ADVANCE PROGRAM

ISOM'21

IN COOPERATION WITH

The Japan Society of Applied Physics (JSAP)

SPIE

The Magnetics Society of Japan (MSJ)

The Institute of Electronics, Information and Communication Engineers (IEICE)

The Chemical Society of Japan

Information Processing Society of Japan

The Institute of Electrical Engineers of Japan

The Institute of Image Electronics Engineers of Japan

The Institute of Image Information and Television Engineers

The Japan Society for Precision Engineering

The Laser Society of Japan

International Symposium on

Imaging, Sensing, and Optical Memory 2021

ISOM'21 will be held online only due to COVID-19, and there is no on-site event.

Oct. 3 - Oct. 6, 2021

SPONSORED BY

- The Optical Society of Japan (OSJ)

COSPONSORED BY

-Optoelectronics Industry and Technology Development Association (OITDA)

FINANCIALLY SUPPORTED BY

-The Takano Eiichi Optical Science Funds

-Support Center for Advanced Telecommunications Technology Research, Foundation

-Konica Minolta Science and Technology Foundation

https:// isom.jp/

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Symposium Schedule

	Oct. 3, Sun	Oct. 4, Mon	
9:00		**Mo-A** Keynote	9:00
		Break	
10:00		**Mo-B** 3D Sensing	10:00
11:00			11:00
12:00		Lunch	12:00
13:00			13:00
	Opening Remarks	**Mo-C** Special Invited	
	Su-A Optical Memory - I	Break	
14:00		**Mo-D** Optical Memory - III	14:00
	Break		
15:00	**Su-B** Optical Memory - II	Break	15:00
	Break	**Mo-E** Imaging - I	
16:00	**Su-C** Holography - I		16:00
		Break	
17:00		**Mo-F** Imaging - II	17:00
18:00			18:00
19:00			19:00
20:00			20:00

	Oct. 5, Tue.	Oct. 6, Wed.	
9:00	**Tu-A** Poster (short presentation)	**We-A** Optical Memory - IV	9:00
10:00			10:00
	Break	Break	
11:00	**Tu-B** Special Session: AR Display	**We-B** Optical Information	11:00
	ISOM'22 Announcement & Photo		
12:00			12:00
	Lunch	Lunch	
13:00			13:00
14:00	**Tu-C** Holography - II	**We-C** Special Session: Emerging Photonic Materials	14:00
	Break		
15:00	**Tu-D** Holography - III		15:00
		Break	
	Break	**We-PD** Postdeadline papers	
16:00			16:00
		Award & Closing	
17:00	**Tu-E** Poster		17:00
18:00	Break		18:00
	Banquet		
19:00			19:00
20:00			20:00

WELCOME TO ISOM'21

WELCOME STATEMENT FROM THE ORGANIZING COMMITTEE CHAIRPERSON

We decided to hold the 31st ISOM (ISOM'21) in a considerably different style from the original plan, in response to the spread of COVID-19 infections. The **ONLINE** conference will be held from Oct. 3 to Oct. 6, 2021 without holding on-site meeting at the Kobe Chamber of Commerce and Industry, Kobe, Japan.

On behalf of the ISOM organizing committee, I am delighted to welcome all of you to the ISOM'21.
The last ISOM meeting held online, was successful to share new developments of holographic memories, digital holography, computational imaging, bio-sensing, display, nanophotonics and plasmonics, etc.

In 2017, ISOM extended the conference scope to broader optical fields and applications, and changed the conference name as "International Symposium on Imaging, Sensing, and Optical Memory." The new ISOM includes the fields of image sensing, medical and bio-optics, nano photonics, information system, holographic technologies, as well as optical memory. We believe that the change of ISOM produces technological innovations in imaging and sensing technologies, and many applications of optical memory technologies in the fields of medical and bio-technologies, image sensing, nanotechnologies, etc.

We are very proud of the ISOM activities, because many of technologies leading new developments and new applications have been first presented and discussed in ISOM meeting. Since the first ISOM meeting in 1987, ISOM has led innovation of optical memory and economic growth in optical industry.
I sincerely ask all of ISOM'21 participants to discuss on new technologies of the next generation optical memory and new applications of optical memory technologies in coming ISOM'21.

志村努

Tsutomu Shimura
ISOM'21 Organizing Committee, Chairperson

INTRODUCTION

The 31st ISOM (ISOM'21) will be held ONLINE ONLY due to the COVID-19 pandemic, from Oct. 3 to Oct. 6, 2021 WITHOUT the on-site meeting at the Kobe Chamber of Commerce and Industry, Hyogo, Kobe, Japan.

The origin of ISOM is SOM (Symposium on Optical Memory), which was held firstly in 1985 in Tokyo as a Japanese domestic symposium. The first ISOM (International Symposium on Optical Memory) was held in 1987 also in Tokyo. Until 1994, ISOM and SOM were held alternately every other year, and since 1995, ISOM has been held every year. The total number of papers of the past symposiums has reached 3,595, and the total number of participants has reached 10,626.

The purpose of the symposium was to provide a forum for information exchange on a broad range of topics covering science and technology in optical memory and its related fields. However, information explosion in the internet and cloud service has been enforcing optical memory to change from that for consumer storage to that for enterprise storage. Many colleagues of us have been seeking for new frontiers of optical memory technologies. Considering this situation, the scopes of ISOM are being continuously updated and have been reorganized in 2016. To further highlight them, the official name of ISOM was changed from "International Symposium on Optical Memory" to "International Symposium on Imaging, Sensing, and Optical Memory" in 2017. Presentations related to the new scopes as well as the conventional ones would be strongly encouraged.

In ISOM'21, along this direction, it will be very much expected to discuss the current status of optical memory, imaging, sensing, and other related technologies. In addition, lots of papers have been submitted more than usual in this ISOM.

We appreciate your participation as presenters and audience, and we are looking forward to seeing you at online meeting.

SCOPE OF THE SYMPOSIUM

ISOM'21 will discuss the current status of Optical Memory, Imaging, Sensing, and Other Related Technologies.

The scope of ISOM'21 covers the above research fields. ISOM will provide the attractive fields to exchange the latest advances and/or ideas in the above research fields and also provide scientific interaction and collaboration.

Topics to be covered in this symposium include, but are not restricted to:

1. Optical Memory
- Professional Archive System
- Holographic Memory
- High-density Recording
- Media and Material Science
- Drive Technologies and Signal Processing
- Components and Devices
- Testing Methods
- Others

2. Imaging
- Computational Imaging
- Wavefront Coding
- Image Processing
- Optical System Design
- Devices
- Others

3. Sensing
- Medical and Bio-systems
- Three-dimensional Sensing
- Digital Holography
- Spectroscopy
- Bio-lab on a Disc
- Others

4. Other Related Technologies
- Optical Interconnection and Switching
- Optical Information Processing
- Nanophotonics and Plasmonics
- Components
- Material
- Display
- Photolithography
- Nonvolatile Memory
- Emerging Technologies and New World
- Others

REGISTRATION

All participants (including speakers) are requested to register, and are encouraged to register in advance (by Sept. 20, 2021) in order to receive the early registration discount.

