colors* contains three elements, and there are seven contour levels to be drawn, the colors c_0, c_1, c_2, c_0, c_1, c_2, c_0 will be used for the seven levels. To call CONTOUR and set the colors to [100, 150, 200]:

```
CONTOUR, Z, C_Colors = [100, 150, 200]
```

Channel Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, PLOTS, POLYFILL, SHADE_SURF, SURFACE, XYOUTS

Corresponding System Variable: None.

Specifies the destination channel index or mask for the operation. This parameter is used only with devices that have multiple display channels. The default is zero.

Charsize Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE, XYOUTS

Corresponding System Variable: !P.Charsize

Sets the overall character size for the annotation. A *Charsize* of 1.0 is normal. The size of the annotation on the axes may be set, relative to *Charsize*, with *XCharsize*, *YCharsize*, and *ZCharsize*. The main title is written with a character size of 1.25 times this parameter.

Charthick Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SURFACE, XYOUTS

Corresponding System Variable: !P.Charthick

Sets the thickness of characters drawn with the software fonts. Normal thickness is 1.0, double thickness is 2.0, etc. If this keyword is omitted, the value of the system variable !P.Charthick is used.

C_Labels Keyword

Used With Routines: CONTOUR

Corresponding System Variable: None.

Specifies which contour levels should be labeled. By default, every other contour level is labeled.

C_Labels allows you to override this default and explicitly specify the levels to label. This parameter is a vector, converted to integer type if necessary. If the *Levels* keyword is specified, the elements of *C_Labels* correspond directly to the levels specified, otherwise, they correspond to the default levels chosen by the CONTOUR procedure. Setting an element of the vector to zero causes that contour label to not be labeled. A nonzero value forces labeling.

Example

To produce a contour plot with four levels where all but the third level is labeled:

```
CONTOUR, Z, Levels = [0.0, 0.25, 0.75, 1.0], $
   C_Labels = [1, 1, 0, 1]
```

Use of this keyword implies use of the *Follow* keyword.

C_Linestyle Keyword

Used With Routines: CONTOUR

Corresponding System Variable: None.

Specifies the linestyle used to draw each contour.

As with *C_Colors*, *C_Linestyle* is a vector of linestyle indices. If there are more contour levels than linestyles, the linestyles are cyclically repeated. The following table lists the available linestyles and their keyword indices:

Index	Linestyle
0	Solid
1	Dotted
2	Dashed
3	Dash Dot
4	Dash Dot Dot Dot
5	Long Dashes

Note The current contouring algorithm draws all the contours in each cell, rather than following contours. Hence, some of the more complicated linestyles will not be suitable for some applications.

Example

To produce a contour plot, with the contour levels directly specified in a vector V, with all negative contours drawn with dotted lines, and with positive levels in solid lines:

```
CONTOUR, Z, Levels = V, C_Linestyle = V LT 0.0
```

Clip Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, PLOTS, POLYFILL, SHADE_SURF, SHADE_SURF_IRR, SURFACE, XYOUTS

Corresponding System Variable: !P.Clip

Sets the coordinates of a rectangle used to clip the graphics output.

The rectangle is specified as a vector of the form $[X_0, Y_0, X_1, Y_1]$, giving coordinates of the lower-left and upper-right corners, respectively. Coordinates are specified in data coordinate units unless an overriding coordinate keyword is present, such as *Normal* or *Device*.

Note Even if no clipping rectangle is specified, PV-WAVE will clip to the plotting window unless the *Noclip* keyword is specified.

Example

To draw a vector using normalized coordinates with its contents clipped within a rectangle covering the display's upper-left quadrant:

```
PLOTS, X, Y, Clip = [0.0, 0.5, 0.5, 1.0], /Normal
```

Color Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, PLOTS, POLYFILL, SHADE_SURF, SHADE_SURF_IRR, SURFACE, XYOUTS

Corresponding System Variable: !P.Color

Sets the color index of text, lines, solid polygon fill, data, axes, and annotation. If this keyword is omitted, !P.Color specifies the color index.

Compress Keyword

Used With Routines: PLOT OPLOT

Corresponding System Variable: !PDT.Compress

Compresses out weekends and holidays from a Date/Time axis. Before you can use this keyword, you must define holidays or weekends with the procedures CREATE_HOLIDAYS and CREATE_WEEKENDS.

C_Thick Keyword

Used With Routines: CONTOUR

Corresponding System Variable: None.

Specifies the line thickness of lines used to draw each contour level. As with *C_Colors*, *C_Thick* is a vector of line thickness values, although the values are floating-point. If there are more contours than thickness elements, elements are repeated. If omitted, the overall line thickness specified by the *Thick* keyword parameter or !P.Thick is used for all contours.

Data Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, PLOTS, POLYFILL, SHADE_SURF, SHADE_SURF_IRR, SURFACE, XYOUTS

Corresponding System Variable: None.

A keyword flag, which if present, indicates that the coordinates are specified in data coordinates (the default). When used with AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, and SURFACE, this keyword also specifies that the *Position* and *Clip* coordinates are in data units.

Device Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, PLOTS, POLYFILL, SHADE_SURF, SHADE_SURF_IRR, SURFACE, XYOUTS

Corresponding System Variable: None.

Express coordinates in device coordinates. When used with AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, and SURFACE, this keyword also specifies that the *Position* and *Clip* coordinates are in device units.

Example

The following code displays an image contained in the variable A and then draws a contour plot of pixels (100:499, 100:399) registered over the pixels:

```
TV, A
```
Display the image.

```
CONTOUR, A(100:499, 100:399), Position = $
   [100,100, 499,399], /Device, /Noerase, $
   XStyle = 1, YStyle = 1
```
Draw the contour plot, specify the coordinates of the plot, in device coordinates, do not erase, set the X and Y axis styles to EXACT.

Note that in the above example, the keyword specification `/Device` is equivalent to `Device = 1`.

DT_Range Keyword

Used With Routines: PLOT

Corresponding System Variable: !PDT.DT_Range

Sets an exact range of values in a Date/Time axis. You must specify the desired start and end values from a Date/Time Julian value. The range may be adjusted slightly by the PLOT procedure, depending on the data. To obtain an exact range set the *XStyle* plotting keyword to two. For more information, see *XStyle*.

Fill_Pattern Keyword

Used With Routines: PLOTS, POLYFILL

Corresponding System Variable: None.

The hardware-dependent fill pattern index for the POLYFILL and PLOTS procedures. If omitted or set to 0, a solid fill results.

Follow Keyword

Used With Routines: CONTOUR

Corresponding System Variable: None.

If present and nonzero, forces the CONTOUR procedure to use the line-following method instead of the cell-drawing method.

CONTOUR can draw contours using one of two different methods:

- The cell-drawing method, used by default, examines each array cell and draws all contours emanating from that cell before proceeding to the next cell. This method is efficient in terms of computer resources but does not allow contour labeling.
- The line-following method searches for each contour line and then follows the line until it reaches a boundary or closes. This method gives better looking results with dashed linestyles, and allows contour labeling, but requires more computer time. It is used if any of the following keywords is specified: *C_Annotation*, *C_Charsize*, *C_Labels*, *Follow*, or *Path_Filename*.

Although these two methods both draw correct contour maps, differences in their algorithms can cause small differences in the resulting plot.

Font Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE, XYOUTS

Corresponding System Variable: !P.Font

An integer that specifies the graphics text font index.

Font index –1 selects the software fonts, which are drawn using vectors. Font number 0 selects the hardware font of the output device. See Chapter 9, *Software Fonts*, in the *PV-WAVE User's Guide* for a complete description of the software fonts. See Appendix A, *Output Devices and Window Systems*, in the *PV-WAVE User's Guide* for more information on the hardware fonts available with each supported output device.

When using three-dimensional transformations, always use the software fonts, as the hardware fonts are not properly projected from three to two dimensions.

Gridstyle Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SURFACE

Corresponding System Variable: !P.Gridstyle

Lets you change the linestyle of tick marks. The default is a solid line. Other linestyle choices and their index values are listed in the following table:

Index	Linestyle
0	Solid
1	Dotted
2	Dashed
3	Dash Dot
4	Dash Dot Dot Dot
5	Long Dashes

One possible use for this keyword is to create an evenly spaced grid consisting of dotted or dashed lines across your plot region. To do this, first set the *Ticklen* keyword to 0.5. This ensures that the dotted or dashed tick style will appear correctly on your plot. Then set the *Gridstyle* keyword to the style you want to use. For example:

```
PLOT, mydata, Ticklen = 0.5, Gridstyle = 1
```

produces a plot with a dotted grid across the entire plot region.

See also *Example 2: Specifying Tick Lengths* on page 80 of the *PV-WAVE User's Guide.*

Horizontal Keyword

Used With Routines: SURFACE

Corresponding System Variable: None.

If set, causes SURFACE to only draw lines across the plot perpendicular to the line of sight. The default is for SURFACE to draw both across the plot and from front to back.

Levels Keyword

Used With Routines: CONTOUR

Corresponding System Variable: None.

Specifies a vector containing the contour levels (maximum of 150) drawn by the CONTOUR procedure.

A contour is drawn for each level specified in *Levels*. If omitted, the data range is divided into approximately six equally-spaced levels.

Example

To draw a contour plot with levels at 1, 100, 1000, and 10000:

```
CONTOUR, Z, Levels = [1, 100, 1000, 10000]
```

To draw a contour plot with levels at 50, 60, ..., 90, 100:

```
CONTOUR, Z, Levels = FINDGEN(6) * 10 + 50
```

Line_Fill Keyword

Used With Routines: PLOTS, POLYFILL

Corresponding System Variable: None.

Indicates that polygons are to be filled with parallel lines, rather than using solid or patterned filling methods.

When using the line-drawing method of filling, the thickness, linestyle, orientation, and spacing of the lines may be specified with keywords.

Linestyle Keyword

Used With Routines: OPLOT, PLOT, PLOTS, POLYFILL, SURFACE

Corresponding System Variable: !P.Linestyle

Specifies the linestyle used to draw the lines or connect data points. The linestyle index is an integer, as shown in the following table:

Index	Linestyle
0	Solid
1	Dotted
2	Dashed
3	Dash Dot
4	Dash Dot Dot Dot
5	Long Dashes

Lower_Only Keyword

Used With Routines: SURFACE

Corresponding System Variable: None.

Indicates that only the lower surface of the object is to be drawn.

Max_Levels Keyword

Used With Routines: PLOT

Corresponding System Variable: !PDT.Max_Levels

Sets the maximum number of levels on a Date/Time axis. For example, assume that the Date/Time data contains years, months, days, hours, minutes, and seconds. If this keyword is set to three, then the Date/Time axis will show three levels: seconds, minutes, and hours.

Max_Value Keyword

Used With Routines: CONTOUR

Corresponding System Variable: None.

Data points with values equal to or above this value are ignored when contouring. Cells containing one or more corners with values above
Max_Value will have no contours drawn through them.

Month_Abbr Keyword

Used With Routines: PLOT

Corresponding System Variable: !PDT.Month_Abbr

Abbreviates month or quarter names to either three characters or one character, depending on the space available on the Date/Time axis. If a one-character abbreviation does not fit, no label is used. If the complete label can fit, it is not abbreviated, even if the keyword is specified. Month names are specified in the system variable !Month_Names. Quarter names are specified in the !Quarter_Names system variable.

NLevels Keyword

Used With Routines: CONTOUR

Corresponding System Variable: None.

The number of equally-spaced contour levels that are produced by CONTOUR. The maximum is 150. The default is six.

If the *Levels* parameter, which explicitly specifies the value of the contour levels, is present this keyword has no effect. If neither parameter is present approximately six levels are drawn.

If the minimum and maximum Z values are Z_{min} and Z_{max}, then the value of the *i*th level is:

$$Z_{min} + (i + 1)(Z_{max} - Z_{min})/(NLevels + 1)$$

where *i* ranges from 0 to *NLevels* – 1.

Noclip Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, PLOTS, POLYFILL, SHADE_SURF, SHADE_SURF_IRR, SURFACE, XYOUTS

Corresponding System Variable: !P.Noclip

Suppresses clipping of the plot, lines, and vector-drawn text. Use this keyword if you want to write text outside the plot window. By default the plot is clipped within the plotting window.

Nodata Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: None.

If this keyword is set, only the axes, titles, and annotation are drawn. No data points are plotted.

Example

To draw an empty set of axes between some given values:

```
PLOT, [XMIN, XMAX], [YMIN, YMAX], /Nodata
```

Noerase Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: None.

Specifies that the screen or page is not to be erased. By default the screen is erased, or a new page is begun, before a plot is produced.

Normal Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, PLOTS, POLYFILL, SHADE_SURF, SHADE_SURF_IRR, SURFACE, XYOUTS

Corresponding System Variable: None.

Indicates that the coordinates are in the normalized coordinate system and range from 0.0 to 1.0.

When used with AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, and SURFACE, indicates that the *Clip* and/or *Position* coordinates are in the normalized coordinate system and range from 0.0 to 1.0.

Nsum Keyword

Used With Routines: OPLOT, PLOT

Corresponding System Variable: None.

Indicates the number of data points to average when plotting.

If *Nsum* is larger than 1, every group of *Nsum* points is averaged to produce one plotted point. If there are *m* data points, then *m* / *Nsum* points are displayed. On logarithmic axes a geometric average is performed.

It is convenient to use *Nsum* when there is an extremely large number of data points to plot because it plots fewer points, the graph is less cluttered, and it is quicker.

Orientation Keyword

Used With Routines: PLOTS, POLYFILL, XYOUTS

Corresponding System Variable: None.

Specifies the angle in degrees, counterclockwise from horizontal, of the text baseline and the lines used to fill polygons.

When used with the POLYFILL procedure, this keyword forces the *Linestyle* type of fill, rather than solid or patterned fill.

Overplot Keyword

Used With Routines: CONTOUR

Corresponding System Variable: None.

Indicates the CONTOUR procedure is to overplot.

No axes are drawn and the previously established scaling remains in effect. You must explicitly specify the values of the contour levels with the *Levels* keyword when using this option.

Path_Filename Keyword

Used With Routines: CONTOUR

Corresponding System Variable: None.

Specifies the name of a file to contain the contour positions.

If *Path_Filename* is present, CONTOUR does not draw the contours, but rather, opens the specified file and writes the positions, in normalized coordinates, into it. The file consists of a series of logical records containing binary data. Each record is preceded with a header structure defining the contour as follows:

```
{CONTOUR_HEADER, TYPE : 0B, HIGH : 0B, $
   LEVEL : 0, NUM : 0L, VALUE : 0.0}
```

The fields are:

- TYPE – A byte which is zero if the contour is open, and one if it is closed.

