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3-D and 4-D Imaging Techniques and Applications

G. Charmaine Gilbreath
Lenny Lipton

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G. Charmaine Gilbreath
Naval Research Laboratory
4555 Overlook Ave SW
Washington, DC 20375
E-mail: charmaine.gilbreath@nrl.navy.mil

Lenny Lipton
www.lennylipton.com
E-mail: Lipton3D@gmail.com

The advent of high-grade three dimensional (3-D) and four dimensional (3-D + time) technologies and algorithms is re-energizing multidimensional projective and interactive 3-D imaging.

To some observers, James Cameron's *Avatar* is the 3-D motion picture that set a new, high bar for stereoscopic entertainment. For scientists and engineers developing entertainment technology, the key changes involve high-field-rate digital projection and improvements in image selection devices. For the imaging scientist and engineer, the breakthroughs in use of advanced camera designs, gaming processors, and efficient algorithms are making true depth and angular recovery for stereo videography a reality.

As further evidence of an idea whose time has come (again), is the happy coincidence that SPIE's *Journal of Electronic Imaging* is independently publishing a special section on 3-D imaging science titled "Stereoscopic Displays and Applications" for the first quarterly issue of 2012. The journal editors, publisher, and guest editors decided to make this a "3-D Season" with our concurrent special sections which focus on different aspects of the problem sets.

In our special section, we have addressed generally three themes, all of which require engineering and imaging science.

1. A set of perspectives on the history and advancement of the field and industry (Gilbreath, Lipton, and Walworth)
2. Algorithms and techniques to reduce the data and create images
   a. using imaging and camera techniques (Bae, Chou, Karpf, Meister, Peng, Shih, Z. Zhang)
   b. using LIDAR in the methodologies (MacKinnon, Shi, D. Zhang)
3. Unique applications (Du, Leberl, Sitnik, and Yang).

The JEI special section papers emphasize stereoscopic viewing and include papers on the viewing experience, as well as descriptions of methods to enhance volumetric image recovery.

There are interesting trends that have begun to mature from the scientific to the engineering phase. Advances have been made with multiview stereoscopic technologies for seamless, wide field-of-view image recovery. Use of "multiscopic" and/or "classical" two-camera stereoscopic capture combined with LIDAR and photogrammetry are obtaining accuracies in 3-D imaging at longer ranges.

The reader will find a number of papers in our special section addressing these themes.

As the methods progress from basic science through engineering into applications, they enable the goals of real-time 3-D imaging at extended ranges, real-time digital holography, and real-time interactive 3-D design.

We would like to extend our thanks to the contributors, the reviewers and especially to Ron Driggers, and the SPIE staff, whose patience, persistence, and humor guided the creation and finally publication of this special section. We hope you enjoy the issue.

G. Charmaine Gilbreath has been active in optical communications and photonics at National Research Labs since 1982. She was elected Fellow to SPIE in 2007. She brings depth, reflected by over 200 publications and presentations in various aspects of the field of photonics, as well as breadth in that she has produced research in nonlinear optics, real-time holography, optical communications, and astronomical sparse aperture imaging. By synthesizing her experience in these areas, she provides technical guidance to the Department of Defense, intelligence communities, and NASA. She has had an abiding interest in 3-D and 4-D imaging reconstruction since her graduate school days.

Leonard ("Lenny") Lipton founded StereoGraphics Corporation in 1980 and was the CTO of RealD from 2005 to 2009. He has been granted fifty patents in the field of electronic stereoscopic displays with about fifty pending. In 1996, he received a Smithsonian award for this invention of CrystalEyes, the first shuttering eyewear product for stereoscopic displays. He led the team that invented the ZScreen, used in tens of thousands of theaters, and he created the first flicker-free field-sequential 3-D display technology, and the primary multiplexing techniques used for many stereoscopic cinema and TV products. He has written four books, including *Independent Filmmaking* (1972) and *Foundations of the Stereoscopic Cinema* (1982). He is a Fellow of the SMPTE and SPIE. He is a member of the Board of Directors Executive Committee of the International 3D Society and a recipient of their Lifetime Achievement Award. As an undergraduate at Cornell he wrote *Puff the Magic Dragon*.