

# Optica Digital Holography and Three-Dimensional Imaging Topical Meeting

**Disclaimer:** this guide is limited to technical program with abstracts and author blocks as of 19 May. For updated and complete information with special events, reference the online schedule or mobile app.

## Monday, 01 June

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### Room 1002

08:30 -- 10:30

#### M1A • Multi-photon I

*Presider: Shi-Wei Chu; National Taiwan Univ., Taiwan and Shi-Wei Chu; National Taiwan Univ., Taiwan*

#### M1A.1 • 08:30 (Invited)

**Pushing the Limits of Imaging Depth and Speed of Multiphoton Microscopy**, Chris Xu<sup>1</sup>; <sup>1</sup>*Cornell Univ., USA*. Multiphoton microscopy is an indispensable tool for high-resolution, non-invasive imaging of structure and function deep within intact tissues and organs. In this talk, we will focus on technology development for in vivo imaging at unprecedented depth and speed in mouse brains, mouse lymph nodes, and mouse cancer models.

#### M1A.2 • 09:00 (Invited)

**Multimodal Chemical Imaging to Study Metabolic Changes in Human Diabetic Kidney Biopsy**, Lingyan Shi<sup>1</sup>; <sup>1</sup>*Univ. of California San Diego, USA*. Abstract not available.

#### M1A.3 • 09:30

**This Study Presents a Dual-Phase Demodulation Technique for MPFM That Extracts Higher-Order Modulation Signals. It Enhances SBR by Over 10x in Drosophila Brains. We Extend This to Anesthetized Mice, Capturing Calcium Dynamics at 30 fps to Observe Neural Propagation with High Contrast and Temporal Precision.**, Ming-Che Chan<sup>1</sup>, Sheng-Kai Luo<sup>1</sup>, Bin-Chen Wu<sup>2</sup>, Guan-Yu Zhuo<sup>3</sup>; <sup>1</sup>*Inst. of Photonic Systems, Taiwan*; <sup>2</sup>*Inst. of Energy and Lighting Photonics, Taiwan*; <sup>3</sup>*College of Biomedical Science and Engineering, Inst. of Biophotonics, Taiwan*. This study presents a Dual-Phase Demodulation technique for multi-photon fluorescence microscopy system by extracting higher-order modulation signals. Results demonstrate a significant enhancement in the Signal-to-Background Ratio in Drosophila whole-brain samples. This study was also applied to neural dynamic observation in mouse brains.

#### M1A.4 • 09:45

**AI-Enhanced 3D Microscopy Powered by Tunable Fiber-Based Ultrafast Sources and Nonlinear Contrasts**, Shih-Hsuan Chia<sup>1</sup>; <sup>1</sup>*National Yang Ming Chiao Tung Univ., Taiwan*. We present an AI-enhanced 3D microscopy platform using versatile fiber sources. Integrating multicolor nonlinear contrasts empowered by tailored spectral conversion in Kerr media, we derive enhanced molecular signatures from structural confocal reflectance data via cGAN-based virtual staining, advancing toward accessible, low-cost virtual biopsies.

#### M1A.5 • 10:00

**Spatially Varying Aberration Compensation for GRIN Multiphoton Volumetric Microendoscopic Imaging**, Risa Kitamura<sup>1</sup>, Pin-Chun Liao<sup>1</sup>, Cheng-Han Wang<sup>1</sup>, Ting-Chen Chang<sup>1</sup>, Shih-Kuo Chen<sup>1</sup>, Shi-Wei Chu<sup>1</sup>; <sup>1</sup>*National Taiwan Univ., Taiwan*. We present a spiral-scanning, spatially varying deconvolution approach for GRIN-based multiphoton microendoscopy that exploits cylindrical aberration symmetry, doubling usable field of view, improving resolution up to 3.5-fold, and boosting signal-to-noise by 250% in deep-brain imaging.

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## M1A.6 • 10:15

**Vertical Bessel Light sheet Microscopy Enables Intravital Whole Brain High-Resolution Imaging in Adult *Drosophila*,** Heng Chang<sup>1,3</sup>, Hsiao-Chun Amy Lin<sup>1</sup>, Bi-Chang Chen<sup>2</sup>, Li-An Chu<sup>3,4</sup>; <sup>1</sup>*Department of Biomedical Engineering and Environmental Sciences, National Tsing Hua Univ., Taiwan;* <sup>2</sup>*Research Center for Applied Sciences, Academia Sinica, Taiwan;* <sup>3</sup>*Brain Research Center, National Tsing Hua Univ., Taiwan;* <sup>4</sup>*Department of Biomedical Engineering, National Taiwan Univ., Taiwan.* We develop vertical Bessel-beam light-sheet microscopy for intravital whole-brain imaging in adult *Drosophila*. The system enables rapid volumetric acquisition with synaptic resolution and reveals asymmetric post-shock neural activity

## Room 1003

08:30 -- 10:30

### M1B • Photo-Acoustic

*President: Hsiao-Chun Amy Lin; National Tsing Hua Univ., Taiwan and Hsiao-Chun Amy Lin; National Tsing Hua Univ., Taiwan*

## M1B.1 • 08:30

**Improving Ultrasound Contrast Using Plane-Wave Excitation in a Volumetric Optoacoustic-Ultrasound Hybrid System,** Tzu-Ting Lin<sup>1</sup>, Issac Esteban<sup>2,3</sup>, Xosé Luís Deán-Ben<sup>2,3</sup>, Daniel Razansky<sup>2,3</sup>, Hsiao-Chun Amy Lin<sup>1</sup>; <sup>1</sup>*National Tsing Hua Univ., Taiwan;* <sup>2</sup>*Univ. of Zurich, Switzerland;* <sup>3</sup>*ETH Zurich, Switzerland.* A unique hybrid system delivering real-time 3D optoacoustic and ultrasound images was developed to expedite clinical translation. We implemented 64-element plane-wave excitation, demonstrating improvement in ultrasound contrast without sacrificing field-of-view.

## M1B.2 • 08:45

**Highly Integrated Photoacoustic Sensor With on-Fiber Microprinted Patterns,** Jianran Zhang<sup>1,2</sup>, Yu Li<sup>1,2</sup>, Jiqiang Kang<sup>1,2</sup>, Kenneth K. Y. Wong<sup>1,2</sup>; <sup>1</sup>*Univ. of Hong Kong, Hong Kong;* <sup>2</sup>*Advanced Biomedical Instrumentation Centre, Hong Kong.* We demonstrate a highly integrated photoacoustic sensor on a single multicore fiber, featuring 3D-microprinted excitation beam-shaping patterns for extended detection depth-of-field and a transparent hollow-core Fabry-Pérot cavity with 3D-printed end face gratings (reflectivity  $\approx 0.7$ ) for sensitive ultrasound detection.

## M1B.3 • 09:00

**Volumetric Visualization of Thermal Ablation Lesions via 3D Deconvolution-Enhanced Photoacoustic Imaging,** Najia Sharmin<sup>1</sup>, Nikki Pui Yue Lee<sup>2</sup>, Kenneth K. Y. Wong<sup>1,3</sup>; <sup>1</sup>*Department of Electrical and Electronic Engineering, The Univ. of Hong Kong, Hong Kong;* <sup>2</sup>*Department of Surgery, The Univ. of Hong Kong, Hong Kong;* <sup>3</sup>*Advanced Biomedical Instrumentation Center, Hong Kong Science Park, Hong Kong.* We demonstrated a 3D deconvolution-enhanced photoacoustic imaging technique for volumetric visualization of laser-induced thermal ablation lesions in ex vivo human liver, resolving their three-dimensional structures and achieving up to  $\sim 30\%$  background noise suppression.

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## **M1B.4 • 09:15**

**Real-Time Perfusion Assessment of in Vivo Tourniquet Release Using 4D Optoacoustic Tomography,** Jia-Yi Tsai<sup>1</sup>, Tsai-Tung Chien<sup>1</sup>, Yu-Siang Lin<sup>1</sup>, Hsiao-Chun Amy Lin<sup>1</sup>; <sup>1</sup>*National Tsing Hua Univ., Taiwan.* We constructed a 4D optoacoustic tomography system with a 512-element concave spherical array and evaluated its potential as a noninvasive tool to assess hyperemia via real-time, label-free monitoring of tourniquet release in a healthy subject.

## **M1B.5 • 09:30**

**Variable-Zone Split-Band Advancing Structural Enhancement of 3D Optoacoustic Tomography,** YU SHENG CHEN<sup>1</sup>, Yin-Jou Chiu<sup>1</sup>, Wei-Lian Ou<sup>1</sup>, Hsiao-Chun Amy Lin<sup>1</sup>; <sup>1</sup>*National Tsing Hua Univ., Taiwan.* We propose variable-zone split-band enhancement for volumetric optoacoustic, combining depth-adaptive spectral shaping with multiband reconstruction to boost deep-tissue contrast while preserving sharp edges for multiscale visualization.

## **M1B.6 • 09:45**

**Abrupt Autofocusing Meta lens for Compact Photoacoustic Imaging,** Zuen Xie<sup>1</sup>, Sunil Vyas<sup>2</sup>, Cheng Hung Chu<sup>2</sup>, Yuan Luo<sup>2</sup>, Hui-Hua Chiang<sup>3</sup>, Kuang-Yuh Huang<sup>4</sup>; <sup>1</sup>*Program for Nanoengineering and Science, National Taiwan Univ. Taipei, Taiwan;* <sup>2</sup>*Inst. of Medical Device and Imaging, National Taiwan Univ., Taiwan;* <sup>3</sup>*Department of Biomedical Engineering, National Yang Ming Chiao Tung Univ., Taiwan;* <sup>4</sup>*Department of Mechanical Engineering, National Taiwan Univ., Taiwan.* Compact photoacoustic microscopes remain challenging due to system component complexity. We demonstrate an abrupt autofocusing meta lens integrating an ultrasound transducer to reduce system complexity, enabling A-scan detection and B-mode imaging with experimentally validated performance.

## **M1B.7 • 10:00**

**Toward Robust Handheld Optoacoustic Imaging: Quantifying Operator-Independent Acquisition,** Yi Li<sup>1</sup>, Janek Gröhl<sup>3</sup>, Rother Rother<sup>2</sup>; <sup>1</sup>*National Cheng Kung Univ., Taiwan;* <sup>2</sup>*Department of Vascular Surgery, Univ. Hospital Erlangen, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Erlangen, Germany, Germany;* <sup>3</sup>*Cancer Research UK Cambridge Inst., Univ. of Cambridge, Cambridge, UK, UK.* Operator-induced variability in handheld multispectral optoacoustic tomography is quantified using complementary full-reference image similarity metrics. Ultrasound-assisted positioning improves acquisition robustness, enabling reproducible handheld optoacoustic imaging.

## **M1B.8 • 10:15**

**Wavefront-Engineered Mid-Infrared Abrupt Autofocus Meta lens for Reflection-Mode Photoacoustic Microscopy,** Hsin-Lu Hsiao<sup>1</sup>; <sup>1</sup>*Inst. of Nanoengineering and Microsystem, National Tsing Hua Univ., Taiwan.* Photoacoustic microscopy (PAM) consists of optical and ultrasonic focusing, normally operated in visible light range, limiting the image object and only receiving the appearance information. By designing a meta lens for mid-IR region, it is possible to develop a more flexible and compact PAM for label-free dynamic image of living cell.

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## Room 1001

11:00 -- 12:00

### M2A • Opening Remarks and Plenary Session I

*Presider: Yuan Luo; National Taiwan Univ., Taiwan*

#### M2A.1 • 11:00 (Plenary)

**Improving IC A Million Times With Optical Lithography**, Burn J. Lin<sup>1</sup>; <sup>1</sup>*National Tsing Hua Univ., Taiwan*. The minimum feature size of Integrated Circuits has been reduced from 5 micrometers to 5 nanometers in 21 steps over almost half of a century. The feature size has been reduced from wavelengths to 1/27<sup>th</sup> of a wavelength. This talk highlights the techniques used to achieve this tremendous achievement.

## Room 1001

12:00 -- 13:00

### M3A • Tutorial Session

*Presider: Yuan Luo; National Taiwan Univ., Taiwan*

#### M3A.1 • 12:00 (Tutorial)

**Optoacoustics Goes Multimodal - Methods and Systems**, Daniel Razansky<sup>2,1</sup>; <sup>1</sup>*Univ. of Zurich, Switzerland*; <sup>2</sup>*ETH Zurich, Switzerland*. The talk covers most recent advances pertaining to the multi-modal combinations of optoacoustics with therapeutic and diagnostic ultrasound, optical microscopy, magnetic resonance imaging and more.

## Room 1002

14:00 -- 16:00

### M4A • Holographic Display and Imaging Systems I

*Presider: Dmitry Pushin; Univ. of Waterloo, Canada and Dmitry Pushin; Univ. of Waterloo, Canada*

#### M4A.1 • 14:00 (Invited)

**Wide-Angle Hologram, a Techniques of Color Display**, Tomasz Kozacki<sup>1</sup>, Maksymilian Chlipala<sup>1</sup>; <sup>1</sup>*Politechnika Warszawska, Poland*. 3D AR\VR technology is the future for handling imaging information. This work shows that wide-angle color holograms are available. We discuss a single-frame solution based on pupil and non-pupil setups as well as methods of FoV increase.

#### M4A.2 • 14:30

**Extension of Field-of-View in Holographic Near-Eye Display Using Spatial Multiplexing Method**, Tzu-Teng Chen<sup>1</sup>, Yu-Chang Chen<sup>1</sup>, Jun-Hao Xu<sup>1</sup>, Wei-Feng Hsu<sup>1</sup>; <sup>1</sup>*National Taipei Univ. of Technology, Taiwan*. This paper presents a holographic near-eye display (HNED) integrating a spatial light modulator and a holographic optical element (HOE) recorded with three lens functions. By reconstructing computer-generated holograms through the HOE, we successfully extended the FoV of the HNED.

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## **M4A.3 • 14:45**

**Variable Depth-of-Focus System for Enhanced Optical Sectioning in Self-Interference Incoherent Digital Holography**, JUNYEONG PARK<sup>1</sup>, Youngrok Kim<sup>1</sup>, Dong-Woo Seo<sup>1</sup>, Sung-Wook Min<sup>1</sup>; <sup>1</sup>*Kyung Hee Univ., Korea (the Republic of)*. This study proposes optical solution for modulate depth of focus in holographic images. The system enables selective extraction of depth layers inherent morphological characteristics of structure.

## **M4A.4 • 15:00**

**Holography-Based 4D Computational Imaging Spectrometer**, Jingyan Chen<sup>1</sup>, Yuxing Li<sup>1</sup>, Yanmin Zhu<sup>1</sup>, Edmund Lam<sup>1</sup>; <sup>1</sup>*Univ. of Hong Kong, Hong Kong*. We present a low-cost, compact 4D dual-shot imaging system called HoloSpec that requires no precisely customized components. It decodes 3D data over 430 spectral channels with high resolution, enabling high throughput 4D acquisition.

## **M4A.5 • 15:15**

**Quantitative Phase Imaging With Geometric Phase Self-Interference Incoherent Digital Holographic Microscope**, Chihyun In<sup>1</sup>, Youngrok Kim<sup>1</sup>, Dong-Woo Seo<sup>1</sup>, Sung-Wook Min<sup>1</sup>; <sup>1</sup>*Kyung Hee Univ., Korea (the Republic of)*. We propose a quantitative phase imaging method based on the transport of intensity equation using a geometric phase self-interference incoherent digital holography microscope, which enables single-shot measurement by acquiring the complex field of the sample.