I. Registration Fee

The Symposium registration information and forms can be obtained from ISOM'21 website (**https://isom.jp/**). If you have any questions, please contact ISOM'21 secretariat office.

Type	Before / On Sept. 20, 2021	Oct. 3-6, 2021
Regular	JPY 55,000	JPY 65,000
Student & Retiree	JPY 15,000	JPY 20,000
~~Banquet~~	~~JPY 5,000~~	~~JPY 7,000~~

The registration fee for the symposium includes admission to all the technical sessions and an online Technical Digest. The information to join the online Symposium will be informed those who paid the participation fee, later.

II. Registration and Payment

Those who wish to attend ISOM'21 will be able to register on the web (https://isom.jp/) after about July, 2021. The deadline for advance registration is **Sept. 20, 2021**. After that, the registration will be processed during the Symposium.

Payment should be made in Japanese Yen by bank transfer (inside Japan only) or by credit cards (VISA and Master Card) payable to ISOM'21. No personal checks will be accepted.

III. Registration Cancellation Policy

As a rule, no refunds of the registration fee will be made for any reasons whatever. Even in the event of registrant unable to attend the symposium, they will be able to download the online Technical Digest.

INSTRUCTION FOR SPEAKERS

ORAL PRESENTATION

► Time assigned for

Type	Total	Presentation	Discussion
Keynote	35 min.	30 min.	5 min.
Special Invited	30 min.	25 min.	5 min.
Invited	25 min.	20 min.	5 min.
Contributed	20 min.	15 min.	5 min.
Post deadline	15 min.	12 min.	3 min.

► All speakers will log in the web system before the beginning of the session and make their presentations online.

► We recommend all speakers to use more than 16-point font. The audience expects well-prepared presentations with clearly visible figures and captions, as well as good conclusions.

POSTER PRESENTATION

► All authors are required to prepare an A0-poster file for their presentations and discussions. At the beginning of the poster session, all authors will make a two-minute short presentation in order. Please note that the presentations will be recorded.

► All authors have to log in the web system and stay in the dedicated page of your poster during the poster session to answer questions (if any) in English.

► Please refer to the ISOM website for the details for the presentation. The instructions will appear.

DEMO PRESENTATION IN POSTER SESSION

Poster presentations with demonstration will be given in the poster session. This is a new approach of poster session in addition to usual poster presentation.

The technical demonstration will be exhibited repeatedly during the session in the ISOM web system. Participants can take a close look at the new technologies!

Technical demonstration 1:
Aerial Display for User Interface in the New Normal

Hirotsugu Yamamoto

Utsunomiya Univ. (Japan)

Technical demonstration 2:
High-speed color digital holographic microscope based on a planar lightwave circuit with a thin film heater

Kazutaka Nakama[1], Hideaki Gomi[1], Kenta Hayashi[1], Katsunari Okamoto[2], Eriko Watanabe[1]

[1]The University of Electro-Communications, [2]Okamoto Laboratory (Japan)

In addition to above presentation, some presenters may show technical demos in the poster session.

PUBLICATION OF SYMPOSIUM PAPERS

Online Technical Digest includes invited papers, accepted contributed papers, and limited numbers of post deadline papers. It will be available from Sept. 24 to Oct. 6, 2021. If you complete the payment, you will be informed of the website of the online Technical Digest on Sept. 24, 2021 and able to download it in advance.

The conference papers will be published in October. 2022 as a special issue of the OPTICAL REVIEW, which is the English-language journal of the Optical Society of Japan (OSJ). The authors who will have, by themselves, presented papers at ISOM'21 will be allowed to submit their papers for publication in this special issue. The authors of invited and contributed (including post-deadline) papers are encouraged to submit Invited Review Papers and Regular Papers, respectively.

The instructions for preparation of manuscript for the special issue will be sent via e-mail after the conference. The deadline for submission of manuscripts is Jan. 31, 2022. Submitted papers will be reviewed based on the OPTICAL REVIEW standard.

GENERAL INFORMATION

I. Official Language

The official language of ISOM'21 is English.

II. Others

To receive further ISOM'21 announcement, please visit ISOM website (https://isom.jp/).

ATTENTION

It is not allowed to take photos and videos of any presentation materials in ISOM'21.

TECHNICAL PROGRAM

October 3, 2021 (Sunday)

13:00 – 13:15 Opening Remarks

Tsutomu Shimura (The University of Tokyo, Japan)
Akinori Furuya (Tokushima Bunri University, Japan)

Su-A: Optical Memory - I

Presider: Ryuichi Katayama (Fukuoka Institute of Technology, Japan)

Su-A-01 **Invited**

13:15 **Long-term optical data storage based on femtosecond laser**

Jingyu Zhang, Jichao Gao, Zhi Yan, Siyuan Liu, Jie Tian

Huazhong University of Sci. and Technol (P.R.China)

The recent progress of long-term optical data storage based on femtosecond laser-induced nanostructures in glass is discussed. The high-speed data writing process and deep-learning enabled high-accuracy readout are also demonstrated.

Su-A-02 **Invited**

13:40 **Nano Heater - A novel Quantum Dot device realizing nano size light and heat source for Heat Assisted Magnetic Recording (HAMR) Hard Disk and beyond**

Takashi Yatsui[1], Satoshi Sugiura[2], Kazumi Kuriyama[2]

[1]Toyohashi Univ. of Technology, [2]InnovaStella, Inc. (Japan)

Due to exploding demand from data-intensive technologies such as IoT, AI, connected autonomous cars and blockchains, Data Centers are expected consume majority of world fs electricity in near future. Nano-sized heat spot provided by Nano-Heater dramatically increases capacity of HDDs and contributes to improve energy efficiency of Data Centers.

Su-A-03

14:05 **Ultrafast laser induced single-nanograting in fused silica for optical data storage application**

Yan Zhi, Gao Jichao, Zhang Jingyu

Wuhan National Laboratory for Optoelectronics, Huazhong University of Science and Technology (P.R.China)

Femtosecond laser produced 40nm line-width single-nanograting in fused silica. Such structure exhibits high-density storage characteristics and can be used for five-dimensional optical data storage. Our demonstrated approach holds the promise to achieve a disc of 7.2TB capacity.

14:25 - 14:40 Break

Su-B: Optical Memory - II

Presiders: Yuichi Nakamura (Toyohashi University of Technology, Japan)
Takayuki Shima(AIST, Japan)

Su-B-01

14:40 **Crosstalk Canceling Method for a Narrow Space Multilayer Optical Disc**

Kimihiro Saito

Kindai University Technical College (Japan)

An interlayer crosstalk canceling method to achieve a narrow layer spacing is studied. If the information on one layer is known, it is possible to extract the proper information on the other layer by using a signal processing of crosstalk cancelation method.

