L.E. Atlas, J.A. Ritcey, K.F. Cheung and R.J. Marks II,
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When the range of this distribution is $<150°$ the percept appears to be that of a rotating cylindrical volume whose axis of rotation is along the mean of the distribution. When the range of the distribution is $>150°$ there is no 3-D percept. As the directional distribution of the stimulus is slowly changed, the occurrence and loss of the 3-D percept shows hysteresislike behavior. This behavior is not altered by large changes in dot density or display area, suggesting a form of local cooperativity. Our results are discussed in the context of cooperative interactions that may be involved in the recovery of structure from motion. **(12 min)**

Monday **MORNING**

20 October 1986 **MJ**

SHAW ROOM

10:00 AM **Pattern Recognition: 2**

Sing H. Lee, University of California at San Diego, Presider

MJ1 Improving the performance of composite matched filters

LES E. ATLAS, JAMES A. RITCEY, KWAN F. CHEUNG, ROBERT J. MARKS II, U. Washington, Department of Electrical Engineering, Seattle, WA 98195.

A composite matched filter (CMF) bank requires fewer filters than a conventional matched filter bank. Indeed, the reduction is logarithmic. When the CMF output can take on either a logic one or a logic zero, we demonstrate that the bipolar CMF with an output threshold of zero many times outperforms the binary CMF where thresholding is normally performed halfway between zero and logic one.[1] For equally likely orthogonal library elements embedded in white Gaussian noise, the bipolar CMF is shown to yield minimum probability of error. A further advantage of the bipolar CMF is that the detection performance is invariant with respect to multiplication of the input by a positive constant. For optical implementation, a disadvantage of bipolar over the binary CMF is the design requirement of bipolar output encoding. **(12 min)**

1. R. J. Marks II and L. E. Atlas, "Image Recognition with Inexact Processing," in *Proceedings, ICASSP 86*, Tokyo, pp. 1461–1464.

MJ2 Real-time image recognition by partially coherent light

BAHRAM JAVIDI, Pennsylvania State U., Electrical Engineering Department, University Park, PA 16802.

A real-time image recognition system that can perform complex signal detection under partially coherent illumination is presented. The unique features of the correlator are that the target under study may be a diffusely illuminated real object, and the real-time correlation signal is produced using a narrowband extended light source. The system employs an optical correlator used with a spatial light modulator (liquid crystal image transducer). Pattern recognition experiments using naturally illuminated real objects are provided and the effects of partially coherent illumination on the spatial phase variations in the output wavefront of the device are investigated. Such nonuniformities may arise from nonflatness and mismatch of various output layers in some liquid crystal image transducers which can degrade the performance of the correlator. The experimental results indicate that the distortion effects present in the output surface of the device can be reduced by relaxing the coherence requirements of the system. A quantitative analysis is presented to study the effects of partially coherent illumination on the real-time correlation signal. **(12 min)**

MJ3 Performance of conventional and composite matched filters with error correction

CHARLES GREEN, KWAN F. CHEUNG, LES E. ATLAS, ROBERT J. MARKS II, U. Washington, Department of Electrical Engineering, Seattle, WA 98195.

Computationally, composite matched filters (CMF) require logarithmically fewer operations than conventional matched filters.[1] In cases where the conventional matched filter is optimal, however, the corresponding CMF is not. The performance of the CMF can be enhanced by the addition of redundant computation for error correction purposes. We accomplish this with the use of linear error correcting block codes. The performance of these augmented CMFs is compared with that of the conventional matched filter both analytically and by simulation. **(12 min)**

1. B. Braunecker, R. Hauck, and A. W. Lohmann, "Optical Character Recognition Based on Nonredundant Correlation Measurements," Appl. Opt. **18,** 2746 (1979).

MJ4 Polychromatic real-time pattern recognition using a liquid crystal television

FRANCIS T. S. YU, T. W. LIN, S. JUTAMULIA, Pennsylvania State U., Electrical Engineering Department, University Park, PA 16802.

