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Special Section Guest Editorial: Holography

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Special Section Guest Editorial: Holography

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Holography is a coherent imaging technique that records the amplitude and phase of the light in a single image. This characteristic allows use of holograms in several applications. The development in analog and digital optical systems, electronic imaging devices, high-speed digital computers, and reliable image processing software has revolutionized this field, making it effective, automated, and easier for visualizing results. Holography is an active research area with diverse approaches. This Special Section on Holography presents a review paper and eighteen research papers on the topics of metrology, hologram-recording, holography principles, security, and 3D displays. The works cover five principal categories—review, metrology, hologram recording, computational holography, and 3D displays projection. We think these papers could give the readers a perspective of the wide variety of holographic applications under study at present.

Review

Review papers help new and consolidated researchers get a clear panoramic view of a specific topic inside a research area. Wang et al. present a review of hardware implementations of computer-generated holography (CGH). They establish that graphics processing units (GPU), field programmable gate arrays (FPGAs), digital signal processors (DSPs), and application-specific integrated circuits (ASICs) already allow real-time CGH. They anticipate two separate research paths in the hardware implementation of CGH, the high-performance hardware platforms and the embedded computers and systems for low-power and low-cost applications

Metrology

One of the most important applications of holography is the measurement of objects such as biological samples. The non-invasive characteristic and the high resolution of the holographic techniques make them a good alternative in the metrology field. Arapov et al. present the results of the theoretical and experimental study of polydisperse media using the three-wave holographic recording method. Dubey and Kumar propose the use of a compact holographic lateral shearing interferometer. Meanwhile, Klenk et al. investigate the effects of selective lysis methods on holographic phase reconstructions of leukocytes, thus demonstrating a reliable sample preparation procedure and opening the discussion about this topic for further studies in hematology applications. Muhire et al. use the Teager–Kaiser energy operator (TKEO) and the spiral phase transform (SPT) to get a robust estimation of energy of amplitude-modulated and frequency-modulated (AM–FM) signals. Belashov and Petrov propose a selective averaging procedure for increasing the reconstruction height map quality of an object surface, using tilted angle illumination. Dwivedi et al. reported a new application of digital holography for the analysis of delaminated regions of polyurethane pads on a polishing tool. Russo et al. analyze the effect of flexural tests in composite materials using speckle pattern interferometry.

Hologram-Recording

The recording of holograms is an active research area. Some applications are the creation of complex and compact optical elements for wavefront manipulation and the recording of huge data quantity in holographic memories. Hofmann et al. present a technique for recording volume holographic optical elements (vHOEs) designed for operation at a wavelength different from the recording wavelength. Hao et al. propose a new phase retrieval method that combined the single-shot interferometric approach with the non-interferometric iterative Fourier transform algorithm for phase-modulated holographic data storage. The authors demonstrate the increase of the code rate as well as faster data transfer rate, preserving the data accuracy.

Computational Holography

Modifications in the optical system in different aspects as light coherence, polarization, and multiwavelength use can help to improve the holographic techniques in time, accuracy, or complexity. Thornton et al. present the effect of degraded temporal coherence in off-axis image digital holography. Huang et al. design an experiment to observe the faithful reconstruction of elliptical polarization holography in which the two orthogonal elliptical polarization waves are applied in the recording stage. Buitrago and Garcia-Sucerquia propose a realistic model of digital holographic microscopy, including the factors of input-field preparation, imaging system, and holographic register. Zhang et al. provide an analysis of the resolution and sampling in digital in-line holography with spherical wave illumination. They also present a guide for selecting the system parameters that reduce the twin image noise. Zhang et al. proposed multiple-image encryption by using optical scanning holography with orthogonal compressive sensing and random phase mask.

3D Displays

The holographic projection is considered the next step in the development of augmented and mixed reality applications, but several processes will have to improve before this happens. Li et al. present an optimized layered method for CGHs synthesizing with a ray-tracing technique. Du et al. propose a floating 3D image display with a large viewing angle and high-resolution based on a multichannel and multivariable (MCMV) correction algorithm, which can provide a natural and realistic 3D scene. Li et al. present a modified single-pass multiview rendering method that achieves real-time 3D display with a large viewing angle. Cruz and González-Velázquez present an analysis of different random-phase distributions and Perlin noise in computer-generated hologram. The effects of different distributions in the frequency-filter effect and the capacity of recording images, with a bigger size that the hologram, are studied.

We wish to thank all the authors for their valuable contributions to this special section. All the works present different and interesting applications of holography and related topics. These works can help the reader to gain a general panoramic of the current research topics in holography. We also want to thank the researchers who agreed to participate in the peer-review process of all the submitted papers. Without their support, this special section would not have beeen possible. The guest editors would like to thank the journal editorial team, especially Eric Lochridge and Karen Klokkevold, for their guidance throughout the process. Expressly, we thank Michael Eismann, editor-in-chief of *Optical Engineering*, for giving us the opportunity to guest edit this special section.