Su-B-02

15:00 **Simulation on Double Semiconductor Ring Resonators with Nano-Antenna for HAMR Device**

Jinghan Chen[1], Ryuichi Katayama[1], Satoshi Sugiura[2]

[1]Fukuoka Institute of Technology, [2]InnovaStella, Inc. (Japan)

A double-ring-resonator with nano-antenna device for heat-assisted magnetic recording was proposed to improve the laser oscillation stability. Numerical simulation on electric field intensity distribution for the device was done to analyze the possible modes and to compare the solutions with a single-ring-resonator device. The double-ring-resonator device had a higher stability.

Su-B-03

15:20 Improving data readout accuracy of multi-dimensional optical storage by deep learning

Siyuan Liu, Zhi Yan, Qiang Cao, Jingyu Zhang

Wuhan National Laboratory for Optoelectronics, Huazhong University of Science and Technology (P.R.China)

A deep learning based readout scheme was employed for five-dimensional optical data storage technique. The bit error rate was reduced by almost five times compared to conventional support vector machine method. An overall readout accuracy of 98.98% was achieved with 7bits per data voxel multiplexing.

15:40 - 15:55 Break

Su-C: Holography - I

Presiders: Takanori Nomura (Wakayama University, Japan)
Tadayuki Imai (Kyoto University of Advanced Science, Japan)

Su-C-01

15:55 Numerical Verification of Rectangular Microchannel Flow Using Phase-Retrieval Holography

Shotaro Noda[1], Yohsuke Tanaka[2], Shigeru Murata[2]

[1]Graduate School of Science and Technology, Kyoto Institute of Technology, [2]Faculty of Mechanical Engineering, Kyoto Institute of Technology (Japan)

In this paper, we have performed numerical experiments to measure micro rectangular channel flow using 3DHPTV. As a result, the error vector was significantly reduced by using the Phase-retrieval holography, and the 3D flow measurement was more accurate than that of the Gabor holography.

Su-C-02

16:15 **Analysis of the effect of an incident angle of an object-illuminating light pulse on reconstructed images in digital light-in-flight recoding by holography**

Asuka Tsuji[1], Mika Sasaki[1], Tomoyoshi Inoue[1], Kenzo Nishio[1], Toshihiro Kubota[2], Yasuhiro Awatsuji[1]

[1]Kyoto Institute of Technology, [2]Kubota Holography Laboratory Corporation (Japan)

We analyzed the effect of the incident angle of the object-illuminating light pulse on the reconstructed images in digital light-in-flight recording by holography. We found that the average width of the reconstructed images becomes wider by decreasing the incident angle of the object-illuminating light pulse.

Su-C-03

16:35 **Whole Phase Curvature-based Particle Positioning and Characterization by Digital Holography using Machine Learning**

Shin-ya Hasegawa, Miaki Takao

Hiroshima Institute of Technology (Japan)

We developed a method of determining the whole curvature-based position and characterizing particles using machine learning. We verified the accuracy of the positioning. The size and refractive index of the measured particles have almost the same values as those provided by the manufacturers, demonstrating the accuracy and fast processing time.

Su-C-04

16:55 **Coherent diffraction imaging using structured phase modulation**

Rujia Li, Liangcai Cao

Tsinghua University (P.R.China)

To solve the phase retrieval problem, the alternative structured phase modulation (ASPM) is used to be physical constraint. The ASPM can act as the phase grating. Modulated intensities are captured with a high signal-to-noise ratio. A complex wavefront can be robustly reconstructed from redundant measurements without a priori knowledge.

October 4, 2021 (Monday)

Mo-A: Keynote

Presiders: Takanori Nomura (Wakayama University, Japan)
Yusuke Nakamura (Hitachi, Ltd., Japan)

Mo-A-01 **Keynote**

9:00 **An Imager for Vital Signal Measurements and Biometric Authentication**

Akio Takimoto, Takashi Nakamura

Japan Display Inc. (Japan)

For the continuous vital signal monitoring with biometric information, we developed a conformable imager with organic photo detector using LTPS-TFT technology. With NIR and red light sources, the imager can obtain not only images of fingerprints/veins but also NIR and red pulse waves to calculate percutaneous oxygen saturation (SpO2).

9:35 - 9:45 Break

Mo-B: 3D Sensing

Presiders: Naofumi Shimizu (International Professional University of Technology in Osaka Department of Information Technology, Japan)
Takayuki Shima(AIST, Japan)

Mo-B-01 **Invited**

9:45 **Development of multi-static scattering field inverse analysis theory and next-generation breast cancer diagnostic imaging technology**

Kenjiro Kimura[1], Ayaka Hirai[2], Akari Inagaki[2], Tomonari Kunihisa[3], Yuichi Tanino[4], Koji Okamoto[5], Yoshiharu Nakashima[6], Takayoshi Yumii[6], Noriaki Kimura[7], Kazuhiko Yamagami[8], Shintaro Takao[9]

[1]Kobe Univ. Center for Mathematical and Data Science, AMED, [2]Kobe Univ., [3]Kobe University Hospital, [4]ICCRC, [5]Medical Corp. Gojinkai Okamoto Clinic, [6]Integral Geometry Science Inc., [7]Integral Geometry Science Inc. AMED, [8]Shinko Hospital, [9]Hyogo Cancer Center, (Japan)

We have developed a scattered field back analysis method, and built a new theoretical framework for a non-destructive method for image

reconstruction of the 3-dimensional structure of the insides of objects using the measurement results of the scattering waves from target objects.

Mo-B-02

10:10 **Preliminary Evaluation of Optical Correlator-based Computational Ghost Imaging for Acquiring Three-Dimensional Information**

Kaito Nakao, Yuta Wada, Shuntaro Aragaki, Taku Hoshizawa, Eriko Watanabe

The University of Electro-Communications (Japan)

We propose a 3D information acquisition system using optical correlator-based CGI which can correlate images at 2.4 M frame/s. A preliminary evaluation of this system was conducted. As a result, we obtained a correlation between the pattern and the object in the depth direction.

Mo-B-03

10:30 **Development of long-range FMCW LiDAR using highly coherent laser source in eye-safe wavelength range**

Koichi Iiyama, Zhou Yu, Yuya Nakamura

Kanazawa University (Japan)

Long range FMCW LiDAR system is developed by using a highly coherent laser source and the k-sampling method in eye-safe wavelength region. The distance measurement up to 200 m is successfully realized, and the outer wall of a building 50 m away is clearly profiled.