- HIGH — A byte which is 1 if the contour is closed and above its surroundings, and is 0 if the contour is below. This field is meaningless if the contour is not closed.
- LEVEL — A short integer with value greater than or equal to zero. (It is an index into the *Levels* array).
- NUM — The longword number of data points in the contour.
- VALUE — The contour value. This a single-precision floating-point value.

Following the header in each record are NUM pairs of single-precision floating (X,Y) values, expressed in normalized coordinates.

The POLYCONTOUR procedure can be used along with this file to fill the closed contours with specified colors. A typical application is to use CONTOUR with the *Path_Filename* keyword to get the path information, use POLYCONTOUR to fill the closed contours, and then use CONTOUR with the *Noerase* keyword to overplot the contours.

Use of this keyword implies use of the *Follow* keyword.

Pattern Keyword

Used With Routines: PLOTS, POLYFILL

Corresponding System Variable: None.

A rectangular array of pixels giving the fill pattern.

If this keyword parameter is omitted, POLYFILL fills the area with a solid color. The pattern array may be of any size; if it is smaller than the filled area the pattern array is cyclically repeated.

Example

To fill the current plot window with a grid of dots:

```
Pattern = BYTARR(10, 10)
```
Define pattern array as 10-by-10.

```
Pattern(5,5) = 255
```
Set center pixel to bright.

```
POLYFILL, !X.Window([0, 1, 1, 0]), $
   !Y.Window([0, 0, 1, 1]), /Normal, $
   Pattern = Pattern
```

Fill the rectangle defined by the four corners of the window with the pattern.

Polar Keyword

Used With Routines: OPLOT, PLOT

Corresponding System Variable: None.

Polar plots are produced when this keyword is present and non-zero.

The X and Y vector parameters, both of which must be present, are first converted from polar to cartesian coordinates. The first parameter is the radius, and the second is θ, expressed in radians.

To make a polar plot:

```
PLOT, /Polar, R, THETA
```

Position Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !P.Position

Allows direct specification of the plot window.

Position is a four-element vector giving, in order, the coordinates $[(X_0, Y_0), (X_1, Y_1)]$ of the lower-left and upper-right corners of the data window. Coordinates are expressed in normalized units ranging from 0.0 to 1.0, unless the keyword */Device* is present, in which case they are in actual device units.

When setting the position of the window, be sure to allow space for the annotation, which resides outside the window. PV-WAVE outputs the message

```
%, Warning: Plot truncated.
```

if the plot region is larger than the screen or page size. The plot region is the rectangle enclosing the plot window and the annotation.

When plotting in three dimensions, the *Position* keyword is a six-element vector with the first four elements describing, as above, the XY position, and with the last two elements giving the minimum and maximum Z coordinates. The Z specification is always in normalized coordinate units.

When making more than one plot per page it is more convenient to set !P.Multi than to manipulate the position of the plot directly with the *Position* keyword.

Example

The following statement produces a contour plot with data plotted in only the upper-left quarter of the screen:

```
CONTOUR, Z, Position = [0.0, 0.5, 0.5, 1.0]
```

Because no space on the left or top edges was allowed for the axes or their annotation, the warning message described above results.

Psym Keyword

Used With Routines: OPLOT, PLOT, PLOTS, POLYFILL

Corresponding System Variable: !P.Psym

Specifies the symbol used to mark each data point.

Normally, *Psym* is 0, data points are connected by lines, and no symbols are drawn to mark the points. Specify this keyword to mark data points with symbols. (Alternatively, , you can set !P.Psym to the symbol index as given in Table 4-4 on page 548.) The keyword *Symsize* is used to set the size of the symbols.

Negative values of *Psym* cause the symbol designated by |*Psym*| to be plotted at each point with solid lines connecting the symbols. For example, a *Psym* value of –5 plots triangles at each data point and connects the points with lines.

Example

The following PV-WAVE code plots an array using points, and then overplots the smoothed array, connecting the points with lines:

```
PLOT, A, Psym = 3
```
Plot using points.

```
OPLOT, SMOOTH(A, 7)
```
Overplot smoothed data.

Save Keyword

Used With Routines: AXIS, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: None.

Saves the 3D to 2D transformation matrix established by SURFACE and SHADE_SURF, and specified by the *Ax* and *Az* keywords, in the system variable field !P.T.

Use this keyword when combining the output of SURFACE and SHADE_SURF with the output of other routines in the same plot.

When used with AXIS, the *Save* keyword parameter saves the scaling parameters established by the call back in the appropriate axis system variable, !X, !Y, or !Z. This causes subsequent overplots to be scaled to the new axis.

Example

To display a two-dimensional array using SURFACE, and to then superimpose contours over the surface: (This example assumes that !P.T3d is zero, its default value.)

```
SURFACE, Z, /Save
```
Make a surface plot and save the transformation.

```
CONTOUR, Z, /Noerase, /T3d
```
Make contours, don't erase, use the 3D to 2D transform placed in !P.T by SURFACE.

To display a surface and to then display a flat contour plot, registered above the surface:

```
SURFACE, Z, /Save
```

Make the surface, save transform.

```
CONTOUR, Z, /Noerase, /T3d, ZValue = 1.0
```

Now display a flat contour plot, at the maximum Z value (normalized coordinates). You can display the contour plot below the surface with a ZValue of 0.0.

Size Keyword

Used With Routines: XYOUTS

Corresponding System Variable: None.

Specifies the character size as a factor of the normal character size. Normal size is 1.0.

Skirt Keyword

Used With Routines: SURFACE

Corresponding System Variable: None.

A skirt around the array at a given Z value is drawn if this keyword parameter is present. The Z value is expressed in data units.

For example:

```
SURFACE, A, Skirt = 100
```

draws the surface of A with a skirt at the Z value 100.

If the skirt is drawn, each point on the four edges of the surface is connected to a point on the skirt which has the given Z value, and the same X and Y values as the edge point. In addition, each point on the skirt is connected to its neighbor.

Spacing Keyword

Used With Routines: PLOTS, POLYFILL

Corresponding System Variable: None.

Specifies the spacing, in centimeters, between the parallel lines used to fill polygons.

Spline Keyword

Used With Routines: CONTOUR

Corresponding System Variable: None.

Specifies that contour paths are to be interpolated using cubic splines.

Use of this keyword implies the use of the *Follow* keyword. The appearance of contour plots of arrays with low resolution may be improved by using spline interpolation. In rare cases, contour lines that are close together may cross because of interpolation.

Splines are especially useful with small data sets (less than 15 array dimensions). With larger data sets the smoothing is not as noticeable and the expense of splines increases rapidly with the number of data points.

You may specify the length of each interpolated line segment in normalized coordinates by including a value with this keyword. The default value is 0.005 which is obtained when the parameter */Spline* is present. Smaller values for this parameter yield smoother lines, up to the resolution of the output device, at the expense of more computations.

Start_Level Keyword

Used With Routines: PLOT

Corresponding System Variable: !PDT.Start_Level

Specifies the initial level of tick labels to be displayed on a Date/Time axis. The subsequent levels depend on the data range and the first level selected.

Index values for the *Start_Level* keyword are listed below:

Index	Start Level
7	Year
6	Quarter
5	Month
4	Week
3	Day
2	Hour
1	Minute
0	Second
–1	Auto-level

Subtitle Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SURFACE

Corresponding System Variable: !P.Subtitle

Produces a subtitle underneath the X axis containing the text in this string parameter.

Symsize Keyword

Used With Routines: OPLOT, PLOT, PLOTS, POLYFILL

Corresponding System Variable: None.

Specifies the size of the symbols drawn when *Psym* is set. The default size of 1.0 produces symbols approximately the same size as a character.

T3d Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, PLOTS, POLYFILL, SHADE_SURF, SHADE_SURF_IRR, SURFACE, XYOUTS

Corresponding System Variable: !P.T3d

A keyword flag which, if present, indicates that the generalized transformation matrix in !P.T is to be used.

!P.T *must* contain a valid transformation matrix before the *T3d* keyword can be used. The matrix can be set by using the *Save* plotting keyword with the appropriate plotting routine.

If *T3d* is not present the user-supplied coordinates are simply scaled to screen coordinates. See the examples in the description of the *Save* plotting keyword.

A valid transformation matrix can be placed in !P.T in several ways:

- Use the *Save* keyword to save the transformation matrix from an earlier graphics operation.
- Establish a transformation matrix using the T3D user library procedure.
- Set the value of !P.T directly.

Text_Axes Keyword

Used With Routines: XYOUTS

Corresponding System Variable: None.

Specifies the plane of vector-drawn text when three-dimensional plotting is enabled. By default, text is drawn in the plane of the XY axes. The horizontal text direction is in the X plane, and the vertical text direction is in the Y plane.

Values of this keyword may range from 0 to 5, with the following effect: 0 for XY, 1 for XZ, 2 for YZ, 3 for YX, 4 for ZX, and 5 for ZY. The notation ZY means that the horizontal direction of the text lies in the Z plane, and the vertical direction of the text is drawn in the Y plane.

Thick Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !P.Thick

Controls the thickness of the lines connecting points. A thickness of 1.0 is normal, 2.0 is double-wide, etc.

Tickformat Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SURFACE

Corresponding System Variable: !P.Tickformat

Lets you use FORTRAN-style format specifiers to change the format of tick labels on the X, Y, and Z axes. For example:

```
PLOT, mydata, Tickformat = '(F5.2)'
```

The resulting plot's tick labels are formatted with a total width of five characters carried to two decimal places. As expected, the width field expands automatically to accommodate larger values. For more information on format specifiers, see *Explicitly Formatted Input and Output* on page 165 of the *PV-WAVE Programmer's Guide*. See also *Example 3: Specifying Tick Label Formats* on page 82 of the *PV-WAVE User's Guide*.

Note that only the `I` (integer), `F` (floating-point), and `E` (scientific notation) format specifiers can be used with *Tickformat*. Also, you cannot place a quoted string inside a tick format. For example, `("<", F5.2, ">")` is an invalid *Tickformat* specification.

See also XTickformat, YTickformat, and ZTickformat.

Ticklen Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !P.Ticklen

Controls the length of the axis tick marks, expressed as a fraction of the window size. The default value is 0.02. Ticklen of 0.5 produces a grid, while a negative *Ticklen* makes tick marks that extend outside the plot region, rather than inwards.

Example

To produce outward-going tick marks of the normal length:

```
PLOT, X, Y, Ticklen = -0.02
```

To provide a new default tick length, set the system variable !P.Ticklen.

Title Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SURFACE

Corresponding System Variable: !P.Title

Produces a main title centered above the plot window.

The text size of this main title is larger than the other text by a factor of 1.25.

For example:

```
PLOT, X, Y, Title = 'Final Results'
```

Upper_Only Keyword

Used With Routines: SURFACE

Corresponding System Variable: None.

Indicates that only the upper surface of the object is to be drawn. By default, both surfaces are drawn.

Week_Boundary Keyword

Used With Routines: PLOT

Corresponding System Variable: !PDT.Week_Boundary

Sets the day of the week on which week tick marks are drawn for the week level on a Date/Time axis.

For example, if you set the week boundary to 'Sunday', weekly tick marks are drawn for each Sunday and each one is labeled with the date.

The week boundary index can be one of the following integers:

Index	Day of Week
0	Sunday
1 (the default)	Monday
2	Tuesday
3	Wednesday
4	Thursday
5	Friday
6	Saturday

Width Keyword

Used With Routines: XYOUTS

Corresponding System Variable: None.

Returns the width of the text string, in normalized coordinate units, to the designated variable.

For example, to put the width of a text string in the variable `w_title`, use:

```
XYOUTS, x, y, 'Title of Graph', Width = w_title
```

XAxis Keyword

Used With Routines: AXIS

Corresponding System Variable: None.

The *XAxis* and *YAxis* keywords indicate which type of axis is to be drawn by the AXIS procedure and its placement.

See also YAxis and ZAxis.

XCharsize Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !X.Charsize

The size of the characters used to annotate the axis and its title.

This field is a scale factor applied to the global scale factor set by !P.Charsize or the keyword *Charsize*.

See also Charsize, YCharsize, and ZCharsize.

XGridstyle Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SURFACE

Corresponding System Variable: !X.Gridstyle

Lets you change the linestyle of tick marks on the X axis. The default is a solid line.

See also Gridstyle.

XMargin Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !X.Margin

A two-element array specifying the margin on the left (bottom) and right (top) sides of the plot window, in units of character size. Default margins are 10 and 3 for the X axis, and 4 and 2 for the Y axis.

See also YMargin and ZMargin.

XMinor Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !X.Minor

The number of minor tick intervals on the particular axis. If set to 0, the default, PV-WAVE automatically determines the number of minor ticks in each major tick mark interval. Setting this parameter to –1 suppresses the minor ticks, and setting it to a positive, nonzero number *n* produces *n* minor tick intervals, and *n* – 1 minor tick marks.

See also YMinor and ZMinor.

XRange Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !X.Range

The desired data range of the axis, a two-element vector. The first element is the axis minimum, and the second is the maximum. PV-WAVE will frequently round this range.

See also YRange and ZRange.

XStyle Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !X.Style

Allows specification of axis options such as rounding of tick values and selection of a box axis. Each option is encoded in a bit. See the following table for details:

Bit	Value	Function
0	1	Exact. By default the end points of the axis are rounded in order to obtain even tick increments. Setting this bit inhibits rounding, making the axis fit the data range exactly.
1	2	Extend. If this bit is set, the axes are extended by 5% in each direction, leaving a border around the data.
2	4	None. If this bit is set, the axis and its text is not drawn.
3	8	No box. Normally, PLOT and CONTOUR draw a box style axis with the data window surrounded by axes. Setting this bit inhibits drawing the top or right axis.
4	16	Inhibits setting the Y axis minimum value to zero, when the data are all positive and nonzero. The keyword *YNozero* sets this bit temporarily.

See also YStyle and ZStyle.

XTickformat Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SURFACE

Corresponding System Variable: !X.Tickformat

Lets you use FORTRAN-style format specifiers to change the format of tick labels for the X axis. For example:

```
PLOT, mydata, XTickformat = '(F5.2)'
```

This keyword works basically the same way as the *Tickformat* keyword. See *Tickformat Keyword* on page 522 for more information.

See also Tickformat, YTickformat, and ZTickformat.

XTicklen Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SURFACE

Corresponding System Variable: !X.Ticklen

Functions the same as the keyword *Ticklen*. *XTicklen*, however, can be applied to the X axis. *XTicklen* supersedes the value of the *Ticklen* setting.

See also Ticklen, YTicklen, and ZTicklen.

XTickname Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !X.Tickname

A string array, of up to 30 elements, containing the annotation of each major tick mark.

If omitted, or if a given string element that contains the null string, PV-WAVE labels the tick mark with its value. To suppress the tick label, supply a string array of one-character-long blank strings. You can do this with the command:

```
REPLICATE(' ', N)
```

(Null strings cause PV-WAVE to number the tick mark with its value.) Note that if there are *n* tick mark intervals, there are *n* + 1 tick marks and labels.

