

Japanese Aerospace Literature This month: *Optical Computers*

N93-20449 Research on satellite-borne high speed data recorder *Tousaigata kousoku deta rekoda no kenkyuu*. SATORU YAMAMOTO, HIROSHI ANEGAWA, and MASAHIRO KASUYA, *National Space Development Agency, Ibaraki (Japan)*. Common Equipment Lab. In its Research and Development Activities of the Tsukuba Space Center pp. 177-182 (SEE N93-20410 07-12)

Design review focused on optical disc system was conducted to pick up future development problems and fundamental evaluation test (radiation irradiation test) on its critical components, optical disc media and optical elements (laser diode and photodiode), were conducted. The results of the design and review were presented as follows: (1) a draft of target specifications of the optical disc data recorder, interchangeable with magnetic Mission Data Recorder (MDR), to be first installed onboard the Advanced Earth Observing Satellite-2 (ADEOS-2) was determined; (2) Japan's ground use optical disc technology was deemed to possess sufficient technical foundation for developing satellite borne optical disc data recorders; (3) measures to accomplish high speed and large capacity, such as disc scale up, and employing multidisc system, high numerical aperture head, and Non Return to Zero (NRZ) system were studied; (4) it was deemed necessary to reduce power consumption by evacuation or decompression as discs size and revolving speed increase; and (5) applying the measures described in the above (3) and (4), a system structure plan suitable for the target specifications could be determined. The fundamental evaluation test demonstrated that there was no notable deterioration on laser diodes or photodiodes, no functional problem on photomagnetic disc media, or no effects on recording magnetic substrate. (Author (NASDA))

A92-54455 Parallel neighborhood operation system by optical parallel logic gate and optical interconnection with prisms. KENJI UYEYAMA and TAKUMI MINEMOTO, *Japanese Journal of Applied Physics, Part 1* (ISSN 0021-4922), Vol. 31, No. 7, July 1992, pp. 2126-2132. 15 Refs.

A system which can perform iterative parallel neighborhood operations is described. The system consists of an optical parallel logic gate, a simple multiple-imaging system, and electronic feedback circuits. The operation of the system is demonstrated by performing simple binary image processings, including dilation, erosion, edge detection, local pattern matching, and corner detection (for which a new algorithm is proposed).

A92-49607 Optical learning neural network using Selfoc microlens array. YOSHIO HAYASAKI, ICHIRO TOHYAMA, TOYOHICO YATAGAI, MASAHIKO MORI, and SATOSHI ISHIHARA, *Japanese Journal of Applied Physics, Part 1* (ISSN 0021-4922), Vol. 31, No. 5B, May 1992, pp. 1689-1693. 10 Refs.

The study proposes an optical network system with learning capabilities and a 2D architecture. This architecture is implemented by a multiple imaging system of Selfoc microlens arrays, which makes it possible to develop a compact optical neural network system. Synaptic weights of neurons are memorized in a Pockels readout optical modulator and the system obtains the learning capabilities. Experimental verification of multiple imaging and learning is presented. In the experiments, the neural network system stores the three patterns by an orthogonal learning method. The performance of the optical neural network system is evaluated in terms of a point spread function of the Selfoc microlens.

A92-49605 Parallel optical Walsh expansion in a pattern recognition preprocessor using planar microlens array. KIMIO MURASHIGE, ATSUSHI AKIBA, TOSHIHIKO BABA, and KENICHI IGA, *Japanese Journal of Applied Physics, Part 1* (ISSN 0021-4922), Vol. 31, No. 5B, May 1992, pp. 1666-1671. 13 Refs.

A parallel optical processor developed for a pattern recognition system using a planar microlens array and a Walsh orthogonal expansion spatial filter is developed. The parallel optical Walsh expansion of multiple images made by the planar microlens array with good accuracy, which assures 99-percent recognition of simple numeral characters in the system, is demonstrated. A novel selection method of Walsh expansion coefficients is proposed in order to enlarge the tolerance of the recognition rate against the deformation of input patterns.