Mo-B-04

10:50 **Linearizing Optical Frequency Chirp of a DFB Laser by Modulation Waveform Optimization Utilizing K-sampling Technique for FMCW**

Meng Shan, Takahiro Ikeda, Koichi Iiyama

Kanazawa University (Japan)

Optical frequency chirp of a DFB laser is linearized by optimizing the modulation waveform using the K-sampling method for FMCW LiDAR. The spatial resolution of the FMCW LiDAR is significantly improved by the proposed method for the modulation frequency up to 20kHz.

Mo-B-05

11:10 **High-Speed Three-Dimensional Object Profiling Using FMCW Optical Ranging System by Continuous Scanning of Laser Beam**

Tomoharu Konishi, Koichi Iiyama

Kanazawa University (Japan)

High-speed object profiling is realized by using the FMCW optical ranging system. The Galvano scanner for laser beam scan is continuously scanned to avoid response delay of the Galvano scanner. As a result, the profiling time is 43 times faster than the system using a step-scanned Galvano scanner.

11:30 - 13:00 Lunch

Mo-C: Special Invited

Presider: Kimihiro Saito (Kindai University Technical College, Japan)

Mo-C-01 **Special Invited**

13:00 **Next-generation cloud storage in glass**

Masaaki Sakakura

Microsoft Research Cambridge (U.K.)

The recent exponential growth of digital data in the cloud forces us to develop a new technology for long-term storage of high capacity and low access latency. Project Silica in Microsoft Research Cambridge has developed data storage of silica using femtosecond laser for the cloud of the new generation.

13:30 – 13:35 Break

Mo-D: Optical Memory - III

Presider: Daisuke Barada (Utsunomiya University, Japan)

Mo-D-01 **Invited**

13:35 **Toward Complex Amplitude Multi-Level Holographic Memory**

Tetsuhiko Muroi, Teruyoshi Nobukawa

Japan Broadcasting Corporation (NHK) (Japan)

We developed three technologies for complex amplitude multi-level recording and reproducing: a 20:9 modulation code optimized using a genetic algorithm, demodulation method using convolutional neural network, and recording method using complex amplitude data page generated by phase hologram. The effectiveness of these technologies was confirmed.

Mo-D-02 **Invited**

14:00 **Designed embedded data for fast phase retrieval in holographic data storage**

Xiao Lin, Changyu Yu, Jianying Hao, Ruixian Chen, Haiyang Song, Xiaodi Tan

Fujian Normal University (P.R.China)

We proposed a method to design an embedded data distribution using iterations to enhance the intensity of the high-frequency signal in the Fourier spectrum. The proposed method increases the anti-noise performance and signal-to-noise ratio of the Fourier spectrum distribution, realizing a more efficient phase retrieval.

Mo-D-03

14:25 **DILS: A Double Insurance LDPC Coding Scheme based on Embedded Data to Improve Reliability for Phase-Modulated Holographic Storage**

Yahui Zhao, Meng Zhang, Qin Yu, Fei Wu, Changsheng Xie

Huazhong University of Science and Technology (P.R.China)

To deal with the complex environmental noise of phase-modulated holographic storage system, this paper proposes a double insurance LDPC coding scheme (DILS) based on embedded data. Simulation results show that DILS significantly improves the reliability and environmental adaptability of the holographic storage system.

14:45 - 15:00 Break

Mo-E: Imaging - I

Presiders: Minoru Takeda (Kyoto Inst. of Technology, Japan)
Tsung Sheng Kao (National Chiao Tung University, R.O.C.)

Mo-E-01 Invited

15:00 Coherent Raman Scattering Microscopy: Ultrafast Optics for High-Contrast Drug Imaging

Terumasa Ito

Tokyo Univ. of Agric. & Tech. (Japan)

The optical design and applications of coherent Raman scattering microscopy, a powerful label-free imaging tool for monitoring the kinetics of small-molecule drugs in live cells or tissues, are presented. The ultrafast pump-probe scheme for high-contrast drug imaging is explained by an analogy between coherent Raman scattering and spatial diffractive optics.

Mo-E-02 Invited

15:25 Multi-Functional Optical Responses of InGaN/GaN Multiple Quantum Wells studied by Laser Terahertz Emission Microscopy

Abdul Mannan[1], Hironaru Murakami[1], Andreas Hangleiter[1], Dmitry Turchinovich[2], Masayoshi Tonouchi[1]

[1]Osaka University (Japan), [2]University Bielefeld (Germany)

We apply laser THz emission microscopy to study the multiple functional optical responses of GaInN/GaN multiple quantum wells due to (i) laser-induced ultrafast dynamical screening of built-in electric field, (ii) capacitive charge oscillation of the excited carriers, (iii) the coherent acoustic phonons, and application to nano-seismology.

Mo-E-03

15:50 **Establishment of Phase-Shift Method with Rectangular-Wave Illumination for Application to Defect-Inspection Apparatus**

Yoshito Onishi[1], Yoshiho Seo[1], Masaoki Matsuoka[2], Shigeru Serikawa[2], Ken Tsugane[2]

[1]Hitachi, Ltd., Research & Development Group, Center for Technology Innovation - Instrumentation, [2]Hitachi High-Tech Fine Systems Corporation, Industrial Infrastructure DIV., (Japan)

We develop the image-processing technology for enhancement of defects with the phase-shift illumination method. Our challenge has been to discriminate actual defects from dark fringes due to artificial structures on the sample. Based on our analytical model, we establish a novel inspection method to discriminate defects with characteristic rectangular-wave illumination.

Mo-E-04

16:10 **Reduction of Random Noise in Parallax Images Acquired by Single-Pixel Imaging using Deep Neural Network**

Kazumasa Kimura[1], Mon Nagata[1], Yuta Wada[1], Yutaro Katano[2], Norihiko Ishii[2], Eriko Watanabe[1], Tetsuhiko Muroi[2]

[1]The University of Electro-Communication, [2]Japan Broadcasting Corporation (Japan)

We propose a 3D image-acquisition method by combining single-pixel imaging with deep neural network (DNN), which can reduce the noise in reconstructed images. This involved designing coding patterns via DNN optimization, which replaced the Hadamard pattern. On testing our method, we obtained parallax images with reduced noise when compared to the conventional method.

16:30 - 16:45 Break

Mo-F: Imaging - II

Presider: Koichi Iiyama (Kanazawa University, Japan)

Mo-F-01 **Invited**

16:45 **Ultrafast wavefront control involving scattering media**

Atsushi Shibukawa[1], Jang Mooseok[2], Hideharu Mikami[1], Yuki Sudo[3]

[1]Research Institute for Electronic Science, Hokkaido University. (Japan), [2]Department of Bio and Brain Engineering, Korea Advanced Institute of Science and Technology (KAIST),)Korea), [3] Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama University, (Japan)

Wavefront control provides various applications such as a scattering lens and light focusing deep inside scattering media, e.g., biological tissues. However, commercially available spatial light modulators severely limit the control speed and hence its utility. Here we show unprecedentedly high-speed wavefront control over 1MHz by our new beam scanning method.

