3D visual system using electronic holography: towards ultra-realistic communication

Kenji Yamamoto, Yasuyuki Ichihashi, Takanori Senoh, Ryutaro Oi, and Taiichiro Kurita

A combination of electronic holography and ray-based image sensors, such as integral photography and camera arrays, is a promising approach to a future 3D visual system.

Holography is a technology that reconstructs light as if the imaged object were still present. It has long attracted attention for use in 3D displays. However, electronic holography has not yet met its full potential, and requires further development for use in communications.

While the capacity to show moving objects is an attractive feature of electronic holography, it nevertheless possesses some challenges. These include removing interrupting light, enlarging the viewing angle (which originates from the large pixel pitch of electronic devices used to display hologram data), and hologram data acquisition in natural light. We have developed electronic holography system prototypes to address these issues. We discuss one of them here: an electronic holography system with a camera array.

Our prototype system uses a camera array, which we designed and manufactured, to capture ray-information from 3D real objects. Figure 1 (a), (b), and (c) depict the camera array, the camera-in-camera array, and the electronic holography system, respectively. The array consists of 25 cameras that are aligned on a circle of radius 1500mm at intervals of 1.2°. The interval between cameras is approximately 32mm, which results in a very densely arranged array. All of the cameras face the center of the circle, where a person will be located.

Dense, high-quality ray information, which we term super-dense ray-information, is necessary to showcase the inherent capacities of electronic holography. The camera array requires view-interpolation signal processing to synthesize super-dense ray information from captured images. Much signal-processing research has been conducted in the research fields of computer vision and graphics, but it is still technically difficult to obtain this information without visible error. Our approach reduces this difficulty.

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In summary, we have worked to advance the prospects of electronic holography and ray-based image sensors for realistic 3D communication. Our approach, based on super-dense ray information, was intended to overcome challenges in signal processing that are common in computer vision and graphics research. Our synthesized image quality was decent (see Figure 2d), but 3D hologram reconstruction was not (see Figure 2e). Our future research aims to overcome this hologram-generation deficiency. Our most recent advanced camera array is comprised of 300 cameras aligned in a circle at 1.2° intervals (see Figure 3), and can capture images from all directions. Details have been presented in Japanese, and will be presented in English at an upcoming SPIE Defense, Security, and Sensing conference.

Author Information

Kenji Yamamoto, Yasuyuki Ichihashi, Takanori Senoh, Ryutaro Oi, and Taiichiro Kurita
National Institute of Information and Communications Technology
Koganei, Japan

Kenji Yamamoto is a senior researcher. His research areas include electronic holography, computer-generated holograms, integral photography, camera arrays, and 3D image processing. He was on the program committee Three-Dimensional Imaging, Visualization, and Display in SPIE Defense, Security, and Sensing 2011.

References


Figure 3. The 300-camera array. The cameras are arranged in a circle at 1.2° intervals.