International Workshop on Holography and Related Technologies 2019

IWH2019

November 5 to 7, 2019

Penang School of Toyohashi Tech,
Jalan Biggs, Pulau Tikus,
10350 George Town, Penang, Malaysia
Dear all IWH2019 participants,

It is my great pleasure to host all of you here in Penang. This is the 13th International Workshop on Holography and technologies. The first workshop was held also here in Penang particularly for discussing volumetric hologram data storage (because of this, the first workshop was named as International Workshop on Holographic Memories, IWHM), so that we came back to the birth place of it.

As shown in the scope, the workshop covers overall aspects on holography and related technologies, holographic memories, displays, holographic measurement, computer generated holograms and digital holography, ranging from their fundamental physics and technologies to practical systems. Since the discovery of “holography” by Gábor Dénes, the Novel price winner in 1947, together with the development of laser, theoretically in 1958 (my birth year!) and experimentally in 1960, it has been founding its important applications in various kinds of human life including volumetric hologram data storage, three-dimensional holographic display, measurement, and so on. Then the term of “holography” has become very popular and attractive for physicists and engineers. Because phase interference of waves is responsible for holography, this phenomenon can be found not only in light propagation but also in any kinds of waves even in electron waves. Therefore, near future, I am expecting to extend the scope of workshop for such non-light holography such as magnetic holography or holographic manipulation of spin waves operating from GHz to THz regime.

On behalf of the workshop, I would like to strongly encourage all of you to discuss the state-of-the-art holography technology. Besides, please enjoy the stay of Penang and its rich nature, historical places and exciting various kinds of Asian foods!

Mitsuteru INOUE, General Chair of IWH2019
INTRODUCTION

International Workshop on Holography and related technologies (IWH2019) will be held at Penang School of Toyohashi Tech, Penang, Malaysia, from Nov. 5 to 7, 2019. This is the Thirteenth workshop which covers overall aspects on holography and related technologies, holographic memories, displays, holographic measurement, computer generated holograms and digital holography, ranging from their fundamental physics and technologies to practical systems. The first International Workshop on Holographic Memories (IWHM2007) was held in Penang, Malaysia. IWHM2008 and IWHM&D2009-2010 were successfully held in Japan, which include overall aspects on holographic memories and display. Since 2011, this workshop has extended the scope furthermore, and IWH covers the holographic display, holographic optical elements, as well as holographic memory. Last year, IWH2018 was held at Suzhou, China with great success. IWH2019 is back to Penang, Malaysia where the birth place of this conference. IWH2019 is jointly organized by the following associations:

- Japan Optomechatronics Association (JOEM)
- Optoelectronics Industry and Technology Development Association (OITDA)
- JSPS Amorphous and Nano-materials and Applications 147 Committee
- IEEE Magnetics Society Nagoya Chapter
- Photonics division, The Japan Society of Applied Physics (JSAP)
- Optical Society of Japan (OSJ)

SCOPE

All topics related to holography including memories, displays, digital holography, computer generated holography, and holographic optical elements are going to be discussed, ranging from their basic physics and technologies to practical applications, such as materials, components, measurements, basic theory and physics, system design, simulations and devices. In what follows is the list of subject areas, which are not restrictive but suggestive:

1. Holographic Memory
2. Holographic Optical Elements
3. Computer Generated Holography
4. Digital Holography
5. Holographic Display
6. Holography Arts and Design
7. Recording Materials
8. Signal Processing for Holography
9. Devices for Holography
10. Simulation for Holography
11. AR, MR, HUD and HMD with Holography
12. Applications
13. Others
## IWH2019 TIME TABLE