## **M4A.6 • 15:30**

**Hybrid FPGA–Jetson Architecture for Real-Time Portable Spectral-Domain OCT**, Hsin-Hao Hsu<sup>1</sup>, Hao-Syuan Chen<sup>1</sup>, Chih-Hsuan Hu<sup>1</sup>, Yun-Tien Tsai<sup>1</sup>, CHUAN-BOR CHUEH<sup>1</sup>, Chia-Hsiang Yang<sup>2,3</sup>, Hsiang-Chieh Lee<sup>1,3</sup>; <sup>1</sup>*Graduate Inst. of Photonics and Optoelectronics, National Taiwan Univ., Taiwan*; <sup>2</sup>*Graduate Inst. of Electronics Engineering, National Taiwan Univ., Taiwan*; <sup>3</sup>*Department of Electrical Engineering, National Taiwan Univ., Taiwan*. We present a standalone, portable, and PC-free spectral-domain OCT (SD-OCT) platform using a hybrid Xilinx FPGA and NVIDIA Jetson architecture. This system achieves high-speed, real-time volumetric imaging and AI-driven segmentation, providing high-fidelity clinical performance.

## **M4A.7 • 15:45**

**Wide Field-of-View Self-Interference Incoherent Digital Holography Using Synthetic Aperture and Homography Based Distortion Correction**, Dong-Woo Seo<sup>1</sup>, Youngrok Kim<sup>1</sup>, Sung-Wook Min<sup>1</sup>; <sup>1</sup>*Kyung Hee Univ., Korea (the Republic of)*. We combine a large-aperture lens and synthetic aperture to widen the field-of-view in self-interference incoherent digital holography using a geometric phase lens. Homography corrects aberrations from the off-axis geometry and lens, resulting in distortion-free reconstruction.

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**Room 1003**

**14:00 -- 16:00**

**M4B • Digital Holographic Techniques for Bio-Imaging I**

*Presider: Pascal Picart; Le Mans Universite, France*

**M4B.1 • 14:00 (Invited)**

**From Complex to ChirpType Impulse Response in Incoherent Holographic Recording: a Historical Perspective Toward Fluorescence Holographic Microscopy**, Ting-Chung Poon<sup>1</sup>, Yaping Zhang<sup>2,3</sup>; <sup>1</sup>Virginia Tech, USA; <sup>2</sup>Kunming Univ. of Science and Technology, China; <sup>3</sup>Cambridge Digital Humanities, Univ. of Cambridge, UK. We review the limitations imposed by a real and nonnegative impulse response in conventional incoherent image processing and examine how two pupil synthesis of the optical transfer function (OTF) enables the realization of a bipolar or even complex impulse response. We then discuss how a chirp type impulse response can be achieved in incoherent digital holography, laying the conceptual groundwork that ultimately led to the development of the first fluorescence holographic microscopy system.

**M4B.2 • 14:30**

**Low-Rank Modal Decomposition of Beat-Resolved Retinal Laser Doppler Holography at 37,000 Frames per Second Reveals Flicker-Evoked Arterial Neurovascular Signatures**, Lancelot Doucet<sup>2</sup>, David Gouyoumdjian<sup>2</sup>, Maxime Boy-Arnould<sup>2</sup>, Fischer Yann<sup>2</sup>, Zacharie Auray<sup>2</sup>, Michael Atlan<sup>2,1</sup>; <sup>1</sup>CNRS, France; <sup>2</sup>ESPCI, France. Beat-resolved retinal Doppler holography yields synchronized blood velocity arterial/venous waveforms in seconds. A per-acquisition low-rank modal decomposition extracts a canonical pulse template and a residual fraction. During 13\,Hz flicker, canonical pulsatile strength decreases while residual heterogeneity increases.

**M4B.3 • 14:45**

**Mod-SE(2) Network for Mayo Endoscopic Subscore Severity Grading**, Clara L. Angelina<sup>1,2</sup>, Sunil Vyas<sup>3,4</sup>, Hsin-Yun Wu<sup>8,5</sup>, Shu-Chen Wei<sup>5</sup>, Hsuan-Ting Chang<sup>1,6</sup>, Yuan Luo<sup>3,7</sup>; <sup>1</sup>Graduate School of Engineering Science and Technology, National Yunlin Univ. of Science and Technology, Taiwan; <sup>2</sup>Department of Electrical Engineering, National Yunlin Univ. of Science and Technology, Taiwan; <sup>3</sup>Inst. of Medical Device and Imaging, National Taiwan Univ., Taiwan; <sup>4</sup>YongLin Inst. of Health, National Taiwan Univ., Taiwan; <sup>5</sup>Department of Internal Medicine, National Taiwan Univ. Hospital, Taiwan; <sup>6</sup>Graduate School of Intelligent Data Science, National Yunlin Univ. of Science and Technology, Taiwan; <sup>7</sup>Taiwan International Bio Research Center, National Taiwan Univ., Taiwan; <sup>8</sup>Program for Precision Health and Intelligent Medicine, Graduate School of Advanced Technology, National Taiwan Univ., Taiwan. Accurate mucosal inflammation assessment in ulcerative colitis is addressed through Mod-SE(2), handcrafted features, UMAP embeddings, and a LightGBM feedback agent. Results show 89.01% multi-domain accuracy on average, demonstrating robust, resilient, generalizable Mayo Endoscopic Sub score classification.

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## **M4B.4 • 15:00**

**Dynamic Mode Decomposition-Based Algorithm for Reconstruction of Off-Axis Holograms**, Rishikesh D. Kulkarni<sup>1</sup>, HARSHAL R. CHAUDHARI<sup>1</sup>; <sup>1</sup>*Indian Inst. of Technology Guwahati, India*. An off-axis digital hologram reconstruction algorithm employing a spatial phase-shifting formulation and dynamic mode decomposition is proposed. The method provides an accurate phase estimate and obviates manual selection of a filter mask.

## **M4B.5 • 15:15**

**Fast Single-Shot HiLo Sectioning for Fiber-Bundle Microendoscopy via CycleGAN**, Wei-Wen Hung<sup>1,2</sup>, Min-Xuan Wang<sup>3</sup>, Yu-Hsin Chia<sup>1,2</sup>, Kuang-Yuh Huang<sup>3,5</sup>, Cheng Hung Chu<sup>2</sup>, Yuan Luo<sup>2,4</sup>; <sup>1</sup>*Department of Biomedical Engineering, National Taiwan Univ., Taiwan*; <sup>2</sup>*Inst. of Medical Device and Imaging, National Taiwan Univ., Taiwan*; <sup>3</sup>*Department of Mechanical Engineering, National Taiwan Univ., Taiwan*; <sup>4</sup>*Program for Precision Health and Intelligent Medicine, National Taiwan Univ., Taiwan*; <sup>5</sup>*Program for Nanoengineering and Nanoscience, National Taiwan Univ., Taiwan*. In this work, we utilized an unsupervised CycleGAN framework to generate HiLo-equivalent images from single fiber-bundle acquisitions, eliminating structured illumination while improving optical sectioning and enabling faster, real-time, clinically practical minimally invasive imaging.

## **M4B.6 • 15:30**

**High-Sensitivity Quantitative Phase Imaging of Migrasomes on a Silicon Wafer**, Xinyi Li<sup>1</sup>, Nansen Zhou<sup>1</sup>, Chenjia Xi<sup>1</sup>, Tong Ling<sup>2</sup>, Xiangzhou Lao<sup>1</sup>, Liting Duan<sup>1</sup>, Qihang Zhang<sup>1</sup>, Renjie Zhou<sup>1</sup>; <sup>1</sup>*The Chinese Univ. of Hong Kong, China*; <sup>2</sup>*Nanyang Technological Univ., Singapore*. For label-free observation of migrasomes and associated retraction fibers, we applied an epi-illumination quantitative phase imaging system. To optimize the image contrast on refraction fibers, we tuned the silicon oxide substrate thickness and illumination wavelength.

## **M4B.7 • 15:45**

**Reflective Polarization Holography and Deep Learning for Opaque Microplastics and Surface Biofilms Identification**, Yanmin Zhu<sup>1,2</sup>, Jingyan Chen<sup>1</sup>, Yuxing Li<sup>1</sup>, Edmund Lam<sup>1</sup>; <sup>1</sup>*Electrical and Electronic Engineering, Univ. of Hong Kong, China*; <sup>2</sup>*School of Biomedical Engineering, The Univ. of Hong Kong, Hong Kong*. We present a reflective polarization holographic system integrated with deep learning to accurately identify opaque microplastics and characterize their surface microbial biofilms in complex environments.

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**Room 1002**

**16:30 -- 18:30**

**M5A • Metasurface I**

*Presider: Cheng Hung Chu; National Taiwan Univ., Taiwan*

**M5A.1 • 16:30 (Invited)**

**Optical Metasurfaces for Imaging, Sensing, and Display**, Junsuk Rho<sup>1</sup>; <sup>1</sup>*Pohang Univ of Science & Technology, Korea (the Republic of)*. In this talk, I will discuss the recent progress of imaging, sensing, and display applications with mass-producible optical metalenses (visible, near-infrared). The basic principle, experimental demonstration, and scalable manufacturing methodologies will be presented.

**M5A.2 • 17:00**

**Microcavity-Assisted Multi-Resonant Metasurfaces for Vectorial Holographic Imaging**, Shih-Hsiu Huang<sup>2</sup>, Hsiu-Ping Su<sup>2</sup>, Chao-Yun Chen<sup>2</sup>, Yu-Chun Lin<sup>2</sup>, Yuzhi Shi<sup>3</sup>, Cheng Hung Chu<sup>1</sup>, Qinghua Song<sup>4</sup>, Pin Chieh Wu<sup>2</sup>; <sup>1</sup>*National Taiwan Univ., Taiwan*; <sup>2</sup>*National Cheng Kung Univ., Taiwan*; <sup>3</sup>*Tongji Univ., China*; <sup>4</sup>*Tsinghua Univ., China*. We demonstrate microcavity-assisted multi-resonant metasurfaces integrating plasmonic meta-atoms with gradient-thickness DBR mirrors, achieving up to 15 high-Q resonances (480-1000 nm) with 81% peak efficiency and enabling multi-wavelength amplitude, phase, and vectorial holographic wavefront engineering.

**M5A.3 • 17:15**

**Underwater Huygens Meta-Optics for Structured Light**, Ming Lun Tseng<sup>1</sup>; <sup>1</sup>*National Yang Ming Chiao Tung Univ., Taiwan*. We report robust GaP Huygens metasurfaces for underwater light generation. Using diverse HIRU geometries, we achieve  $2\pi$  phase control with low fabrication sensitivity and high transmittance via the Kerker condition. A 300-nm SiO<sub>2</sub> layer ensures mechanical resilience. We demonstrate self-healing Bessel and obstacle-bypassing AAF beams in water.

**M5A.4 • 17:30**

**Topology Optimization Enables Freeform Matrix Fourier Optics**, Yu-Qi Zhou<sup>1</sup>, Yu-Tzu Liu<sup>1</sup>, Yun-Chien Wu<sup>1</sup>, Yao-Wei Huang<sup>1</sup>; <sup>1</sup>*National Yang Ming Chiao Tung Univ., Taiwan*. We demonstrate single-layer metasurface matrix Fourier optics using adjoint inverse design, routing multiple polarizations to distinct far-field positions with high contrast, achieving 94.4% simulated and 98.7% experimental performance for compact polarization analysis optical analysis devices.

**M5A.5 • 17:45**

**Nonlocal Meta-Lens for High-Quality-Factor Wavefront Shaping**, Rong Lin<sup>1</sup>; <sup>1</sup>*City Univ. of Hong Kong, Hong Kong*. We propose a nonlocal Huygens' meta-lens for high-quality-factor wavefront shaping. Local and nonlocal effects are manipulated to achieve a high quality-factor, efficiency, and effective incident-angle dispersion. Wavelength-selective bright-field and edge-enhanced imaging are demonstrated through the adjustment of output spin states.

**M5A.6 • 18:00 (Invited)**

**Metasurface Enabled Refractive Index Tomography and Small Particle Sensing**, Zhaowei Liu<sup>1</sup>; <sup>1</sup>*Univ. of California San Diego, USA*. In this talk, I will discuss two examples of using metasurface for imaging and sensing applications. The first example employs a diffractive

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optical element to capture multifocal intensity images and form snapshot parallel refractive index tomography. The second example demonstrates a meta-amplified dark-field interferometric scattering microscopy technique with significantly improved contrast and signal-to-noise ratio for detecting nanometric particles.

## Room 1003

16:30 -- 18:30

### M5B • Applications of Digital Holography and 3D Imaging I

President: To be Announced

#### M5B.1 • 16:30 (Invited)

##### Application of Multidimensional Holographic Imaging to Inter-Disciplinary

**Science**, Pascal Picart<sup>1</sup>; <sup>1</sup>LAUM CNRS, Le Mans Univ., France. We aim at discussing the crucial role of holography in inter-disciplinary science; In this talk, we will focus on its connection with research in material science and behavioral science.

#### M5B.2 • 17:00

##### Relationship Between Vertical Observation Angle and Horizontally Flipped Floating

**Images in an Arc 3D Display**, China Terauchi<sup>1</sup>, Kensuke Tamano<sup>1</sup>, Shiro Suyama<sup>1</sup>, Hirotsugu Yamamoto<sup>1</sup>; <sup>1</sup>Utsunomiya Univ., Japan. This study investigates horizontal flipping of the floating image in the arc 3D display. Using an arc 3D substrate with a radius of 50 cm and light incident at 30 degrees, the image flips horizontally around 30 degrees when the vertical observation angle is changed from 15 degrees to 40 degrees but isn't flipped outside this region.

#### M5B.3 • 17:15

##### Effect of an Annular Polarizer on Noise Reduction in Color Incoherent Digital

**Holography**, Mao Takahashi<sup>1</sup>, Teruyoshi Nobukawa<sup>1</sup>, Ryohei Hokari<sup>2</sup>, Genki Kuwano<sup>2</sup>, Kazuma Kurihara<sup>2</sup>, Kei Hagiwara<sup>1</sup>, Tetsuhiko Muroi<sup>1</sup>; <sup>1</sup>Japan Broadcasting Corporation, Japan; <sup>2</sup>AIST, Japan. We developed an annular polarizer to suppress noise in incoherent digital holography (IDH). To evaluate its performance across the visible spectrum, we constructed a color IDH system and demonstrated that the annular polarizer effectively reduced noise at red, green, and blue wavelengths.

#### M5B.4 • 17:30

##### Third Harmonic Generation Angiography With Aggregation Induced

**Nanomaterials**, Changhuo Xu<sup>1</sup>, Tzu-Ming Liu<sup>1</sup>; <sup>1</sup>Univ. of Macau, Macao. We developed OTBP, a crystalline AIE nanomaterial for efficient backward third-harmonic generation. Its optimized size enables deep-tissue angiography at ultralow laser powers, minimizing photodamage while maximizing contrast.

#### M5B.5 • 17:45

##### Deep Learning Enabled Phase Derivative Estimation in Digital Holographic

**Interferometry**, Viren S Ram<sup>1</sup>, Rajshekhar Gannarvarpu<sup>1</sup>; <sup>1</sup>Indian Inst. of Technology Kanpur, India. In this paper, we present a deep learning assisted subspace method for estimating phase derivative having dynamic intensity fluctuations. The robustness of the proposed model have been validated via simulation results under extreme noise environment.

#### M5B.6 • 18:00

# Optica Digital Holography and Three-Dimensional Imaging Topical Meeting

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**Holographic Autofocus Based on Step Size Decreasing Search and Particle Swarm Optimization Morphology Detection**, Ying Luo<sup>1</sup>, Wenjing Zhou<sup>1</sup>, Yingjie Yu<sup>1</sup>, Ting-Chung Poon<sup>2</sup>; <sup>1</sup>*Shanghai Univ., China*; <sup>2</sup>*Department of Electrical and Computer Engineering, Virginia Tech, USA*. By integrating step-size decreasing search with particle swarm optimization algorithms, we resolved focusing errors in digital holographic reconstruction, achieving automatic focusing and clear reconstruction of holographic images.

**M5B.7 • 18:15**

**Polarization-Based Axial Localization for Three-Dimensional Fluorescence Imaging**, Mingyang Xu<sup>1</sup>, Naru Yoneda<sup>1</sup>, Osamu Matoba<sup>1</sup>; <sup>1</sup>*Kobe Univ., Japan*. We investigate depth-dependent polarization behavior in fluorescence microscopy. Based on this behavior, depth estimation of fluorescent beads is achieved using the degree of polarization, as demonstrated through polarization-resolved fluorescence imaging experiments.

