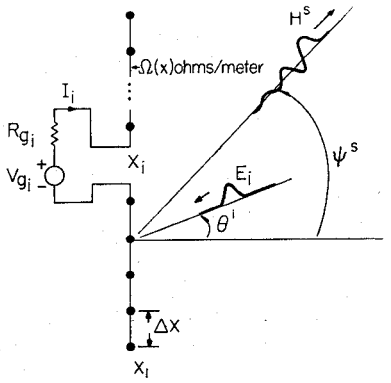

Fig. 1. Geometry of thin-wire antenna as scatterer, receiver, or radiator.

integro-differential equation for the wire currents. The form of this equation is similar to a one-dimensional wave equation which is then solved numerically on a digital computer by marching on in time. Once the currents have been found the far zone fields they produce are also computed numerically on the digital computer.

The input to the computer program is read in six data groups which control

1) type of problem to be analyzed;
2) wire geometry;
3) excitation;
4) wire loading;
5) far zone field computation;
6) output data options.

Instructions for preparing the data are presented to the user in the comment cards at the beginning of the main program. In addition, all input data are checked for maximum dimension allowances and reset if necessary. The units of time are light meters (one light meter is the time it takes a wave moving at the velocity of light to travel 1 m).

The incident plane wave for the case of the scattering or receive antenna problem is a Gaussian shaped pulse:

$$E^i(x, t) = -\sqrt{\frac{\mu}{\epsilon}}\frac{a_n}{\sqrt{\pi}}\exp\left[-a_n^2(t + x\sin\theta^i)^2\right]. \quad (1)$$

Note that the peak of this pulse reaches the origin at $t=0$. The generator voltage used for the case of the radiating antenna is a smoothed step waveform given by

$$V_g(t) = \int_{-\infty}^{t} E^i(0, t')dt'. \quad (2)$$

The width of the pulse in (1) or the rise time of the step in (2) is approximately $4/a_n$ light meters.

The program prints out the input data, the wire currents that are computed at each sample point in space time, and the far zone magnetic field normalized by the distance from the origin at each point in direction time.

The program has been run on both Univac 1108 and IBM 360 computers and requires approximately 43 000 words. Execution time on a Univac 1108 is found to be approximately

$$kN_wN_T(N_w + N_p)$$

where

N_w number of wire sample points (NXW);
N_p number of far field directions (NP);
N_T number of time sample points;
k 1.6×10^{-4} s.

Good agreement is found when the program results are compared with both experimental measurements and results computed by taking the inverse Fourier transform of frequency domain solutions.

This program computes the smoothed impulse response or the smoothed step response of these scattering and antenna problems. It should be pointed out that the response due to any time varying waveform can be computed from the impulse response by a simple convolution operation. In particular, the Fourier transform of the impulse response yields the entire frequency response directly. Thus a single time domain calculation for the impulse response solves a particular scattering or antenna problem for all excitations.

References

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Contributors

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Since April 1967 she has been with the Department of Electronic Engineering, University of Tokyo, Tokyo, Japan, where she worked on microwave semiconductor devices until March 1970.

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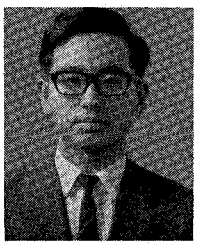

Hideki Hasegawa (M'70) was born in Tokyo, Japan, on June 22, 1941. He received the B.E., M.E., and Ph.D. degrees in electronic engineering from the University of Tokyo, Tokyo, Japan, in 1964, 1966, and 1970, respectively. During his postgraduate studies, he worked on microwave semiconductor devices and circuits.

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From 1964 to 1967 he served with the U. S. Navy and was assigned as an Instructor of Electrical Engineering at the Naval Postgraduate School, Monterey, Calif. He was previously associated with the Missile and Space Vehicle Department, General Electric Company; C-Cor Electronics; the Naval Missile Center; and ECM Division, Sanders Associates, Inc. In September 1970 he returned to the Naval Postgraduate School, where he is currently an Assistant Professor in the Department of Electrical Engineering.