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<thead>
<tr>
<th>4 Nov.</th>
<th>5 Nov.</th>
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<tbody>
<tr>
<td>8:30</td>
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<td>BUS (from Evergreen hotel to TUT Penang) 8:30 departure</td>
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<td>9:00</td>
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<td>Oral 9:00–10:40 (100 min)</td>
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<td>Oral 11:00–13:00 (110 min)</td>
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<td>11:00</td>
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<td>Registration &amp; Get together (15:00–17:00)</td>
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<td>12:00</td>
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<td>Lunch (12:00–13:00)</td>
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<td>Opening</td>
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<td>14:00</td>
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<td>Keynote 13:10–13:50 (40 min)</td>
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<td>Registration</td>
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<td>16:00</td>
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<td>Oral 15:30–17:10 (100 min)</td>
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<td>Break 15:00–15:30</td>
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<td>18:00</td>
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<td>Lunch (13:00–14:00)</td>
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<td>19:00</td>
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<td>Oral 14:00–15:50 (110 min)</td>
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<td>21:00</td>
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<td>Round Table Discussion 16:10–17:00 (50 min)</td>
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**Breaks:**
- 10:40–11:10
- 10:30–11:00
- 10:30–11:00
- 15:50–16:10
- 15:00–15:30
- 10:40–11:10

**Transportation:**
- BUS (from Evergreen hotel to TUT Penang) 11:00 departure
- BUS (from TUT Penang to Evergreen hotel) 13:10 departure
- BUS (from TUT Penang to Evergreen hotel) 14:00 departure
- BUS (from Evergreen hotel to Banquet) 18:30 departure
- BUS (from Banquet to Evergreen hotel)
## Presentation Schedule

### Day1 (5 Nov.)

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<tr>
<th>No.</th>
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<tbody>
<tr>
<td>5p-1</td>
<td>13:10</td>
<td>13:50</td>
<td>Takuji Yoshida</td>
<td>Sony Corporation</td>
<td>Keynote</td>
<td>A Plastic Holographic Waveguide Combiner for Lightweight and Highly-transparent Augmented Reality Glasses</td>
</tr>
<tr>
<td>5p-2</td>
<td>13:50</td>
<td>14:10</td>
<td>Tso-Hua Wu</td>
<td>National Taiwan University</td>
<td>Multi-focus plane holographic differential confocal microscopy</td>
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<tr>
<td>5p-3</td>
<td>14:10</td>
<td>14:30</td>
<td>Toshihiro Kasezawa</td>
<td>Egarim</td>
<td>Holographic thin film type Polarized Beam Splitter ~Egarim PBS ~</td>
<td></td>
</tr>
<tr>
<td>5p-4</td>
<td>14:30</td>
<td>15:00</td>
<td>Osamu Matoba</td>
<td>Kobe University</td>
<td>invited</td>
<td>3D fluorescence imaging techniques for biomedical applications</td>
</tr>
<tr>
<td></td>
<td>15:00</td>
<td>15:30</td>
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<td></td>
<td>Break</td>
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</tbody>
</table>

**Presider:** Tsutomu Shimura, The University of Tokyo, Japan

| 5p-5 | 15:30 | 16:00 | Yuki Nagahama        | Tokyo University of Agriculture and Technology | invited         | Interactive refraction correction system for holographic retinal view display |
| 5p-6 | 16:00 | 16:30 | Xiaodi Tan           | Fujian Normal University                      | invited         | Four-Channel Recording by Orthogonal Polarization Holography          |
| 5p-7 | 16:30 | 16:50 | Yoshiki Terashima    | Utsunomiya University                         |                 | Aerial Image Augments a Flat-Panel Display                             |
| 5p-8 | 16:50 | 17:10 | Yusuke Hirai         | Utsunomiya University                         |                 | Facets acquisition method of real 3D objects with unclear texture from multi-viewpoint images |