See also YTickname and ZTickname.

XTicks Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !X.Ticks

The number of major tick *intervals* to draw for the axis. If omitted PV-WAVE will select from three to six tick intervals. Setting this field to *n*, where *n* > 0, produces exactly *n* tick intervals, and *n* + 1 tick marks.

See also YTicks and ZTicks.

XTickv Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !X.Tickv

The data values for each tick mark, an array of up to 30 elements.

This keyword allows you to directly specify tick data values, producing graphs with non-linear tick marks. PV-WAVE scales the axis from the first tick value to the last, unless you directly specify a range. If you specify *n* tick intervals, you must specify *n* + 1 tick values.

See also YTickv and ZTickv.

XTitle Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !X.Title

Places a title below the X axis.

See also Title, YTitle, and ZTitle.

XType Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT

Corresponding System Variable: None.

Specifies a linear axis if zero; specifies a logarithmic axis if one; and if set to 2, enables compressed Julian numbers to be used directly with the PLOT or OPLOT procedures.

YAxis Keyword

Used With Routines: AXIS

Corresponding System Variable: None.

This keyword works like XAxis.

YCharsize Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Y.Charsize

This keyword works like XCharsize.

YGridstyle Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SURFACE

Corresponding System Variable: !Y.Gridstyle

Lets you change the linestyle of tick marks on the Y axis. The default is a solid line.

For more information, see Gridstyle.

YMargin Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Y.Margin.

This keyword works like XMargin.

YMinor Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Y.Minor.

This keyword works like XMinor.

YNozero Keyword

Used With Routines: AXIS, OPLOT, PLOT

Corresponding System Variable: None.

Inhibits setting the minimum Y axis value to zero when the Y data are all positive and nonzero, and no explicit minimum Y value is specified (using *Yrange*, or !Y.Range).

By default, the Y axis spans the range of 0 to the maximum value of Y, in the case of positive Y data. Set bit 4 in !Y.Style to make this option the default.

YRange Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Y.Range

This keyword works like XRange.

YStyle Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Y.Style

This keyword works like XStyle.

YTickformat Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SURFACE

Corresponding System Variable: !Y.Tickformat

Lets you use FORTRAN-style format specifiers to change the format of tick labels for the Y axis. For example:

```
PLOT, mydata, YTickformat = '(F5.2)'
```

This keyword works like XTickformat.

YTicklen Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SURFACE

Corresponding System Variable: !Y.Ticklen

This keyword works like XTicklen.

YTickname Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Y.Tickname

This keyword works like XTickname.

YTicks Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Y.Ticks

This keyword works like XTicks.

YTickv Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Y.Tickv

This keyword works like XTickv.

YTitle Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Y.Title

This keyword works like XTitle.

YType Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT

Corresponding System Variable: None.

This keyword works like XType, except this keyword can have no effect on Date/Time plots.

Z Keyword

Used With Routines: PLOTS, POLYFILL, XYOUTS

Corresponding System Variable: None.

Provides the Z coordinate if a Z parameter is not present in the call. This is of use only if the three-dimensional transformation is in effect.

ZAxis Keyword

Used With Routines: AXIS, CONTOUR, SURFACE

Corresponding System Variable: None.

Specifies the existence of a Z axis for CONTOUR, and the placement of the Z axis for SURFACE. For AXIS, the *ZAxis* keyword indicates that a Z axis is to be drawn and where it should be placed.

CONTOUR draws no Z axis by default. Include the *ZAxis* keyword in the call to CONTOUR to draw a Z axis. This is of use only if a three-dimensional transformation is established.

By default, SURFACE draws the Z axis at the upper-left corner of the axis box. To suppress the Z axis, use `ZAxis = -1` in the call. The position of the Z axis is determined from *ZAxis* as follows: 1 = lower-right, 2 = lower-left, 3 = upper-left, and 4 = upper-right.

ZCharsize Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Z.Charsize

This keyword works like XCharsize.

ZGridstyle Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SURFACE

Corresponding System Variable: !Z.Gridstyle

Lets you change the linestyle of tick marks on the Z axis. The default is a solid line.

For more information, see Gridstyle.

ZMargin Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Z.Margin

This keyword works like XMargin.

ZMinor Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Z.Minor

This keyword works like XMinor.

ZRange Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Z.Range

This keyword works like XRange.

ZStyle Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Z.Style

This keyword works like XStyle, except this keyword has no effect on Date/Time plots.

ZTickformat Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SURFACE

Corresponding System Variable: !Z.Tickformat

This keyword works like XTickformat.

ZTicklen Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SURFACE

Corresponding System Variable: !Z.Ticklen

This keyword works like XTicklen.

ZTickname Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Z.Tickname

This keyword works like XTickname.

ZTicks Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Z.Ticks

This keyword works like XTicks.

ZTickv Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Z.Tickv

This keyword works like XTickv.

ZTitle Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: !Z.Title

This keyword works like XTitle.

ZType Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT

Corresponding System Variable: None.

This keyword works like XType.

ZValue Keyword

Used With Routines: AXIS, CONTOUR, OPLOT, PLOT, SHADE_SURF, SHADE_SURF_IRR, SURFACE

Corresponding System Variable: None.

Sets the Z coordinate, in normalized coordinates in the range of 0 to 1, of the axis and data output from PLOT, OPLOT, and CONTOUR.

This has an effect only if !P.T3d is set and the three-dimensional to two-dimensional transformation is stored in !P.T. If *ZValue* is not specified, CONTOUR will output each contour at its Z coordinate, and the axes and title at a Z coordinate of 0.0.

4

CHAPTER

System Variables

This chapter discusses the PV-WAVE system variables. For more information on system variables, see Chapter 2, *Constants and Variables*, in the *PV-WAVE Programmer's Guide*.

!C

The cursor system variable. Currently, its only function is to contain the subscript of the largest or smallest element found by the MAX and MIN functions.

!D

A structure containing information about the current graphics output device. Fields are described in the following sections.

The fields of the !D structure are read-only.

!D.Fill_Dist

The line interval, in device coordinates, required to obtain a solid fill.

!D.Flags

A longword of flags. Each bit is a flag encoded as shown in the following table:

Table 4-1: !D.Flags Bit Definitions

Bit	Value	Function
0	1	Device has scalable pixel size (e.g., PostScript).
1	2	Device can output text at an arbitrary angle using hardware.
2	4	Device can control line thickness with hardware.
3	8	Device can display images.
4	16	Device supports color.
5	32	Device can polygon fill with hardware.
6	64	Device hardware characters are monospace.
7	128	Device can read pixels (TVRD).
8	256	Device supports windows.

!D.N_Colors

The number of simultaneously available colors. In the case of devices with windows, this field is set after the window is initialized. For monochrome systems, !D.N_Colors is 2, and for color systems it is normally 256.

!D.Name

A string containing the name of the device.

!D.Table_Size

This field contains the number of color table indices available on the device. Devices without color tables have this field set to 0.

!D.Unit

The logical number of the file open for output by the current graphics device. This field only has meaning if the file is accessible to the user from PV-WAVE, and is 0 if no file is open. For example, the PostScript driver maintains this field with the unit number of the file open for PostScript output. In the case of Tektronix output to a file, !D.Unit may be set to either + or – the logical unit number.

!D.Window

The index of the currently open window. Set to –1 if no window is open. Used only with devices that support windows.

!D.X_Ch_Size / !D.Y_Ch_Size

The normal width and height of a character in device units. These fields are set after the window is initialized.

!D.X_Px_Cm / !D.Y_Px_Cm

The number of pixels per centimeter in the X and Y directions.

!D.X_Size / !D.Y_Size

The total size of the display in the X and Y directions. These values determine the maximum possible size of any PV-WAVE

window, unless !D.X_Vsize and !D.Y_Vsize are smaller, in which case, !D.X_Vsize and !D.Y_Vsize determine the maximum size.

!D.X_Vsize / !D.Y_Vsize

Reports the size of the current window, and is updated when the window is resized.

!Date_Separator

A string containing, by default, a slash (/) character. This character is used to separate the parts of a date on output (for example, 5/15/1992). To use a different character, change the value of this variable. This variable is used by the DT_PRINT, DT_TO_STR, and DC_WRITE_* routines.

!Day_Names

An array of strings containing the names of the days of the week. This system variable is used by the DAYNAME function to return the names of the days for a specified PV-WAVE date and time variable.

!Dir

Contains the name of the main PV-WAVE directory (that is, the directory containing the files PV-WAVE needs to run).

!Display_Size

Contains the pixel dimensions of the display screen for devices running the X Window System.

!Dpi

Contains the double-precision value of pi. This is a read-only system variable.

!DT_Base

Contains the value of Julian Day 1 (September 14, 1752) as a !DT structure. Used in various Date/Time calculations. This value can be overridden using the *Base* keyword as a parameter to the SEC_TO_DT and DT_TO_SEC routines.

This variable can also be modified directly; however, if you do this, you must set the last field (the recalc flag) of the !DT structure to 1. For more information, see the section *Recalc Flag* in Chapter 7, *Working with Date/Time Data*, in the *PV-WAVE User's Guide*.

!Dtor

Contains the conversion factor to convert degrees to radians. The value is π / 180, which is approximately 0.01745. This is a read-only system variable.

!Edit_Input

Enables or disables the keyboard line-editing feature.

!Err

Contains the code of the last I/O error message. The CURSOR function also uses !Err to store the return value of the function. This enables the user to determine which mouse button was pushed.

!Err_String

Contains the text of the last I/O error message. This is a read-only system variable.

!Holiday_List

This system variable is created by the CREATE_HOLIDAYS procedure. It is a Date/Time variable containing holidays as defined by CREATE_HOLIDAYS. This system variable does not have a default value. This variable can hold up to 50 holiday definitions.

!Journal

Contains the logical unit number of journal output. If there is no journal output, !Journal = 0. This is a read-only system variable.

!Lang

Identifies the language currently being used. The default is "american".

!Month_Names

An array of strings containing the names of the months. This system variable is used by the MONTH_NAME function to return the names of the months for a specified PV-WAVE date and time variable.

!Mouse

Used by the CURSOR function to store the X and Y position of the mouse, the mouse button status, and a date/time stamp. The fields for this variable are:

```
!Mouse.X
!Mouse.Y
!Mouse.Button
!Mouse.Time
```

For additional information on this variable and its fields, see the CURSOR procedure..

!Msg_Prefix

Contains a prefix string for error messages issued by PV-WAVE. The default is a percent sign. This system variable provides a way to distinguish error messages from normal output.

!Order

Controls the direction of image transfers. If !Order is 0, images are transferred from bottom to top (i.e., the row with a 0 subscript is

written on the bottom). Setting !Order to 1 transfers images from top to bottom.

!P

The main system variable structure for plotting.

All fields, except !P.Multi, have a directly corresponding keyword parameter in the main plot procedures: AXIS, PLOT, OPLOT, CONTOUR, and SURFACE.

The fields of the !P structure are explained in the following sections.

!P.Background

Corresponding Plot Keyword: *Background*

The background color index. When erasing a window, all pixels are set to this color. The default value is 0.

!P.Charsize

Corresponding Plot Keyword: *Charsize*

The overall character size of all annotation. The normal size is 1. The main plot title size is 1.25 times this parameter.

!P.Charthick

Corresponding Plot Keyword: *Charthick*

The thickness of characters drawn with the vector fonts. Normal thickness is 1.0, double thickness is 2.0, and so on.

!P.Clip

Corresponding Plot Keyword: *Clip*

The device coordinates of a rectangle used to clip the graphics window. The rectangle is specified as a four-element vector of the form $[(X_0, Y_0), (X_1, Y_1)]$. The coordinates specify the lower-left

and upper-right corners of the clipping rectangle, respectively. Normally the clipping rectangle is set to the plot window.

!P.Color

Corresponding Plot Keyword: *Color*

Color index used to draw data, axes, and annotation.

!P.Font

Corresponding Plot Keyword: *Font*

The index of the graphics text font. Font = –1 uses the software-drawn fonts (also called Hershey or vector-drawn fonts). Font = 0 uses the hardware-drawn fonts. See *Software Fonts* on page 291 of the *PV-WAVE User's Guide*, for a complete description of the vector-drawn fonts. For information on hardware-drawn fonts available for a particular output device, see Appendix A, *Output Devices and Window Systems*, in the *PV-WAVE User's Guide.*

When using three-dimensional transformations, always use the vector-drawn fonts, as the hardware fonts are not properly projected from three to two dimensions.

!P.Gridstyle

Corresponding Plot Keyword: *Gridstyle*

Lets you change the default linestyle of X, Y, and Z axis tick marks. The default is a solid line. Other linestyle choices and their index values are listed in the following table:

Table 4-2: Linestyles

Index	Linestyle
0	Solid
1	Dotted
2	Dashed
3	Dash Dot

4	Dash Dot Dot Dot
5	Long Dashes

!P.Linestyle

Corresponding Plot Keyword: *Linestyle*

The style of the lines used to connect points. The linestyle index is an integer, as described in the following table:

Table 4-3: Linestyles

Index	Linestyle
0	Solid
1	Dotted
2	Dashed
3	Dash Dot
4	Dash Dot Dot Dot
5	Long Dashes

!P.Multi

Allows making multiple plots on a page or a screen. It is a five-element integer array defined as follows:

- !P.Multi(0) contains the number of plots remaining on the page. If !P.Multi(0) is less than or equal to 0, the page is cleared, the next plot is placed the upper-left-hand corner, and !P.Multi(0) is reset to the number of plots per page.
- !P.Multi(1) is the number of plot columns per page. If ≤ 0, one is assumed. If more than two plots are positioned in either the X or Y direction, the character size is halved.
- !P.Multi(2) is the number of rows of plots per page. If ≤ 0, one is assumed.
- !P.Multi(3) is the number of plots stacked in the Z dimension.

- !P.Multi(4) is 0 to make plots from left to right (column major), and top to bottom, and is 1 to make plots from top to bottom, left to right (row major).

Example

To position two plots across the page:

```
!P.Multi = [0, 2, 0, 0, 0]

PLOT, X0, Y0 ;Make left plot

PLOT, X1, Y1 ;Right plot
```

To position two plots vertically:

```
!P.Multi = [0, 0, 2, 0, 0]

PLOT, X0, Y0 ;Make top plot

PLOT, X1, Y1 ;Bottom plot
```

To make four plots per page, two across and two up and down:

```
!P.Multi = [0, 2, 2, 0, 0]
```

and then call plot four times.

To reset !P.Multi back to the normal one plot per page:

```
!P.Multi = 0
```

For more information on !P.Multi, see *Drawing Multiple Plots on a Page* on page 83 of the *PV-WAVE User's Guide*.

