

Proceedings

SPIE Volume 901

Image Processing, Analysis, Measurement, and Quality

Gary W. Hughes, Patrick E. Mantey, Bernice E. Rogowitz
Chairs/Editors

part of
SPSE's International Symposium and Exposition on
Electronic Imaging Devices and Systems '88

Andras I. Lakatos
General Chair



Sponsored by
SPSE—The Society for Imaging Science and Technology



Cosponsored by
SPIE—The International Society for Optical Engineering

13-15 January 1988
Los Angeles, California

Published by
SPIE—The International Society for Optical Engineering
P.O. Box 10, Bellingham, Washington 98227-0010 USA
Telephone 206/676-3290 (Pacific Time) • Telex 46-7053

SPIE (The Society of Photo-Optical Instrumentation Engineers) is a nonprofit society dedicated to advancing engineering and scientific applications of optical, electro-optical, and optoelectronic instrumentation, systems, and technology.

IMAGE PROCESSING, ANALYSIS, MEASUREMENT, AND QUALITY

SPIE Volume 901

Conference Committee

Chairs

Gary W. Hughes

David Sarnoff Research Center

Patrick E. Mantey

University of California/Santa Cruz

Bernice E. Rogowitz

IBM/Thomas J. Watson Research Center

Session Chairs

Session 1—Image Acquisition

Gary W. Hughes, David Sarnoff Research Center

Session 2—Image Processing and Analysis

Patrick E. Mantey, University of California/Santa Cruz

Session 3—Spatial Vision and Spatial Sampling

Bernice E. Rogowitz, IBM/Thomas J. Watson Research Center

Session 4—Color Vision and Color Sampling

Bernice E. Rogowitz, IBM/Thomas J. Watson Research Center

Session 5—Spatial/Temporal/Color Interactions

Bernice E. Rogowitz, IBM/Thomas J. Watson Research Center

INTRODUCTION

In Image Science we share a common goal. Whether we work in creating, processing, compressing, encoding, transmitting, or displaying images, our goal is to make images that "look good." It is this common focus that unified the three sessions in the Image Measurement and Quality symposium. In this symposium, we explored the relationship between the physical properties of visual displays and how we perceive them. This is the classic problem of visual psychophysics, to uncover the laws that relate the physical energies of our world, on the one hand, and human sensation and perception, on the other.

Visual psychophysics provides a body of knowledge about the perception of stimuli that vary in luminance, contrast, spatial frequency, velocity, hue, etc. This descriptive and predictive understanding can often be applied directly to improving image quality. Visual psychophysics also provides a repertoire of experimental and theoretical tools that can contribute to the development and evaluation of new technologies (e.g., television, HDTV, coding algorithms). None of these psychophysical models, however, can simply predict the visual response to the complex spatial, temporal, and chromatic images produced on our digital displays. The new image technologies ask questions to which visual psychophysics has no answers. The purpose of the Image Measurement and Quality symposium was to explore these questions.

In organizing these sessions, my goal was to encourage an intellectual dialogue between scientists in visual psychophysics, display technology, and image processing. The papers in this proceedings are organized under three topics: Spatial Vision and Spatial Sampling, Color Vision and Color Sampling, and Spatial/Temporal/Color Interactions. Each session focuses on a topic that relates to a broad range of technologies and brings together speakers from a wide range of disciplines.

Session 3, Spatial Vision and Spatial Sampling, is primarily concerned with the visual effects of spatial sampling. Here, papers explore the physics and psychophysics of sampled images, developed metrics based on linear systems analysis to characterize image quality, and considered the particular constraints imposed by LCD, TFT-LCD, and CRT technologies for text and image display.

The Color Vision and Color Sampling, Session 4, is concerned with color representation on sampled, dynamic, and photographic displays. In this session, papers develop algorithms for minimizing the effects of color sampling, for representing image on output devices with different color gamuts, and for improving the uniformity of color spaces.

Session 5, Spatial/Temporal/Color Interactions, is concerned with interactions in the processing of spatial, temporal, luminance, and color information. In this session, new psychophysical results are presented on the importance of luminance edges for color perception, various interaction effects are discussed, and a display system based on the spatio/temporal sensitivity of human observers is presented.

I want to thank all the speakers for their contributions. The papers attracted a large, steady audience and generated interesting questions and lively discussions. I am sure you will find the written papers equally stimulating. I also want to thank Dr. Peter Haubner from Siemens for his unscheduled presentation on international visual standards for display terminals.

In many ways, the Image Measurement and Quality symposium was unusual. The attendees represented many disciplines in the Image Science community, and although many of the participants worked mainly on one technology, the concepts presented were largely technology-independent. In each session, we heard papers from several different perspectives. Each paper helped define the area of research on the frontier between vision science and image/display technology.

