

PROCEEDINGS OF SPIE

***Display Technologies and
Applications for Defense, Security,
and Avionics II***

**John Tudor Thomas
Andrew Malloy**
Editors

**18, 20 March 2008
Orlando, Florida, USA**

Sponsored by
SPIE

Volume 6956

Proceedings of SPIE, 0277-786X, v. 6956

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

The papers included in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. The papers published in these proceedings reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from this book:

Author(s), "Title of Paper," in *Display Technologies and Applications for Defense, Security, and Avionics II*, edited by John Tudor Thomas, Andrew Malloy, Proceedings of SPIE Vol. 6956 (SPIE, Bellingham, WA, 2008) Article CID Number.

ISSN 0277-786X
ISBN 9780819471475

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA
Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445
SPIE.org

Copyright © 2008, Society of Photo-Optical Instrumentation Engineers

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/08/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.

The logo for SPIE Digital Library features the word "SPIE" in a bold, sans-serif font above the words "Digital Library" in a smaller, lighter font. To the right of the text is a stylized graphic consisting of four vertical bars of increasing height from left to right, with a curved line above them.

SPIDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first publication. Utilization of CIDs allows articles to be fully citable as soon they are published online, and connects the same identifier to all online, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc.

The CID number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

Contents

- vii *Conference Committee*
- ix *Introduction*
- xi *Display content in advanced NVG and HMD systems: a pilot/flight surgeon's concerns (Plenary Paper) [6955-05]*
J. C. Antonio, NAVAIR/NAWCAD (USA)

SURVEILLANCE AND INFORMATION EXTRACTION

- 6956 02 **Displays for future intermediate UAV** [6956-01]
D. Desjardins, J. Metzler, D. Blakesley, C. Rister, A.-R. Nuhu, Air Force Research Lab. (USA)
- 6956 03 **The Advanced Linked Extended Reconnaissance & Targeting Technology Demonstration project** [6956-03]
M. Edwards, General Dynamics Canada (Canada)
- 6956 04 **Content-based image exploitation for situational awareness** [6956-04]
D. Gains, General Dynamics Canada (Canada)

HUMAN/DISPLAY INTERACTION

- 6956 05 **Vibrotactile target saliency** [6956-05]
A. Toet, E. L. Groen, M. Oosterbeek, TNO Human Factors (Netherlands); I. T. C. Hooge, Utrecht Univ. (Netherlands)
- 6956 06 **Fused quad audio/visual and tracking data collection to enhance mobile robot and operator performance analyses** [6956-06]
B. A. Weiss, B. Antonishek, R. Norcross, National Institute of Standards and Technology (USA)
- 6956 07 **Hover training display: rationale and implementation** [6956-07]
D. L. Still, L. A. Temme, U.S. Army Aeromedical Research Lab. (USA)

NVG COMPATIBILITY

- 6956 08 **Automated intensifier tube measuring system** [6956-10]
J. Partee, C. Paul, Penn State Univ. (USA); M. Sartor, RDIS, LLC (USA); J. West, N. Wichowski, B. McIntyre, Penn State Univ. (USA)
- 6956 09 **Adapting deployed touch screen displays for NVG compatibility** [6956-11]
C. Gaudette, Wamco, Inc. (USA)

- 6956 0A **An alternative to radiance limits for vision enhancement device cockpit integration** [6956-08]
P. L. Marasco, Air Force Research Lab. (USA)

3D SYSTEM-LEVEL PERSPECTIVES

- 6956 0B **3D display applications for defense and security (Invited Paper)** [6956-12]
S. D. Robinson, P. J. Green, Planar Systems (USA)
- 6956 0C **Investigations into optimal color and shape primitives using the Perspecta 3D volumetric display** [6956-13]
G. A. Reis, P. R. Havig, E. L. Heft, Air Force Research Lab. (USA); J. P. McIntire, General Dynamics Advanced Information Systems (USA)
- 6956 0D **Comparison of 3D displays using objective metrics** [6956-14]
P. Havig, Air Force Research Lab. (USA); J. McIntire, General Dynamics Advanced Information Systems (USA); S. Dixon, J. Moore, G. Reis, Air Force Research Lab. (USA)

DISPLAY DESIGN

- 6956 0G **Ruggedized flat panel displays using COTS components** [6956-17]
R. Smith-Gillespie, E3 Displays (USA)
- 6956 0H **15.1-inch touch tactical avionics display (Best Paper Award)** [6956-18]
B. D. Hufnagel, T. J. Barnidge, J. L. Tchon, Rockwell Collins, Inc. (USA)
- 6956 0I **Designing display enhancement windows for commercial and military applications** [6956-19]
M. J. Dent, Optical Filters USA LLC (USA)

LCD BACKLIGHTING

- 6956 0J **High performance RGB LED backlight in high temperature environment** [6956-20]
G. Grabski, W. Gurr, J. Green, Korry Electronics Co. (USA)
- 6956 0K **Advanced flat panel display backlighting techniques** [6956-21]
R. Smith-Gillespie, E3 Displays (USA)

OLED DISPLAY APPLICATIONS

- 6956 0M **The use of OLED display technology in military applications** [6956-24]
M. Trakalo, S. Lorimer, General Dynamics Canada (Canada)
- 6956 0N **OLED displays in a ground-mobile application** [6956-27]
J. Thomas, S. Lorimer, General Dynamics Canada (Canada)