**Presider:** Osamu Matoba, Kobe University, Japan

### Day2 (6 Nov.)

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<tbody>
<tr>
<td>6a-1</td>
<td>9:00</td>
<td>9:30</td>
<td>Shuo Wang</td>
<td>Beijing Institute of Graphic Communication</td>
<td>invited</td>
<td>An Exploration of Holomontage for Creative Design Applications of Digital Holograms</td>
</tr>
<tr>
<td>6a-2</td>
<td>9:30</td>
<td>10:00</td>
<td>Daisuke Barada</td>
<td>Utsunomiya University</td>
<td>invited</td>
<td>Principle of Acoustic Wave Source Measurement by Digital Holography with Spatial and Temporal Carrier</td>
</tr>
<tr>
<td>6a-3</td>
<td>10:00</td>
<td>10:20</td>
<td>Takumi Ujiie</td>
<td>Utsunomiya University</td>
<td></td>
<td>Digital holography with burst imaging method</td>
</tr>
<tr>
<td>6a-4</td>
<td>10:20</td>
<td>10:40</td>
<td>Yuta Goto</td>
<td>(NICT)National Institute of Information</td>
<td></td>
<td>Fundamental Experiment for Displacement Measurement by Digital Holography with Spatially Divided Images</td>
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<tr>
<td></td>
<td>10:40</td>
<td>11:10</td>
<td></td>
<td></td>
<td>Break</td>
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</tr>
</tbody>
</table>

**Presider:** Hideyoshi Horimai, HOLOMEDIA, Japan

| 6a-5| 11:10 | 11:40 | Xiao Lin             | Fujian Normal University                    | invited         | Improved phase retrieval method for phase for collinear phase-modulated holographic data storage |

**Presider:** Xiaodi Tan, Fujian Normal University, China

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**IWH2019 ADVANCE PROGRAM**
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<tbody>
<tr>
<td>6a-6</td>
<td>11:40</td>
<td>12:10</td>
<td>Yuichi Nakamura</td>
<td>Toyohashi University of Technology</td>
<td>invited</td>
<td>Design and Properties of Heat Dissipation Multi-Layered Media for Magnetic Hologram Memory</td>
</tr>
<tr>
<td>6a-7</td>
<td>12:10</td>
<td>12:40</td>
<td>Tsutomu Shimura</td>
<td>The University of Tokyo</td>
<td>invited</td>
<td>Phase modulated time series signal holographic memory</td>
</tr>
<tr>
<td>6a-8</td>
<td>12:40</td>
<td>13:00</td>
<td>Naru Yoneda</td>
<td>Wakayama University</td>
<td></td>
<td>Holographic Data Storage Based on Compressive Sensing</td>
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<td>Lunch</td>
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<tr>
<td>6p-1</td>
<td>14:00</td>
<td>14:30</td>
<td>Wei-Chia Su</td>
<td>National Changhua University of Education</td>
<td>invited</td>
<td>The Design of Holographic Illumination Element for LCoS Panels</td>
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<tr>
<td>6p-2</td>
<td>14:30</td>
<td>14:50</td>
<td>Tomohiro Maeda</td>
<td>Hokkaido University</td>
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<td>Experiment on Mode Conversion Based on Wavefront Superposition Method</td>
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<tr>
<td>6p-3</td>
<td>14:50</td>
<td>15:10</td>
<td>Sunil Vyas</td>
<td>National Taiwan University</td>
<td></td>
<td>Volume holographic method for generation of abrupt autofocusing beams</td>
</tr>
<tr>
<td>6p-4</td>
<td>15:10</td>
<td>15:30</td>
<td>Sih-Yuan Chen</td>
<td>National Central University</td>
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<td>Wavelength-division multiplexing with spherical waves by a volume holographic optical element</td>
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<tr>
<td>6p-5</td>
<td>15:30</td>
<td>15:50</td>
<td>Shota Okazaki</td>
<td>Utsunomiya University</td>
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<td>Preparation of cylindrical wave diffractive lens for wide band light by volume hologram</td>
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<td>16:10</td>
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<td>Round Table Discussion</td>
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**Day3 (7 Nov.)**