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Paul R. McIsaac (S'49–A'59–M'60) was born in Brooklyn, N. Y., on April 20, 1926. He received the B.E.E. degree from Cornell University, Ithaca, N. Y., in 1949, and the M.S.E. and Ph.D. degrees from the University of Michigan, Ann Arbor, in 1950 and 1954, respectively. During the 1951–1952 academic year, he studied at the University of Leeds, Leeds, England, on a fellowship.

From 1954 to 1959 he was a Research Engineer in the Microwave Tube Division of the Sperry Gyroscope Company, Great Neck, N. Y. In 1959 he joined the faculty of Cornell University, where he is currently Professor of Electrical Engineering. During the 1965–1966 academic year he was a Visiting Professor at Chalmers University of Technology, Gothenburg, Sweden. His fields of interest include microwave electronics and the application of symmetry analysis to electromagnetic theory.

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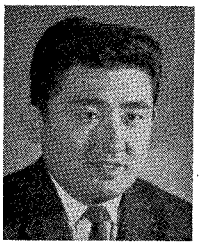

Tom Y. Otoshi (S'53–M'56) was born in Seattle, Wash., on September 4, 1931. He received the B.S.E.E. and M.S.E.E. degrees from the University of Washington, Seattle, in 1954 and 1957, respectively.

From 1956 to 1961, he was a member of the Technical Staff at Hughes Aircraft Company, Culver City, Calif., where he was engaged in guided missile checkout equipment development, microwave primary standards, antenna research, and the development of microwave components. In 1961 he joined the Communications Elements Research Section of the Jet Propulsion Laboratory, Pasadena, Calif., where he is currently a Senior Engineer. He has been involved with the calibration of low-noise antenna systems and research related to deep space communication systems.

Mr. Otoshi is a member of Tau Beta Pi and Sigma Xi.

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Parbhubhai D. Patel was born in Minkachh, India, on September 9, 1939. He received the B.E. (mechanical) degree from Maharaja Sayajirao University, Baroda, India, in 1962, and the M.S. (mechanical) and Sc.D. (aeronautical) degrees from Columbia University, New York, N. Y., in 1963 and in 1968, respectively.

From 1962 to 1963 he was a Research Assistant in the Department of Mechanical Engineering, Columbia University, where he worked on a research project on fuel cells, sponsored by the National Science Foundation. From 1963 to 1964 he was an Assistant in the Electronics Laboratory, Columbia University. From 1964 to 1969 he was a member of the Solid Mechanics Department, Research Division, Foster Wheeler Corporation, Livingston, N. J. In 1969 he joined Bell Telephone Laboratories, Inc., North Andover, Mass. His fields of interest have included thermal and stress analysis, electromagnetic theory, and computer-aided machine designs. He holds a patent in the thermal stress area and is the author of several papers.

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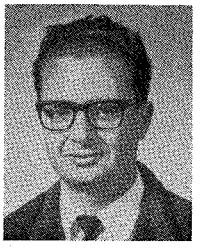

Charles T. Stelzried (S'57–M'61) received the B.S.E. and M.S.E. degrees from the University of California, Los Angeles, in 1957 and 1959, and the Ph.D. degree in engineering from the University of Southern California, Los Angeles, in 1969.

He has been at the Jet Propulsion Laboratory, Pasadena, Calif., since 1953 and is currently engaged in deep space communication research as supervisor of the Radio Frequency Techniques Group. He has several patent disclosures on microwave devices.

Dr. Stelzried is a member of Tau Beta Pi, the American Association for the Advancement of Science, and Sigma Xi.

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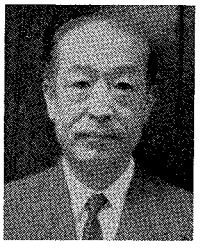

Hisayoshi Yanai (M'57–SM'63) was born in Okayama, Japan, on May 19, 1920. He received the B.E. degree in electrical engineering in 1942, and the Ph.D. degree for research on measurements of dielectric properties in dm-wave region in 1953, both from the University of Tokyo, Tokyo, Japan. From 1954 to 1955, he studied at the Institute of Technology, Munich, Germany.

In 1945, after three years of military service, he joined the staff of the Electrical Engineering Department, University of Tokyo. In 1947 he became an Assistant Professor, and since 1960 he has been a Professor at the University of Tokyo, where he is currently concerned with semiconductor devices and circuits.

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