!P.Noclip

Corresponding Plot Keyword: *Noclip*

A field, which if set, inhibits the clipping of the graphic vectors and vector-drawn text. By default, graphic vectors are clipped within the plotting window.

!P.Nsum

Corresponding Plot Keyword: *Nsum*

The number of adjacent points to sum to obtain a plotted point. If !P.Nsum is larger than 1, every group of !P.Nsum points is averaged to produce one plotted point. If there are *m* data points, then *m* / !P.Nsum points are displayed. On logarithmic axes a geometric average is performed.

It is convenient to use *Nsum* when there is an extremely large number of data points to plot because it plots fewer points, the graph is less cluttered, and it is quicker.

!P.Position

Corresponding Plot Keyword: *Position*

Specifies the position of the plot within the graphics window. It is called by specifying a four-element vector as follows:

```
!P.Position = [Xmin, Ymin, Xmax, Ymax]
```

The minimum and maximum position values are specified in normalized coordinates. For example, to position a plot in the center of the screen, type:

```
!P.Position = [0.2, 0.2, 0.8, 0.8]
```

Note The !P.Position variable will only position the plot itself, and the annotation on the axes may be cut off. If the plot and its associated annotation must be positioned, use the Region field of the !P system variable.

!P.Psym

Corresponding Plot Keyword: *Psym*

The plot symbol index. Each point drawn by PLOT and OPLOT is marked with a symbol if this field is non-zero. Set !P.Psym to the symbol index as given in Table 4-4 on page 548 to mark data points with symbols.

Negative values of !P.Psym cause the symbol designated by |!P.Psym| to be plotted at each point with solid lines connecting the symbols. For example, a !P.Psym value of –5 plots triangles at each data point and connects the points with lines.

Table 4-4: Symbols Selected by !P.Psym

!P.Psym Value	Symbol Drawn
0	No symbol, connect points with solid lines
1	Plus sign
2	Asterisk
3	Period
4	Diamond
5	Triangle
6	Square
7	X
8	User-defined, see the USERSYM procedure
9	Undefined
10	Data points are plotted in the histogram mode. Horizontal and vertical lines connect the plotted points, as opposed to the normal method of connecting points with straight lines.
–value	Negative values connect symbols with solid lines

!P.Region

Specifies the positioning of the plot and its associated annotation (i.e., anything that can be specified with the PLOT command). The difference between !P.Region and !P.Position is that !P.Region provides a margin around the plot to accommodate plot annotation. It is called by specifying !P.Region's maximum and minimum values in normalized coordinates:

```
!P.Region = [Xmin, Ymin, Xmax, Ymax]
```

For example, to position a plot with its associated annotation in the center of the screen, type:

```
!P.Region = [0.2, 0.2, 0.8, 0.8]
```

!P.Subtitle

Corresponding Plot Keyword: *Subtitle*

The plot subtitle, placed under the X axis label.

!P.T

Contains the homogeneous 4-by-4 transformation matrix.

!P.T3D

Corresponding Plot Keyword: *T3d*

Enables the three-dimensional to two-dimensional transformation contained in the homogeneous 4-by-4 matrix !P.T.

!P.Thick

Corresponding Plot Keyword: *Thick*

The thickness of the lines connecting points. A thickness of 1.0 is normal, 2 is double-wide, and so on.

!P.Tickformat

Corresponding Plot Keyword: *Tickformat*

Changes the default format for X, Y, and Z axis tick labels using FORTRAN-style format specifiers.

See !X.Tickformat for more information.

!P.Ticklen

Corresponding Plot Keyword: *Ticklen*

The length of the tick marks, expressed as a fraction of the plot size. The default value is 0.02. A !P.Ticklen of 0.5 produces a grid, while a negative value for !P.Ticklen makes tick marks that extend outside the window, rather than inwards.

See also !X.Ticklen, !Y.Ticklen, and !Z.Ticklen.

!P.Title

Corresponding Plot Keyword: *Title*

The main plot title. The text size of this main title is larger than the other text by a factor of 1.25.

!Path

Contains the colon-separated directory path to search for procedures, functions, and arguments of executive commands.

!PDT

The main system variable structure for Date/Time plotting attributes. The fields of this structure are described below.

!PDT.Box

Corresponding Plot Keyword: *Box*

If zero, the background box for the Date/Time axis labels is off; if one, the background box is turned on. The default is zero — no box.

!PDT.Compress

Corresponding Plot Keyword: *Compress*

If zero, compression is off; if one, compression is on. The default is zero — no compression.

!PDT.Exclude_Holiday

If compression is set with the *Compress* keyword or !PDT.Compress, and this system variable is set to one, holidays are excluded from the results of Date/Time routines such as DT_ADD, DT_SUBTRACT, and DT_DURATION. The default is one.

!PDT. Exclude_Weekend

If compression is set with the *Compress* keyword or !PDT.Compress, and this system variable is set to one, weekends are excluded from the results of Date/Time routines such as DT_ADD, DT_SUBTRACT, and DT_DURATION. The default is one.

!PDT.Max_Levels

Corresponding Plot Keyword: Max_Levels

Sets the maximum number of levels on a Date/Time axis. For more information, see the *Max_Levels* keyword in Chapter 3, *Graphics and Plotting Keywords*.

!PDT.Month_Abbr

Corresponding Plot Keyword: *Month_Abbr*

If one, month names are abbreviated if there is not enough room to draw them on a plot axis; if zero, month names will not be abbreviated, and only the months which fit the space available on the axis will be displayed. The default is zero — months are not abbreviated.

!PDT.Start_Level

Corresponding Plot Keyword: *Start_Level*

Allows you to override the starting level of the Date/Time axis labels that PV-WAVE derives. The default is –1, which causes starting levels to be selected automatically.

!PDT.DT_Crange

Contains axis ranges generated by the PLOT procedure.

!PDT.DT_Range

Corresponding Plot Keyword: *DT_Range*

Can be used to specify an exact Date/Time axis range. You must pass in the desired start and end values from a Date/Time Julian value. The specified range may be adjusted slightly depending on the data. To force an exact axis range (exactly as specified), set the *XStyle* keyword to two. See the description of *XStyle* in Chapter 3, *Graphics and Plotting Keywords*.

!PDT.DT_Offset

This is a read-only system variable, which is mainly for internal PV-WAVE use.

!PDT.Week_Boundary

Corresponding Plot Keyword: *Week_Boundary*

Allows you to set a different day of the week as the boundary for numbering the start of the week on the axis levels. (O = Sunday, 1= Monday, etc.)

!Pi

The floating-point value of pi. This is a read-only system variable.

!Product

(Read only) Identifies the product being run: either "cl" or "advantage".

!Prompt

A string variable containing the prompt used by PV-WAVE.

!Quarter_Names

Array of strings containing the names for fiscal quarters. The default names of these labels are Q1, Q2, Q3, and Q4.

!Quiet

If set to 1, suppresses compiler messages from being shown on the display screen.

!Radeg

A floating-point value for converting radians to degrees. The value is 180 / π or approximately 57.2958. This is a read-only system variable.

!Start

Contains the value of the time at which you started PV-WAVE as a Date/Time structure.

!Time_Separator

A string containing, by default, a colon (:) character. This character is used to separate the parts of a time (for example, 07:54:58.000). To use a different character, change the value of this variable. This variable is used by the DT_PRINT, DT_TO_STR, and DC_WRITE_* routines.

!Version

A structure whose four string fields contain the current operating system, architecture and name (platform) of the machine running PV-WAVE, and the current PV-WAVE version number. This is a read-only system variable.

!Weekend_List

This system variable is created by the CREATE_WEEKENDS procedure. It contains an array of long integers, where ones repre-

sent weekends and zeros represent weekdays. The values are defined by the CREATE_WEEKENDS routine.

!X

The system variables !X, !Y, and !Z, are structures that affect the appearance and scaling of the three axes. The fields for !X are described here. !Y and !Z have identical fields with identical meanings and usage.

In addition, almost all fields have corresponding keyword parameters, with identical function, but with temporary effect. For example, to suppress the minor tick marks on the X axis using the !X system variable:

```
!X.Minor = -1
```

while to suppress them in the call to PLOT:

```
PLOT, X, Y, XMinor = -1
```

The name of the keyword parameter is simply the name of the system variable field, prefixed with the letter X, Y, or Z.

The fields for the !X system variable are explained in the following sections.

!X.Charsize

Corresponding Plot Keyword: XCharsize

The size of the characters used to annotate the axis and its title. This field is a scale factor applied to the global scale factor. For example, setting !P.Charsize to 2.0 and !X.Charsize to 0.5 results in a character size of 1.0 for the X axis.

!X.Crange

The *output* axis range. Setting this variable has no effect; set !X.Range to change the range. !X.Crange(0) always contains the minimum axis value, and !X.Crange(1) contains the maximum axis value of the last plot.

!X.Gridstyle

Corresponding Plot Keyword: XGridstyle

Lets you change the default linestyle of X axis tick marks. The default is a solid line. Other linestyle choices and their index values are listed in the following table:

Table 4-5: Linestyles

Index	Linestyle
0	Solid
1	Dotted
2	Dashed
3	Dash Dot
4	Dash Dot Dot Dot
5	Long Dashes

!X.Margin

Corresponding Plot Keyword: XMargin

A two-element array specifying the margin on the left (top) and right (bottom) sides of the *plot window*, in units of character size. The plot window is the rectangular area that contains the plot data (i.e., the area enclosed by the axes).

The default values for !X.Margin are [10, 3], which yields a 10-character-wide left margin and a 3-character-wide right margin. The values for !Y.Margin are [4, 2], for a four-character-high bottom margin and a two-character-high top margin.

When calculating the size and position of the plot window, PV-WAVE first determines the plot region, the area enclosing the window plus the axis annotation and titles. It then subtracts the appropriate margin from each side, obtaining the window.

!X.Minor

Corresponding Plot Keyword: XMinor

The number of minor tick intervals. If !X.Minor is 0, the default, the number of minor ticks is automatically determined. You can force a given number of minor tick intervals by setting this field to the desired number. To suppress minor tick marks, set !X.Minor to –1.

!X.Range

Corresponding Plot Keyword: XRange

The input axis range, a two-element vector. The first element is the axis minimum, and the second is the maximum. Set this field, or use the corresponding keyword parameter, to specify the data range to plot. Because of the axis end point rounding, the final axis range may not be equal to this input range. The field !X.Crange contains the axis range used for the plot.

Set both elements equal to 0 for automatic axis ranges:

```
!X.Range = 0
```

Example

To force the X axis to run from 5.5 to 8.3:

```
!X.Range = [5.5, 8.3]

PLOT, X, Y
```

Alternatively, by using keywords:

```
PLOT, X, Y, XRange = [5.5, 8.3]
```

Note that even though the range was set to (5.5, 8.3), the resulting plot has a range of (5.5, 8.5), because of the axis rounding. To inhibit rounding, set !X.Style to 1.

!X.Region

Corresponding Plot Keyword: None.

Contains the normalized coordinates of the region. This field is similar to !X.Window in that it is set by the graphics procedures and is a two-element floating-point array.

!X.S

The scaling factors for converting between data coordinates and normalized coordinates (a two-element array). The formula for conversion from data (X_d) to normalized (X_n) coordinates is:

$$X_n = S_i X_d + S_0$$

If logarithmic scaling is in effect, substitute $\log_{10} X_d$ for X_d.

!X.Style

Corresponding Plot Keyword: XStyle

The style of the axis encoded as bits in a longword. The axis style may be set to exact, extended, none, or no box using this field. See the following table for details.

Bit	Value	Function
0	1	Exact. By default the end points of the axis are rounded in order to obtain even tick increments. Setting this bit inhibits rounding, making the axis fit the data range exactly.
1	2	Extend. If this bit is set, the axes are extended by 5% in each direction, leaving a border around the data.
2	4	None. If this bit is set, the axis and its annotation is not drawn.
3	8	No box. Normally, PLOT and CONTOUR draw a box style axis with the data window surrounded by axes. Setting this bit inhibits drawing the top or right axis.

4	16	Inhibits setting the Y axis minimum value to zero, when the data are all positive and non-zero. The keyword YNozero sets this bit temporarily.

Example

To set the X axis style to exact, use:

```
!X.Style = 1
```

or by using a keyword parameter:

```
PLOT, X, Y, XStyle = 1
```

!X.Thick

The thickness of the axis line and tick marks. 1.0 is normal.

!X.Tickformat

Corresponding Plot Keyword: XTickformat

Changes the default format for X axis tick labels using FORTRAN-style format specifiers. For example, the following statement changes the default tick label format to floating-point numbers carried to two decimal places.

```
!X.Tickformat = '(F5.2)'
```

The specified width of the format is at least five characters; however, this width expands automatically to accommodate larger values.

For more information on format specifiers, see *Explicitly Formatted Input and Output* on page 165 of the *PV-WAVE Programmer's Guide*. See also *Example 3: Specifying Tick Label Formats* on page 82 of the *PV-WAVE User's Guide*.

Note that only the `I` (integer), `F` (floating-point), and `E` (scientific notation) format specifiers can be used with !X.Tickformat. Also, you cannot place a quoted string inside a tick format. For example, `("<", F5.2, ">")` is an invalid !X.Tickformat specification.

!X.Ticklen

Corresponding Plot Keyword: XTicklen

The length of tick marks, expressed as a fraction of the plot size. The default value is 0.02. A negative value makes tick marks that extend outside the window, rather than inward.

!X.Tickname

Corresponding Plot Keyword: XTickname

The annotation for each tick. A string array of up to 30 elements. Setting elements of this array allows direct specification of the tick label. If this element contains a null string, the default value, PV-WAVE annotates the tick with its numeric value. Setting the element to a 1-blank string suppresses the tick annotation.

Example

To produce a plot with an abscissa labeled with the days of the week:

```
!X.Tickname = ['SUN', 'MON', 'TUE', 'WED', $
   'THU', 'FRI', 'SAT']
```

Set up X axis tick labels.

```
!X.Ticks = 6
```

Use six tick intervals, requiring seven tick labels.

```
PLOT, Y
```

Plot the data, this assumes that Y contains 7 elements.

The same plot can be produced, using keyword parameters, with:

```
PLOT, Y, XTickname = ['SUN', 'MON', 'TUE', $
   'WED', 'THU', 'FRI', 'SAT'], XTicks = 6
```

Set fields, as above, only temporarily.

See Chapter 7, *Working with Date/Time Data*, in the *PV-WAVE User's Guide* for information on creating axes with date and time data.

!X.Ticks

Corresponding Plot Keyword: XTicks

The number of major tick intervals to draw for the axis. If !X.Ticks is set to 0, the default, PV-WAVE will select from three to six tick intervals. Setting this field to *n*, where $n > 0$, produces exactly *n* tick intervals, and $n + 1$ tick marks.