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## Tuesday, 02 June

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### Room 1002

08:30 -- 10:30

#### Tu1A • Holographic Display and Imaging Systems II

Presider: Dalip Mehta; Indian Inst. of Technology Delhi, India

#### Tu1A.1 • 08:30 (Invited)

**Holographic Display with Occlusion Support and High Color Fidelity**, Jae-Hyeong Park<sup>1,2</sup>, Woongseob Han<sup>1</sup>, Chanseul Lee<sup>1</sup>, Chun Chen<sup>2</sup>, Minseong Kim<sup>1</sup>, Myeong-Ho Choi<sup>2</sup>; <sup>1</sup>*Electrical and Computer Engineering, Seoul National Univ., Korea (the Republic of)*; <sup>2</sup>*Inter-Univ. Semiconductor Research Center, Seoul National Univ., Korea (the Republic of)*. Holographic displays are advancing rapidly with the integration of recent AI-based techniques. In this talk, we present our latest work aimed at enhancing the realism of holographic three-dimensional imagery. Specifically, we demonstrate mutual occlusion between holographic images and real-world objects, as well as faithful color reproduction, enabling a more immersive and visually accurate experience.

#### Tu1A.2 • 09:00

**Real-Time Adaptive Holographic Near-Eye Display System Based on Visual Range Modulation Framework**, Tuvshinjargal Amgalan<sup>1,2</sup>, Ganbat Baasantseren<sup>2</sup>, Munkh-Uchral Erdenebat<sup>3</sup>, Ki-Chul Kwon<sup>1</sup>, Hoonjong Kang<sup>4</sup>, Nam Kim<sup>1</sup>; <sup>1</sup>*Chungbuk National Univ., Korea (the Republic of)*; <sup>2</sup>*National Univ. of Mongolia, Mongolia*; <sup>3</sup>*Kyungpook National Univ., Korea (the Republic of)*; <sup>4</sup>*Wonkwang Univ., Korea (the Republic of)*. We propose an adaptive holographic near-eye display based on a visual range modulation framework that integrates a dynamic eye-responsive perceptual interface. The system supports real-time holographic image acquisition and vision-extended visualization seamlessly integrated with the real-world environment, driven entirely by user eye commands.

#### Tu1A.3 • 09:15

**Camera-in-the-Loop Optimization for High-Fidelity Far-Field Holography With SLMs**, Stephan Reichelt<sup>1</sup>, Markus Zimmermann<sup>1</sup>, Andreas Brenner<sup>1</sup>, Tobias Haist<sup>1</sup>; <sup>1</sup>*Universität Stuttgart, Germany*. We demonstrate camera-in-the-loop calibration of a phase-only SLM holographic system, enabling accurate digital-twin modeling and experimental far-field speckle suppression for far-field holographic projections.

#### Tu1A.4 • 09:30

**Extending and Enlarging the Field of View in Near-Eye Displays Using Multiplexed Volume Holographic Lens Assemblies Technology**, CHING HSIANG CHANG<sup>1</sup>, Chen-Yuan Kuo<sup>1</sup>, Chun-Yu Hsieh<sup>1</sup>, Yu-Hua Chou<sup>1</sup>, Yeh-Wei Yu<sup>1</sup>, Tsung-Hsun Yang<sup>1</sup>, Ching-Cherng Sun<sup>1</sup>; <sup>1</sup>*National Central Univ., Taiwan*. We propose a multiplexed volume holographic optical element system to extend the field of view of near-eye displays. By combining lens array and angular multiplexing, the system magnifies the viewing angle and expands the eye-box.

# Optica Digital Holography and Three-Dimensional Imaging Topical Meeting

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## Tu1A.5 • 09:45

**Multilayer Foveated Near-eye Display Using a Spatial Light Modulator and Focus Tunable Optic**, Sahar Kheibarihafshejani<sup>1</sup>, Jae-Hyeung Park<sup>1,2</sup>; <sup>1</sup>*Inter-Univ. Semiconductor Research Center, Seoul National Univ., Korea (the Republic of)*; <sup>2</sup>*Department of Electrical and Computer Engineering, Seoul National Univ., Korea (the Republic of)*. This study presents a foveated near-eye display system integrating a spatial light modulator with a focus-tunable lens to generate layered imagery. Dynamic magnification control preserves high foveal resolution while progressively reducing image detail toward the peripheral visual field.

## Tu1A.6 • 10:00

**Dynamic Eyebow Steering Module for Holographic Near-Eye Displays via Temporal Polarization Multiplexing**, Erkhembaatar Dashdavaa<sup>1,2</sup>, Erdenebayar Bayarsaikhan<sup>1</sup>, Munkh-Uchral Erdenebat<sup>1,2</sup>, Hyeon-Su Jeong<sup>1</sup>, Min-Seok Kim<sup>1</sup>, Ji-Sub Park<sup>1,2</sup>, Hak Rin Kim<sup>1,3</sup>; <sup>1</sup>*School of Electronic and Electrical Engineering, Kyungpook National Univ., Korea (the Republic of)*; <sup>2</sup>*XR Display Industry-Academia Research Inst., Kyungpook National Univ., Korea (the Republic of)*; <sup>3</sup>*School of Electronics Engineering, Kyungpook National Univ., Korea (the Republic of)*. We propose a polarization-dependent bi-stacked geometric-phase prism with quarter-waveplate retardation (QWP-GPP) enabling two-dimensional pupil steering and scalable eyebow expansion through temporally polarization multiplexed gaze-contingent activation, achieving high optical efficiency for compact holographic near-eye displays.

## Tu1A.7 • 10:15

**Efficiency Enhancement of Exit Pupil Expansion Light Guide With Volume Holographic Optical Element**, Bing Hong Qiu<sup>1</sup>, Chung Wei Lin<sup>1</sup>, Ching Yuan Chen<sup>1</sup>, Guan Ying Su<sup>1</sup>, Yeh-Wei Yu<sup>1</sup>, Tsung-Hsun Yang<sup>1</sup>, Ching-Cherng Sun<sup>1</sup>; <sup>1</sup>*National Central Univ., Taiwan*. In this study, a dispersive volume holographic optical element (VHOE<sub>d</sub>) enabled spectral matching, and the source size was further optimized, increasing optical efficiency of the white-light exit pupil expansion lightguide from 1.6% to 9%.

## Room 1003

08:30 -- 10:30

### Tu1B • Holographic Optical Elements and Applications I

*Presider: Yoshio Hayasaki; Utsunomiya Univ., Japan*

#### Tu1B.1 • 08:30 (Invited)

**Volume Holographic Optical Element-Embedded Lightguide for AR/MR Glasses**, Ching-Cherng Sun<sup>1</sup>, Wen-Kai Lin<sup>3</sup>, Wei-Chia Su<sup>4</sup>, SHIUAN-HUEI Lin<sup>2</sup>, TSUNG-XIAN lee<sup>5</sup>, WAN-PIN Tsai<sup>5</sup>, Chi Sun<sup>6</sup>, Tsung-Hsun Yang<sup>1</sup>; <sup>1</sup>*National Central Univ., Taiwan*; <sup>2</sup>*Department of Electrophysics, National Yang Ming Chiao Tung Univ., Taiwan*; <sup>3</sup>*Department of Photonics, Feng Chia Univ., Taiwan*; <sup>4</sup>*Graduate Inst. of Photonics, National Changhua Univ. of Education, Taiwan*; <sup>5</sup>*Graduate Inst. of Color and Illumination Technology, National Taiwan Univ. of Science and Technology, Taiwan*; <sup>6</sup>*Wyant College of Optical Sciences, Univ. of Arizona, USA*.

We propose and experimentally demonstrate lightguide-based mixed reality (MR) glasses incorporating volume holographic optical elements (VHOEs), which can be regarded as the most important elements for coupling in/out the incoming image from a micro-projector. The VHOE design is carefully optimized in conjunction with key optical performance metrics of the

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glasses, including eye box size, field of view (FOV), color fidelity, image distortion, and optical efficiency.

## Tu1B.2 • 09:00

**Objective Quality Assessment for Holographic Fringe Pattern**, Hoonjong Kang<sup>1</sup>, Nam Kim<sup>2</sup>; <sup>1</sup>*Graduate School of JABA, Wonkwang Univ., Korea (the Republic of)*; <sup>2</sup>*School of Information and Communication Engineering, Chungbuk National Univ., Korea (the Republic of)*. This study defines three essential requirements for objective quality assessment in holography and introduces PSNR-on-AS as a compliant evaluation method. Our results verify that PSNR-on-AS serves as a robust and valid objective assessment tool specifically optimized for holographic fringe patterns.

## Tu1B.3 • 09:15

**Design Framework of Augmented Reality Near-Eye Display Using Dual Metalenses and a Holographic Image Combiner**, Sehoon Kim<sup>1</sup>, Dohyeon Kim<sup>1</sup>, Sun-Je Kim<sup>1</sup>; <sup>1</sup>*School of Electrical Engineering, Soongsil Univ., Korea (the Republic of)*. We present a refractive-free augmented reality near-eye display using two achromatic metalenses and a holographic image combiner. The system replaces refractive optics while maintaining full-color operation and practical eye relief. Performance is validated through sequential ray tracing and FFT-based MTF analysis.

## Tu1B.4 • 09:30

**Analysis of Continuously Varying Temporal Signals in Holographic Storage Systems: a Comparison Between Pulse and Sinusoidal Types**, Shih-Hsuan Kong<sup>1</sup>, Tzu-Chieh Huang<sup>1</sup>, Yu-Che Lu<sup>1</sup>, Yeh Wei Yu<sup>1</sup>, Tsung-Hsun Yang<sup>1</sup>, Ching-Cherng Sun<sup>1</sup>; <sup>1</sup>*Department of Optics and Photonics, National Central Univ., Taiwan*. We propose a cylindrical-wave architecture. Optimized sinusoidal coding, refined by a genetic algorithm, outperforms pulse coding, mitigating diffraction efficiency decay and ensuring energy uniformity for superior fidelity and readout speed.

## Tu1B.5 • 09:45

**Numerical Analysis of the Diffraction Properties in a Cylindrical Wave Volume Holographic Optical Element**, Daisuke Barada<sup>1</sup>; <sup>1</sup>*Utsunomiya Univ., Japan*. The diffraction properties of a volume holographic optical element (VHOE) formed by the interference of a plane wave and a cylindrical wave are numerically analyzed using rigorous coupled-wave analysis (RCWA). Diffraction from a line pattern is calculated to clarify the Bragg selectivity and thickness dependence of the VHOE.

## Tu1B.6 • 10:00 (Invited)

**Modified Split-Lohmann Holography and Holographic Signal Converter**, Tomoyoshi Shimobaba<sup>1</sup>, Fan Wang<sup>1</sup>, Masato Shotoku<sup>1</sup>, Tomoyoshi Ito<sup>1</sup>; <sup>1</sup>*Chiba Univ., Japan*. Split-Lohmann holography enables the calculation of 3D holograms by utilizing the Lohmann lens principle, offering shorter computation times than conventional layer-based methods. However, this technique suffers from depth-dependent shifts and ringing artifacts arising from each layer in 3D reconstructions. We propose a modified split-Lohmann holography method to mitigate these issues. Furthermore, we discuss a holographic signal converter that implements this modified approach.

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**Room 1002**

**11:00 -- 13:00**

**Tu2A • Digital Holographic Techniques for Bio-Imaging I**

*Presider: Partha Banerjee; Univ. of Dayton, USA*

**Tu2A.1 • 11:00 (Invited)**

**Multi-Spectral and Hyper-Spectral Quantitative Phase and Auto-Fluorescence**

**Microscopy for Biomedical Applications**, Dalip Mehta<sup>1</sup>, Himanshu Joshi<sup>1</sup>, Atul Kumar<sup>2</sup>, Gaurav Pant<sup>1</sup>, Varun Surya<sup>2</sup>, Deepika Mishra<sup>2</sup>; <sup>1</sup>*Indian Inst. of Technology Delhi, India*; <sup>2</sup>*All India Inst. of Medical Sciences, India*. We have developed multi-spectral and hyper-spectral quantitative phase and autofluorescence microscopy for label-free diagnosis of oral cancer and oral potentially malignant disorders. Fluorescence and phase microscopy of endogenous fluorophores is analyzed for biopsy without staining.

**Tu2A.2 • 11:30**

**Novel Biomarkers in Melanoma Cells Derived by Holographic Incoherent-Light-Source Quantitative Phase Imaging**, Michaela S. Marcondes<sup>2</sup>, Daniel Zicha<sup>2,1</sup>; <sup>1</sup>*Inst. of Physical Engineering, Faculty of Mechanical Engineering, Brno Univ. of Technology, Czechia*; <sup>2</sup>*Central European Inst. of Technology, Czechia*. Molecular biomarkers are complex as they operate in networks and are dependent on the host genetic background. Here, we present biomarkers derived from dynamic morphometry of cancer cells, which directly reflect invasiveness and metastatic phenotype.

**Tu2A.3 • 11:45**

**Holographic Tracking and Analysis for Studying Swimming Microorganisms**, Laurence G. Wilson<sup>1</sup>, Sam A. Matthews<sup>1</sup>, Daniel B. Edelmann<sup>2</sup>, Kai M. Thormann<sup>2</sup>, Martin A. Bees<sup>1</sup>; <sup>1</sup>*Univ. of York, UK*; <sup>2</sup>*Institut für Mikrobiologie und Molekularbiologie, Justus-Liebig-Universität Gießen, Germany*. Digital holographic microscopy images the motion of microorganisms at high speed, and in three dimensions. We present three brief case studies showcasing biological and biomedical insight gained in bacterial, eukaryotic and archaeal domains.

**Tu2A.4 • 12:00**

**Synergy of Dual-Modality Plasmonic and Fluorescence Imaging on an Integrated Chip**, Mohammad Sadman Mallick<sup>1</sup>, Saswat Mohapatra<sup>1</sup>, Wei-Chuan Shih<sup>1</sup>; <sup>1</sup>*Univ. of Houston, USA*. We present a dual-modality plasmonic and fluorescence imaging technique on an integrated chip that facilitates molecular-specific capture of biological targets such as small extracellular vesicles. The dual modalities synergize label-free, unbiased representation of all detection targets, and targeted molecular interrogation among these targets.

**Tu2A.5 • 12:15**

**Single-Shot Point Diffraction Interference Microscope Based on Geometric Phase-Shifting Using a Polarized Camera**, Akio Mizutani<sup>1</sup>; <sup>1</sup>*Osaka Metropolitan Univ., Japan*. Single-shot point diffraction interference microscope based on geometric phase-shifting using a polarized camera was developed for observing a transparent object in real time. Phase images of a moving *Euglena* could be observed at video rate.

**Tu2A.6 • 12:30 (Invited)**

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**Adaptive Quantum Imaging With Entangled Photons Towards Label-Free Biomedical Diagnostics**, Juergen W. Czarske<sup>1</sup>; <sup>1</sup>*Technische Universität Dresden, Germany*. A quantum microscope using wavefront shaping for label-free tissue characterization is presented. Entangled photons, interacting with the sample in the infrared range and detected in the visible range, enable advantageous measurements with undetected light.

## Room 1003

11:00 -- 13:00

### Tu2B • Computer Generated Holograms and Metasurface Holograms

Presider: Radim Chmelik; *Brno Univ. of Technology, Czechia*

#### Tu2B.1 • 11:00 (Invited)

##### **Hologram Design Platform for Material Laser Processing and Laser Excitation**

**Display**, Yoshio Hayasaki<sup>1</sup>, Nami Kuroo<sup>1</sup>, Kota Kumagai<sup>1</sup>, Satoshi Hasegawa<sup>1</sup>; <sup>1</sup>*Utsunomiya Univ., Japan*. A design framework for computer-generated holograms offers efficient material excitations using beam shaping in material laser processing and laser excitation display.