A92-47824 Nonlinear behavior of twin-stripe semiconductor lasers and its application to optical logic operations. MASANOBU WATANABE, *Electrotechnical Laboratory, Researches* (ISSN 0366-9106), No. 934, Jan. 1992, 97 pp. 98 Refs.

Results are presented on computed light-current nonlinearity of a twin-stripe laser with 2-micron-wide anode stripes separated by 3 microns. The mechanism of the nonlinearity including negative differential efficiency is explained on the basis of the peculiar lateral-mode behavior observed. The computed results, particularly on the mechanism of nonlinearity, are verified by experimental results including light current characteristics, near- and far-field patterns, and spectra measured systematically as functions of the injected-current ratio and the interstripe etching depth. The properties of an optical tristable device realized by adding a positive feedback circuit to a twin laser with light-current nonlinearity are described. Results of computer simulations show that a symmetrically pumped twin-stripe laser can generate cross-coupled lateral modes.

A92-49604 Two-dimensional optical buses for massively parallel processing. SHIGERU KAWAI and MASANORI MIZOGUCHI, *Japanese Journal of Applied Physics, Part 1* (ISSN 0021-4922), Vol. 31, No. 5B, May 1992, pp. 1663-1665. 8 Refs.

Optical interconnections using two-dimensional waveguides are presented. Light beams whose incident angles are greater than the critical angle of a waveguide can propagate within that waveguide, which behaves as an optical bus. Such optical buses are suitable for massively parallel processing because they have a large number fan-outs and no skew. Estimated propagation distance in the waveguides is roughly 500 mm. One to several hundred interconnections may be achieved. Glass plates with concave lenses are used to demonstrate bus operations. (Author)

A92-48337 Self-scanning light-emitting device (SLED) using npnp thyristor structure. YUKIHIISA KUSUDA, KIYOSI TONE, SHUHEI TANAKA, and KEN YAMASHITA, *Japanese Journal of Applied Physics, Part 1* (ISSN 0021-4922), Vol. 31, No. 5A, May 1992, pp. 1280-1286. 13 Refs.

A new functional optoelectronic device, the 'self-scanning light-emitting device (SLED)' is proposed and demonstrated. The SLED consists of light-emitting thyristors whose turn-on voltages interact with each other through the resistor network. The SLED acts as an optical shift register, and the light-emitting element is automatically transferred by input clock pulses. GaAs SLED operation is successfully demonstrated using three-phase transfer clock pulses, and 3 MHz is obtained as the maximum transfer rate. The diode-coupled SLED, where the turn-on voltages of the thyristors interact through the pn diode in order to obtain the transfer operation driven by a two-phase clock pulse, is proposed. The SLED has several unique functions and will become a new key device in the optoelectronic field and in optical information processing. (Author)

A92-37796 Optical image processing using liquid crystal panels. YASUYUKI HANAZAWA, and TATSUO UCHIDA, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 31, No. 3B, March 15, 1992, pp. L349-L351. 6 Refs.

The authors have already proposed an optical parallel logic device using two liquid crystal panels and three color polarizers with suitable absorption property. This device can execute all sixteen types of binary logic by changing the wavelength and direction of polarization of incident light. In this paper, the authors propose an optical parallel logic device in which the number of wavelengths required for the operation is decreased from four to three, thereby eliminating the need for a steep absorption edge for the color polarizers, which enables the use of commercially available color polarizers. (Author)

A92-32428 A new optical neuron device for all-optical neural networks. KOJI AKIYAMA, AKIO TAKIMOTO, MICHIOHITO MIYAUCHI, YASUNORI KURATOMI, JUNKO ASAYAMA, and HISAHITO OGAWA, (Japan Society of Applied Physics, International Conference on Solid State Devices and Materials, Yokohama, Japan, Aug. 27-29, 1991) *Japanese Journal of Applied Physics, Part 1* (ISSN 0021-4922), Vol. 30, Dec. 1991, pp. 3887-3892. 9 Refs.

