FD5. Transient Response and Time Evolution of Two-Dimensional Solutions of Optical Computing in a Coherent Processor with Feedback. R. Akins and S. H. Lee, Department of Electrical Engineering and Computer Sciences, University of California at San Diego, La Jolla, Calif. 92093.—The transient response of a confocal Fabry–Perot (coherent optical processor with feedback) has been experimentally studied over the time period from the moment light first enters the system to when steady state operation is established. To facilitate this transient response study, a Blumlein-driven electro-optic gate was constructed to provide a square diagnostic pulse with nanosecond rise and fall time and up to 200-nsec duration, as the characteristic circulation time through the processor is in the 10-nsec regime. Light at several discrete points of the two-dimensional (2-D) output was measured sequentially with a high-speed avalanche photodiode and displayed on a fast oscilloscope. The entire 2-D optical output as a function of time was also obtained by incorporating a linear phase-shifting wedge inside the confocal Fabry–Perot at an appropriate location to provide spatial separation to the successive 2-D outputs corresponding to sequential circulation inside the Fabry–Perot. Such experimental studies reveal interesting phenomena related to the evolution of an optically computed solution of a partial differential equation that is due to (1) consecutive additions of the feedback cycles, (2) feedback polarity, and (3) the processing or filtering functions inside the confocal Fabry–Perot. (13 min.)

FD6. Optical Reconstruction of Coded Aperture Images. G. Indebetouw and W. P. Shing, Department of Physics, Virginia Polytechnic Institute and State University, Blacksburg, Va. 24061.—Several codes, featuring improved autocorrelation properties, have been recently studied by several authors for coded aperture imaging. Most often, the reconstruction of the coded image is computed digitally. We are studying the use of a scanning optical correlator to reconstruct such images. This technique may offer some advantages, especially when the data are voluminous and are available on film. The decoding is performed at frame rate by scanning the coded image with a light amplitude distribution representing the decoding array. Either a spatially integrating or a pinhole detector can be used, leading to, respectively, an incoherent system with high immunity to noise or a coherent system allowing for spatial filtering and for using a complex point spread function. The detected signal is then used to modulate a display. The possibility of using an electronic loop here enhances the system’s flexibility. Some preliminary results and simulations using several different codes will be presented and compared. (13 min.)

FD7. Two Cellular Structures for Real-Time Spatial Light Modulators. Ravindra A. Athale and S. H. Lee, Department of Electrical Engineering and Computer Sciences, University of California at San Diego, La Jolla, Calif. 92093.—The important role of real-time spatial light modulators (SLM’s) in optical processing is well known.1 The liquid crystal light valve and Photo Titus are two examples of relatively well developed SLM’s. The detector and the electro-optic material in these two SLM’s are optically isolated from each other by a light-blocking layer and a dielectric mirror. In this paper we describe two new SLM structures in which optical isolation is attained by spatially separating the detectors from the modulators within one resolution cell of a two-dimensional array. Electrically, the detector part of the cell controls the light intensity transmitted through the modulator part of the cell. The attractive features of these structures are (1) better control over input/output response of SLM by controlling the impedance matching conditions between the detector and modulator, which are dependent on the shape of the cellular electrode, and (2) wider choice of detection and modulation mechanisms by utilizing the effects of transverse or longitudinal electric fields across the detector and modulator. Experimentally, devices with these new structures have been fabricated by using CdS as the photococonductor and a twisted nematic liquid crystal as the electro-optic modulating material. We studied the effects of these new structures on the input-output responses of the devices and used these devices to demonstrate binary logic and thresholding (with an adjustable threshold level) and bistable operation.2 (13 min.)

* Now at U.S. Naval Research Laboratory, Code 6030, Washington, D.C. 20375.


FRIDAY, OCTOBER 30, 1981

DAVID G. GOEBEL, Presider

PINE HILLS, 9:00 A.M.

Optical Detectors

Contributed Papers

FE1. Absolute Spectral Irradiance Measurements Based on a Self-Calibrated Silicon Photodiode. Edward F. Zalewski and Warren K. Gladden, Radiometric Physics Division, National Bureau of Standards, Washington, D.C. 20234.—We will describe the direct calibration of the absolute spectral response over the slit function of a monochromator-based spectroradiometer. This technique employs a self-calibrated silicon photodiode as the basis of the traceability to absolute SI units. Also to be discussed is the accuracy of the measurement of the spectral irradiance of a lamp using this technique and the comparison to conventional blackbody-based techniques. (13 min.)

FE2. Linearity Effects on Silicon Self-Calibration. A. Russell Schaeffer and Edward F. Zalewski, Radiometric Physics Division, National Bureau of Standards, Washington, D.C. 20234.—In conjunction with the National Bureau of Standards program to intercompare the calculated synchrotron radiant flux emitted from SURF II with that measured by using a silicon filter radiometer, one of the most critical elements is the linearity of response of the photodiode used for determining the electron beam current in the storage ring. In order to minimize the difference in flux levels between that used in the direct electron-counting determination of the beam current and the flux level necessary for the silicon filter radiometer measurement, the silicon self-calibration must be performed at as low a flux level as possible. Techniques and implications upon detector linearity and how they relate to the physics of the silicon photodiode self-calibration method will be discussed. (13 min.)