Recently, the low-cost black-and-white liquid crystal TV has been applied to real-time optical signal processing. In this work a color liquid crystal TV was used as a spatial light modulator to perform polychromatic real-time pattern recognition. The pixel structure of the LCTV display panel provides multiple Fourier spectra of the input signal. An individual polychromatic Fourier spectrum consists of several colors corresponding to the polychromatic light used. Particular color filters were placed prior to the individual Fourier spectrum in order to synthesize monochromatic holographic matched spatial filters. The phase variation of the display panel obscures the spatial-invariant processing to a certain degree. However, two-color optical correlation has been performed successfully in a simple polychromatic pattern recognition. **(12 min)**

MJ5 Image recognition in the presence of speckle

JOSEPH MARRON, Environmental Research Institute of Michigan, P.O. Box 8618, Ann Arbor, MI 48107; G. MICHAEL MORRIS, U. Rochester, Institute of Optics, Rochester, NY 14627.

Techniques for performing digital image recognition on speckled images are presented. Rather than performing speckle reduction, the speckled image is correlated directly with a reference function. Statistical properties of the correlation value are derived using the multiplicative noise model for image plane speckle. It follows that the correlation value is a Gaussian random variable. Statistical detection theory dictates that images are distinguishable when the standard derivations of the correlation values are small compared to the separation of the mean values. Several reference functions are considered for both intensity correlation and correlation for which the input speckled images are clipped. One reference function considered is the incoherent image of the desired object: another is the maximum-likelihood reference function. Experiments performed on planar rough objects indicate good agreement between theory and experiment. The best ability to discriminate is obtained using the maximum-likelihood reference function. **(12 min)**

Monday **MORNING**

20 October 1986 **MK**

NISQUALLY ROOM

10:00 AM **Radiometry**

Michael Hercher, Optra, Inc., Presider

MK1 Radiometry as a short-wavelength limit of phase-space representation of statistical wavefields

J. T. FOLEY, Mississippi State U., Physics Department, Mississippi State, MS 39762; GOVIND S. AGARWAL, U. Hyderabad, School of Physics, Hyderabad-500 134, India; EMIL WOLF, U. Rochester, Department of Physics & Astronomy, Rochester, NY 14627.

Attempts to elucidate the foundation of radiometry have up to now met with limited success. It was found, for example, that although many different functions exhibiting some of the properties of the radiance may be defined within the framework of second-order correlation theory of statistical wavefields, none of them satisfies all the basic postulates of radiometry.[1] We show that the various definitions are different phase-space representations of the cross-spectral density.[2] The particular form depends on the choice of a mapping function from configuration space to phase space.[3] We also show that, in the short-wavelength limit, different generalized radiance functions of a quasi-homogeneous source reduce to the same quantity, recently discussed elsewhere,[4] which may be identified with the radiance of traditional radiometry. **(12 min)**

1. A. T. Friberg, J. Opt. Soc. Am. **69,** 192 (1979).
2. E. Wolf, J. Opt. Soc. Am. **68,** 6 (1978), Sec. IV.
3. G. S. Agarwal and E. Wolf, Phys. Rev. D **2,** 2187 (1970); **2,** 2161 (1970).
4. J. T. Foley and E. Wolf, Opt. Commun. **55,** 236 (1985).

MK2 Spectral irradiance scales based on filtered absolute silicon photodectors

ROBERT J. BRUENING, U.S. National Bureau of Standards, Metrology, Gaithersburg, MD 20899.

A scale of spectral irradiance has been realized for the 400–700-nm wavelength range based on absolute silicon photodetectors with wavelengths selected by interference filters. Using this equipment, an absolute radiometric scale was produced independent of the traditional approaches to absolute radiometry based on either the thermal physics of blackbodies or absolute thermal detectors. From these data, a photometric scale of luminous intensity has been realized. The detector based