A new optical neuron device has been developed. The device can perform both summation and thresholding operations in optics, and consists of a PIN a-Si:H photoreceptor, aluminum neuron electrodes and a ferroelectric liquid crystal light modulator. The a-Si:H photoreceptor shows characteristics of an ideal quantum efficiency and a good linearity. The optical neuron device exhibits a response time of about 30 microns for incident light power of 9 microW and a contrast ratio of 300:1. Using this neuron device, a lenslet array and a memory mask, an all-optical neural network has been constructed. The network demonstrates an associate memory function on purely optical parallel processing without any help from electric computation. (Author)

A92-14028 Application of fiber optic components to a data bus. TSUYOSHI SUGAWA, YASUNORI MURAKAMI, and KUNIO TABE, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 39, No. 452, 1991, pp. 457-464.

The fundamentals and performance characteristics of optical fiber communication are addressed. The system design of an optical communication network is discussed, and the development of the optical transmitter and receiver, and of the nonlinear optical coupler is outlined.

A91-11657 Experimental demonstration of optical three-layer neural network. NOBUYUKI KASAMA, YOSHIO HAYASAKI, TOYOHICO YATAGAI, MASAHIKO MORI, and SATOSHI ISHIHARA, (International Commission for Optics, Japan Society of Applied Physics, and Optoelectronic Industry and Technology Development Association, International Topical Meeting on Optical Computing, Kobe, Japan, Apr. 8-12, 1990) *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 29, Aug. 1990, pp. L1565-L1568. 8 Refs.

An optical three-layer neural network using a microchannel plate spatial light modulator is demonstrated. The back-propagation learning algorithm is used to calculate optimum weight matrices. Experimental results on learning of exclusive OR operation are presented. (Author)

A92-17420 Optical logic element using ferroelectric liquid crystal with electrical feedback. HIROSHI MORITAKE, AKIRA TAGAWA, MASANORI OZAKI, and KATSUMI YOSHINO, (Ferroelectric materials and their applications; Proceedings of the 8th Meeting, Kyoto, Japan, May 29-31, 1991. A92-17401 05-76) *Japanese Journal of Applied Physics, Part 1* (ISSN 0021-4922), Vol. 30, Sept. 1991, pp. 2373-2376. 9 Refs.

Optical bistability in surface-stabilized ferroelectric liquid crystal (SSFLC) with an electrical feedback has been studied. The hysteresis in the transmission-voltage curve which is characteristic of SSFLC is found to contribute to the expansion of the optical bistable region. Dynamic characteristics of the switching between optical bistable states by an incident light pulse have also been studied. A new multilogic element with both OR and AND functions which can be selected by controlling the duration of the reset light pulse can be realized. (Author)

A91-32793 Design of optically coupled three-dimensional content addressable memory. HIROSHI OKANO, HIROKAZU TAKATA, REIJI AIBARA, SHIN YOKOYAMA, KIYOMI HATA et al., *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 30, March 1, 1991, pp. L338-L341.

An optically coupled three-dimensional content addressable memory is newly proposed and an example of parallel data processing systems with this memory is described. The new memory employs the optically coupling flip-flop with LEDs and photoconductors for optical data transfer. The optically coupling flip-flop is optimized in design for achieving a high data transfer rate. Simultaneous data inspection through several memory layers can be implemented by using the optically coupled three-dimensional content addressable memory. (Author)

A91-18318 Optical configurations for solving equations using nonlinear etalons. XUNONG LU, TOSHIO HONDA, NAGAAKI OHYAMA, MIXIAN WU, and GUOFAN JIN, *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 29, Oct. 1990, pp. L1836-L1839. 6 Refs.