#### Tu2B.2 • 11:30

##### **Phase-Only Hologram Generation Using Integer Quantized Neural Networks**

Yutaka Endo<sup>1</sup>, Antoni J. Wojcik<sup>2</sup>, Dilawer Singh<sup>2</sup>, Timothy D. Wilkinson<sup>2</sup>; <sup>1</sup>*Kanazawa Univ., Japan*; <sup>2</sup>*Univ. of Cambridge, UK*. We propose a quantized neural network for high-speed phase-only hologram generation. Using integer quantization and an optimized architecture, our model achieves approximately 25 fps on a CPU with image quality comparable to floating-point models.

#### Tu2B.3 • 11:45

##### **Synthesis of Color Computer Generated Holograms in Self-Interference Digital Holography**

Elena Stoykova<sup>1</sup>, Kihong Choi<sup>2</sup>, Keehoon Hong<sup>2</sup>; <sup>1</sup>*Bulgarian Academy of Sciences, Bulgaria*; <sup>2</sup>*Electronics and Telecommunications Research Inst., Korea (the Republic of)*. We developed an accelerated approach for synthesis of color computer generated holograms for modeling in self-interference incoherent digital holography and studied the impact of the number of the object point sources on quality of the holograms and reconstructions.

#### Tu2B.4 • 12:00

##### **Continuous Hologram Synthesis for a Wide Range of Pixel Pitches via Implicit Neural Representations**

Otoya Shigematsu<sup>1</sup>, Ryoichi Horisaki<sup>1</sup>; <sup>1</sup>*Univ. of Tokyo, Japan*. We propose a hologram synthesis method that enables flexible pixel-pitch control based on implicit neural representations. It realizes a continuous hologram representation, suggesting a promising approach to computationally efficient hologram synthesis and compact hologram storage.

#### Tu2B.5 • 12:15

##### **High-Accuracy Light Propagation Calculation Method for Off-Axis Regions**

Hiroto Nishimura<sup>1</sup>, Kotomi Nakanishi<sup>1</sup>, Prasenjit Paul<sup>1</sup>, Boaz J. Jackin<sup>2</sup>, Munekazu Date<sup>3</sup>, Kenji Yamamoto<sup>1</sup>; <sup>1</sup>*Tokushima Univ., Japan*; <sup>2</sup>*Kochi Univ., Japan*; <sup>3</sup>*Tokushima Bunri Univ., Japan*. This paper proposes a high-accuracy light propagation computation method for off-axis regions, reducing errors compared with Fresnel approximation and enabling off-axis

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computation with arbitrary sampling intervals, validated experimentally.

## Tu2B.6 • 12:30

**Holographic Optogenetic Cellular Activity Manipulation by Adjusting Height Using Single-Photon Holographic Microscope in Mouse Brain**, Yuta Fukumoto<sup>1</sup>, Naru Yoneda<sup>1,2</sup>, Mitsuhiro Morita<sup>1,3</sup>, Osamu Matoba<sup>1,2</sup>; <sup>1</sup>*Graduate School of System Informatics, Graduate School of System Informatics, Kobe Univ., Japan*; <sup>2</sup>*Center of Optical Scattering Image Science (OaSIS), Center of Optical Scattering Image Science (OaSIS), Kobe Univ., Japan*; <sup>3</sup>*Graduate School of Science, Graduate School of Science, Kobe Univ., Japan*. Using a wide field-of-view, we achieved simultaneous and selective spot formation in single-photon holographic optical stimulation for optogenetic manipulation of cellular activity on mouse brain cells, based on measurements of mouse brain morphology.

## Tu2B.7 • 12:45

**Dual-Sided Metalens-Enabled Illumination for Light-Sheet Fluorescence Microscope**, PING SHUN HSIEH<sup>1,2</sup>, Hung-Chuan Hsu<sup>1,2</sup>, Chun Chun Chang<sup>1,2</sup>, Cheng Hung Chu<sup>1</sup>, Sunil Vyas<sup>1</sup>, Din Ping Tsai<sup>3,4</sup>, Yuan Luo<sup>1,5</sup>, Kuang-Yuh Huang<sup>2</sup>; <sup>1</sup>*Inst. of Medical Device and Imaging, National Taiwan Univ., Taiwan (R.O.C.), Taiwan*; <sup>2</sup>*Department of Mechanical Engineering, National Taiwan Univ., Taiwan (R.O.C.), Taiwan*; <sup>3</sup>*Department of Electrical Engineering, City Univ. of Hong Kong, Kowloon, Hong Kong SAR, China, Hong Kong*; <sup>4</sup>*Centre for Biosystems, Neuroscience, and Nanotechnology, City Univ. of Hong Kong, Kowloon, Hong Kong SAR, Hong Kong*; <sup>5</sup>*YongLin Inst. of Health, National Taiwan Univ., Taiwan (R.O.C.), Taiwan*. Light-sheet fluorescence microscopy enables optically sectioned images for volumetric imaging. To simplify the illumination arm configuration while minimizing sample-induced stripe artifacts, we use metalens-based dual-sided illumination combined with deconvolution to further improve image quality.

## Room 1001

14:00 -- 15:30

### Tu3A • Plenary Session II and Keynote Session I

*Presider: Tatiana Latychevskaia; Paul Scherrer Institut, Switzerland*

#### Tu3A.1 • 14:00 (Plenary)

**Computational Microscopy with Coherent Diffractive Imaging and Ptychography**, Jianwei Miao<sup>1</sup>; <sup>1</sup>*Univ. of California Los Angeles, USA*. Computational microscopy based on coherent diffractive imaging and ptychography unifies microscopy and crystallography by replacing lenses with diffraction and algorithms, enabling imaging across nine orders of magnitude in length scale, from sub-angstrom atomic structures to centimeter-scale tissues.

#### Tu3A.2 • 15:00 (Keynote)

**Underwater Optical Sensing and Imaging in Turbidity Using Multi-Dimensional Integral Imaging and Deep Learning (Keynote Address)**, Bahram Javidi<sup>1</sup>, Gregory Aschenbrenner<sup>1</sup>, Gokul Krishnan<sup>1</sup>; <sup>1</sup>*Univ. of Connecticut, USA*. This keynote address presents an overview of recently reported advances in underwater optical sensing and imaging in turbidity using multi-dimensional integral imaging and deep learning.

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## Poster Area- Exhibits

15:30 -- 16:30

### Tu4A • Poster Session I

#### Tu4A.1

##### **Nanoscale Mapping of Ocular Mitochondrial Ultra-Structure via MAGNIFY Expansion Microscopy,**

Wing Yat Lee<sup>1</sup>, Ming-Kang Lim<sup>2</sup>, Yung-Wei Liao<sup>1</sup>, Li-An Chu<sup>1</sup>, Yueh-Feng Wu<sup>1</sup>; <sup>1</sup>*Department of Biomedical Engineering, National Taiwan Univ., Taiwan;* <sup>2</sup>*Department of Biomedical Engineering and Environmental Sciences, National Tsing Hua Univ., Taiwan.* We resolve mitochondrial ultra-structures in mouse ocular tissues using MAGNIFY expansion microscopy. Compared to 4x expansion, the 8x protocol reveals superior morphological details and membrane-matrix organization, providing critical insights into organelle-linked ocular pathologies.

#### Tu4A.2

**CITL-Based Low-Speckle Holographic Display With Microlens Array,** JunYu Lin<sup>1</sup>, Yu Chih Lin<sup>1</sup>; <sup>1</sup>*Feng Chia Univ., Taiwan.* A holographic display system is proposed that integrates a camera-in-the-loop algorithm for aberration compensation and a micro-lens array to expand the field of view. The 3D profile of the target is captured using fringe projection profilometry, and multi-view CGHs are generated via a layer-based S-FFT algorithm and displayed using a single SLM.

#### Tu4A.3

##### **Compensation in Automotive HUDs Using Measured Windshield Freeform**

**Profiles,** Zhong-Yong Lin<sup>1</sup>, You-Hsun Li<sup>1</sup>, Zheng-Xuan Zeng<sup>1</sup>, Wen-Kai Lin<sup>1</sup>, Chih-Hao Chuang<sup>1</sup>; <sup>1</sup>*Feng Chia Univ., Taiwan.* To mitigate windshield-induced distortion in PHUDs, this work uses inverse mapping. Grid data from Zemax were processed in MATLAB to create pre-distorted images via resampling. This lowered peak distortion from 5.8% to 4.58%. Multi-viewpoint simulations reveal perspective-dependent residual distortion, necessitating further optimization.

#### Tu4A.4

**Dual-Spectrum Three-Dimensional Light Field Microscopic System Using Deep Learning-Based End-to-End Multimodal Fusion Network,** Munkh-Uchral Erdenebat<sup>1</sup>, Erkhembaatar Dashdavaa<sup>1</sup>, Jingwen Bu<sup>1</sup>, Suyeon Park<sup>1</sup>, Hak Rin Kim<sup>1</sup>; <sup>1</sup>*Kyungpook National Univ., Korea (the Republic of).* We propose a advanced 3D microscopic system capable of RGB and SWIR sensors. To achieve accurate, high-fidelity reconstructions, the system integrates an multimodal fusion network. This architecture effectively synthesizes data from disparate spectral channels to generate high-precision 3D models of micro-objects with enhanced topological detail.

#### Tu4A.5

**GPU-Accelerated Electronic Holographic 3D Display With a Hand-Drawn Interface,** Rio Hanyu<sup>1</sup>, Takashi Nishitsuji<sup>1</sup>; <sup>1</sup>*Faculty of Science, Toho Univ., Japan.* We propose a GPU-accelerated holographic display with a hand-drawn interface. Subdividing cubic strokes into quadratic segments enables real-time 4K generation, outperforming conventional systems in

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reconstruction quality via a deterministic analytical framework.

## Tu4A.6

**Digital Scanning Lightsheet Microscopy for Drosophila Functional Imaging With Treadmill Ball & Visual Stimulation System**, SiangHe Wang<sup>1</sup>, Heng Chang<sup>1</sup>, Li-An Chu<sup>1</sup>; <sup>1</sup>*National Tsing Hua Univ., Taiwan*. We develop upright and inverted Bessel light-sheet systems enabling invasive whole-brain imaging and revealing ellipsoid body dynamics during closed-loop visual navigation. (tel:+03-572-5077, e-mail : sianghe.wang@gmail.com).

## Tu4A.7

**Physics-Based Deconvolution for Improved Initialization of Iterative HiODT Reconstruction**, Monika Kocourková<sup>1</sup>, Ivana Michálková<sup>1</sup>, Radim Chmelík<sup>1</sup>; <sup>1</sup>*CEITEC BUT, Czechia*. We propose a physics-based deconvolution approach for initialization of iterative holographic incoherent optical diffraction tomography. Improved convergence, stability, and quantitative accuracy of three-dimensional refractive index reconstruction are demonstrated using hiQPI z-stack data.

## Tu4A.8

**Self-Reference in-Line Digital Holography System With High-Speed Polarization Image Sensor and Daily-use Light**, Tatsuki Tahara<sup>1</sup>; <sup>1</sup>*National Inst of Information & Comm Tech, Japan*. I construct a self-reference in-line digital holography system with a light-emitting diode to obtain a complex amplitude distribution of an object wave with high temporal resolution. The effectiveness of the system is experimentally confirmed.

## Tu4A.9

**HiLo Fluorescence Endomicroscopy Using Unsupervised RCAN-CycleGAN**, CHIA YU LIN<sup>1,2</sup>, Yu-Hsin Chia<sup>1,2</sup>, Sunil Vyas<sup>2</sup>, Yuan Luo<sup>2,3</sup>; <sup>1</sup>*Department of Biomedical Engineering, National Taiwan Univ., Taiwan*; <sup>2</sup>*Inst. of Medical Device and Imaging, National Taiwan Univ., Taiwan*; <sup>3</sup>*Inst. of Health, National Taiwan Univ., Taiwan*. We present an unsupervised RCAN-CycleGAN framework that translates single-shot wide-field fluorescence endomicroscopy images into high-contrast, optically sectioned HiLo images using only unpaired training data. The model generates HiLo-quality output from a single wide-field exposure without structured illumination hardware.

## Tu4A.10

**Common-Path Digital Holographic Microscopy Using a Gradient Metabiprism for Quantitative Phase Imaging**, Ping-Feng Wei<sup>1,2</sup>, Cheng Hung Chu<sup>2,3</sup>, Sunil Vyas<sup>2,3</sup>, Yuan Luo<sup>1,2</sup>; <sup>1</sup>*Program for Precision Health and Intelligent Medicine, National Taiwan Univ., Taiwan*; <sup>2</sup>*Inst. of Medical Device and Imaging, National Taiwan Univ., Taiwan*; <sup>3</sup>*YongLin Inst. Of Health, National Taiwan Univ., Taiwan*. We demonstrate a compact common-path digital holographic microscope using a gradient metabiprism. The proposed architecture enables stable and high-fidelity 3D quantitative phase imaging of human lung cancer cells.

## Tu4A.11

**Near-Eye Display with Dual Image Plane Based on VHOE's Wavelength Selectivity**, Wen-Kai Lin<sup>1</sup>, Ying-Pin Tsai<sup>2</sup>, Wei-Chia Su<sup>2</sup>; <sup>1</sup>*Department of Photonics, Feng Chia Univ., Taiwan*; <sup>2</sup>*Graduate Inst. of Photonics, National Changhua Univ. of Education, Taiwan*. This

# Optica Digital Holography and Three-Dimensional Imaging Topical Meeting

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study proposes a VHOE-based dual-image-plane near-eye display that utilizes wavelength-selective linear volume gratings and lens-integrated out-couplers to generate and control two distinct image planes located at optical infinity and 600 mm.

## Tu4A.12

**Light-Sheet Formation by DCRA-Mediated Monochromatic Beam Interference**, Cong-Wei Yao<sup>1</sup>, Yung-I Hsieh<sup>1</sup>, Chieh-Han Lu<sup>1</sup>; <sup>1</sup>*National Taiwan Normal Univ., Taiwan*. A DCRA forms periodic interference from a focused Gaussian beam. 1D simulations show spacing set by DCRA period and linewidth by beam profile. Tunable designs may enable light-sheet plane illumination in fluorescence microscopy.

## Tu4A.13

**Virtual Image Distance Measurement System**, Wen-Kai Lin<sup>1</sup>, Ying-Pin Tsai<sup>2</sup>, Chih-Hao Chuang<sup>1</sup>; <sup>1</sup>*Feng Chia Univ., Taiwan*; <sup>2</sup>*National Changhua Univ. of Education, Taiwan*. This work proposed an image distance measure system. An SLM and a camera were employed to measure the distance. A VHOE-based lightguide was utilized to filter the wavelength and enhance the depth resolution

## Tu4A.14

**Holographic Waveguide Display Using a Transmission Holographic Optical Element**, Hui-Ying Wu<sup>1</sup>, Ki-Chul Kwon<sup>1</sup>, Hoonjong Kang<sup>2</sup>, Nam Kim<sup>1</sup>; <sup>1</sup>*Chungbuk National Univ., Korea (the Republic of)*; <sup>2</sup>*Wonkwang Univ., Korea (the Republic of)*. A transmission-type holographic optical element (HOE) with high optical efficiency based on analysis of the optical properties is presented. The experimental results confirm that the transmission HOE can be used to enhance the spectral energy in a holographic waveguide display.

## Tu4A.15

**Towards Browser-Based Real-Time CGH Computation Using WebGPU**, Takashi Nishitsuji<sup>1</sup>, Hayato Teshima<sup>1</sup>, Ren Suzuki<sup>1</sup>, Rio Hanyu<sup>2</sup>; <sup>1</sup>*Faculty of Science, Toho Univ., Japan*; <sup>2</sup>*Graduate school of Science, Toho Univ., Japan*. We demonstrate browser-based computer-generated hologram computation using WebGPU across multiple browsers and operating systems and compare its performance with CUDA where available. Potential applicability to real-time distributed and volunteer computing frameworks is briefly discussed.

## Tu4A.16

**Fractional Topological Charge Measurement of Vortex Beam Using off-Axis Interference**, Allarakha Shikder<sup>1</sup>, Naveen K. Nishchal<sup>1</sup>; <sup>1</sup>*Indian Inst. of Technology Patna, India*. Optical vortex beams with fractional topological charges show unique intensity profiles and helical phase profiles. An interferometric off-axis method for measuring fractional topological charges is presented.