!X.Tickv

Corresponding Plot Keyword: XTickv

The data values for each tick mark, an array of up to 30 elements. You can directly specify the location of each tick by setting !X.Ticks to the number of tick marks (the number of intervals +1) and storing the data values of the tick marks in !X.Tickv. If, by default, !X.Tickv(0) is equal to !X.Tickv(1), PV-WAVE will automatically determine the value of the tick mark.

!X.Title

Corresponding Plot Keyword: XTitle

A string containing the axis title.

!X.Type

Corresponding Plot Keyword: XType

Specifies the type of axis, 0 for linear, 1 for logarithmic, 2 for Date/Time.

!X.Window

Contains the normalized coordinates of the axis end points, the plot window. This field is set by PLOT, CONTOUR, and SURFACE. Changing its value has no effect. It is a two-element floating-point array.

!Y

The main Y axis system variable structure. !Y and !X have identical fields with identical meanings and usage. See !X for more information.

!Z

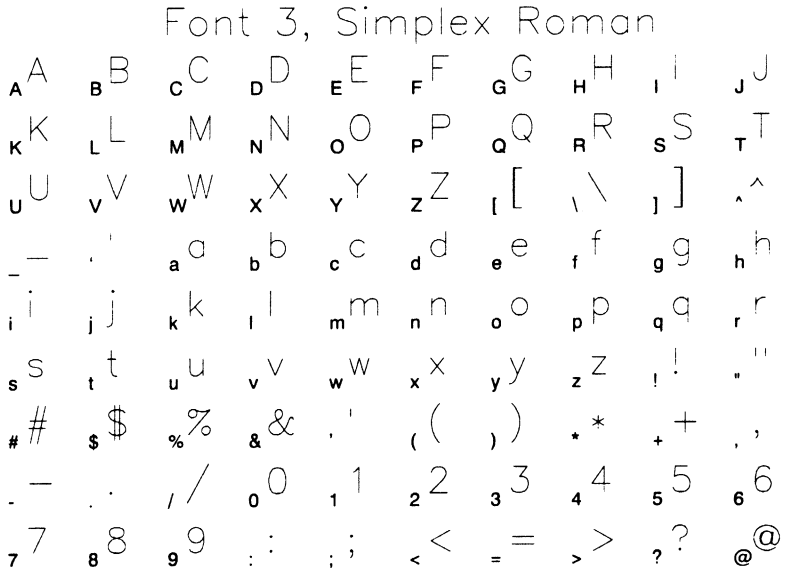
The main Z axis system variable structure. !Z and !X have identical fields with identical meanings and usage. See !X for more information.

5

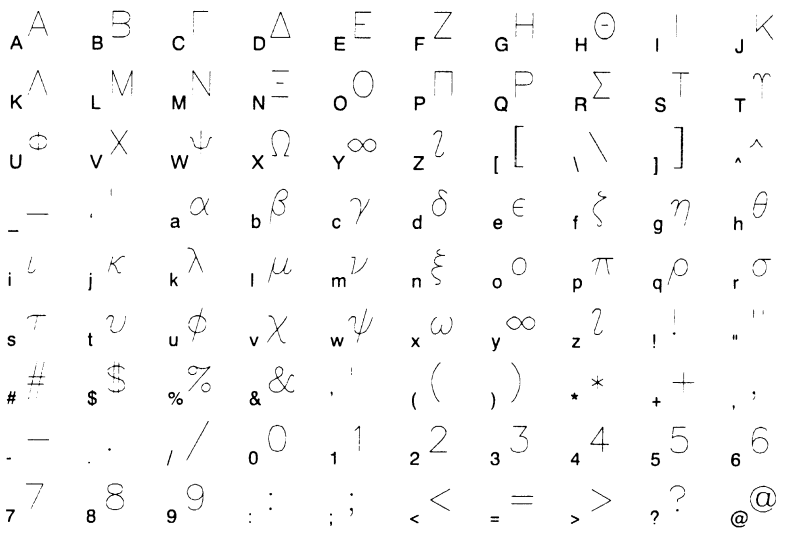
APPENDIX

Software Character Sets

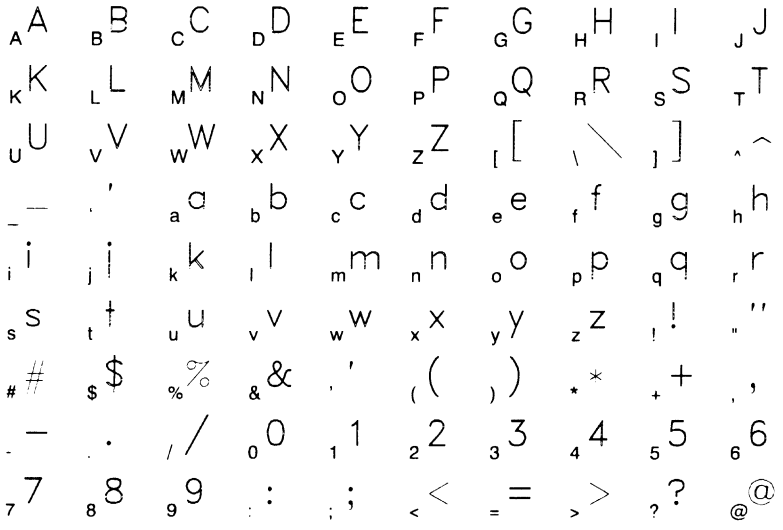
Software Character Sets



Font 4, Simplex Greek



Font 5, Duplex Roman



Font 6, Complex Roman

A A	B B	C C	D D	E E	F F	G G	H H	I I	J J
K K	L L	M M	N N	O O	P P	Q Q	R R	S S	T T
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_ _	` '	a a	b b	c c	d d	e e	f f	g g	h h
i i	j j	k k	l l	m m	n n	o o	p p	q q	r r
s s	t t	u u	v v	w w	x x	y y	z z	{ !	| ''
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7 7	8 8	9 9	: :	; ;	< <	= =	> >	? ?	@ @

Font 7, Complex Greek

A A	B B	C Γ	D Δ	E E	F Z	G H	H Θ	I I	J K
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U Φ	V X	W Ψ	X Ω	Y ∞	Z ℓ	[[	\ \	]]	^ ^
_ _	` '	a α	b β	c γ	d δ	e ϵ	f ζ	g η	h θ
i ι	j κ	k λ	l μ	m ν	n ξ	o o	p π	q ρ	r σ
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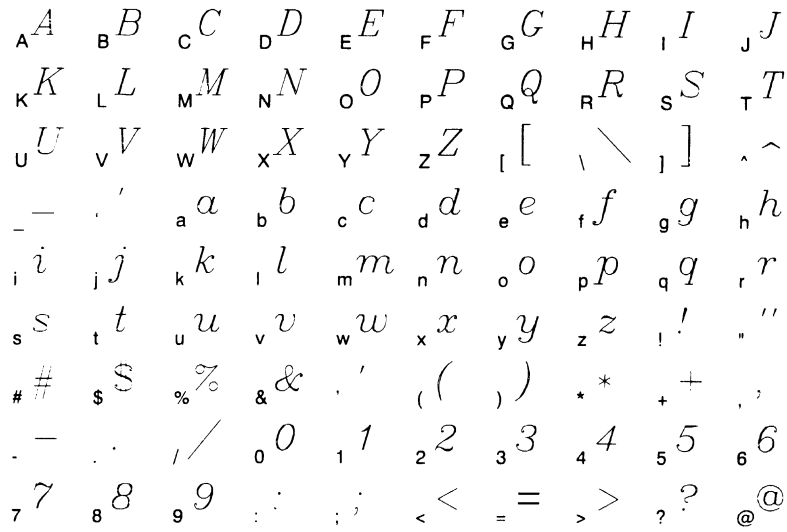
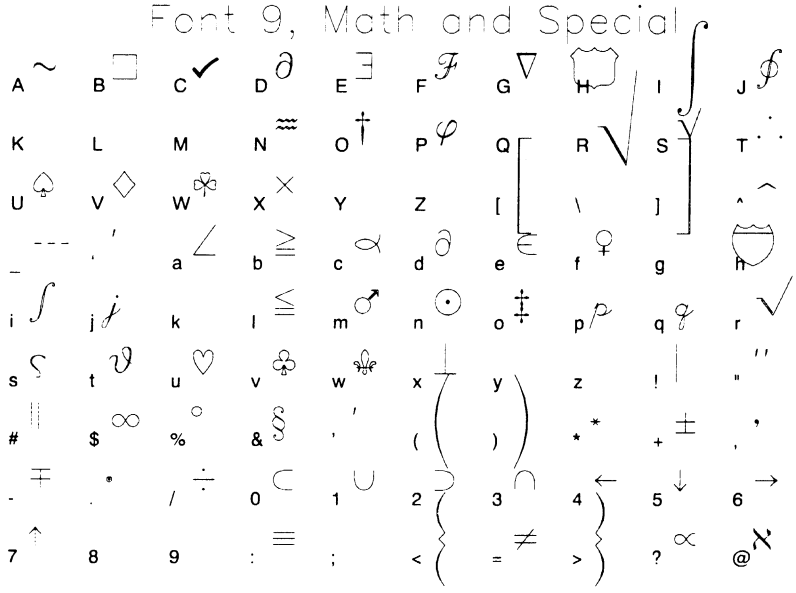
- –	. .	/ /	0 0	1 1	2 2	3 3	4 4	5 5	6 6
7 7	8 8	9 9	: :	; ;	< <	= =	> >	? ?	@ @

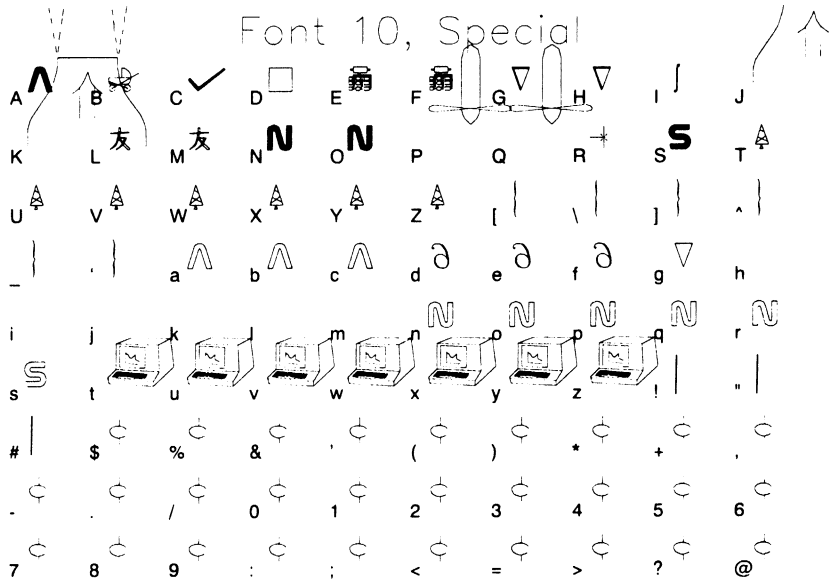
Font 8, Complex Italic



Font 9, Math and Special



Font 10, Special



Font 11, Gothic English

A B C D E F G H I J
K L M N O P Q R S T
U V W X Y Z [\ ] ^
_ ` a b c d e f g h
i j k l m n o p q r
s t u v w x y z { | }
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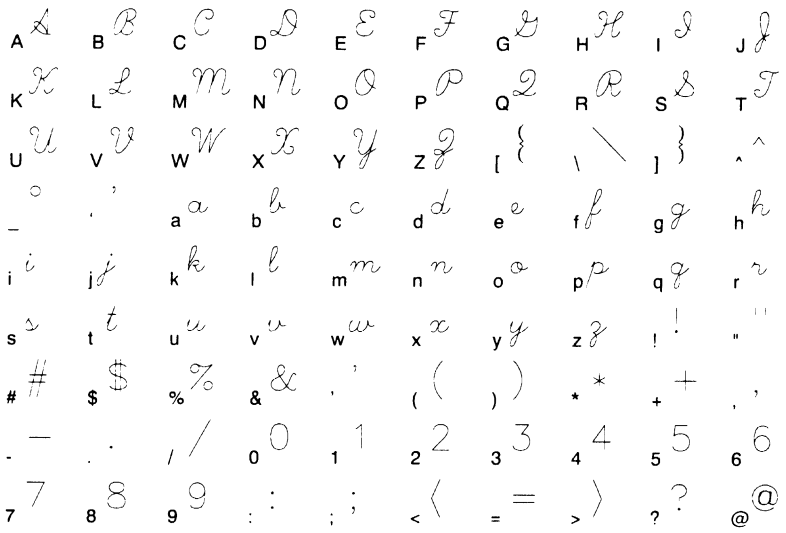
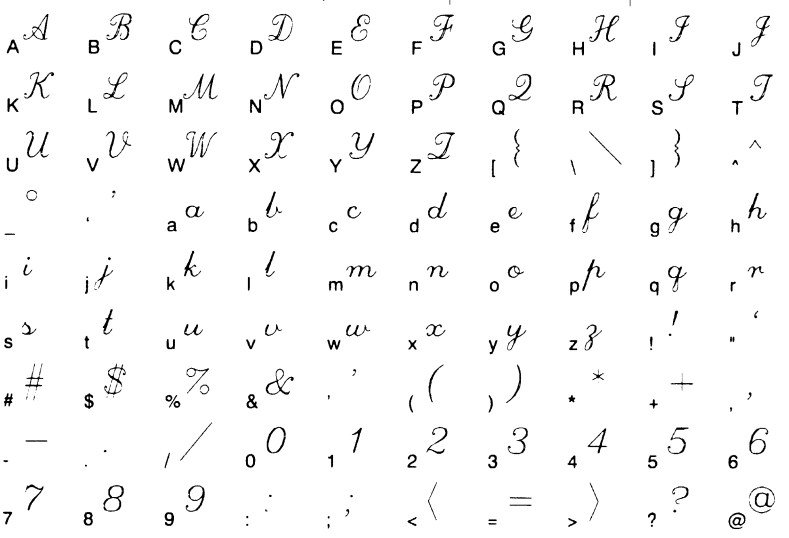
- . / 0 1 2 3 4 5 6
7 8 9 : ; < = > ? @