FE3. Silicon Photodiode Response as a Function of the Angle of the Incident Beam. Warren K. Gladden and Edward F. Zalewski, Radiometric Physics Division, National Bureau of Standards, Washington, D.C. 20234.—We investigated the variation of silicon photodiode response with incident angle of radiation at the He-Ne laser wavelength. Since corrected response is proportional to internal quantum efficiency, a theoretical analysis of its angular variation is presented. This analysis shows the internal quantum efficiency to be negligible at the 1% level, and the experimental measurements presented are in good agreement with the theory. The effect of detector response nonlinearity is also discussed. (13 min.)

FE4. Withdrawn.
FE5. Responsivity and Noise Characteristics of a HgCdTe Photodetector at High Flux Levels. KATHERINE CREATHE, PAUL NARUM, AND ROBERT W. BOYD, The Institute of Optics, University of Rochester, Rochester, N.Y. 14627.—We present laboratory measurements of the response and noise characteristics of a Hg0.8Cd0.2Te photodetector. The detector was operated over a range of flux levels from 10^15 to 10^19 photons/cm^2/sec. The response shows significant departures from linearity at the higher flux levels. The noise measurements show that the generation-recombination process contributes to the predominant noise source in this detector system. At high flux levels an excess noise that is due to the Bose-Einstein nature of the radiation field also contributes to the system noise. (13 min.)

FE6. Withdrawn.

FE7. A Room Temperature Subnanosecond Infrared Detector Using Semiconducting Diamond. JEFF F. YOUNG, L. A. VERMEULEN,* AND H. M. VAN DRIEL, Department of Physics, University of Toronto, 60 St. George Street, Toronto, Ontario, Canada MSS 1A7.—We have performed room temperature time-resolved measurements of the photoconductive response of natural and synthetic semiconducting diamonds using 1-6-μm 20-ps pulses from a mode-locked Nd:YAG laser. The measurements were obtained from a coaxial SMA transmission line by using a technique similar to that developed by Auston et al.1 For a boron acceptor concentration of 2.6 × 10^16 cm^-3 and a nitrogen donor concentration of 1.5 × 10^15 cm^-3, a material-limited time response of ~150 psec is observed, yielding a hole recombination cross section of 4 × 10^-13 cm^2. This cross section is similar to that observed for various extrinsic germanium infrared detectors. However, because the impurity ionization energy in these latter detectors is typically less than 0.1 eV, cryogenic cooling is required. With semiconducting diamond that has an acceptor activation energy of 0.35 eV, we have observed fast room temperature photoconductive response for 0.4 ≤ λ ≤ 4.3 μm. The detectivity and saturation characteristics of the detector will be discussed. (13 min.)

* Department of Physics, University of Witwatersrand, South Africa.

FE8. Calorimetry at 10.6 μm Using BeO as an Absorber. JON E. SOLLID, CHRISTOPHER W. BJORK, AND STEPHEN J. LEVINGS, Los Alamos National Laboratory, MS-533, Los Alamos, N.Mex. 87545.—The use of beryllium oxide as the radiation absorbing element in isoperibol calorimeters has two advantages. First, hybrid circuit fabrication techniques can be used to apply solder pads for the desired number of thermocouples. This eliminates the need for thermally conducting epoxies, which are expensive, require 4-8 h curing time, and contribute nonlinear thermal properties. Second, with the same techniques, calibration resistors can be sintered directly onto the BeO substrate to allow electrical heating with known energy. Inked thermocouple material can also be used. However, metallic thermocouples (chromel-constantan) were chosen in this application for their high responsivity (60.2 μV/K). These calorimeters may be used for any radiation that deposits energy in the BeO. They have been used for protons as well as for 10.6-μm radiation. At 10.6 μm their sensitivity is about 1 mV/J. Their sensitivity to electrically deposited heat is about twice as high, showing that the effective absorptivity of the BeO for 10.6-μm radiation is approximately 0.5. The absorbing BeO wafer is 32 mm square and 0.25 mm thick. The cooling mechanism for these pulse-measuring calorimeters is primarily radiative. To within 2% they behave as ideal isoperibol calorimeters. The maximum irradiance at which surface flashing occurs is about a gigawatt per square centimeter. (13 min.)

FE9. Mechanism of Infrared Laser Sensitization of Photographic Film. D. NAOR, A. PLUSBERG, AND I. ITZKAN, Acco Everett Research Laboratory, Inc., 2385 Revere Beach Parkway, Everett, Mass. 02149.—Recently, it was reported that pulsed IR laser irradiation can sensitize ordinary silver halide photographic emulsions so that irradiation by a subsequent visible pulse permits visualization of the IR laser fluence distribution. We have determined that the mechanism by which sensitization occurs is through heating. In the high-intensity reciprocity failure (HIRF) regime the sensitivity of photographic emulsions to visible light increases with increasing temperature, and the degree of sensitization depends on the visible wavelength. Observing a striking similarity between the spectral sensitization that is due to heating and IR (10.6 μm) irradiation, we performed a series of experiments designed to demonstrate that the response of the emulsion is determined by the equations of heat diffusion. Experimental results confirm that is indeed the case. By using the visible spectral range, which optimizes sensitization, we have extended this IR visualization technique to the fluence range 10 mJ/cm^2 to 1 J/cm^2 and have calibrated various emulsions to permit quantitative measurements. We have demonstrated 50-line/mm resolution limited only by heat diffusion. Since HIRF temperature response is known to be a function of sensitizer, it is likely that the range of detectable fluence may be extended by the use of temperature-sensitive sensitizers in the emulsion. (13 min.)