## Tu4A.17

**Wide Angle Lensless Projection by Phase-Only Computer-Generated Holograms**, Peiyu Lin<sup>1</sup>, Jung-Ping Liu<sup>1</sup>; <sup>1</sup>*Feng Chia Univ., Taiwan*. Holography can reconstruct light fields without a lens, and thus it is promising for the application of lensless projection. Here we compare three different algorithms of phase-only computer-generated holograms in terms of not only the image quality but also the projection angle.

## Tu4A.18

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**Fast High-Precision Hologram Generation Based on Low-Precision Hologram Enhanced by Deep Learning**, Yaping Huang<sup>2</sup>, Zhen Wu<sup>2</sup>, Jianshe Ma<sup>2</sup>, Shuming Jiao<sup>1</sup>, Ping Su<sup>2</sup>; <sup>1</sup>*Great Bay Univ., China*; <sup>2</sup>*Shenzhen International Graduate School, Tsinghua Univ., China*. Based on deep learning, we restore low-precision holograms generated fast by the simplified and approximate accurate phase-added stereograms (APAS) algorithm, thereby ensuring both computational speed and display quality of the holograms.

## Tu4A.19

Withdrawn

## Tu4A.20

**High-Q Color Selectivity Metasurface With 2D Topology Optimization for AR Applications**, Wan-Tzu Kuo<sup>1</sup>, Chih-Yao Hsu<sup>1</sup>, Huan-Teng Su<sup>1</sup>, Wei-Zhe Li<sup>1</sup>, Yao-Wei Huang<sup>1</sup>; <sup>1</sup>*National Yang Ming Chiao Tung Univ., Taiwan*. By leveraging adjoint-based topology optimization for asymmetric freeform gratings, we demonstrate high-Q nonlocal metasurfaces that achieve precise RGB control and superior color purity, significantly enhancing optical efficiency for augmented reality visual systems.

## Tu4A.21

**Vector Angular Spectrum Analysis of Autofocusing Circular Airy Beam**, Sunil Vyas<sup>1</sup>, Cheng Hung Chu<sup>1</sup>, Yuan Luo<sup>1</sup>; <sup>1</sup>*National Taiwan Univ., Taiwan*. Autofocusing circular Airy beams and their superposition's were numerically studied using the vector angular spectrum method. Radial polarization enhanced longitudinal-field-mediated compression, producing lens-free needle-like foci. Results provide insights for structured-light engineering and fluorescence microscopy applications.

## Tu4A.22

**An Airy Light-Sheet Illumination Microscope Using Cubic Phase Metasurface**, Cheng-Han Shih<sup>1</sup>, Hung-Chuan Hsu<sup>1</sup>, Chun Chun Chang<sup>1</sup>, Cheng Hung Chu<sup>1</sup>, Sunil Vyas<sup>1</sup>, Kuang-Yuh Huang<sup>1</sup>, Din Ping Tsai<sup>2</sup>, Yuan Luo<sup>1</sup>; <sup>1</sup>*National Taiwan Univ., Taiwan*; <sup>2</sup>*Department of Electrical Engineering, City Univ. of Hong Kong, Hong Kong*. Light-sheet fluorescence microscopy enables fast volumetric imaging with minimal photobleaching and phototoxicity. To extend the field of view while simplifying the experimental setup, we use a cubic phase metasurface to generate Airy light-sheet illumination.

## Tu4A.23 •

**Efficient Calculation of Realistic and Wide-FOV CGH Based on Orthographic Ray-Wavefront Conversion**, Aya Kudo<sup>1</sup>, Ryo Higashida<sup>2</sup>, Saori Takeyama<sup>1</sup>, Masahiro Yamaguchi<sup>1</sup>; <sup>1</sup>*Inst. of Science Tokyo, Japan*; <sup>2</sup>*NHK Science & Technology Research Laboratories, Japan*. We propose an efficient wide-FOV CGH calculation method based on orthographic ray-wavefront conversion. This suppresses edge artifacts and reduces memory usage, enabling high-quality 128K × 128K pixels, 64.3° × 64.3° FOV 3D reconstructions.

## Tu4A.24

**Monolithically Integrated Metasurface on a PCSEL for Depth Perception**, Jin-Min Chou<sup>1</sup>, Wen-Cheng Hsu<sup>1,2</sup>, Wen-Chien Miao<sup>1,2</sup>, Yu-Heng Hong<sup>2</sup>, Hao-Chung Kuo<sup>1,2</sup>, Yao-Wei Huang<sup>1</sup>; <sup>1</sup>*National Yang Ming Chiao Tung Univ., Taiwan*; <sup>2</sup>*Hon Hai Research Inst., Taiwan*. We demonstrate a flip-chip integrated PCSEL–metasurface dot projector enabling compact

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structured-light depth sensing, achieving ~2450x volume reduction, 28.7% lower power, and reliable 3D reconstruction within a 70 cm range.

## Tu4A.25

**Augmented-Reality Racing Helmet Based on a Synergy of Holographic Approach and Laser-Beam Scanning Technology**, Sergey Ivanov<sup>1</sup>, Ekaterina Musikhina<sup>1</sup>, Maksim Kiselev<sup>1</sup>, Ilya Radko<sup>1</sup>, Aleksey Arsenin<sup>1</sup>, Valentyn Volkov<sup>1</sup>; <sup>1</sup>XPANCEO, *United Arab Emirates*. An AR solution for racing and motorcycle helmets uses optical holography and laser beam scanning. Our optical system provides bright images, wide field of view (50°), and excellent sunlight contrast. Flexible integration minimizes certification requirements.

## Tu4A.26

**Application of Wide-Angle Coaxial-Polarization Compound-eye Camera for Surface Smoothness Examination of ID Cards**, Yoshinori Akao<sup>1</sup>; <sup>1</sup>*Natl Research Institute of Police Science, Japan*. The smoothness of ID card surfaces was examined by combining a wide-angle compound camera with a polarized optical system and coaxial incident illumination. With reference objects of known roughness, it was considered possible to evaluate.

## Tu4A.27

**Lensless Projection-Plane Rotation via Phase-Modulated Segmented Holography for Display Applications**, Nehemiah Chuan-Feng Kuo<sup>2</sup>, Pei-Shiuan Tsai<sup>2</sup>, Chih-Hao Chuang<sup>1</sup>, Hoang-Yan Lin<sup>2</sup>; <sup>1</sup>*Department of Photonics, Feng Chia Univ., Taiwan*; <sup>2</sup>*Photonics and Optoelectronics, National Taiwan Univ., Taiwan*. We utilize a segmented-rotation hologram (SRH) method for computational phase modulation that enables projection-plane rotation without additional optical components. Numerical simulations demonstrate a 45° rotation. As a front-end preprocessor, SRH can precompensate geometric distortions, showing strong potential for HUD and VR systems.

## Tu4A.28

Withdrawn

## Tu4A.29

**Statistical Approach to Holographic Incoherent-Light-Source Quantitative Phase Imaging with Live Cancer Cells**, Daniel Zicha<sup>1</sup>; <sup>1</sup>*Inst. of Physical Engineering, CEITEC Brno Univ. of Technology, Czechia*. Highly quantitative measurements of cellular responses provide relevant information about invasive and metastatic phenotypes. The data form an unbalanced hierarchical structure, including treatment, experiment, movie, cell, and time-point measurements, which is efficiently addressed by ANOVA.

## Tu4A.30

**Hologram Printing System Utilizing a Robotic Arm for the Production of Large HOE**, Prasenjit Paul<sup>1</sup>, Kotomi Nakanishi<sup>1</sup>, Hiroto Nishimura<sup>1</sup>, Boaz J. Jackin<sup>2</sup>, Munekazu Date<sup>3</sup>, Kenji Yamamoto<sup>1</sup>; <sup>1</sup>*Faculty of Science & Engineering, Tokushima Univ., Japan*; <sup>2</sup>*Faculty of Science & Engineering, Kochi Univ., Japan*; <sup>3</sup>*Faculty of Science & Engineering, Tokushima Bunri Univ., Japan*. The printing of holographic optical elements necessitates precise spatial and angular beam management. We present a HOE printer system controlled by a robot that utilizes calibrated bilinear interpolation to regulate beam direction while maintaining placement accuracy. This approach enables the creation of versatile, scalable, hologram fabrication.

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## Tu4A.31

**Generation of Structured Light for 3D Measurement Using a VHOE With Incoherent NIR Illumination**, Shota Hasui<sup>1</sup>, Daisuke Barada<sup>1</sup>; <sup>1</sup>*Utsunomiya Univ., Japan*. We previously measured a target using structured light with a line beam diffracted from a VHOE. Bragg-selective replay enables the desired diffracted beam at a different wavelength. Here we measure targets using near-infrared replay.

## Tu4A.32

**A Fast Computation Method for Adding Blur to Holographic Reconstructions**, Kotomi Nakanishi<sup>1</sup>, Prasenjit Paul<sup>1</sup>, Hiroto Nishimura<sup>1</sup>, Boaz J. Jackin<sup>2</sup>, Munekazu Date<sup>3</sup>, Kenji Yamamoto<sup>1</sup>; <sup>1</sup>*Tokushima Univ., Japan*; <sup>2</sup>*Kochi Univ., Japan*; <sup>3</sup>*Tokushima Bunri Univ., Japan*. We incorporate blur by multiplying the propagation kernel with a Gaussian kernel before a single convolution on the input image, effectively reducing computational cost by half while achieving a PSNR up to 40.4 dB.

## Tu4A.33

**Stereoscopic Optical Correlator for Space Debris Detection and Localization**, Akash Pal<sup>1</sup>, Jyoti Bikash Mohapatra<sup>1</sup>, Jyothish Monikantan<sup>2</sup>, Naveen K. Nishchal<sup>1</sup>; <sup>1</sup>*Indian Inst. of Technology Patna, India*; <sup>2</sup>*ISRO Inertial Systems Unit, India*. The study investigates the utility of a stereoscopic optical correlator for the detection and localization of space debris. Testing with a lab-generated dummy model dataset shows the utility of the correlator.

## Tu4A.34

**Deep Learning-Enabled Structured-Light Inspection for Real-Time Steel Billet Tail Ends**, Tung-Ying Wu<sup>2</sup>, Bo-Han Tang<sup>1</sup>, Tzu-Wei Liu<sup>1</sup>, Chuan-Wang Chang<sup>3</sup>, Cheng-Mu Tsai<sup>1</sup>; <sup>1</sup>*National Chung Hsing Univ., Taiwan*; <sup>2</sup>*China Steel Corporation, Taiwan*; <sup>3</sup>*National Chin-Yi Univ. of Technology, Taiwan*. We propose a real-time system using YOLOv8 and 3x3 grid lasers for billet tail inspection. By detecting intersections with YOLO-Cross, the system achieves 0.36 mm/pixel resolution, providing stable, automated quantification of surface defects.

## Tu4A.35

**Marginal Quantum Optical Coherence Tomography for sub-Seconds Acquisition Time a-Scan**, Pablo Daniel Yepiz-Graciano<sup>2</sup>, Daniel Salamanca-Roldán<sup>1</sup>, Héctor Cruz-Ramírez<sup>2</sup>, Alfred U'Ren<sup>2</sup>, Roberto Ramirez Alarcón<sup>1</sup>; <sup>1</sup>*Centro de Investigaciones en Optica AC, Mexico*; <sup>2</sup>*Instituto de Ciencias Nucleares, Universidad Nacional Autónoma de México, Mexico*. We report an optimized implementation of spectral-domain quantum optical coherence tomography (SD-QOCT) capable of acquiring axial scans (A-scans) of multilayer samples in the absence of mechanical scanning at an unprecedented speed.

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**Room 1002**

**16:30 -- 18:30**

**Tu5A • Phase Processing, Retrieval Techniques and Applications I**

*Presider: Jae-Hyeung Park; Seoul National Univ., South Korea*

**Tu5A.1 • 16:30 (Invited)**

**Phase Unwrapping and Reconstruction Based on Transport of Intensity and**

**Phase**, Partha P. Banerjee<sup>1</sup>; <sup>1</sup>*Univ. of Dayton, USA*. The transport of intensity and phase, respectively, represent the conservation of energy and eikonal propagation in a virtual refractive index induced by diffraction. They are a useful phase-unwrapping tool, and conceptually similar to multiwavelength holography.

**Tu5A.2 • 17:00**

**3D Fluorescence Imaging Using Guide-Star-Based Scattering Compensation in Multi-**

**Layered Media**, Mine Shintaro<sup>1</sup>, Mitsuhiro Morita<sup>1</sup>, Naru Yoneda<sup>1</sup>, Luis Ordóñez<sup>1</sup>, Osamu Matoba<sup>1</sup>; <sup>1</sup>*Kobe Univ., Japan*. In this presentation, we propose a scattering compensation method for three-dimensional fluorescence imaging that uses deconvolution with a point spread function estimated from a guide-star. Especially, we demonstrate image recovery of fluorescent beads in a layered scattering medium.

**Tu5A.3 • 17:15**

Withdrawn

**Tu5A.4 • 17:30**

**High-Throughput 3D Localization With Aberration Estimation in Interferometric Scattering Microscopy via an Approximate Interferometric Point Spread Function**

**Model**, Wei Liaoliao<sup>1</sup>, Caroline L. Anyi<sup>1</sup>, Huakun Li<sup>1</sup>, Haitao Nie<sup>2</sup>, Bihan Wen<sup>3</sup>, Tong Ling<sup>1,3</sup>; <sup>1</sup>*School of Chemistry, Chemical Engineering and Biotechnology, Nanyang Technological Univ., Singapore*; <sup>2</sup>*Department of Electrical and Electronic Engineering, The Univ. of Hong Kong, China*; <sup>3</sup>*School of Electrical and Electronic Engineering, Nanyang Technological Univ., Singapore*. We present a hybrid physics-learning framework for aberration-robust iSCAT 3D localization, combining analytical iPSF modeling with wavefront aberration estimation to achieve sub-2 nm axial precision in simulations and enable real-time, high-throughput nanoparticle tracking.

**Tu5A.5 • 17:45**

**Characteristics Evaluation of Single-Shot Vector Optical Field Imaging Using Transport-of-Intensity Equation**, Yuki Yamamoto<sup>1</sup>, Suguru Shimomura<sup>1</sup>, Yusuke Ogura<sup>1</sup>; <sup>1</sup>*Univ. of Osaka, Japan*. We present characteristics of a single-shot vector optical field measurement system using the transport-of-intensity equation with a quadratically distorted grating. Simulation results demonstrate phase retrieval of spatially-structured polarization light and indicate characteristics depending on parameters.

**Tu5A.6 • 18:00**

**Single-Shot Holographic Imaging Through Fog Using Synthetic Waves**, Gregory Nero<sup>1</sup>, Florian Willomitzer<sup>1</sup>; <sup>1</sup>*Wyant College of Optical Sciences, Univ. of Arizona, USA*. We use synthetic wavelength imaging to acquire holographic information of objects obscured by dynamic fog in single-shot. We show that phase maps acquired at a computationally assembled synthetic wave are unspckled which allows for ranging and shape estimation of the obscured

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object.

## Tu5A.7 • 18:15

**Pitch-Invariant Direct Phase Modulation for Fresnel Diffraction Imaging**, Hsuan-Ting Chang<sup>1</sup>, Jie-Wei Chen<sup>1</sup>, Chih-Hao Chuang<sup>2</sup>; <sup>1</sup>*National Yunlin Univ of Science and Tech, Taiwan*; <sup>2</sup>*Department of Photonics, Feng Chia Univ., Taiwan*. We present a new approach to modifying the phase-only function (POF) obtained from the Gerchberg-Saxton algorithm. This method overcomes the limitation of POFs modulated using our previous method, which could not modify the SLM pitch during optical experiments.