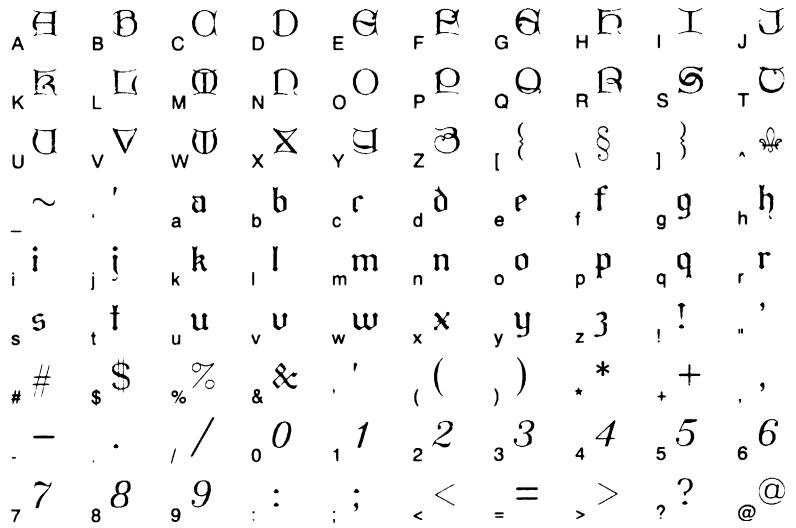
Font 12, Simplex Script



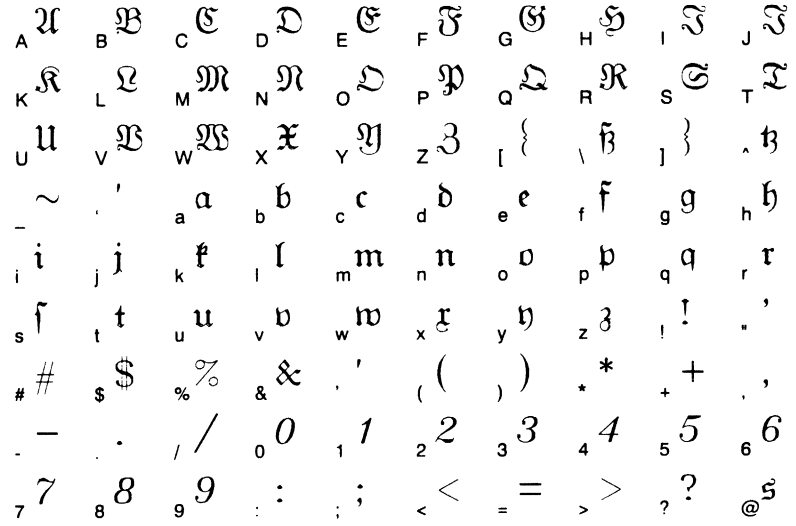
Font 13, Complex Script



Font 14, Gothic Italian



Font 15, Gothic German



Font 16, Cyrillic

A А	B Б	C В	D Г	E Д	F Е	G Ж	H З	I И	J Й
K К	L Л	M М	N Н	O О	P П	Q Р	R С	S Т	T У
U Ф	V Х	W Ц	X Ч	Y Ш	Z Щ	[Ы	\ Э	] Ь	^ Ю
_ Я	` '	a а	b б	c в	d г	e д	f е	g ж	h з
i и	j й	k к	l л	m м	n н	o о	p п	q р	r с
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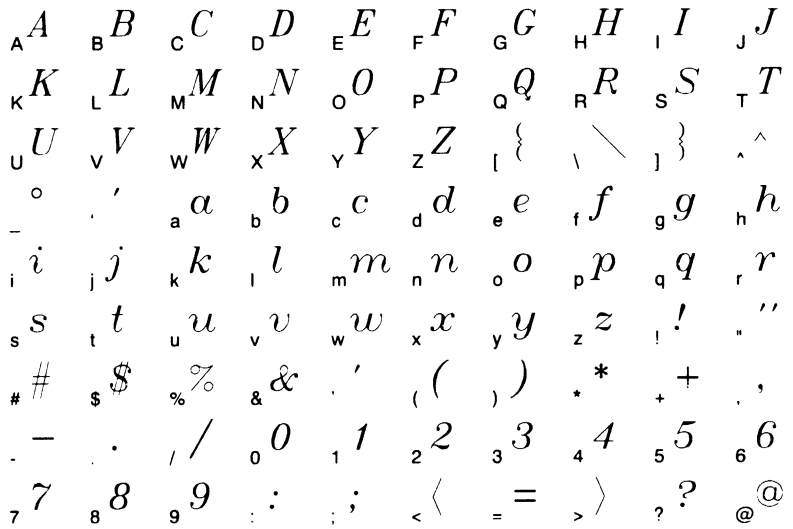

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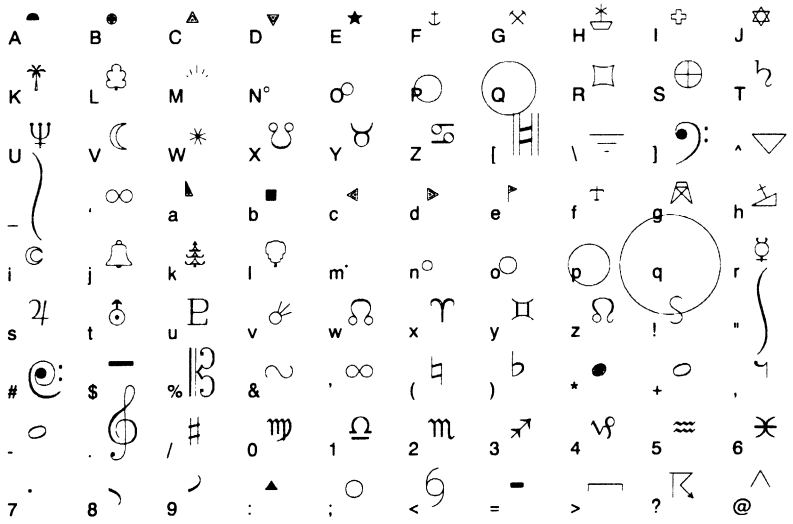
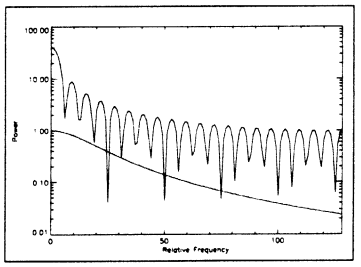


A

APPENDIX

Picture Index

2D Plots



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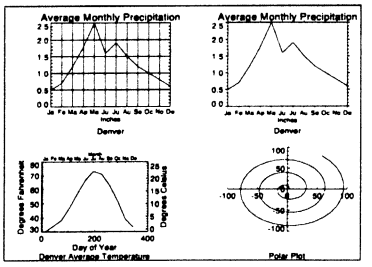

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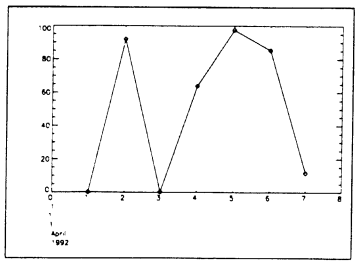

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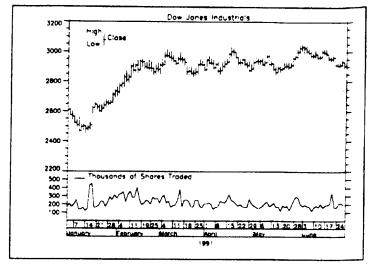

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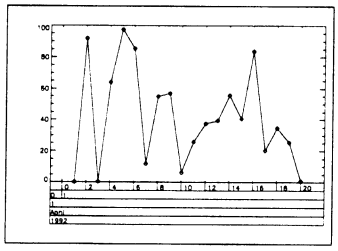

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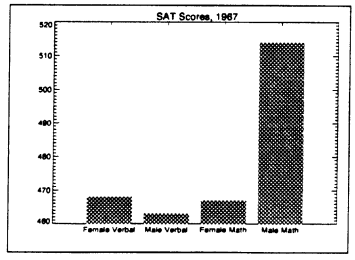

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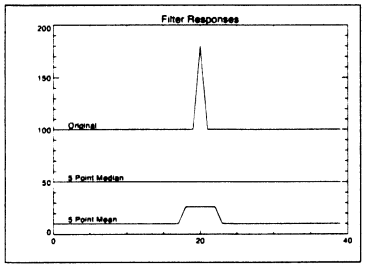

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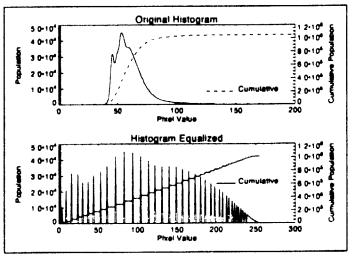

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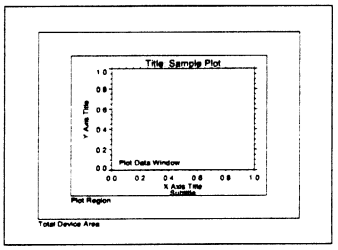

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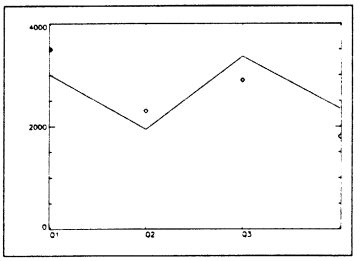

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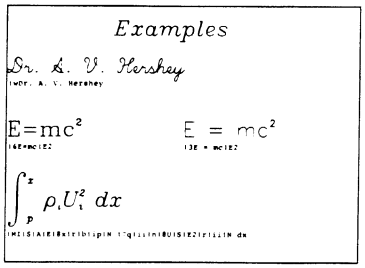

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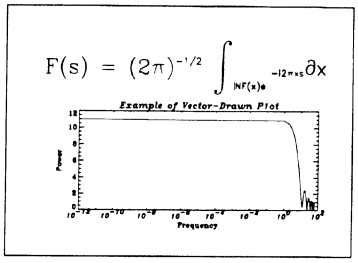

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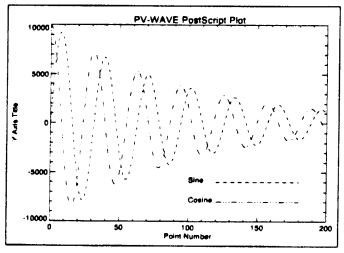

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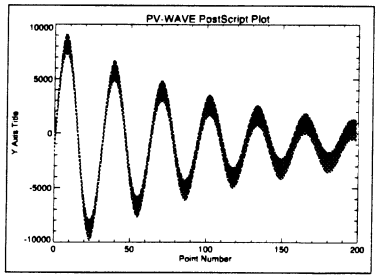

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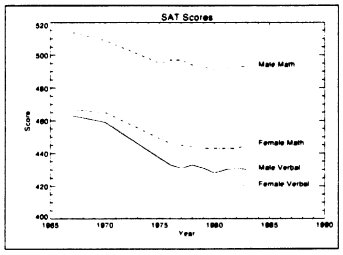

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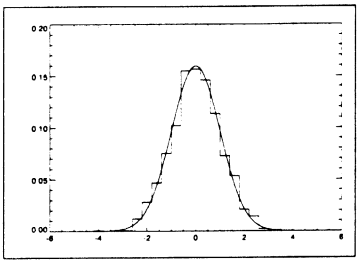

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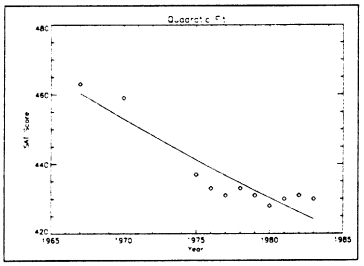

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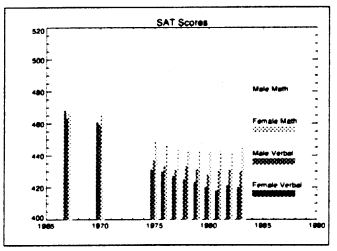

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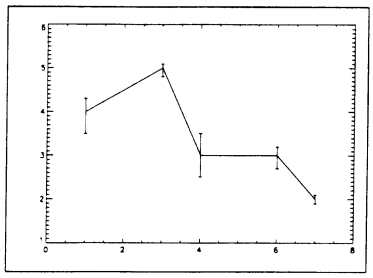

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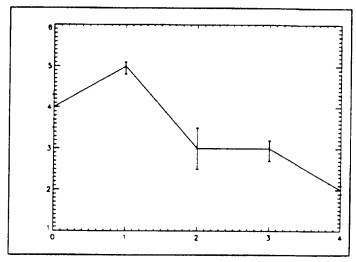

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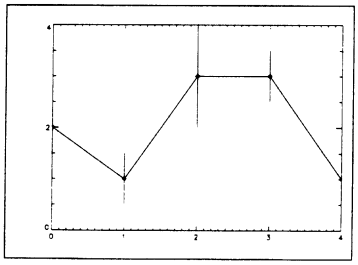

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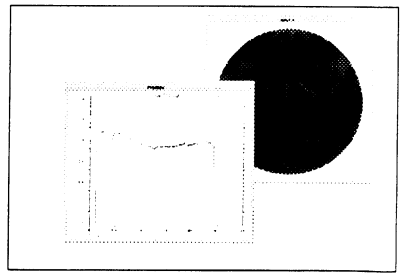

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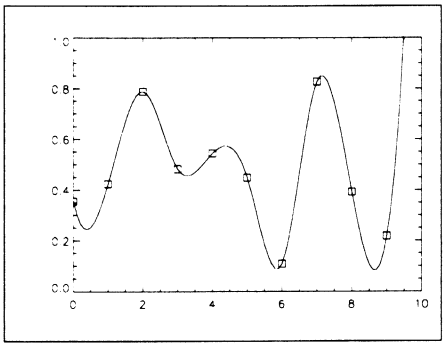

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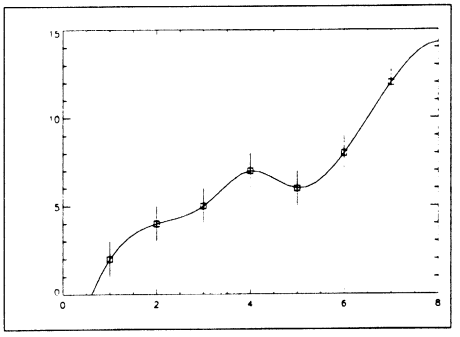

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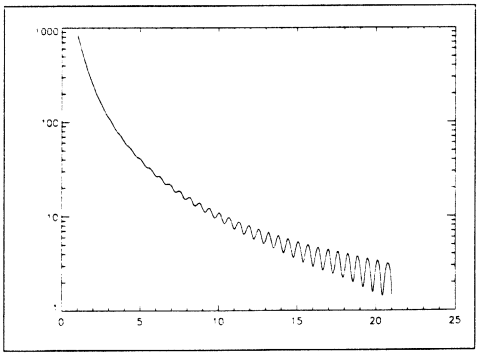

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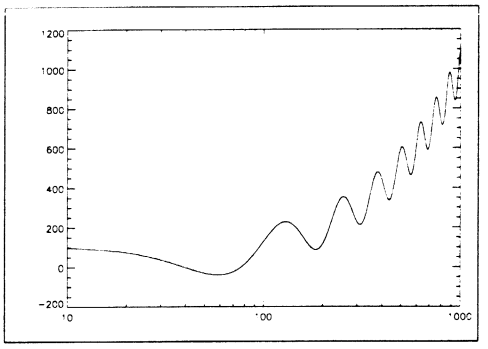