Mo-F-02

17:10 **Deeply Sub-Wavelength Non-Contact Optical Metrology of Sub-Wavelength Objects**

Rendón-Barraza Carolina[1], Eng Aik Chan[1], Yuan Guanghui[1], Adamo Giorgio[1], Pu Tanchao[2], I. Zheludev Nikolay[1]

[1]Centre for Disruptive Photonic Technologies, The Photonics Institute, School of Physical and Mathematical Sciences, Nanyang Technological University, (Singapore), [2]Centre for Photonic Metamaterials and Optoelectronics Research Centre, University of Southampton (U.K.)

We experimentally demonstrate that a linear dimension of a sub-wavelength nanoscale object can be measured with an accuracy of ~$\lambda/260$ by a deep-learning-enabled examination of its diffraction pattern.

Mo-F-03

17:30 **Investigation of Biological Responses of a Living Biological Cell after Focused Electron Beam Exposure**

Asahi Tanaka, Wataru Inami, Yoshimasa Kawata

Shizuoka Univ. (Japan)

Focused electron beam irradiation is applied to analyze functions of subcellular biological components. We report morphological change was induced at a process structure in a neuro-like cell after direct focused electron beam exposure. This modification may be mediated by increased intracellular calcium ion concentration in the irradiated compartment.

October 5, 2021 (Tuesday)

Tu-A: Poster Session (Short presentation)

Presiders: Takanori Nomura (Wakayama University, Japan)
Kimihiro Saito (Kindai University Technical College, Japan)
Yusuke Nakamura (Hitachi, Ltd., Japan)
Takayuki Shima(AIST, Japan)

9:00 – 10:20

Tu-A-01

9:05 **Detection of acoustic beat by parallel phase-shifting digital holography**

Sota Hashimoto[1], Yuki Takase[1], Tomoyoshi Inoue[1], Kenzo Nishio[1], Peng Xia[1], Sudheesh K Rajput[2], Osamu Matoba[2], Yasuhiro Awatsuji[1]

[1]Kyoto Institute of Tecnology, [2]Kobe University, (Japan)

We experimentally succeeded in imaging of low-pressure sound by using a parallel phase-shifting digital holography as a demonstration, we recorded an acoustic beat caused by two sounds radiated from two speakers. We confirmed that the acoustic beat frequency was successfully detected.

Tu-A-02

9:08 **Full-Color Computer-Generated Holography Using Digital Micromirror Device**

Yu Yamada, Shuhei Yoshida

Kindai University (Japan)

The wavefront diffracted from object can be calculated based on diffraction theory by a computer. And holograms can be synthesized from object wavefront. In this study, the purpose is to obtain a full-color reproduction image of computer-generated holography using a digital micromirror device and a laser diode.

Tu-A-03

9:11 **Breast tissue diagnosis using local entropy extracted from quantitative phase images**

Kensei Ota, Masanori Takabayashi

Kyushu Institute of Technology (Japan)

We propose to use local entropy (LE) of quantitative phase images for tissue diagnosis. As a result of the demonstration using the quantitative phase images of breast tissue cores obtained using spatial light interference microscopy (SLIM), the statistical differences could be confirmed even between some adjacent grades.

Tu-A-04

9:14 **Fabrication of ITO Diffraction Grating Structure for Infrared Plasmonics by Thermal Nanoimprint Lithography**

Noriyuki Hasuike, Kohei Funahashi, Nobutoshi Miyamoto, Takeshi Maeda, Minoru Takeda

Kyoto Inst. of Tech. (Japan)

ITO diffraction grating structure was fabricated on polyimide film by using the combination of thermal nanoimprint lithography (NIL) and RF sputtering. The samples were prepared under various NIL process parameters, and surface morphologies and plasmonic characteristics were discussed in comparison with the structure fabricated by focused ion beam method.

Tu-A-05

9:17 **A page data by multiple intensity-modulated signal with different phase code for holographic memory**

Jun Igarashi, Satoshi Honma

University of Yamanashi, (Japan)

In this paper, we propose a method to record a complex amplitude-modulated page consisting of multiple intensity-modulated signals with different phase codes. Each intensity-signal is selectively extracted and reproduced by a spatial filter, as a result, it is possible to detect the signal by a camera device directly.

Tu-A-06

9:20 **FMCW-Digital holography for analyzing the curing process of UV-curable adhesive with temporal polarization states of the object wave**

Hikaru Hamada, Yoshinobu Aoki, Masayuki Yokota

Shimane Univ., (Japan)

We have proposed a method combining FMCW technique and digital holography. In this study, we have investigated temporal variations in the polarization states of the object wave passing through a UV-curable adhesive. Thereby, both the polarization analysis and assessment of the curing process were simultaneously performed.

Tu-A-07

9:23 **A Study of Demodulation Scheme Using Deep Learning for Holographic Data Storage**

Yamato Saito, Shuhei Yoshida

Kindai University (Japan)

In this study, we examined the improvement effect of the demodulation method using CNN for the error rate in demodulating data page recorded to photorefractive crystal by shift multiplexing with spherical waves and analyzed the types of salient errors.

Tu-A-08

9:26 **Realistic Simulation Model of $Ge_2Sb_2Te_5$ Phase Change Alloys for Optical Device**

Haruyuki Sano[1], Masashi Kuwahara[2]

[1]National Institute of Technology, Ishikawa College, [2]National Institute of Advanced Industrial Science and Technology, (Japan)

We have constructed a multi-physics simulation system to realistically reproduce the phase change of $Ge_2Sb_2Te_5$ (GST) considering the polycrystalline growth. The calculated results agree with the high-speed crystallization experiment due to laser light irradiation on a time scale of several hundred ns.

Tu-A-09

9:29 **Transmission Characteristics of Real Vehicle for Electric Field Communication**

Naoya Takahashi[1], Hiroshi Odajima[1], Daichi Kawamoto[1], Hiroshi Nakamura[2], Masaya Sugino[2]

[1]HOSEI University, [2]NEXTY Electronics Corporation (Japan)

This paper presents the electric field communication using a real vehicle. The transmission characteristics of the real vehicle closely matched with those of the wide metal plate. Furthermore, we also verified that the pass loss is independent of the distance in electric field communication applied on the real vehicle.

Tu-A-11

9:32 **Communication Improvement in IBC Wearable Device via Impedance Adjustment**

Hiroshi Odajima, Naoya Takahashi, Daichi Kawamoto, Mitsuru Shinagawa

HOSEI University (Japan)

We investigated communication improvement using a transmitter impedance adjustment circuit. The maximum power was received from four wearable device positions.