## Room 1003

16:30 -- 18:30

## Tu5B • Holographic Optical Elements and Applications II

Presider: Ting-Chung Poon; *Virginia Tech, USA*

### Tu5B.1 • 16:30 (Invited)

**Holographic Incoherent-Light-Source Optical Diffraction Tomography**, Radim Chmelik<sup>1</sup>, Zbynek Dostal<sup>1</sup>, Monika Kocourkova<sup>1</sup>, Vera Kollarova<sup>1</sup>, Ivana Michalkova<sup>1</sup>, Michala Slaba<sup>1</sup>, Matej Spacek<sup>1</sup>; <sup>1</sup>*Brno Univ. of Technology, Czechia*. A novel optical diffraction tomography approach based on Holographic Incoherent-light-source Quantitative Phase Imaging is presented. Three-dimensional reconstructions are obtained from optically sectioned image data. The method's unique capabilities are demonstrated through simulations and experimental validation.

### Tu5B.2 • 17:00

**Crosstalk in Orbital Angular Momentum Photon State Detection Due to Distorted Hologram**, Yusei Kameda<sup>1</sup>, Yoko Miyamoto<sup>1</sup>; <sup>1</sup>*Univ. of Electro-Communications, Japan*. Holograms are often used to detect orbital angular momentum (OAM) photon states. We examine how a typical distortion in an electron-beam-fabricated hologram affects hologram alignment and crosstalk in OAM photon state detection.

### Tu5B.3 • 17:15

**SLM-Based Optical System for Temporal Super-Resolution Video Recording by Digital Holography Using Angular-Multiplexing Recording**, Ryotaro Doi<sup>1</sup>, Ken Morita<sup>1</sup>, Takashi Kakue<sup>1</sup>; <sup>1</sup>*Chiba Univ., Japan*. We propose an optical system using four spatial-light modulators for temporal super-resolution digital holographic video recording using angular-multiplexing recording. This system can reduce the number of optical components by 52 % compared to the conventional configuration.

### Tu5B.4 • 17:30

**Refractive Index Information Measurement of Volume Holographic Optical Elements**, Chun Lin Lin<sup>1</sup>, Chi Ho Lee<sup>1</sup>, Jun-Sheng Hsiao<sup>1</sup>, Yeh-Wei Yu<sup>1</sup>, Tsung-Hsun Yang<sup>1</sup>, Ching-Cherng Sun<sup>1</sup>; <sup>1</sup>*National Central Univ., Taiwan*. This study proposes a quality-inspection method for Volume Holographic Optical Element (VHOE) that combines volume holographic gratings with Optical Diffraction Tomography (ODT) to accurately measure phase and

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reconstruct refractive index distributions.

## **Tu5B.5 • 17:45**

**Embedding an Off-Axis Interferometer in a Volumetric HOE for Compact Lensless Polarization-Sensitive Holographic Microscopy**, Maria J. Lopera Acosta<sup>1,2</sup>, Yunfeng Nie<sup>2</sup>, Heidi Ottevaere<sup>2</sup>, Carlos Trujillo<sup>1</sup>; <sup>1</sup>*Universidad EAFIT, Colombia*; <sup>2</sup>*Vrije Universiteit Brussel, Belgium*. A compact lensless digital holography platform is presented in which an off-axis interferometer is embedded in a volumetric holographic optical element, enabling single-beam operation and extension to polarization-sensitive imaging within an alignment-robust architecture.

## **Tu5B.6 • 18:00 (Invited)**

**Manipulation of Ultrafast Lasers Based on Binary Holography**, Shih-Chi Chen<sup>1</sup>; <sup>1</sup>*Chinese Univ. of Hong Kong, Hong Kong*. I will present the development of an ultrafast multi-focus laser scanning method based on a digital micromirror device (DMD) and Lee holography for both closed-loop applications, where thousands of individually programmable laser foci can be automatically generated to perform 3D random-access scanning at an unprecedented rate of 12 kHz for different applications. To achieve closed-loop application, a parallel algorithm was developed and implemented on a compute unified device architecture (CUDA) via a graphics processing unit (GPU), which enables automatic generation of digital holograms at up to 8000 fps. To demonstrate the unique capability of the method, we present three case studies, including (1) characterizing the particle behavior at solid-liquid interfaces; (2) measuring the microrheology dynamics during the formation process of a self-assembled 3D hydrogel device, and (3) simultaneously tracking hundreds of particles in a microfluidic system. In conclusion, the new solution will enable many advanced studies that cannot be achieved by existing approaches, such as real-time measurements of protein folding dynamics, precise monitoring of intracellular molecular interactions, high-throughput diagnostics in microfluidic devices, and in situ characterization of nanomaterials during synthesis, etc.

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## Wednesday, 03 June

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### Room 1002

08:30 -- 10:30

#### W1A • Optical Coherence Tomography

*Presider: Hsiang-Chieh Lee; National Taiwan Univ., Taiwan*

#### W1A.1 • 08:30 (Invited)

**Optical Coherence Tomography Angiography and its Biomedical Applications**, Ruikang K. Wang<sup>1</sup>; <sup>1</sup>*Univ. of Washington, USA*. This talk highlights OCT and OCT angiography fundamentals, enabling technologies, and key biomedical applications that benefit from visualizing microcirculatory blood flow

#### W1A.2 • 09:00

**Bessel-Beam Optical Coherence Microscopy Charts Network-Level Stroke Responses in the Cortex**, Lukas Glandorf<sup>1,2</sup>, Jeanne Droux<sup>3</sup>, Etienne Jessen<sup>4</sup>, Bastian Wittmann<sup>5</sup>, Bruno Weber<sup>6</sup>, Susanne Wegener<sup>3</sup>, Bjoern Menze<sup>5</sup>, Rainer Leitgeb<sup>7</sup>, Dominik Schillinger<sup>4</sup>, Mohamad El Amki<sup>3</sup>, Daniel Razansky<sup>2,1</sup>; <sup>1</sup>*Inst. for Biomedical Engineering, Department of Information Technology and Electrical Engineering, ETH Zurich, Switzerland*; <sup>2</sup>*Inst. of Pharmacology and Toxicology & Inst. for Biomedical Engineering, Univ. of Zurich, Switzerland*; <sup>3</sup>*Department of Neurology, Univ. Hospital Zurich and Univ. of Zurich, Switzerland*; <sup>4</sup>*Inst. for Mechanics, Technical Univ. of Darmstadt, Germany*; <sup>5</sup>*Department of Quantitative Biomedicine, Univ. of Zurich, Switzerland*; <sup>6</sup>*Inst. of Pharmacology and Toxicology, Univ. of Zurich, Switzerland*; <sup>7</sup>*Center for Medical Physics and Biomedical Engineering, Medical Univ. Vienna, Austria*. To understand microvascular resilience, OMNIMap performs functional mapping of the microvascular network using extended-focus optical coherence microscopy. We reveal a conserved topological organization that mitigates individual capillary stalls, preserving network perfusion after ischemic stroke.

#### W1A.3 • 09:15

**Full-Field Swept-Source Optical Coherence Tomography With High Resolution, High Speed, and High Definition for Label-Free Functional and Structural Imaging of Cancer Spheroid**, Suzuyo Komeda<sup>1</sup>, Nobuhisa Tateno<sup>1</sup>, Xibo Wang<sup>1</sup>, Ann Detje<sup>2</sup>, Yue Zhu<sup>1</sup>, Ibrahim A. El-Sadek<sup>1,3</sup>, Yusong Liu<sup>1</sup>, Rion Morishita<sup>1</sup>, Atsuko Furukawa<sup>4</sup>, Satoshi Matsusaka<sup>4</sup>, Yoko Miura<sup>2,5</sup>, Shuichi Makita<sup>1</sup>, Yoshiaki Yasuno<sup>1</sup>; <sup>1</sup>*Computational Optics Group, Univ. of Tsukuba, Japan*; <sup>2</sup>*Inst. of Biomedical Optics, Univ. of Lübeck, Germany*; <sup>3</sup>*Department of Physics, Faculty of Science, Damietta Univ., Egypt*; <sup>4</sup>*Faculty of Medicine, Univ. of Tsukuba, Japan*; <sup>5</sup>*Department of Ophthalmology, Univ. of Lübeck, Germany*. High-quality imaging of cancer spheroids by full-field swept-source optical coherence tomography is demonstrated. High-resolution label-free imaging is achieved by refocusing, despeckling, and dynamic optical coherence tomography. Additionally, high-speed imaging is achieved by neural network.

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## W1A.4 • 09:30

**Label Free Liver Disease Model Analysis Based on 1700 nm Spectroscopic OCT Imaging System,** Tae Joong Eom<sup>1</sup>; <sup>1</sup>*Pusan National Univ., Korea (the Republic of)*. Liver disease staging requires assessment of lipid accumulation and fibrosis. We developed a 1700 nm swept-source spectroscopic polarization-sensitive OCT system for simultaneous lipid-sensitive spectroscopic imaging and birefringence analysis and validated its applicability in mouse models of NAFLD and NASH for liver disease evaluation.

## W1A.5 • 09:45

**Robust Assessment of the in Vivo Mouse Eye Using a Depth-Extended SS-OCT System,** Yen-Shan Lin<sup>1</sup>, Jian-Zhi Wang<sup>1</sup>, Yi-Ting Tseng<sup>1</sup>, Kuang-Lei Huang<sup>1</sup>, Xin-Yu Hou<sup>1</sup>, Chien-Hua Peng<sup>1</sup>, Po-Jen Shih<sup>1</sup>, Hsiang-Chieh Lee<sup>1</sup>; <sup>1</sup>*National Taiwan Univ., Taiwan*. A high-speed, depth-extended swept-source OCT system was developed for precise in vivo ocular biometry in mice. By integrating a frequency-doubling circuit and a tailored measurement protocol, single cross-sectional scans enable highly repeatable full-eye biometric assessment.

## W1A.6 • 10:00

**Integrated SS-OCT Monitoring and Thermal Simulation of Femtosecond Laser Tissue Ablation,** Yu-Hsuan Chien<sup>1</sup>, Hao-Hsun Chung<sup>1</sup>, Chien-Hua Peng<sup>1</sup>, Chuan-Bor Chueh<sup>1</sup>, Hao-Chuan Huang<sup>1</sup>, Yu-Hsiang Cheng<sup>1</sup>, Te-Cheng Su<sup>1</sup>, Hsiang-Chieh Lee<sup>1</sup>; <sup>1</sup>*National Taiwan Univ., Taiwan*. In this study, we present a multimodal platform integrating SS-OCT and femtosecond laser for ablation monitoring. Comparisons with COMSOL bioheat simulations on porcine skin revealed high consistency, validating the system capability for visualizing laser-induced ablation dynamics.

## W1A.7 • 10:15

**Few-Shot Learning of Lung Tumor Grading From Intraoperative OCT Imaging,** Chi-En Chang<sup>1</sup>, ALoysius Niko<sup>1</sup>, Hung-Chang Liu<sup>2</sup>, Chia-Wei Sun<sup>1</sup>; <sup>1</sup>*National Yang Ming Chiao Tung Univ., Taiwan*; <sup>2</sup>*Mackay Memorial Hospital, Taiwan*. We present an intelligent optical coherence tomography system integrated with few-shot learning for intraoperative lung tumor grading. The system enables real-time classification of normal, benign, and invasive adenocarcinoma tissues using limited labeled data with promising accuracy.

## Room 1003

08:30 -- 10:30

## W1B • Phase Processing, Retrieval Techniques and Applications II

*Presider: Julianna Winnik; Politechnika Warszawska, Poland*

### W1B.1 • 08:30 (Invited)

**Metrology and Standardization for 2D/3D Quantitative Phase Imaging Systems,** Malgorzata Kujawinska<sup>1</sup>; <sup>1</sup>*Inst. of Micromechanics and Photonics, Warsaw Univ. of Technology, Poland*. In this paper we present methodology for metrological evaluation of a variety 2D and 3D quantitative phase imaging (QPI) instrumentation based on coherent and incoherent light methods and used in biomedical applications. The methodology entails suitable phantoms, assessment metric and easily reproducible protocol attainable for numerical and experimental analysis. The necessary steps for introducing standardization of 2D/3D QPI systems are discussed.

# Optica Digital Holography and Three-Dimensional Imaging Topical Meeting

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## W1B.2 • 09:00

**Deep Learning-Based Virtual Histological Staining and Segmentation in Label-Free Quantitative Differential Phase Contrast Microscopy**, Yuan-Chung Cheng<sup>1</sup>, Yung An Chen<sup>2</sup>, Yi-Ting Chen<sup>3</sup>, Sunil Vyas<sup>1</sup>, Yuan Luo<sup>1</sup>; <sup>1</sup>*National Taiwan Univ., Taiwan*; <sup>3</sup>*National Taiwan Univ. Hospital, Taiwan*. We present an AI-assisted iDPC microscopy framework for label-free virtual histological staining of renal tissue. Using unpaired CycleGAN translation, iDPC phase maps are converted into virtual periodic acid–Schiff and hematoxylin and eosin images without paired stained acquisitions, reducing staining time and chemical use.

## W1B.3 • 09:15

**Fresnel Binary Computer-Generated Hologram Produced by Stochastic Gradient Descent**, Jung-Ping Liu<sup>1</sup>, Hao En Tang<sup>1</sup>; <sup>1</sup>*Feng Chia Univ., Taiwan*. Stochastic gradient descent (SGD) has been proved to be a promising technique to produce a phase-only computer-generated hologram (CGH). Here we apply SGD to produce high-quality Fresnel binary CGHs in both on-axis scheme and off-axis scheme.

## W1B.4 • 09:30

**Continuous Phase-Shifting Holography Utilizing a Moving Diffraction Grating**, Georgy S. Kalenkov<sup>1</sup>; <sup>1</sup>*UTS, Australia*. A theoretical model for digital hologram registration using a translating Ronchi grating based on the continuous phase-shifting method is proposed. The theory is experimentally validated through quantitative phase imaging of an optical fiber splice, demonstrating micron-scale localization accuracy.

## W1B.5 • 09:45

**Seeing Through Multiple Diffusive Scattering via Layer-Decomposed Optical Transmission Learning**, Libang Chen<sup>1</sup>, Qihang Bian<sup>2</sup>, Xuyu Zhang<sup>3,5</sup>, Yifan Chen<sup>4</sup>, Zhe Sun<sup>4</sup>, Honglin Liu<sup>3</sup>, Yikun Liu<sup>2</sup>, Tzu-Ming Liu<sup>1</sup>; <sup>1</sup>*Univ. of Macau, Macao*; <sup>2</sup>*Sun Yat Sen Univ., China*; <sup>3</sup>*Chinese Academy of Sciences, China*; <sup>4</sup>*China Telecom, China*; <sup>5</sup>*Univ. of Shanghai for Science and Technology, China*. We model thick scattering media as cascaded thin layers and identify a sharp invertibility degradation with increasing depth. A layer-decomposed optical transmission network enables stable reconstruction and accurate recovery in two-layer strong scattering experiments.

## W1B.6 • 10:00

Withdrawn

## W1B.7 • 10:15

**Discrete Cosine Transform-Based Recursive Approach for Phase Retrieval Using Transport of Intensity and Phase Equations**, Ram Kumar<sup>1</sup>, shilpa kanjilal<sup>1</sup>, Partha P. Banerjee<sup>2</sup>, Naveen K. Nishchal<sup>1</sup>; <sup>1</sup>*Indian Inst. of Technology Patna, India*; <sup>2</sup>*Dayton Univ., USA*. A recursive transport of intensity and phase equations-based phase retrieval framework is proposed that uses discrete cosine transform for suppressed boundary artefacts.

# Optica Digital Holography and Three-Dimensional Imaging Topical Meeting

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**Room 1002**

**11:00 -- 13:00**

**W2A • Digital Holographic Techniques for Bio-Imaging III**

*Presider: Victor Dyomin; Tomsk State Univ., Russian Federation*

**W2A.1 • 11:00 (Invited)**

**Holographic Microscopy for Development of Wide Field-of-View and Deep Depth**

**Region**, Osamu Matoba<sup>1</sup>, Naru Yoneda<sup>1</sup>, Mitsuhiro Morita<sup>1</sup>; <sup>1</sup>*Kobe Univ., Japan*. The holographic microscope has two functions: optogenetics-based manipulation of cell activity and calcium imaging for observing cell activity. We have been developing two types of holographic microscopies, those are one-photon excitation and two-photo excitation. Both systems have trade-off between field-of-view and spatial resolution. The depth range is also another important metric. We present two types of holographic microscopes and the results in cultured cells and mice.