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<tr>
<td>7a-1</td>
<td>9:00</td>
<td>9:30</td>
<td>Zehao He</td>
<td>Tsinghua University</td>
<td>invited</td>
<td>Designed random phase modulation for computer generated hologram</td>
</tr>
<tr>
<td>7a-2</td>
<td>9:30</td>
<td>10:00</td>
<td>Tomoyoshi Shimobaba</td>
<td>Chiba University</td>
<td>invited</td>
<td>Hologram compression using deep-learning and complex amplitude encoding using binarized amplitude</td>
</tr>
<tr>
<td>7a-3</td>
<td>10:00</td>
<td>10:30</td>
<td>Hideyoshi Horimai</td>
<td>HOLOMEDIA</td>
<td>invited</td>
<td>New product development integrating hologram technology</td>
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<td>10:30</td>
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**Presider : Yeh-Wei Yu, National Central University, China**

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<tbody>
<tr>
<td>7a-4</td>
<td>11:00</td>
<td>11:30</td>
<td>Yeh-Wei Yu</td>
<td>National Central University</td>
<td>invited</td>
<td>A position servo of holographic data storage system using disc embedded volume holographic optical element</td>
</tr>
<tr>
<td>7a-5</td>
<td>11:30</td>
<td>12:00</td>
<td>Ryushi Fujimura</td>
<td>Utsunomiya University</td>
<td>invited</td>
<td>Optimization of recording parameters for large density holographic data storage</td>
</tr>
<tr>
<td>7a-6</td>
<td>12:00</td>
<td>12:20</td>
<td>Soki Hirayama</td>
<td>The University of Tokyo</td>
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<td>Noise Analysis of a Surface Collinear Holographic Memory</td>
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<td>12:20</td>
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<td>Summary of Round Table Discussion</td>
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**Presider : Daisuke Barada, Utsunomiya University, Japan**
Day 1 (5 Nov.)

13:10 5p-1  A Plastic Holographic Waveguide Combiner for Light-weight and Highly-transparent Augmented Reality Glasses

Takuji Yoshida  Sony Corporation  (Keynote Talk)

We have developed a unique production process of a full-color plastic holographic waveguide combiner with a light-weight and see-through capability. The novel plastic waveguide technology enables us to expand the market for augmented reality (AR).

13:50 5p-2  Multi-focal plane holographic differential confocal microscopy

Tso-Hua Wu  National Taiwan University

Confocal microscopy is commonly utilized to obtain a high-contrast optical-sectioning image. However, confocal point-by-point scanning is time-consuming. Here, we propose a non-axial-scanning differential confocal microscopy which integrates multiplexed volume holographic gratings (MVHGs) and differential confocal microscopy (DCM) to acquire multi-focal information and three-dimensional reconstructed images.

14:10 5p-3  Holographic thin film type Polarized Beam Splitter ~Egarim PBS ~

Toshihiro Kasezawa  Egarim

Based on the orthogonal optical axis theory, a new exposure system for Egarim PBS was established, the angular dependence of reflective and transmissive Egarim PBS was investigated, and theoretical analysis was performed.

14:30 5p-4  3D fluorescence imaging techniques for biomedical applications

Osamu Matoba  Kobe University  (invited Talk)

Three-dimensional fluorescence imaging techniques are presented. One is the off-axis common-path incoherent digital holography. The experimental results using live plant cells are presented. The other technique is discussed.
15:00  **Coffee Break**

15:30  **5p-5**  
**Interactive refraction correction system for holographic retinal view display**  
Yuki Nagahama  
Tokyo University of Agriculture and Technology  
*(invited Talk)*

In this research, a real-time hologram generation for the holographic retinal view display is realized using GPU and we correct the refractive errors of the user’s eye lens interactively.

16:00  **5p-6**  
**Four-Channel Recording by Orthogonal Polarization Holography**  
Xiaodi Tan  
Fujian Normal University  
*(invited Talk)*

Four-channel volume holographic recording with linear polarization-sensitive holography, based on the null reconstruction effect (NRE) of polarization holography. The presented technique can be expected to improve holographic data storage recording density by additional channel.