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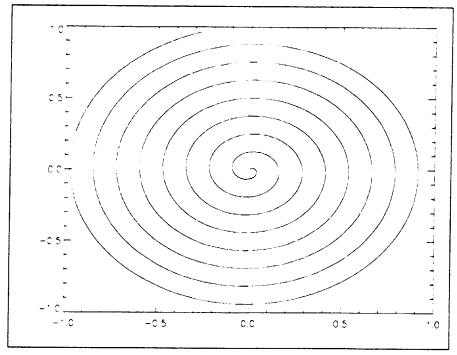

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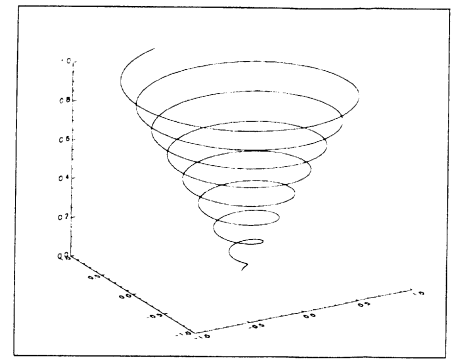

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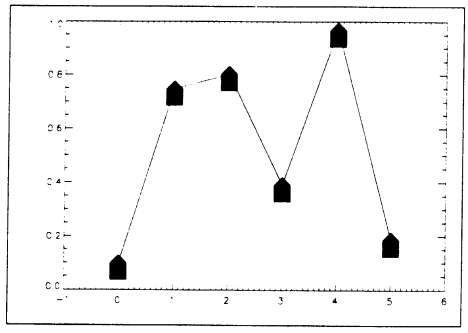

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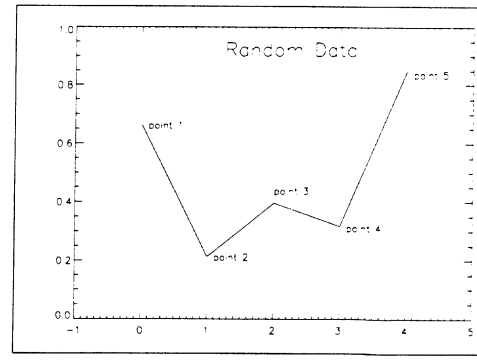

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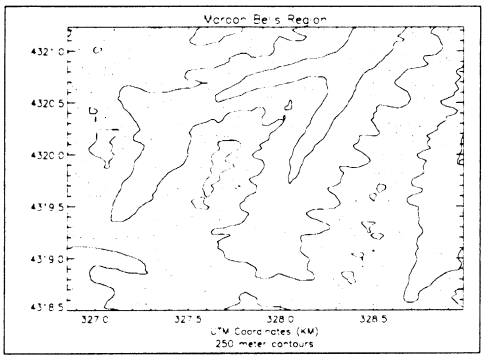
Contour Plots



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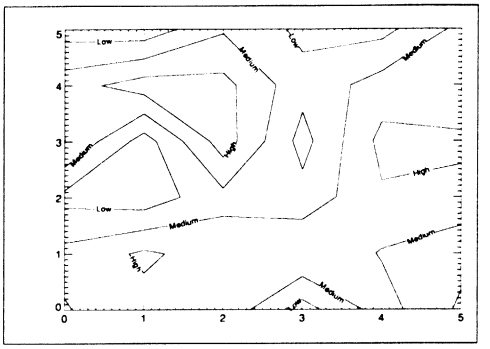

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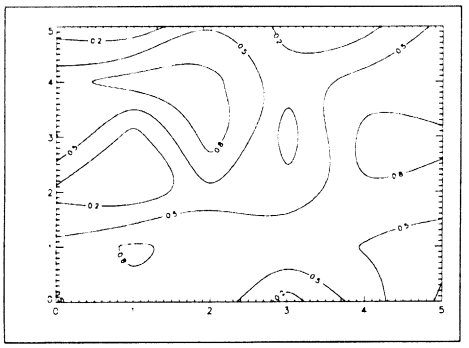

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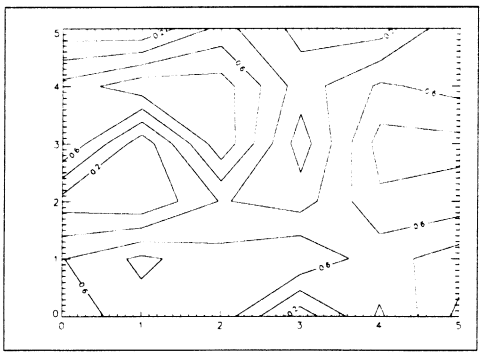

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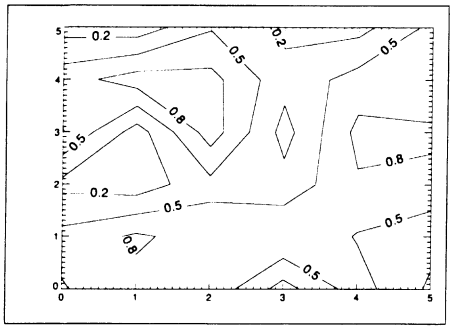

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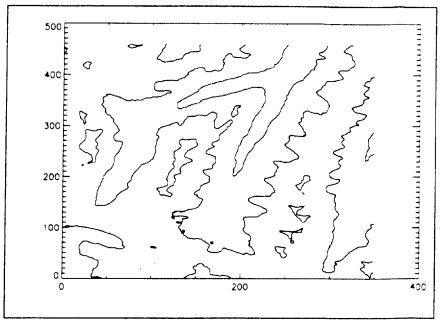

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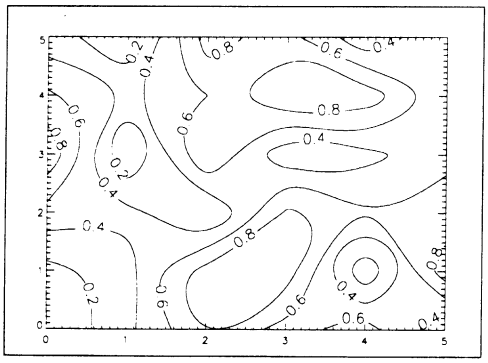

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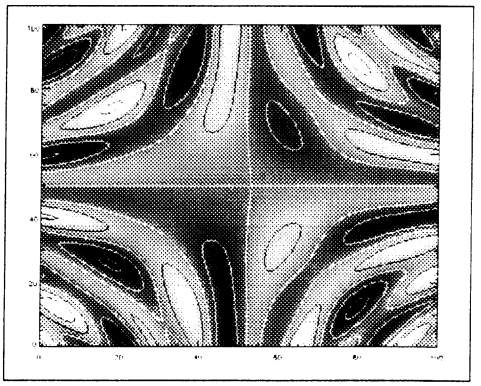

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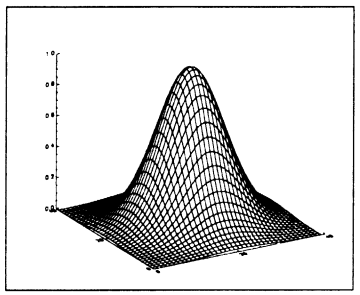
3D Plots, Surface and Shaded Surface Plots



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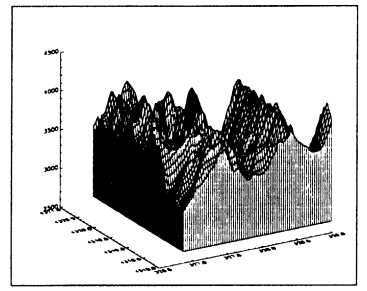

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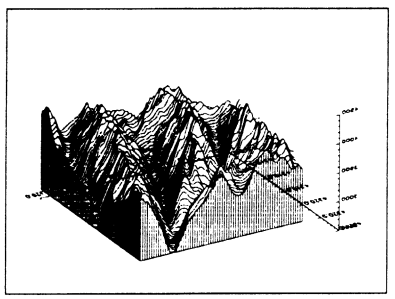

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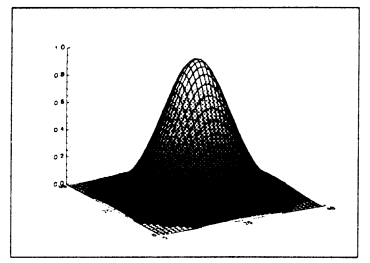


Figure 4-16 on page 133 of the *PV-WAVE User's Guide*.

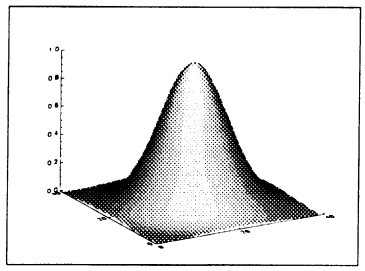
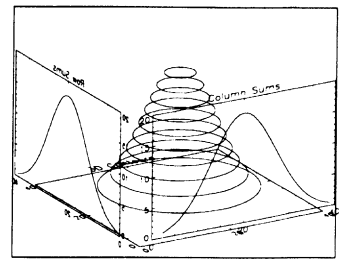


Figure 4-16 on page 133 of the *PV-WAVE User's Guide*.



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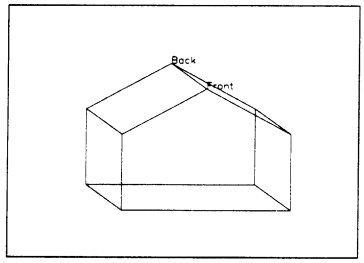

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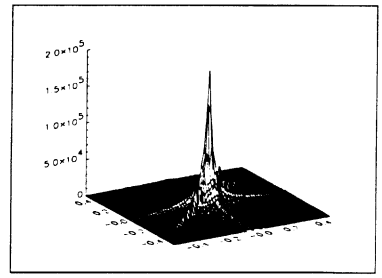

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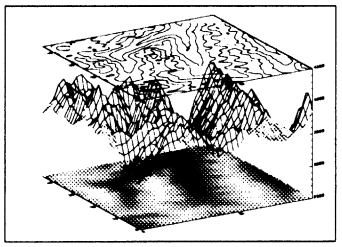

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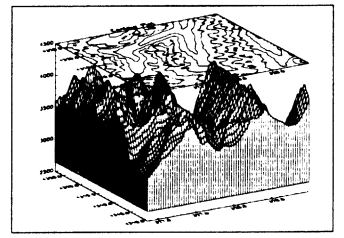

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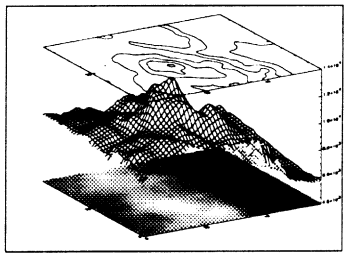

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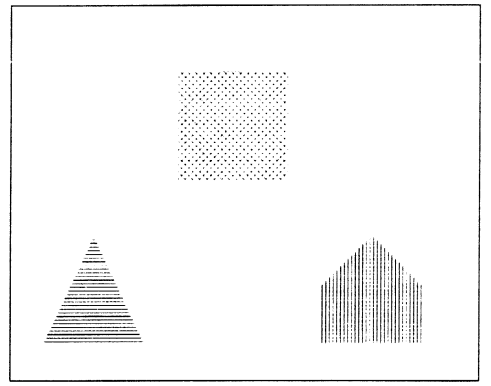

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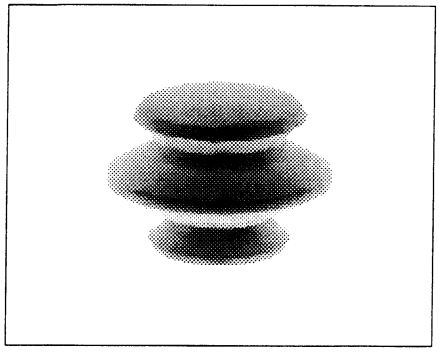

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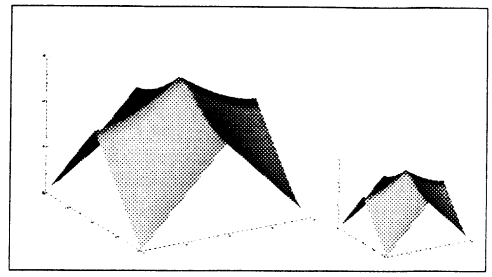

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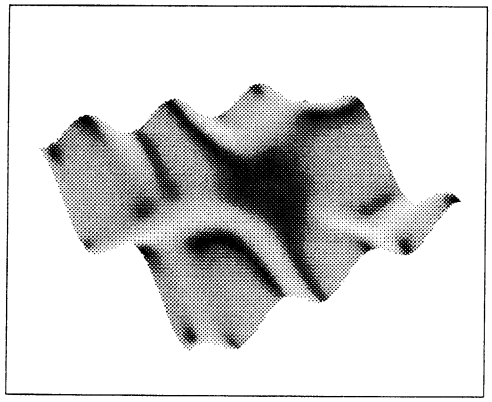

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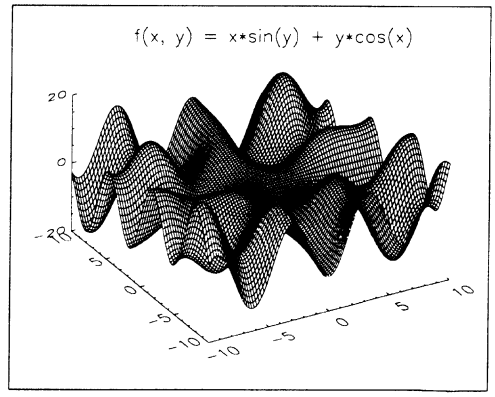

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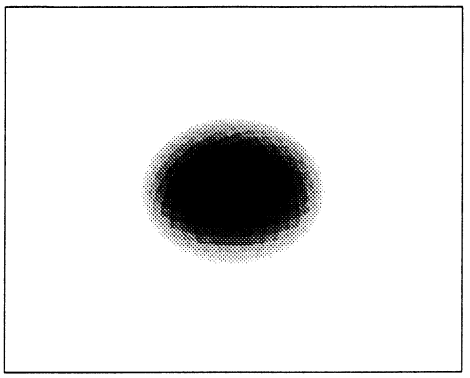

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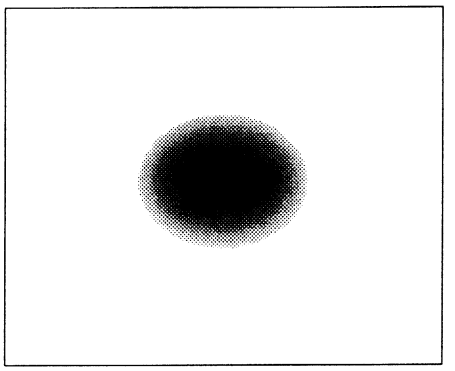