Bernice E. Rogowitz
IBM/Thomas J. Watson Research Center

IMAGE PROCESSING, ANALYSIS, MEASUREMENT, AND QUALITY

SPIE Volume 901

Contents

Conference Committee v
Symposium Organizers vi

SESSION 1. IMAGE ACQUISITION. 1
Introduction. 2
901-01 128 X 1024 element TDI image sensor with small, high performance pixels, R. H. Dyck, Y. S. Abedini,
J. S. Kim, K. K. Shah, Fairchild Weston Systems Inc. 3
901-03 Pictorial applications for range sensing cameras, V. M. Bove, Jr., Massachusetts Institute of Technology. 10
901-04 Robust high-speed triangulation-based ranging with orthonormal data projections, D. D. Harrison, M. P. Weir,
General Electric Co. 18
901-05 Test station for thin film electroluminescent (TFEL) edge emitter array, a potential low-cost, all solid state
imaging device, Z. K. Kun, D. Leksell, J. A. Asars, N. J. Phillips, Westinghouse Corp. 25

SESSION 2. IMAGE PROCESSING AND ANALYSIS. 33
Introduction. 34
901-08 Task specific complexity metrics for electronic vision, J. J. Carlson, J. B. Jordan, G. M. Flachs, New Mexico
State Univ. 35
901-10 Image sequence processing for target estimation in forward looking infrared imagery, Z. Mao,
R. N. Strickland, Univ. of Arizona. 44
901-37 Topological perspective on the structure of images, A. P. Blicher, IBM/Thomas J. Watson Research Ctr. 54
901-11 Registration and comparison of electronic images obtained at different times for aging studies of the
U.S. constitution, A. R. Calmes, National Archives and Records Administration; E. A. Miller, Jet
Propulsion Lab. 61
901-13 Real time vehicle recognition, A. Houghton, N. L. Seed, R. W. M. Smith, Univ. of Sheffield (UK). 65
901-14 Background updating for real-time image processing at TV rates, N. L. Seed, A. D. Houghton, Univ. of
Sheffield (UK). 73
901-15 Real-time multidirectional data compression of full motion video, N. J. Fedele, A. A. Acampora,
R. M. Bunting, David Sarnoff Research Ctr. 82
901-38 Unified approach to the change of resolution: space and grey level, M. Werman, S. Peleg, H. Rom, Hebrew
Univ. (Israel). 91
901-16 Compression of digitized images for transmission and storage applications, D. R. Ahlgren, J. Crosbie,
D. Erigat, Telephoto Communications. 105
901-17 Color coding stereo pairs for noninterlaced displays, P. Chesnais, W. Plesniak, Massachusetts Institute
of Technology. 114
901-18 Microscopy using optical phase conjugation in a hybrid analog/digital system, P. S. Brody, C. Garvin,
Harry Diamond Labs. 119

IMAGE MEASUREMENT AND QUALITY. 127
Introduction. 128

SESSION 3. SPATIAL VISION AND SPATIAL SAMPLING. 129
901-28 Psychophysics of spatial sampling, B. E. Rogowitz, IBM/Thomas J. Watson Research Ctr. 130
901-29 Quality criteria for quantized images, R. Shaw, Rochester Institute of Technology. 139
901-30 Linear systems metrics of image quality for flat-panel displays, R. J. Beaton, User Interface Lab. 144
901-31 Perceptual analysis of sampled color monitor displays, A. P. Pica, David Sarnoff Research Ctr. 152
901-32 Image quality for discrete-element displays: variables, metrics and measurements, D. L. Moon, Univ.
of Dayton. 161
901-33 Analysis and measurement of resolution of shadow mask CRT displays, H. Veron, MITRE Corp. 171
901-34 Contrast-detail curve measurement and analysis in radiological imaging, C. H. Goodman Mumba,
J. R. Prince, Univ. of Oklahoma and Oklahoma Teaching Hospitals. 176

(continued)

SESSION 4. COLOR VISION AND COLOR SAMPLING.	185
901-23 Color psychophysics and display technology: avoiding the wrong answers and finding the right questions, W. Cowan, National Research Council of Canada.	186
901-24 Digital display and printing of color images based on uniform color spaces, R. S. Gentile, J. P. Allebach, E. Walowit, Purdue Univ.	194
901-25 Calculated color sensations applied to image reproduction, J. J. McCann, Polaroid Corp.	205
901-39 Towards a uniform lightness, hue, and saturation color model, H. Levkowitz, G. T. Herman, Univ. of Pennsylvania.	215
901-27 Real-time measurement systems for color CRT characterization, J. R. Pekelsky, W. B. Cowan, N. L. Rowell, National Research Council Canada.	223
SESSION 5. SPATIAL/TEMPORAL/COLOR INTERACTIONS.	229
901-20 Spatial and temporal aspects of red/green opponency, D. H. Kelly, SRI International.	230
901-21 Impact of boundaries on color: stabilized image studies, J. Larimer, NASA/Ames Research Ctr.; T. Piantanida, SRI International.	241
901-22 Luminance and chrominance contrast in emissive display, R. J. Martel, RCA Corp.	248
901-40 Adaptive color coding based on spatial/temporal features, W. Bender, Massachusetts Institute of Technology.	253
901-35 Design of systems that display moving images based on spatio-temporal vision data, W. E. Glenn, K. G. Glenn, New York Institute of Technology.	258
Addendum	268
Author Index	269