**W2A.2 • 11:30**

**Polarization-Encoded Axial-Shearing Incoherent Digital Holography With Voltage-Tunable Shear and Coherence-Guided Optimization for 3D Fluorescence**

**Microscopy**, Vishal Prajapati<sup>1</sup>, Naru Yoneda<sup>1,2</sup>, Osamu Matoba<sup>1,2</sup>; <sup>1</sup>*Kobe Univ., Japan*; <sup>2</sup>*Center of Optical Scattering Image Science,, Japan*. We present a polarization-encoded axial-shearing incoherent holography system for 3D fluorescence microscopy, using a voltage-tunable liquid-crystal lens and coherence-guided fringe-visibility optimization to encode depth in spatial coherence, improving signal-to-noise ratio and axial reconstruction from emission.

**W2A.3 • 11:45**

**Real-Time Label-Free Digital Holographic Imaging Flow Cytometry of Rare Cells via an**

**Event Sensor**, Natan T. Shaked<sup>1</sup>; <sup>1</sup>*Tel Aviv Univ., Israel*. We propose a new label-free imaging flow cytometry approach combining microfluidics, event-based sensing, digital holographic microscopy, and deep learning for rare-cell detection. An event-based camera enables high-throughput monitoring and triggers holographic imaging, while enabling rapid classification of cancer cells in liquid biopsies.

**W2A.4 • 12:00**

**High-Speed GPU-Accelerated Architecture for Real-Time Line-Field SD-OCT Imaging**, Tai-

Ang Wang<sup>1</sup>, Yin-Shen Cheng<sup>1</sup>, Chieh Shen<sup>1</sup>, Hsiang-Chieh Lee<sup>1,2</sup>; <sup>1</sup>*Graduate Inst. of Photonics and Optoelectronics, National Taiwan Univ., Taiwan*; <sup>2</sup>*Department of Electrical Engineering, National Taiwan Univ., Taiwan*. We demonstrate a GPU-accelerated line-field SD-OCT platform achieving significant latency reduction. Quantitative performance analysis shows high-speed 2D/3D visualization and enhanced frame rates, providing superior real-time image quality for industrial and biomedical non-destructive testing.

**W2A.5 • 12:15**

**Astigmatism-Corrected Metalens Design With Experimental Beam-Profile Validation**, Li-

Hsun Hsieh<sup>1</sup>, Cheng Hung Chu<sup>2</sup>, Kuang-Yuh Huang<sup>1</sup>, Yuan Luo<sup>3,2</sup>; <sup>1</sup>*Department of Mechanical Engineering, National Taiwan Univ., Taiwan*; <sup>2</sup>*Inst. of Medical Device and Imaging, National Taiwan Univ., Taiwan*; <sup>3</sup>*Department of Biomedical Engineering, National Taiwan Univ., Taiwan*. We designed two metalens objectives to quantify astigmatism correction: a corrected design and a matched reference. Ray-tracing optimized the phase and RCWA nanopillar libraries enabled layout. Beam profiles show a more circular PSF and tighter, symmetric

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focusing.

## W2A.6 • 12:30

### **Hybrid Neural-Network-Initialized Reconstruction for Holographic Incoherent-Light-Source Optical Diffraction Tomography**, Ivana Micháľková<sup>1</sup>, Vera Kollarova<sup>1</sup>, Radim Chmelik<sup>1</sup>; <sup>1</sup>*Brno Univ. of Technology, Czechia*. A hybrid framework for 3D refractive index reconstruction from hiQPI z-stacks is presented, combining neural-network initialization with physics-based iterative reconstruction. Representative simulations illustrate faster convergence behavior and reduced missing-cone effects.

## W2A.7 • 12:45

**Analytical OCT-Model-Based Computational Despeckling for Full-Field Swept-Source Optical Coherence Tomography**, Xibo Wang<sup>1</sup>, Shuichi Makita<sup>1</sup>, Suzuyo Komeda<sup>1</sup>, Nobuhisa Tateno<sup>1</sup>, Cunyou Bao<sup>1</sup>, Atsuko Furukawa<sup>2</sup>, Satoshi Matsusaka<sup>2</sup>, Makoto Kobayashi<sup>3</sup>, Yoshiaki Yasuno<sup>1</sup>; <sup>1</sup>*COG, Univ. of Tsukuba, Japan*; <sup>2</sup>*Inst. of Clinical Medicine, Univ. of Tsukuba, Japan*; <sup>3</sup>*Faculty of Medicine, Univ. of Tsukuba, Japan*. To suppress speckle in optical coherence tomography, we propose a new model-based numerical despeckling method and validate it using biological samples, demonstrating effective speckle suppression and image quality improvement.

## Room 1003

11:00 -- 13:00

### W2B • Contemporary Topics in Digital Holography and 3D Imaging I

*Presider: Wolfgang Osten, Germany*

## W2B.1 • 11:00 (Invited)

### **Diffraction-Grating-Based Shearing Holographic Microscopy and Tomography**, Julianna Winnik<sup>1</sup>; <sup>1</sup>*Inst. of Micromechanics and Photonics, Warsaw Univ. of Technology, Poland*. Shearing interferometry enables robust, low-noise imaging. Because it measures sheared object phase differences rather than absolute phase, it poses unique challenges. We present approaches to unlock its potential for 2D and 3D imaging.

## W2B.2 • 11:30

### **Deconvolution-Based Reconstruction in Incoherent Digital Holography**, Hiyori Ema<sup>1</sup>, Tatsuki Tahara<sup>2</sup>, Yasuhiro Takaki<sup>1</sup>; <sup>1</sup>*Tokyo Univ. of Agriculture and Technology, Japan*; <sup>2</sup>*National Inst. of Information and Communications Technology, Japan*. We propose a deconvolution-based reconstruction technique for incoherent digital holography that utilizes information about the spectral range of recording light, which improves image resolution. We also applied this technique to holographic fluorescence microscopy.

## W2B.3 • 11:45

### **Diffusion Model-Based Approach for Imaging Through Unknown and Randomly Varying Scattering Media**, Quang S. Trieu<sup>1</sup>, Dominick Rizk<sup>1</sup>, Georges Nehmetallah<sup>1</sup>; <sup>1</sup>*Catholic Univ. of America, USA*. We propose a diffusion model-based approach for imaging through unknown and randomly varying scattering media. By integrating the Optical memory effect into the diffusion framework, the proposed method enables robust image reconstruction with strong

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generalization across diverse unseen scattering media.

## W2B.4 • 12:00

**Light-in-Flight Recording by Holographic Microscopy Using a Commercially Available Optical Microscope**, Yasuhiro Awatsuji<sup>1</sup>, Ryosei Yamada<sup>1</sup>, Keita Kita<sup>1</sup>, Shuma Yamamoto<sup>1</sup>, Kantaro Hanzawa<sup>1</sup>, Kenzo Nishio<sup>1</sup>, Toshihiro Kubota<sup>2</sup>; <sup>1</sup>*Kyoto Inst. of Technology, Japan*; <sup>2</sup>*Kubota Holography Laboratory Corporation, Japan*. We present a technique for recording videos of enlarged image of light propagation in a microscopic field. This technique is based on light-in-flight recording by holography using a commercially available optical microscope.

## W2B.5 • 12:15

**Speckle Correlation-Based Optical Particle Estimator (SCOPE)**, Qihang Zhang<sup>1</sup>, George Barbastathis<sup>2</sup>, Renjie Zhou<sup>1</sup>; <sup>1</sup>*Chinese Univ. of Hong Kong, Hong Kong*; <sup>2</sup>*Massachusetts Inst. of Technology, USA*. Based on our new developed physics model for the back-scattered speckle correlation under various particle sizes and sample thicknesses, we built an optical probe to estimate the particle size with high generalization ability.

## W2B.6 • 12:30

**Lensless, Lossless, Bathless HoloVAM**, Andreas Madsen<sup>1</sup>, Jesper Glückstad<sup>1</sup>; <sup>1</sup>*Syddansk Universitet, Denmark*. We introduce lensless HoloVAM using phase-only holography to tomographically cure centimeter-scale 3D parts in under 30 seconds with a 30 mW, 405 nm laser, without any relay optics or index matching bath, enabling compact, photon-efficient volumetric fabrication.

## W2B.7 • 12:45

**Architectural Analysis of DeepQuadrature Network for Quantitative Phase Imaging of Biological Cells**, Maria Cywinska<sup>1</sup>, Wiktor Forjasz<sup>1</sup>, Wojciech Ogonowski<sup>1</sup>, Julianna Winnik<sup>1</sup>, Azeem Ahmad<sup>2</sup>, Balpreet Ahluwalia<sup>2</sup>; <sup>1</sup>*Politechnika Warszawska, Poland*; <sup>2</sup>*Arctic Univ. of Norway, Norway*. We analyze how architectural parameters of the DeepQuadrature neural network influence quantitative phase reconstruction of biological cells, evaluating trade-offs between model complexity, reconstruction accuracy, and preservation of biologically relevant cellular structures.

## Room 1001

14:00 -- 15:00

## W3A • Keynote Session II

*Presider: Malgorzata Kujawinska; Politechnika Warszawska, Poland*

## W3A.1 • 14:00 (Keynote)

**Meta Photonics: From Classical to Quantum**, Din Ping Tsai<sup>1</sup>; <sup>1</sup>*City Univ. of Hong Kong, Hong Kong*. Meta-devices enable the mass production of nano-antennas via semiconductor microelectronics, controlling the phase, polarization, and amplitude of electromagnetic waves. This talk highlights the design, fabrication, and applications of optical meta-devices in imaging, sensing, etc.

## W3A.2 • 14:30 (Keynote)

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**Tribute to Jim Trolinger - Scientist, Holographer, Artist, Collector, WWT, and Friend,** Wolfgang Osten<sup>1</sup>; <sup>1</sup>*Universität Stuttgart, Germany*. With deep sadness we had to learn about the passing of Dr. James D. Trolinger, on 26th November 2025, - a brilliant optical physicist, holographer, artist, and collector.

## Poster Area- Exhibits

15:00 -- 16:00

### W4A • Poster Session II

#### W4A.1

**Investigation of Speckle Design Methods for Super-Resolution Ghost Imaging,** Yuto Ikeno<sup>1</sup>, Naru Yoneda<sup>1</sup>, Osamu Matoba<sup>1</sup>; <sup>1</sup>*Kobe Univ., Japan*. We design speckles to realize super-resolution ghost imaging by enforcing a target intensity probability density function and a target autocorrelation. Simulation results show that the proposed speckles have narrowed autocorrelation compared with Rayleigh speckles.

#### W4A.2

**Quantitative Analysis of TEM Images Using the Concept of Virtual Refractive Index,** Ram Kumar<sup>1</sup>, shilpa kanjilal<sup>1</sup>, Anurag Gupta<sup>1</sup>, Partha P. Banerjee<sup>2</sup>, Naveen K. Nishchal<sup>1</sup>; <sup>1</sup>*Indian Inst. of Technology Patna, India*; <sup>2</sup>*Dayton Univ., USA*. The virtual refractive index map of the sample WS<sub>2</sub> is computed from its intensity images recorded through the transmission electron microscope and analyzed statistically.

#### W4A.3 •

**Adaptive Self-Supervised QDPC Microscopy With Virtual Staining,** Cheng Yu<sup>1</sup>, Yuan-Chung Cheng<sup>1</sup>, Ying-Ju Chen<sup>1</sup>, Sunil Vyas<sup>1</sup>, Yuan Luo<sup>1</sup>; <sup>1</sup>*National Taiwan Univ., Taiwan*. qDPC microscopy enables rapid acquisition of quantitative phase images for improved sample characterization. However, conventional methods require careful regularization tuning. Here, we propose a self-supervised approach for biological samples, enabling robust reconstruction and virtual staining for biomedical applications.

#### W4A.4

**Deep Learning Method for Phase Retrieval Under Severe Noise and Rapid Amplitude Fluctuations,** Vishnu S. K<sup>1</sup>, Viren S Ram<sup>1</sup>, Rajshekhar Gannarvarpu<sup>1</sup>; <sup>1</sup>*Indian Inst. of Technology Kanpur, India*. This article proposes a deep learning assisted subspace method for extracting phase from a interferogram under severe noise and fluctuating amplitude conditions. The accuracy of this method is verified using a simulated interferogram.

#### W4A.5

**Attention-Enhanced DeepBessel Neural Network for Full-Field Vibration Profilometry,** Wiktor Forjasz<sup>1</sup>; <sup>1</sup>*Politechnika Warszawska, Poland*. This study introduces an attention-augmented extension of the DeepBessel convolutional neural network for reconstruction of vibration amplitude distributions from time-averaged interferograms, aiming to improve feature weighting, reduce Bessel-related artifacts, and enhance prediction accuracy.

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## W4A.6

**Digital Holography and Artificial Intelligence for Textile Identification Using Fringe-Based CNN Analysis**, Binghao Chen<sup>1</sup>, Jingyan Chen<sup>1</sup>, Edmund Lam<sup>1</sup>, Yanmin Zhu<sup>1</sup>; <sup>1</sup>*Electrical and Electronic Engineering, Univ. of Hong Kong, China*. We present a convolutional neural network (CNN) framework trained on reconstructed holographic fringe patterns for classifying cotton, polyester, and linen. Experiments achieve up to 78% accuracy at high resolution. The proposed approach demonstrates the potential of digital holography for automated fabric identification.

## W4A.7

**Investigation of Fast Dynamics in Concrete Materials With 3 Colors Digital Holography**, Alexandre R. Klein<sup>1</sup>, Silvio Montresor<sup>1</sup>, Mourad Bentaha<sup>1</sup>, Pascal Picart<sup>1</sup>; <sup>1</sup>*LAUM, France*. This paper presents a non-destructive testing approach based on three-color digital holography to investigate nonlinear behavior in concrete materials. First experimental results obtained on damaged concrete samples demonstrate the method's capability to detect and characterize structural degradation.

## W4A.8

**Confocal Microscopy Using a Volume Holographic Lens Array**, Randy Yan Jie Kor<sup>1</sup>; <sup>1</sup>*National Taiwan Univ., Taiwan*. We demonstrate a PQ:PMMA volume holographic lenslet array illuminator that generates uniform super-Gaussian multifocal spots for faster CCD-based multifocal confocal imaging with digital pinholing and image stitching, while maintaining optical sectioning and image quality.

## W4A.9

**In Vivo Label-Free Imaging of Single-RBC Glycated Hemoglobin Using Color-Resolved Third-Harmonic-Generation Microscopy**, Xuhao Ye<sup>1</sup>, Tzu-Ming Liu<sup>1</sup>, Tzung-Dau Wang<sup>2</sup>, Chi-Kuang Sun<sup>2</sup>; <sup>1</sup>*Univ. of Macau, Macao*; <sup>2</sup>*National Taiwan Univ., Taiwan*. We demonstrate in vivo single-cell HbA1c quantification using color-resolved third-harmonic-generation microscopy. By leveraging the Soret-band absorption redshift between hemoglobin variants, we achieve motion-artifact-free, label-free chemical imaging within human capillaries.

## W4A.10

Withdrawn

## W4A.11

**Dual-View Phase Imaging of Acoustic Vortex From Ultrasonic Phased Array by Digital Holography With Angular Multiplexing**, Katsuyuki SASAKI<sup>1</sup>, Ken Morita<sup>1</sup>, Takashi Kakue<sup>1</sup>; <sup>1</sup>*Chiba Univ., Japan*. We demonstrated dual-view phase imaging of acoustic vortex using digital holography with angular multiplexing. By comparing simulation and experimental results, we successfully captured the characteristics of acoustic vortex of 40 kHz.