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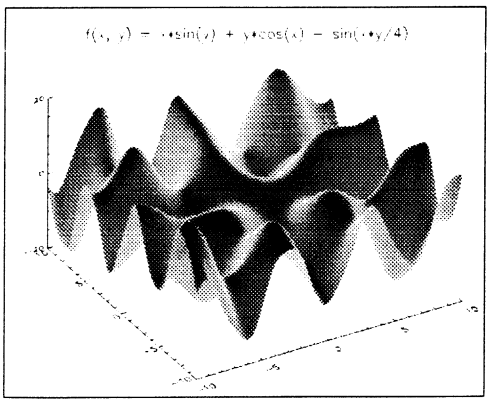

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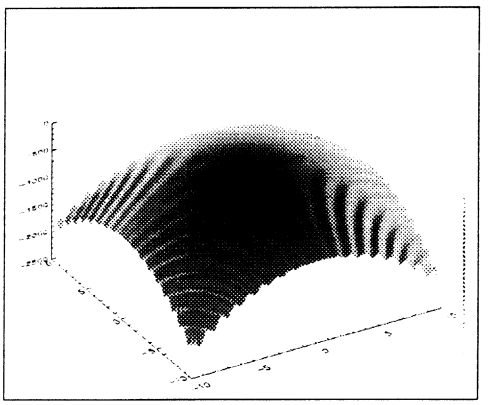

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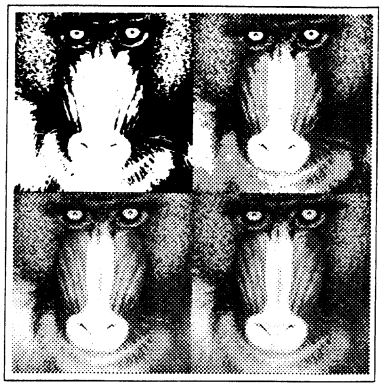

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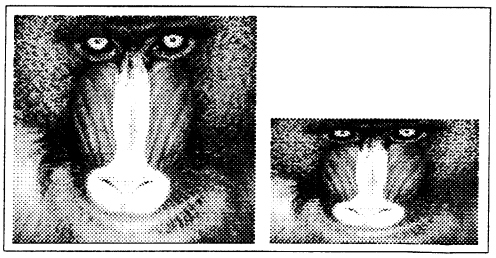

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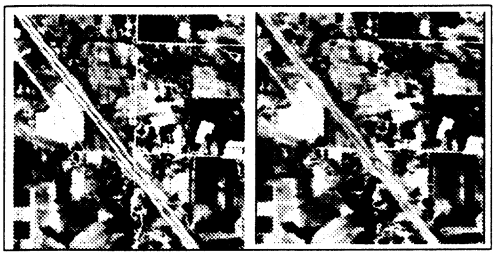

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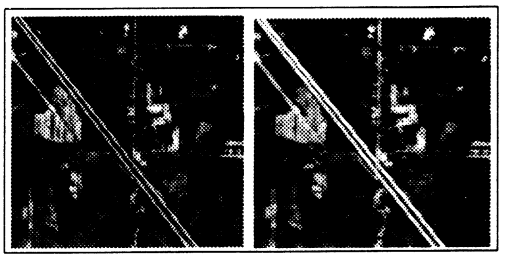
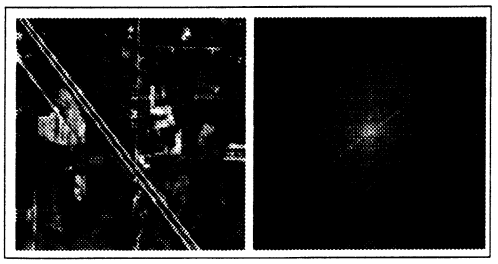


Figure 2-11 on page 258 of the *PV-WAVE Reference, Volume 1.*



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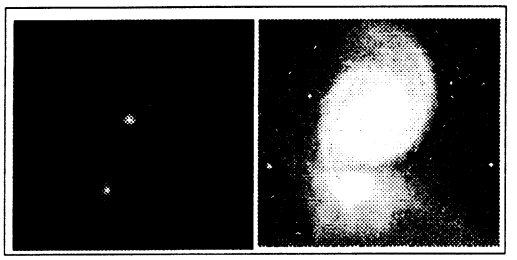

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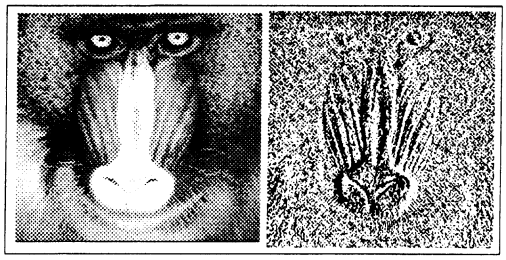

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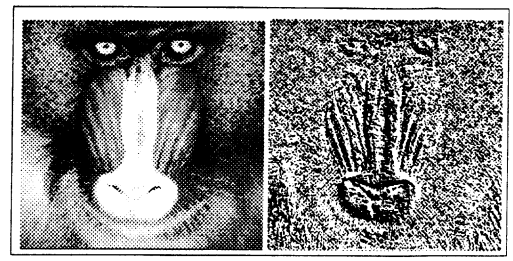

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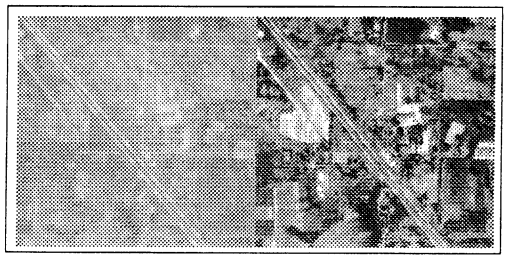

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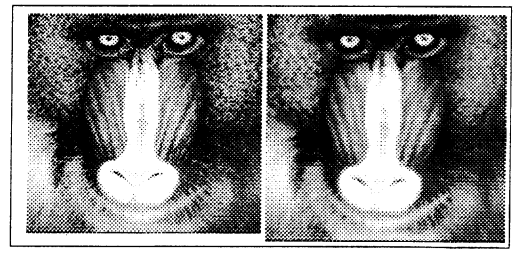

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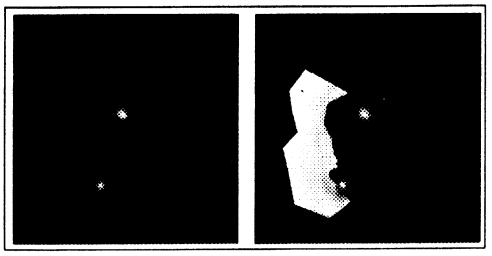

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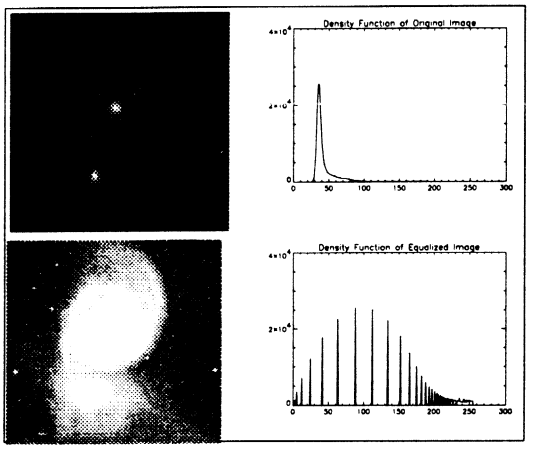

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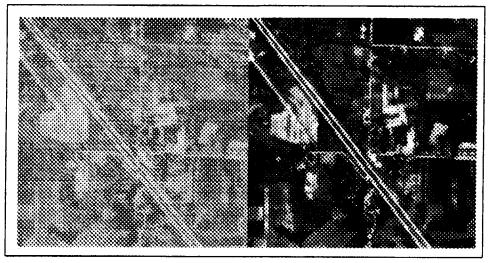

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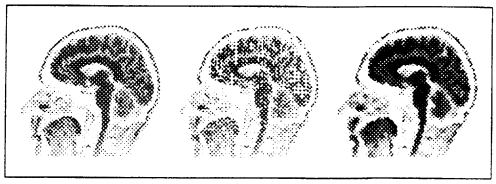

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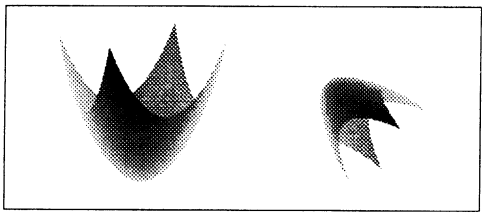

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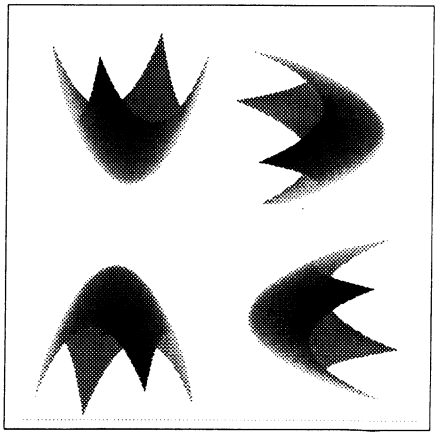

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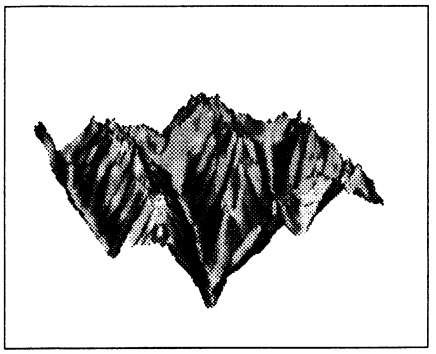
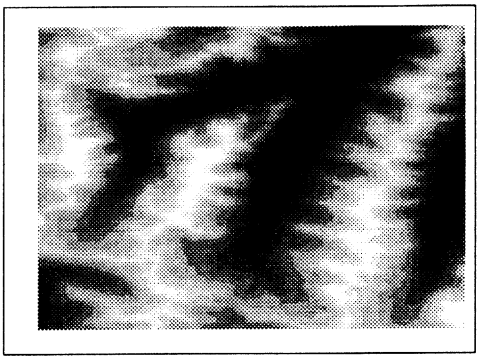


Figure 4-17 on page 134 of the *PV-WAVE User's Guide*.



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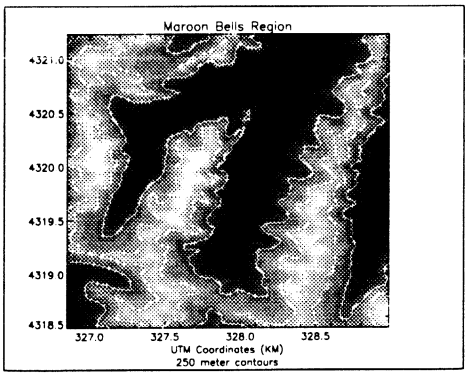

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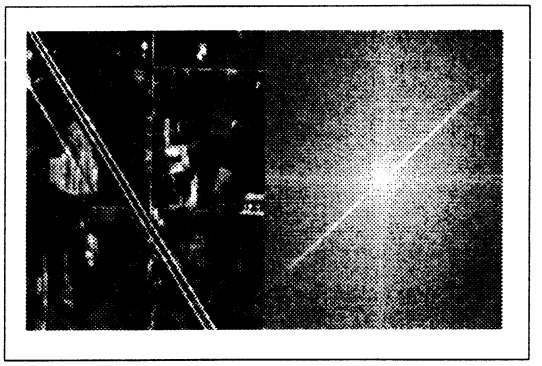

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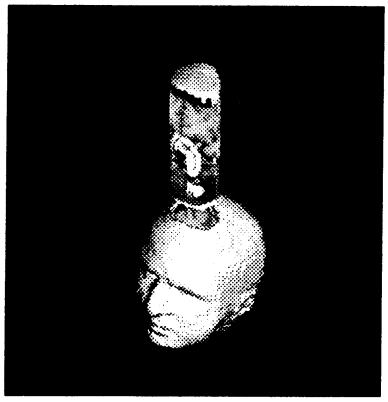

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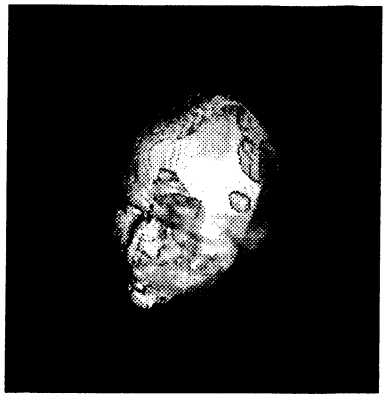

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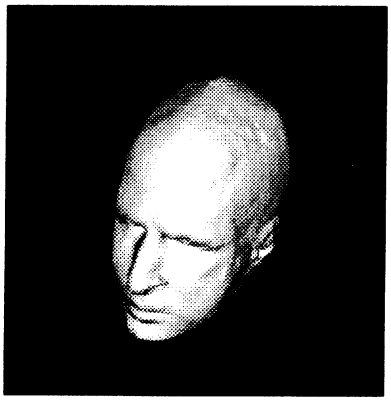

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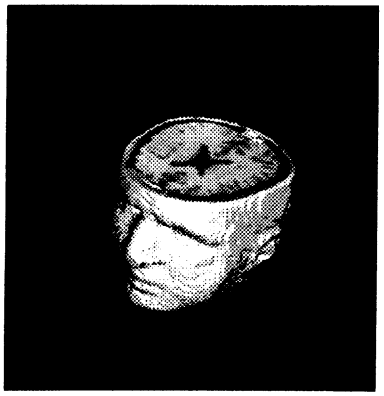

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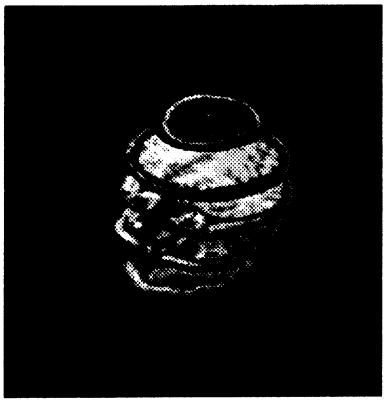

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Multivolume Index

This is a multivolume index that includes references to the *PV-WAVE User's Guide* (UG), *PV-WAVE Programmer's Guide* (PG), and both volumes of the *PV-WAVE Reference* (R1 and R2).

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