Tu-A-12

9:35 **Interference Measurement in Electric Field Communication on Large Metal Plate using Electro-Optic Technique**

Daichi Kawamoto[1], Naoya Takahashi[1], Hiroshi Odajima[1], Mitsuru Shinagawa[1], Kohei Hamamura[2], Hiroshi Nakamura[2], Masaya Sugino[2]

[1]HOSEI University, [2]NEXTY Electronics Corporation (Japan)

We studied electric field communication on a large metal plate with interference noise by using an electro-optic tool. We found that the influence of the electro-optic tool on the communication was negligible. We can successfully estimate the power of the signal and interference noise during communication.

Tu-A-13

9:38 **Improving data density and readout accuracy of multi-dimensional optical storage by deep learning clustering**

Siyuan Liu, Zhi Yan, Qiang Cao, Jingyu Zhang

Wuhan National Laboratory for Optoelectronics, Huazhong University of Science and Technology (P.R.China)

In this work, we successfully implemented the deep-learning-enabled clustering for laser parameters selection of a multi-dimensional optical storage application. 10 out of 60 states were selected for birefringent retardance multiplexing. Compared with conventional method, our technique demonstrates the improvement in data density and decoding accuracy.

Tu-A-14

9:41 **Expanded Convolutional Network: background removal for 5D optical data storage in glassfting digital holography**

Jie Tian, Zhi Yan, Jingyu Zhang

Wuhan National Laboratory for Optoelectronics, Huazhong University of Science and Technology (P.R.China)

In this work, we successfully demonstrated the background removal of adjacent data layers based on convolutional network. The data readout accuracy increased six times after implementing such deep learning approach.

Tu-A-15

9:44 **Joint Detection Scheme with Partial Response Maximum Likelihood and Neural Networks for Holographic Data Storage**

Seongkwon Jeong, Jaejin Lee

Soongsil University (Korea)

In this paper, we propose a joint detection scheme with a partial response maximum likelihood (PRML), which consists of an equalizer and detector, and two MLPs for HDS to provide performance improvement.

Tu-A-16

9:47 **Evaluation of Dielectric Film Thickness using Integral of Electric Field in Electro-Optic Crystal**

Kazuto Nishiyama[1], Mitsuru Shinagawa[1], Jun Katsuyama[2], Yoshinori Matsumoto[2], Nobuhiro Tomosada[2]

[1]HOSEI University, [2]Yokogawa Electric Corporation (Japan)

In this paper, we measured the thickness of a dielectric film using the electro-optic (EO) sensor system. We proposed a method for evaluating the thickness of a dielectric film by integrating the electric field distribution in the EO crystal using electromagnetic field simulation.

Tu-A-17

9:50 **Numerical simulations on spatial resolution enhancement of digital holograms using deep learning**

Tatsuya Tsutsui, Masanori Takabayashi

Kyushu Institute of Technology (Japan)

We propose to convert a low-resolution digital hologram to the high-resolution one using super-resolution convolutional neural network (SR-CNN) which enables spatial resolution enhancement. The numerical simulation results show that the reconstructed images from the resolution enhanced digital hologram are of higher quality than those from the original low-resolution digital hologram.

Tu-A-18

9:53 **Phasor Diagram Analysis of Two-layer Electrode Receiver in Intra-body Communication**

Nana Akatani, Haruomi Hanazawa, Mitsuru Shinagawa

HOSEI University (Japan)

We proposed a phasor-diagram-based method for analyzing the noise reduction mechanism using a two-layer electrode receiver in Intra-body communication. The maximum signal-to-noise ratio was obtained by adjusting the noise to a minimum in the differential detection. We confirmed that the two-layer electrodes receiver were effective in achieving stable communication.

Tu-A-19

9:56 **Fabrication and evaluation of multilayer recording medium for volumetric magnetic hologram memory using SiO_2 as a thermal diffusion layer**

Akira Yamaguchi, Kenta Tanaka, Yuichi Nakamura, Goto Taichi, Boey Pang Lim, Hironaga Uchida, Mitsuteru Inoue

Toyohashi University of Technology (Japan)

We have developed a magnetic hologram memory using a magnetic garnet film (Bi:RIG). To avoid the disappearance of interference pattern due to heat diffusion during recording, Bi:RIG/SiO_2 multilayer medium in which SiO_2 was used as heat dissipation layer was fabricated and evaluated the properties to confirm no degradation of properties.

Tu-A-20

9:59 **Frequency-Dependent Noise Generation using Equalizing Technique for Electro-Optic Sensor Simulator**

Mayuko Yamagishi[1], Mai Tominaga[1], Mitsuru Shinagawa[1], Jun Katsuyama[2], Yoshinori Matsumoto[2], Nobuhiro Tomosada[2]

[1]HOSEI University, [2]Yokogawa Electric Corporation (Japan)

The frequency-dependent noise was generated using the Gaussian noise and the equalizing technique in the simulation of EO sensor. We confirmed that the frequency-dependent laser intensity noise is removed through differential detection, and the receiver noise is not removed.

Tu-A-21

10:02 **A multi-dimensional shingled sub-diffraction optical data storage in glass**

Jichao Gao, Zhi Yan, Jingyu Zhang

Wuhan National Laboratory for Optoelectronics, Huazhong University of Science and Technology (P.R.China)

In this work, we demonstrated the multiplexed data writing in a shingled manner. This approach enables multi-dimensional data storage in the sub-diffraction regime without involving shorter wavelength and high NA objective lens.

Tu-A-22

10:05 **Decomposing Two-Dimensional Interference into Two Serial One- Dimensional Interferences for Holographic Data Storage Systems**

An Thien Nguyen, Jaejin Lee

Soongsil University (D. P. R. Korea)

We propose the method to analyze the 2D GPR target into two serial 1D GPR targets. This helps us design the detection close to the 2D detection. Our proposed can achieve the gain of 2.5 dB at the BER 10^-3 compared to the previous GPR target.

Tu-A-23

10:08 **Effect of iron site substitution on the magnetic and optical properties of Bi-substituted garnets for magnetic hologram memory**

Shingo Korekawa, Yuichi Nakamura, Mitsuteru Inoue, Boey Pang Lim, Hironaga Uchida, Taichi Goto

Toyohashi University of Technology (Japan)

We have studied to realize rewritable magnetic hologram memory using stable magnetic iron garnets. The effect of Al or Ga substitution to the iron site of magnetic garnet on the properties was investigated.As the amount of substitution increased, the Faraday rotation angle and extinction coefficient tended to decrease.

Tu-A-24

10:11 **Design of Achromatic Metalens of High NA and Polarization Insensitivity in Visible Range Based on Bilayer and Isotropic Structure**

Kim Jae Won, Kim Joo Young

Yonsei Univ. (Korea)

To multi parameterize the controllable geometric parameters to achieve achromatic meta-lens, bi-layer structure applied achromatic meta-lens functioning in visible wavelength region has been studied which has numerical aperture of 0.5 and polarization insensitivity.

Tu-A-25

10:14 **Improved Modulation Decoding Scheme with New Criterion Utilizing Received Sequences for Holographic Data Storage Systems**

Seongkwon Jeong, Jaejin Lee

Soongsil University (Korea)

In this paper, we propose a modulation decoding scheme with new criterion utilizing received codewords for HDSS to improve system performance.