16:30  **5p-7**  
**Aerial Image Augments a Flat-Panel Display**  
Yoshiki Terashima  
Utsunomiya University

We have created an optical system for displaying aerial image on the surface of the flat-panel display. Furthermore, we verified the difference between the proposed method and the conventional method.

16:50  **5p-8**  
**Facets acquisition method of real 3D objects with unclear texture from multi-viewpoint images**  
Yusuke Hirai  
Utsunomiya University

In this study, a method to acquire facet data from real 3D objects used by generating CGHs for 3D display is proposed. The facets are acquired from multi-viewpoint images.

**Day2  (6 Nov.)**

9:00  **6a-1**  
**An Exploration of Holomontage for Creative Design Applications of Digital Holograms**  
Shuo Wang  
Beijing Institute of Graphic Communication  
*(invited Talk)*

The narration of the Chinese porcelain is a significant project. For building on these results, an experimental artwork will be presented based a novel concept: holomontage, as well as its narrative language will be explored.
9:30  6a-2  Principle of Acoustic Wave Source Measurement by Digital Holography with Spatial and Temporal Carrier

Daisuke Barada  Utsunomiya University  (invited Talk)

In conventional digital holography, acoustic wave propagation cannot be calculated. In this work, it is theoretically proved that the acoustic wave source can be measured by digital holography with spatial and temporal carrier.

10:00  6a-3  Digital holography with burst imaging method

Takumi Ujiie  Utsunomiya University

Application of a burst imaging method to a digital holography (DH) that needs to capture multiple images is demonstrated. The burst imaging method was applied to the phase-shifting DH and it is experimentally demonstrated.

10:20  6a-4  Fundamental Experiment for Displacement Measurement by Digital Holography with Spatially Divided Images

Yuta Goto  (NICT) National Institute of Information

Digital holography (DH) can detect displacement the object. In this study, we propose the 3D displacement measurement by DH with spatially divided images, and confirmed the potential for displacement measurement with a single image sensor.

10:40  Coffee Break

11:10  6a-5  Improved phase retrieval method for phase for collinear phase-modulated holographic data storage

Xiao Lin  Fujian Normal University  (invited Talk)

We proposed the advanced non-interferometric phase retrieval method based on the collinear system to increase the code rate and storage density by 2 times and accelerate phase retrieval further.
11:40 6a-6  **Design and Properties of Heat Dissipation Multi-Layered Media for Magnetic Hologram Memory**

Yuichi Nakamura  Toyohashi University of Technology  *(invited Talk)*

Heat dissipation multilayered media (HDL media) for magnetic hologram were designed, and performances of fabricated HDL medium were evaluated. It showed diffraction efficiency higher than single layer film and non-error reconstruction was achieved.

12:10 6a-7  **Phase modulated time series signal holographic memory**

Tsutomu Shimura  The University of Tokyo  *(invited Talk)*

In order to increase data storage density, we developed a time-series signal holographic memory system. The advantage of this system is that RLL coding can be adopted. Recently we applied phase modulation to this system in angle multiplexing and colinear system.

12:40 6a-8  **Holographic Data Storage Based on Compressive Sensing**

Naru Yoneda  Wakayama University

To increase the recording density of holographic data storage, the introduction of three-dimensional data-page is proposed. The proposed method is realized by using a computer-generated hologram technique and compressive sensing. Its feasibility is numerically confirmed.

13:00  **Lunch**

14:00 6p-1  **The Design of Holographic Illumination Element for LCoS Panels**

Wei-Chia Su  National Changhua University of Education  *(invited Talk)*

In this paper, the holographic waveguide backlight for LCoS panels was proposed. The element can be operated with white LED. Then the full-color display can be achieved with LCoS panel.
14:30  6p-2  **Experiment on Mode Conversion Based on Wavefront Superposition Method**  
Tomohiro Maeda   Hokkaido University  

We experimentally demonstrated that the wavefront superposition method, in which the converted light includes components of target and radiation modes, could perform more efficient mode conversion than the conventional method without degradation of modal crosstalk.