Based on the characteristics of ZnSe optical bistable etalons, an all-optical parallel method which can add multiple input laser beams and perform the multiplication of two multibit binary numbers is proposed. By changing the mounted angles of nonlinear etalon devices, more complicated functions can be obtained. With the use of these functional systems, the possibility of solving linear equations mainly based on iterative methods is then described. Some simple experimental results are also presented. (Author)

A91-10779 Beam scanning binary logic. HIDEO ITOH, SEIJI MUKAI, MASANOBU WATANABE, MASAHIKO MORI, and HIROYOSHI YAJIMA, (International Commission for Optics, Japan Society of Applied Physics, and Optoelectronic Industry and Technology Development Association, International Topical Meeting on Optical Computing - OC'90, Kobe, Japan, Apr. 8-12, 1990) *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 29, July 1990, pp. L1268, L1269. 6 Refs.

A beam-scanning laser diode (BSLD) is presently applied to a novel optoelectronic logic operation, designated 'beam-scanning binary logic' (BSBL), that covers the implementation of both the basic logic gates and a spatial code encoder for photodetection, while allowing a greater reduction of the number of active devices than ordinary binary logic operations. BSBL executes multifunctional logic operations simultaneously. The data connections between logic gates in BSLD are flexible, due to the ability to electrically control both output power and laser-beam direction.

A91-10769 Microchannel spatial light modulator using liquid crystal for modulating material. NAOHISA MUKOHZAKA, TSUTOMU HARA, and YOSHIO SUZUKI, (International Commission for Optics, Japan Society of Applied Physics, and Optoelectronic Industry and Technology Development Association, International Topical Meeting on Optical Computing - OC'90, Kobe, Japan, Apr. 8-12, 1990) *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 29, July 1990, pp. L1227-L1230.

Optical parallel processing is an attractive technique for treating today's vast quantities of information in parallel. In this field, a spatial light modulator which modulates the light in two dimensions is required. A microchannel spatial light modulator (MSLM) using LiNbO₃ for a modulating material has been developed. However, it has physical limitations in readout light intensity, the spatial resolution and operating speed. In order to improve the characteristics of MSLM, liquid crystal (LC) is adopted for the modulating material. In this paper, the structure of the device and the operating principle are explained. The basic experimental results of the device are also shown. (Author)

A91-10795 Optical implementation of semantic networks based on association. YOSHIO HAYASAKI, NOBUYUKI KASAMO, TOYOHICO YATAGAI, MASAHIKO MORI, SATOSHI ISHIHARA et al., (International Commission for Optics, Japan Society of Applied Physics, and Optoelectronic Industry and Technology Development Association, International Topical Meeting on Optical Computing - OC'90, Kobe, Japan, Apr. 8-12, 1990) *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 29, July 1990, pp. L1321-L1324. 8 Refs.

An optical system combining a semantic network technique and an associative network architecture is presented. In the optical implementation of the associative system, an MSLM (microchannel spatial light modulator) is used to store an optimum weight matrix. The optimum weight matrix is calculated by a dynamic learning rule. (Author)

A91-10794 Shift-invariant associative memory based on anamorphic incoherent correlator. MASATO TAKINO, NORIHITO OHTSU, and TOYOHICO YATAGAI, (International Commission for Optics, Japan Society of Applied Physics, and Optoelectronic Industry and Technology Development Association, International Topical Meeting on Optical Computing - OC'90, Kobe, Japan, Apr. 8-12, 1990) *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 29, July 1990, pp. L1317-L1320. 9 Refs.

An architecture of an optical associative memory based on 1-D incoherent correlation using an anamorphic optical system is proposed. The proposed associative memory system has a shift-invariant feature because cross correlation is used in the recording and recalling processes. Computer simulation of the shift invariance for the proposed associative memory system is described. To increase memory capacity, a position separation method is proposed. Experimental verification of autoassociation is presented. (Author)

A91-10778 Optical logic operations using three-beam phase-conjugate interferometry. MASAHIRO OGUSU, SHUN-ICHI TANAKA, and KAZUO KURODA, (International Commission for Optics, Japan Society of Applied Physics, and Optoelectronic Industry and Technology Development Association, International Topical Meeting on Optical Computing - OC'90, Kobe, Japan, Apr. 8-12, 1990) *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 29, July 1990, pp. L1265-L1267. 5 Refs.