POSTER SESSION

6956 0O **Holographic 3D display of overlapped pattern by pick-upped image using integral imaging technique** [6956-25]
S.-H. Lee, S.-C. Kim, E.-S. Kim, Kwangwoon Univ. (South Korea)

6956 0P **Efficient generation of computer generated holographic video using novel look-up table**
[6956-26]
J.-H. Yoon, S.-C. Kim, E.-S. Kim, Kwangwoon Univ. (South Korea)

Author Index

Conference Committee

Symposium Chair

Larry B. Stotts, Defense Advanced Research Projects Agency (USA)

Symposium Cochair

Ray O. Johnson, Lockheed Martin Corporation (USA)

Program Track Chairs

Clarence E. Rash, U. S. Army Aeromedical Research Laboratory (USA)

Jacques G. Verly, Université de Liège (Belgium)

Conference Chairs

John Tudor Thomas, General Dynamics Canada Ltd. (Canada)

Andrew Malloy, Naval Research Laboratory (USA)

Program Committee

Daniel D. Desjardins, Consultant (USA)

Eric W. Forsythe, Army Research Laboratory (USA)

Grzegorz J. Grabski, Korry Electronics Company (USA)

David C. Huffman, L-3 Communications Display Systems (USA)

Kalluri R. Sarma, Honeywell International, Inc. (USA)

Murray Trakalo, General Dynamics Canada Ltd. (Canada)

Session Chairs

- 1 Surveillance and Information Extraction
John Tudor Thomas, General Dynamics Canada Ltd. (Canada)
- 2 Human/Display Interaction
Daniel D. Desjardins, Consultant (USA)
- 3 NVG Compatibility
Kalluri R. Sarma, Honeywell International, Inc. (USA)
- 4 3D System-Level Perspectives
David C. Huffman, L-3 Communications Display Systems (USA)

- 5 3D Display Hardware
David C. Huffman, L-3 Communications Display Systems (USA)
- 6 Display Design
Grzegorz J. Grabski, Korry Electronics Company (USA)
- 7 LCD Backlighting
Murray Trakalo, General Dynamics Canada Ltd. (Canada)
- 8 OLED Display Applications
John Tudor Thomas, General Dynamics Canada Ltd. (Canada)

Introduction

The 2008 Display Technologies and Applications for Defense, Security and Avionics II conference addressed recent developments and a wide range of technologies surrounding direct view displays. The focus, reflected in these proceedings, is firmly in the military sector for applications with a variety of themes that highlights many current requirements and issues.

With recent battle requirements from Iraq in mind, surveillance is a topic of heightened interest for our audience. In addition to information from the field, there are papers on recent thrusts concerning surveillance vehicles and information handling from Canada and on image processing aimed at assisting operators in threat/target detection and tracking requirements.

The session on human/display interaction includes new information on issues such as crew overload and use of tactile senses to overcome visual and aural overload. This session also addresses human factors and perception problems in helicopter training as well as development of human interfaces for robotic controlling vehicles.

A session on night vision system compatibility delivers information on automated measurement of image intensifiers as well as information on new polymeric filter materials specifically designed to address the need for low-cost application to already fielded displays that employ resistive touch screens. In addition, the issues surrounding deployment of short-wave infrared imagers in cockpits, is discussed in some detail, focusing around specification of radiance limits.

3D displays have been demonstrated over a period of many decades, but recent materials developments have made 3D a practical choice for several demanding applications. An invited paper from Planar Systems addresses both technology options for 3D direct-view displays and compatible applications in a wide-ranging look at the topic. Those interested in 3D displays will particularly appreciate the guidance on image quality and processing requirements. Other presenters address developments such as 3D for vehicle driving and for robotic control as well as the difficult topic of developing metrics for assessment of 3D displays.

Following the theme of display hardware, a session on 2D displays includes a paper from E3 Displays that addresses difficult issues surrounding the ruggedisation of COTS display components for military applications, offering important insight into ruggedisation needs and methods. Rockwell Collins provides design insight and performance data for an impressive 15" cockpit display with a very low reflectance resistive touch panel. Optical Filters USA

provides valuable insight into how to specify display filters and critically, what not to do.

Maintaining the theme on 2D LCDs, the session dedicated to LCD backlighting includes useful design details on both RGB- and white LED-based systems developed by Korry and E3 Displays, respectively. These sessions share technical information intended to advance the state of the art in an established technical area that is vital to most LCD-based equipments.

The final session is dedicated to OLED, a new display technology that is yet to see widespread application in military systems. General Dynamics Canada presents two papers describing both the general theme of OLED application to military display needs and a description of a specific project aimed at exploring the unknowns and risks associated with fielding a new display technology. This latter paper addresses work done to build and test a small OLED display to be field tested on a 155mm howitzer.

The 2008 Display Technologies and Applications conference sought to provide insight into both current developments and technology aspects related to displays and display applications. The 26 papers presented at the 2008 conference contribute to many of the most interesting facets of display technology, providing useful information to designers, developers, and users.

John Tudor Thomas
Andrew Malloy