14:50  6p-3  **Volume holographic method for generation of abrupt autofocusing beams**  
Sunil Vyas   National Taiwan University  

We experimentally demonstrate the generation of abrupt autofocusing beam through volume holographic optical element. PQ: PMMA photopolymer substrate is used for fabricating volume phase gratings. Present results may find important applications in optical-tweezers and laser-material processing.

15:10  6p-4  **Wavelength-division multiplexing with spherical waves by a volume holographic optical element**  
Sih-Yuan Chen   National Central University  

In this study, we analyze the characteristics on the spatial and temporal domains of a volume holographic optical element(VHOE) which is constructed by interference of spherical waves. We applied the characteristics to dense wavelength-division multiplexing(DWDM).

15:30  6p-5  **Preparation of cylindrical wave diffractive lens for wide band light by volume hologram**  
Shota Okazaki   Utsunomiya University  

In this study, a cylindrical wave diffraction lens for wide band light was prepared using volume hologram technology to improve the performance and cost of a HMD.

15:50   **Coffee Break**

16:10   **Round Table Discussion**
Day 3 (7 Nov.)

9:00 7a-1  **Designed random phase modulation for computer generated hologram**

Zehao He  Tsinghua University  *(invited Talk)*

The effect of the random phase range on the display quality is evaluated. A designed random phase modulation method for computer generated hologram is proposed based on the evaluation results.

9:30 7a-2  **Hologram compression using deep-learning and complex amplitude encoding using binarized amplitude**

Tomoyoshi Shimobaba  Chiba University  *(invited Talk)*

We introduce our latest studies for holographic display: “a dynamic-range compression technique using a DNN” and “complex amplitude encoding of phase-only hologram.” The details will be shows in the presentation.

10:00 7a-3  **New product development integrating hologram technology**

Hideyoshi Horimai  HOLOMEDIA  *(invited Talk)*

We have been developing several new products by integrating the unique features and functions of hologram technology. Our developing field expanded to 3D-Display, BIPV, Illuminator, Holographic-PBS, Glossy-Surface Inspection etc. We will introduce all of them.

10:30  **Coffee Break**

11:00 7a-4  **A position servo of holographic data storage system using disc embedded volume holographic optical element**

Yeh-Wei Yu  National Central University  *(invited Talk)*

We proposed a volume holographic optical element embedded in the disc of holographic data storage system for position servo. The concept was proved by both simulation and experiment. In the experiment, astigmatism was induced in the reference beam of the volume holographic optical element to improve the lateral tolerance.
11:30  7a-5  Optimization of recording parameters for large density holographic data storage

Ryushi Fujimura    Utsunomiya University    (invited Talk)

In order to investigate effect of an aperture in Fourier plane of signal images, a holographic simulator considering a realistic hologram shape was developed. The recording parameters were optimized for achieving largest storage density.

12:00  7a-6  Noise Analysis of a Surface Collinear Holographic Memory

Soki Hirayama    The University of Tokyo

New type of a holographic read-only memory using a surface hologram is proposed. This method enables collective duplication and stable read-out performance. In this study, we investigate inherent noise factors of the proposed method.

12:20  Summary of Round Table Discussion

12:40  Closing
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URGENT ANNOUNCEMENT!! to the participant from abroad.
If it is difficult to transfer the fee from overseas to the Japanese bank, you can register by e-mail to IWH and pay the fee determined by the registered date by cash at the conference site.

Instructions for the presentation

- **Invited presentation**: Presentation 25 min. / Discussions 5 min.
- **Contributed oral presentation**: Presentation 15 min. / Discussions 5 min.
VENUE

Penang School of Toyohashi Tech
Jalan Biggs, Pulau Tikus, 10350 George Town, Penang, Malaysia

Access to Penang School of Toyohashi Tech
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FLOOR MAP
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■ Evergreen Laurel Hotel Penang
   53 Persiaran Gurney, George Town, Penang, Malaysia
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MEMO