Tu-PP-01

10:17 **Improving noise immunity by using a deep neural network in optical-correlator-based single-pixel imaging**

Yuta Wada

The University of Electro-Communications (Japan)

We proposed a hologram-based optical correlator, and combined it with an SPI system to realize optical-correlator-based imaging. We show that introducing deep learning to this method can remove noise. The proposed network structure can remove spatial noise conditions that fluctuate with time, which is difficult to remove with conventional methods.

10:20 - 10:45 Break

Tu-B: Special Session: AR Display

Presider: Yusuke Nakamura (Hitachi, Ltd., Japan)

Tu-B-01 **Invited**

10:45 **Retinal Laser Imaging Display for Medical Healthcare, AR and VR Applications**

Mitsuru Sugawara

QDLaser, Inc. (Japan)

This paper describes the basic principle and design rule of retinal laser imaging display and various medical healthcare applications, including eyewear as low vision aids and handy and portable visual-filed equipment. Technology development for AR and VR applications based on retinal laser imaging is also discussed.

Tu-B-02 Invited

11:10 Aerial Display for User Interface in the New Normal

Hirotsugu Yamamoto

Utsunomiya Univ. (Japan)

Aerial display is a new field of information display which forms a real image in the mid-air. Aerial display enables us directly to handle information without physical touch. This paper shows a wide variety of optical designs and applications of aerial display for user interface in the New Normal.

11:35 - 12:00 ISOM'22 Announcement & Photo

12:00 - 13:30 Lunch

Tu-C: Holography - II

Presider: Masanori Takabayashi (Kyushu Inst. of Technology, Japan)

Tu-C-01 Invited

13:30 High-speed imaging by parallel phase-shifting digital holography

Yasuhiro Awatsuji

Kyoto Institute of Technology (Japan)

Parallel phase-shifting digital holography is a technique capable of recording a complex amplitude distribution of object with a single-shot exposure. The authors review recent progress in high-speed imaging based on parallel phase-shifting digital holography: motion picture recording of ultrasound propagation, 3-D tracking of micro objects, and so on.

Tu-C-02

13:55 Compensation of Distortion Aberration and Defocus Blur in Depth Images Acquired via Incoherent Digital Holography

Tetsuhiko Muroi, Teruyoshi Nobukawa, Yutaro Katano, Kei Hagiwara, Norihiko Ishii

Japan Broadcasting Corporation (NHK) (Japan)

We compensated for the distortion aberration and defocus blur in the depth image acquired via incoherent digital holography. The distortion could be compensated using the camera parameters and distortion coefficients. The

defocus blur could be compensated by applying point-spread function to each object image. We successfully obtained compensated depth images.

Tu-C-03

14:15 **High-speed color digital holographic microscope based on a planar lightwave circuit with a thin film heater**

Kazutaka Nakama[1], Hideaki Gomi[1], Kenta Hayashi[1], Katsunari Okamoto[2], Eriko Watanabe[1]

[1]The University of Electro-Communications, [2]Okamoto Laboratory (Japan)

We developed a high-speed, color planar lightwave circuit digital holographic microscope (PLC-DHM) employing a thin film heater for the thermo-optical phase shifter. We also propose a four-step phase shift method involving the sharing of three interference fringes with three laser sources, which affords color videos with 33.3 fps.

14:35 - 14:45 Break

Tu-D: Holography - III

Presider: Osamu Matoba (Kobe University, Japan)

Tu-D-01

14:45 **Common-path configuration for single-shot phase-shifting incoherent digital holography with a single diffraction grating**

Teruyoshi Nobukawa, Yutaro Katano, Tetsuhiko Muroi, Norihiko Ishii

Japan Broadcasting Corporation (NHK) (Japan)

Common-path configuration for single-shot phase-shifting incoherent digital holography with a single diffraction grating is proposed. The proposed method makes use of a geometric phase to introduce four-step phase shifts and individually create four holograms. The effectiveness of the proposed method was verified by a proof-of-principle experiment.

Tu-D-02

15:05 Distribution Optimization for Computer-Generated Hologram

Zehao He, Liangcai Cao

Tsinghua Unviersity (P.R.China)

We analyze errors in computer-generated holography caused by SLMs. For phase-only SLMs, an optimization method based on frequencies is proposed to improve the quality of reconstruction.

Tu-D-03

15:25 3D super-resolution projection using single-lens spatial cross-modulation method

Xinruinan Zhang[1], Atsushi Okamoto[1], Hisatoshi Funakoshi[2], Akihisa Tomita[1]

[1]Hokkaido University, [2]Gifu University (Japan)

Common-path configuration for single-shot phase-shifting incoherent digital holography with In this paper, we perform numerical calculations to show how the spatial cross-modulation method (SCMM) can be applied to realize three-dimensional super-resolution displays. The SCMM can regenerate an optical complex amplitude by combining a single spatial light modulator and a random phase diffuser.

15:45 - 15:50 Break

Tu-E: Poster Session

Presiders: Takanori Nomura (Wakayama University, Japan)
Kimihiro Saito (Kindai University Technical College, Japan)
Yusuke Nakamura (Hitachi, Ltd., Japan)
Takayuki Shima(AIST, Japan)

15:50 - 17:50

17:50 - 18:00 Break

18:00 - 19:00 Banquet

October 6, 2021 (Wednesday)

We-A: Optical Memory - IV

Presiders: Osamu Matoba (Kobe University, Japan)
Daisuke Barada (Utsunomiya University, Japan)

We-A-01 **Invited**

9:00 **Single-shot Detection of Phase-encoded Signals in Holographic Data Storage System**

Ryushi Fujimura, Michito Tokoro

Utsunomiya University (Japan)

We have recently proposed a simple and stable phase detection method for holographic data storage systems. Phase information can be obtained from the intensities at pixel boundaries without using any additional reference waves. This presentation reports on our recent progress on this method.

We-A-02

9:25 **Numerical simulations of neural network hardware based on self-referential holography**

Rio Tomioka, Masanori Takabayashi

Kyushu Institute of Technology (Japan)

A novel method of optical neural network (ONN) hardware referred to as self-referential holographic neural network (SR-HNN) is proposed. The numerical simulation of the binary classification task of handwritten numeric images using SR-HNN was performed and sufficiently high classification accuracy was achieved.

We-A-03

9:45 **Phase-modulated holographic data storage with one-times Nyquist recording based on deep learning**

Hao Jianying, Xiao Lin, Yongkun Lin, Mingyong Chen, Ruixian Chen, Xiaodi Tan

College of Photonic and Electronic Engineering, Fujian Normal University (P.R.China)

In this paper, we propose a lensless phase retrieval method based on deep learning, which realizes directly phase retrieval from diffraction intensity map. By establishing the relationship between the intensity and the phase, we realized one-times Nyquist frequency spectrum recording, which can improve storage density greatly by saving recording materials.

