Special Issue Guest Editorial

Optical Pattern Recognition

B.V.K. Vijaya Kumar, MEMBER SPIE
Carnegie Mellon University
Department of Electrical
and Computer Engineering
Pittsburgh, Pennsylvania 15213

Over the past five years, interest in optical pattern recognition appears to have increased. Possible factors include the availability of improved 2-D spatial light modulators (SLMs), new correlation filter designs, and improvements in interfacing hardware. This special issue on optical pattern recognition pulls together 18 important papers in the above areas.

The first six papers deal with various theoretical issues related to correlation filters. In the first paper, Dickey et al. propose the design of a complex ternary matched filter that can be implemented on a ternary SLM yet appears to yield signal-to noise ratios close to those obtained with the matched filters. This is followed by a paper by Ersoy et al. on the advantages of nonlinear matched filtering where both input signal and reference signal transforms are subjected to nonlinear operations. Javidi's paper compares the performance of nonlinear joint transform correlators with nonlinear frequency plane correlators. While these three papers are concerned with the recognition of a known image (with no distortions), the next three papers deal with distortion-invariant optical pattern recognition. Sudharsanan et al. present elegant space-domain techniques for synthesizing composite filters yielding sharp correlation peaks and good noise tolerance. In the fifth paper, Gheen discusses the underlying geometrical aspects of low clutter, distortion-invariant correlation filters with the help of linear vector spaces. The final paper in this group, by Hassebrook et al., suggests the use of banks of linear phase coefficient composite filters for distortion-invariant optical pattern recognition.

The next four papers deal with important aspects related to the practical implementation of correlators. The paper by Lindell and Flannery discusses the results of an experimental investigation of the use of transform ratio ternary phase-amplitude filters. An issue often ignored is what to do once correlation outputs are produced optically. Walsh and Giles discuss the role of statistical analysis of correlation peaks in distortion-invariant pattern recognition. This is followed by a paper by Chiou and Yeh describing a novel optical method for selectively enhancing images with specific symmetry. While 2-D SLMs are still being improved, 1-D acousto-optics devices represent a mature technology. Molley and Stalker discuss methods as well as experimental results in using AO devices for various image recognition applications.

The last eight papers deal with various aspects of the joint transform correlator (JTC) technique. In the first of these, Fielding and Horner describe a JTC architecture requiring only one focal length and only binary SLMs. This is followed by a discussion of some new binarization techniques for the JTC by Rogers et al. The paper by Davis et al. explores the reasons for a number of anomalies usually observed in the output of a JTC. Rosen et al. present iterative learning procedures that can be employed to generate synthetic reference patterns for use in JTCs. The next paper, by Lu et al., presents the results obtained from a compact optical neural network of 64 neurons using Kohonen's self-organizing feature map algorithm for unsupervised learning. The use of JTC in adaptive tracking of moving targets is explored in the paper by Yu et al. The last two papers in this group present very important hardware details for the implementation of JTCs. Kirsch and Gregory present the details of a new video driver developed for the magneto-optic SLM. Finally, the paper by Loudin et al. presents experimental results from a single SLM hybrid digital/optical joint transform correlator.

I believe that the above collection of papers presents a unique view of the current research activity in optical pattern recognition. A special issue like this would not be possible without the help of many people. First, I would like to thank all of the authors for contributing their work and meeting the various deadlines. I would like to thank my secretary, Anne Simpson, for taking care of the logistics on our end, the editorial staff at *Optical Engineering* for their professional support, and Jack Gaskill for providing this opportunity. Finally, I would like to acknowledge the help of the 36 reviewers in evaluating the manuscripts.

B.V.K. Vijaya Kumar received his bachelor of technology and master of technology degrees in electrical engineering from the Indian Institute of Technology, Kanpur, in 1975 and 1977, respectively. After completing his Ph.D. in electrical engineering at Carnegie Mellon University (CMU) in 1980, he worked there for two years as a research associate. He is currently an associate professor in the Department of Electrical and Computer Engineering at CMU. His research interests are primarily in optical pattern recognition, magnetic recording, and neural networks. Professor Kumar has published about 120 technical papers in the above areas and in listed in *Marquis's Who's Who in Optical Sciences and Engineering*. He is a topical editor for *Applied Optics* and is a member of IEEE, OSA, SPIE, Sigma Xi, and the International Neural Network Society.