An experimental arrangement of the three-beam phase conjugate interferometer is proposed in which a phase of any of the three signal beams is easily and independently controlled by the small rotation of a mirror set in each optical path, and its performance is reported. Using this arrangement, several optical logic operations of two binary patterns, such as XOR, OR, XOR(bar), and NAND, are demonstrated. (Author)

A91-10777 An approach to the optical MSD adder (Modified signed-digit number system). HIDEYA TAKAHASHI, KENJI MATSUSHITA, and EIJI SHIMIZU, (International Commission for Optics, Japan Society of Applied Physics, and Optoelectronic Industry and Technology Development Association, International Topical Meeting on Optical Computing - OC'90, Kobe, Japan, Apr. 8-12, 1990) *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 29, July 1990, pp. L1262-L1264.

The intrinsic parallelism of optical elements for computation is presently taken fuller advantage of than heretofore possible through an optical implementation of the modified signed digit (MSD) number system, which yields carry-free addition and subtraction. In the present optical implementation of the MSD system, optical phase data are used to preclude negative value representation. Attention is given to an MSD adder array for addition operations on two n-digit trinary numbers; the output is composed of $n + 1$ trinary digits.

A91-10775 Neighborhood operations of optical parallel processor. MASASHI HASHIMOTO, KEN-ICHI KITAYAMA, and NAOHISA MUKOHZAKA, (International Commission for Optics, Japan Society of Applied Physics, and Optoelectronic Industry and Technology Development Association, International Topical Meeting on Optical Computing - OC'90, Kobe, Japan, Apr. 8-12, 1990) *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 29, July 1990, pp. L1256-L1258.

An optical shifter for pixelwise optical shifting of patterns is presently introduced into a polarization encoding-based optical parallel processor, in order to achieve neighborhood operations. The optical filter may be implemented by means of an acoustic deflector, a spatial light modulator, or mechanical devices; a mechanical shifter is presently employed. Such operations as edge extraction, for a binary pattern based on the sequential operation of a logical sum of XORs, are demonstrated.

A91-10774 Integrated optic digital vector processor using parallel collinear acousto-optic interactions. NOBUO GOTO, YUKIHIRO KANAYAMA, and YASUMITSU MIYAZAKI, (International Commission for Optics, Japan Society of Applied Physics, and Optoelectronic Industry and Technology Development Association, International Topical Meeting on Optical Computing - OC'90, Kobe, Japan, Apr. 8-12, 1990) *Japanese Journal of Applied Physics, Part 2* (ISSN 0021-4922), Vol. 29, July 1990, pp. L1252-L1255. 11 Refs.

An integrated optic processor to multiply vectors or matrices using multiple collinear acoustooptic interactions is proposed. When 200 wavelength-multiplexed signals are used to represent a 200-component vector, the processing rate to multiply a (200 x 200) matrix with a vector can be 9.8 billion OPS in a 16-bit number representation. A demonstration of a 2 x 2 processor is shown by an experiment with a channel-waveguide-type module. (Author)

A91-11662 An optical parallel computing system with electronic feedback circuits. JING CHEN, KENJI UYEYAMA, KAZUAKI YOSHIDA, YASUHIRO YANAGI, and TAKUMI MINEMOTO, *Japanese Journal of Applied Physics, Part 1* (ISSN 0021-4922), Vol. 29, Aug. 1990, pp. 1474-1478.

A hybrid optical computing system consisting of an optical parallel logic gate and feedback loops has been developed. Pockels readout optical modulator devices are used as spatial light modulators in the gate. The feedback loops consist of electronic circuits. The system can perform various repeated parallel computations, and experimental results of several logic operations can be obtained.