We-A-04

10:05 **Improvement in Diffraction Efficiency of Volume Holographic Mode De-Multiplexer with Dual Wavelength method by Using Thick Medium**

Yuya Kuroda[1], Atsushi Okamoto[2], Akihisa Tomita[2], Taketoshi Takahata[3], Satoshi Shinada[4], Yuta Goto[4], Naoya Wada[4]

[1]Graduate School of Information Science and Technology Hokkaido University, [2]Faculty of Information Science and Technology Hokkaido University, [3]OPTOQUEST Advanced Optical Device Development Research Division, [4]National Institute of Information and Communications Technology (NICT). (Japan)

Volume holographic mode de-multiplexer with dual-wavelength method requires a large exposure amount during the recording process of volume hologram because the infrared light is used for readout. In that case, we experimentally confirmed that a thick medium, which has the large dynamic range, is effective for improving the diffraction efficiency.

10:25 - 10:35 **Break**

We-B: Optical Information

Presiders: Minoru Takeda (Kyoto Inst. of Technology, Japan)
Kimihiro Saito (Kindai University Technical College, Japan)

We-B-01 **Invited**

10:35 **Toward practical quantum computation using optical quantum memory and photon-number-resolving detector**

Mamoru Endo, Akira Furusawa

The University of Tokyo (Japan)

Practical optical quantum information processing cannot be completed in a closed space such as inside a cavity, so quantum information must be encoded on a traveling wave of light. This presentation introduces our methodology for this purpose using photon-number-resolving detectors and quantum memories to achieve fault-tolerant universal quantum computation.

We-B-02

11:00 Image-based Communication for IoT Devices Using Digital Optical Coding

Ryo Watanabe, Jun Tanida

Osaka University (Japan)

Image-based communication schemes have attracted a lot of attention. We especially focused on digital optical coding and applied it to functional communication for IoT devices. We built an experimental testbed for monitoring dust in an atmospheric environment and evaluated the performance.

We-B-03

11:20 Improvement of mode compensation accuracy using a random diffuser in progressive phase conjugation

Zeyu Shen, Shuanglu Zhang, Atsushi Okamoto, Akihisa Tomita

Hokkaido University (Japan)

To compensate for mode coupling of the spatial mode beam in the multimode fiber, we conducted a numerical analysis to evaluate the improvement of mode compensation accuracy using a random diffuser in progressive phase conjugation (PPC). The results showed that the accuracy can be improved by the proposed method.

11:40- 13:30 Lunch

We-C: Special Session: Emerging Photonic Materials

Presiders: Din Ping Tsai (The Hong Kong Polytechnic University, Hong Kong)
Masanori Takabayashi (Kyushu Inst. of Technology, Japan)

We-C-01 **Invited**

13:30 **High Dimensional Optical Meta-devices: Classical to Quantum**

Mu Ku Chen, Xiaoyuan Liu, Jingcheng Zhang, Jiaqi Yuan, Din Ping Tsai

Department of Electrical Engineering, City University of Hong Kong (Hong Kong)

Meta-devices are novel optical ultra-flat components by artificial nanoantennas. In this talk, the applications of meta-lens are presented from classical optics to quantum optics. The imaging and sensing are demonstrated by an achromatic meta-lens array with light-field system. High-dimensional quantum entanglement light source is demonstrated by a meta-lens array.

We-C-02 **Invited**

13:55 **Metasurface on Silicon Photonics for Free-space Applications**

Ping-Yen Hsieh[1], Yi Zhao[1], Chung-Yu Hsu[1], Min Chul Shin[2], Michal Lipson[2], You-Chia Chang[1]

[1]National Yang Ming Chiao Tung University (R.O.C.), [2]Columbia University (U.S.A.)

We demonstrate a platform of metasurface on silicon photonics to couple the guided mode to the free space with engineered amplitude and phase profiles. We report examples including metalenses monolithically integrated on silicon waveguides, mode size converters with millimeter emitting apertures, and compact 2D beam steerers.

We-C-03 Invited

14:20 Dielectric metasurface for imaging and visualization

Kentaro Iwami

Department of Mechanical Systems Engineering, Tokyo University of Agriculture and Technology (Japan)

Dielectric metasurface attract interests because of its capability to versatile wavefront shaping and high efficiency. This paper reports on our recent advancements on dielectric metasurface at the visible wavelength. Rotational varifocal moire metalens for wide focal length tuning and metasurface hologram for wide viewing-angle will be introduced.

We-C-04 Invited

14:45 Varifocal lens using electro-optical effect of $KTa_{1-x}Nb_xO_3$ single crystal and its performance improvement

Sohan Kawamura[1], Tadayuki, Imai[2], Soichi Oka[1], Masayuki Tsuda[1]

[1]NTT Device Innovation Center, NTT Corporation, [2]Kyoto University of Advanced Science (Japan)

$KTa_{1-x}Nb_xO_3$ (KTN) exhibits a huge electro-optical effect due to its large dielectric constant.Varifocal lenses using KTN are attractive because of their large aperture, fast response time, and high transparency, but increased lens power is required.We succeeded in increasing the lens power by changing the shape of KTN.

15:10 - 15:25 Break

We-PD: Post Deadline

Presider: Koichi Iiyama (Kanazawa University, Japan)

We-PD-01

15:25 Phase Imaging of Meta-devices

Mu Ku Chen[1], Xiaoyuan Liu[1], Jingcheng Zhang[1], Jiaqi Yuan[1], Maoxiong Zhao[2], Yiwen Zhang[2], Ang Chen[3], Wenzhe Liu[2], Jiajun Wang[2], Bo Wang[2], Xiaohan Liu[2], Haiwei Yin[3], Lei Shi[2,3], Jian Zi[2], Din Ping Tsai[1]

[1]Department of Electrical Engineering, City University of Hong Kong (Hong Kong), [2]Department of Physics, Fudan University,[3]Shanghai Engineering Research Center of Optical Metrology for Nano-fabrication (P.R.China)

The quality of the optical phase distribution is the critical factor of meta-devices. The performance of the designed novel functions closely relies on it. We have successfully developed an interferometric imaging phase measurement system for optical meta-devices. High precision quantitative characterization can be achieved with 0.05 rad accuracy in real-time.

We-PD-02

15:40 Dual-plane coupled retrieval for digital holographic reconstruction

Zhengzhong Huang, Liangcai Cao

Tsinghua University (P.R.China)

Digital holographic imaging can quantitatively extract the intensity and phase of objects. We present a rapidly converging iterative procedure based on two-plane coupled retrieval. Full camera bandwidth reconstruction can be reached by combining the advantages of in-line and off-axis holography without any prior assumptions in the object plane.

15:55 - 16:10 Award & Closing

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