## W4A.12

**Assessing Wound Healing in Vivo Using a Dual-Function Phosphorescent Probe Sensitive to Tissue Oxygenation and Regenerating Collagen**, Weiming Zheng<sup>1</sup>, Xiaoyan Wang<sup>1</sup>, Xuhao Ye<sup>1</sup>, Zhiming Zhang<sup>1</sup>, Tzu-Ming Liu<sup>1</sup>; <sup>1</sup>*Univ. of Macau, Macao*. The Re<sup>1</sup>-diimine

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complex probe is designed for simultaneous quantification of tissue oxygenation and collagen regeneration in wound healing. Utilizing phosphorescence lifetime imaging, it allows for noninvasive evaluation of healing stages in chronic wounds.

## W4A.13

**Depth-Resolved OCTA Imaging for Quantitative Microvascular Assessment in Elderly Populations**, HSIN YU HUANG<sup>1</sup>; <sup>1</sup>*National Yang Ming Chiao Tung Univ., Taiwan*. Optical coherence tomography angiography provides depth-resolved nailfold imaging without contrast agents. Quantitative microvascular features from unsupervised clustering correlate with cardiac function and arterial stiffness, supporting OCTA as a practical noninvasive cardiovascular assessment tool in oldest-old populations.

## W4A.14

**Deep Learning–Based Broadband Wavelength Classification From Speckle Images Through Scattering Media**, Mao Higuchi<sup>1</sup>, Riku Minebayashi<sup>1</sup>, Kakeru Yamamoto<sup>1</sup>, Wataru Watanabe<sup>1</sup>; <sup>1</sup>*Ritsumeikan Univ., Japan*. We demonstrate deep-learning-based broadband wavelength classification from speckle patterns transmitted through scattering media. Using 40-nm-bandwidth illumination across 450-650 nm, central wavelengths are identified with over 99% accuracy via deep learning.

## W4A.15

**Deep Learning-Based Defocus Removal Considering Scattering Noise for 3D Computational Fluorescence Imaging**, Ryo Nosaka<sup>1</sup>, Naru Yoneda<sup>1</sup>, Osamu Matoba<sup>1</sup>; <sup>1</sup>*Kobe Univ., Japan*. A deep learning method for the transport-of-intensity-equation-based optical computational 3D microscopy that removes scattering haze and defocus artifacts is proposed. By training with a physics-based scattering model, we achieved high-contrast optical sectioning in thick mouse brain samples.

## W4A.16

**Decoupling Refractive Index and Thickness in Quantitative Phase Imaging Using Alternating Minimization (AM) Method**, George Nehmetallah<sup>1</sup>, Minh N. Huynh<sup>1</sup>; <sup>1</sup>*Catholic Univ. of America, USA*. This study proposes a computational approach using alternating minimization and physical constraints to decouple refractive index and thickness from a single quantitative phase image. The method enables accurate morphological reconstruction of complex geometrical cells without requiring multi-acquisition microscopy.

## W4A.17

**Imaging Through Dynamic Scattering Media by Deep Learning With Spatial Attention**, Riku Minebayashi<sup>1</sup>, Kakeru Yamamoto<sup>1</sup>, Wataru Watanabe<sup>1</sup>; <sup>1</sup>*Ritsumeikan Univ., Japan*. We demonstrate a deep-learning framework that combines image preprocessing and spatial attention for imaging through dynamic scattering media by selectively emphasizing spatially informative speckle regions. The combined approach improves reconstruction robustness and accuracy in milk-suspended water.

## W4A.18

**Manipulation of Intensity Correlation Distribution via Phase Modulation for High-Brightness Quantum Holography**, Kai Nishida<sup>1</sup>, Naru Yoneda<sup>1,2</sup>, Kanako Yoshimura<sup>1</sup>, Osamu Matoba<sup>1,2</sup>; <sup>1</sup>*Grad. Sch. System Informatics, Kobe Univ., Japan*; <sup>2</sup>*OaSIS, Kobe Univ., Japan*. Quantum holography reconstructs phase distributions by measuring intensity

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correlations with introduced phase differences. We applied phase modulation to polarization-entangled photon pairs generated using a BiBO crystal and successfully observed the correlation distribution.

## W4A.19

**Data-Driven Optical Correlation Approach to Transparent Object Recognition**, Ram Kumar<sup>1</sup>, Jyoti Bikas Mohapatra<sup>1</sup>, Naveen K. Nishchal<sup>1</sup>; <sup>1</sup>*Indian Inst. of Technology Patna, India*. We present a learning-based optical correlation approach for transparent and phase object recognition. Phase retrieval via the transport-of-intensity equation generates inputs for a fringe-adjusted joint transform correlator, enabling convolutional neural network classification from correlation maps.

## W4A.20

**Improving Optical Coherence Microscopy Image Quality With Richardson–Lucy Deconvolution and Blending**, Pai Yu Cheng<sup>1,2</sup>, Yuan Luo<sup>3,4</sup>; <sup>1</sup>*Biomedical Engineering, National Taiwan Univ., Taiwan*; <sup>2</sup>*Far Eastern Memorial Hospital, Taiwan*; <sup>3</sup>*Inst. of Medical Device and Imaging, National Taiwan Univ., Taiwan*; <sup>4</sup>*YongLin Inst. of Health, National Taiwan Univ., Taiwan*. This study presents an OCM post-processing pipeline combining Richardson-Lucy deconvolution and alpha-blending. Results show a 10.9% FWHM improvement and significantly higher SSIM, effectively eliminating stitching artifacts while restoring high-resolution structural details in large-scale tissue mosaics.

## W4A.21

**Effect on Floating Image Color by use of Colored Retro-Reflectors as Backgrounds in AIRR**, Yuka Sato<sup>1</sup>, Shiro Suyama<sup>1</sup>, Hirotsugu Yamamoto<sup>1</sup>; <sup>1</sup>*Utsunomiya Univ., Japan*. This study investigates the color characteristics of an aerial image by use of aerial imaging by retro-reflection using colored retro-reflectors. Experimental results show that the perceived aerial image color is influenced more by the background properties of the retro-reflector than by the projected image color itself.

## W4A.22

**GPU Accelerated Gabor Filter Bank Method for Normalization of Interferograms**, Kanishk Sharma<sup>3</sup>, Subrahmanya K. N<sup>1</sup>, Viren S Ram<sup>2</sup>, Rajshekhar Gannarvarpu<sup>2,3</sup>; <sup>1</sup>*Vidyashilp Univ., India*; <sup>2</sup>*Electrical Engineering, Indian Inst. of Technology Kanpur, India*; <sup>3</sup>*Center for Lasers and Photonics, Indian Inst. of Technology Kanpur, India*. This article introduces a GPU-based implementation of Gabor Filter Bank method for fringe normalization and compares the execution time with sequential implementation on CPU for fringe patterns of various sizes.

## W4A.23

**Dynamic Interferogram Demodulation in Diffraction Phase Microscopy Using GPU-Accelerated Second-Order Optimization**, Subrahmanya K. N<sup>1</sup>, Rajshekhar Gannarvarpu<sup>2,3</sup>; <sup>1</sup>*Vidyashilp Univ., India*; <sup>2</sup>*Electrical Engineering, Indian Inst. of Technology Kanpur, India*; <sup>3</sup>*Center for Lasers and Photonics, Indian Inst. of Technology Kanpur, India*. We propose GPU-accelerated second-order optimization for dynamic interferogram demodulation in diffraction phase microscopy, achieving robust phase retrieval under severe noise and amplitude fluctuations with significant computational speedup, validated through synthetic interferograms.

## W4A.24

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Withdrawn

## W4A.25

### **Nanoparticle Characterization and Velocity Analysis via Speckle Intensity Pattern Fluctuation**

Ploynumthong Chaiyotha<sup>1</sup>, Pakkhanan Sirikarntayuprakit<sup>1</sup>, Prathan Buranasiri<sup>1</sup>; <sup>1</sup>*King Mongkut's Inst. of Tech. Ladkrabang, Thailand*. We use laser speckle to examine differences between two sizes of reference particles, 100 nm and 1,000 nm, by analyzing fluctuation intensity and velocity from a sequence of frames of speckle pattern fluctuation

## W4A.26

### **Multi-Plane Numerical Reconstruction-Based Phase Denoising in Digital Holographic Interferometry**

Rishikesh D. Kulkarni<sup>1</sup>, Pramod Rastogi<sup>2</sup>; <sup>1</sup>*Indian Inst. of Technology Guwahati, India*; <sup>2</sup>*École Polytechnique Fédérale de Lausanne, Switzerland*. A simple method for phase denoising in digital holographic interferometry is proposed based on multi-plane numerical reconstruction of hologram. Pixel-wise averaging of optical wavefronts evaluated at these planes effectively removes speckle noise without phase blurring.

## W4A.27

### **Common-Path Off-Axis Digital Holographic Microscopy Enabled by a GaN Meta-Biprism for Stable Quantitative Phase Imaging**

Wang Yu-Xiang<sup>1</sup>, Cheng Hung Chu<sup>2</sup>, Sunil Vyas<sup>2</sup>, Yuan Luo<sup>1,2</sup>; <sup>1</sup>*PHIM, National Taiwan Univ., Taiwan*; <sup>2</sup>*YongLin Inst. of Health, National Taiwan Univ., Taiwan*. We introduce a GaN meta-biprism to build a common-path off-axis DHM. We validate single-shot quantitative phase on targets and lung cells. Phase-step measurements match AFM within experimental error, and time-series recordings show stable phase with low drift.

## W4A.28

### **Dispersion-Based 4D Feature Learning for Waterborne Particle Monitoring**

Jingyan Chen<sup>1</sup>, Yuxing Li<sup>1</sup>, Yanmin Zhu<sup>1</sup>, Edmund Lam<sup>1</sup>; <sup>1</sup>*Univ. of Hong Kong, Hong Kong*. We propose a compact AI-based 4D feature learning method termed Snapshot HoloSpec for real-time monitoring of waterborne microparticles, achieving a macro F1 of 98.11% and enabling real-time, label-free environmental monitoring.

## W4A.29

### **SNR Enhancement in Common-Path Digital Holographic Microscopy**

Jenifer Manta<sup>1</sup>, Deep Arya<sup>1</sup>, Adesh Ashruba Gawai<sup>1</sup>, Rishikesh D. Kulkarni<sup>1</sup>; <sup>1</sup>*Indian Inst. of Technology Guwahati, India*. We report signal-to-noise ratio enhancement strategy for common-path digital holographic microscopy based on temporal averaging of holograms recorded with laterally shifted non-uniform illumination. This enables effective noise suppression while preserving phase fidelity and spatial resolution.

## W4A.30

### **Gain-Invariant Retinal Arterial Velocity Waveform Shape Metrics From Beat-Resolved Laser Doppler Holography Under Reversible Moderate Intraocular Pressure Elevation**

David Gouyoumdjian<sup>2</sup>, Lancelot Doucet<sup>2</sup>, Maxime Boy-Arnould<sup>2</sup>, yann fischer<sup>2</sup>, Zacharie Auray<sup>2</sup>, Justine Lafolie<sup>3</sup>, Vivien Vasseur<sup>3</sup>, raphael lejoyeux<sup>3</sup>, sophie bonnin<sup>3</sup>, aude couturier<sup>3</sup>, dan milea<sup>3</sup>, Michael Atlan<sup>1,2</sup>; <sup>1</sup>*CNRS, France*; <sup>2</sup>*ESPCI, France*; <sup>3</sup>*Rothschild Foundation Hospital, France*. Retinal laser Doppler holography at 37,000 frames per second

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yields beat-resolved arterial velocity waveforms. We introduce three gain-invariant pulse-shape metrics and show they separate baseline from reversible moderate intraocular-pressure elevation in seconds-long acquisitions.

## W4A.31

**Integrated-Resonant Meta-Devices for Wavefront Manipulation**, Rong Lin<sup>1</sup>; <sup>1</sup>*City Univ. of Hong Kong, Hong Kong*. Integrated-resonant meta-devices combining multiple meta-atoms and resonant modes enhance design flexibility, enabling broadband achromatic focusing, wavelength-selective control, and tunable out-of-plane functionalities for advanced, multifunctional, and compact optical systems.

## W4A.32

**Benchmarking GAN Inversion Encoders for High-Fidelity Reconstruction of Ulcerative Colitis Images**, Vu Quang Thinh Tran<sup>1</sup>, Clara L. Angelina<sup>2,3</sup>, Sunil Vyas<sup>4,5</sup>, Hsin-Yun Wu<sup>1,6</sup>, Shu-Chen Wei<sup>6</sup>, Yuan Luo<sup>1,4</sup>; <sup>1</sup>*Program for Precision Health and Intelligent Medicine, Graduate School of Advanced Technology, National Taiwan Univ., Taiwan*; <sup>2</sup>*Graduate School of Engineering Science and Technology, National Yunlin Univ. of Science and Technology, Taiwan*; <sup>3</sup>*Department of Electrical Engineering, National Yunlin Univ. of Science and Technology, Taiwan*; <sup>4</sup>*Inst. of Medical Device and Imaging, National Taiwan Univ., Taiwan*; <sup>5</sup>*YongLin Inst. of Health, National Taiwan Univ., National Taiwan Univ., Taiwan*; <sup>6</sup>*Division of Gastroenterology and Hepatology, National Taiwan Univ. Hospital, Taiwan*. This study benchmarks colonoscopy image reconstruction. We introduce a Latent Bank method to improve standard encoders, but High-Fidelity GAN Inversion achieves superior quality (FID = 22.12, MS-SSIM > 0.91), proving the best for colonoscopy images.

## W4A.33

**3D Immunohistochemistry Pathology for Differentiation of Invasive Ductal Carcinoma and Ductal Carcinoma in Situ Breast Cancer via Image Processing and Quantitative Analysis**, QianYu Lin<sup>1</sup>, MING-YANG WANG<sup>2,1</sup>, CHUNG-YEN HUANG<sup>3</sup>, Chi-Kuang Sun<sup>1</sup>; <sup>1</sup>*National Taiwan Univ., Taiwan*; <sup>2</sup>*Department of Surgery, National Taiwan Univ. Hospital, Taiwan*; <sup>3</sup>*Department and Graduate Inst. of Pathology, National Taiwan Univ. Hospital, Taiwan*. We propose and demonstrate a nondestructive 3D quantitative pathology framework integrating a custom immunohistochemical staining protocol, image processing, 3D reconstruction, and data analysis to quantitatively differentiate ductal carcinoma in situ from invasive ductal carcinoma.

## W4A.34

**Two-Photon Ag-MtDNA Autofluorescence as a Label-Free Reporter of Cell Death and Sepsis in Cells, CLP Mice, and Humans**, Chon In Cheang<sup>1</sup>, Yiling Hu<sup>1</sup>, Ku Lu<sup>1</sup>, Tzu-Ming Liu<sup>1</sup>; <sup>1</sup>*Univ. of Macau, Macao*. Red autofluorescence from lysosomal aggregated mitochondrial DNA (Ag mtDNA) reports cell death, CLP mouse sepsis, and human sepsis. Two-photon spectroscopy at 1060 nm detects a characteristic 600 nm excimer-like emission peak, enabling label-free, mechanistically grounded monitoring of systemic pathology.

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**Room 1002**

**16:00 -- 18:00**

**W5A • Applications of Digital Holography and 3D Imaging II**

*Presider: Osamu Matoba; Kobe Univ., Japan*

**W5A.1 • 16:00 (Invited)**

**Digital Underwater Particle Holography for Arctic Research Provided**, Victor V. Dyomin<sup>1</sup>, Igor Polovtsev<sup>1</sup>, Alexandra Davydova<sup>1</sup>; <sup>1</sup>*Tomsk State Univ., Russian Federation*. Multipurpose submersible holographic camera is adapted for in situ analysis of marine particles in the Arctic. Geometric-optical camera model for measurement accuracy improvement is considered. Natural measurements of plankton, suspension and methane bubbles are presented.

**W5A.2 • 16:30**

**Tailored Fractional Vortex Phase Coding for Incoherent Digital Holography and Three**

**Dimensional Imaging**, Nandan Singh<sup>1</sup>; <sup>1</sup>*Kumaun Univ., India*. Fractional vortex based phase coding is employed to engineer structured point spread functions for incoherent digital holography. Tunable anisotropy and frequency regularized nonlinear reconstruction enable scan free three-dimensional imaging with improved resolution and robustness.

**W5A.3 • 16:45**

**Metalens Characterization With Holographic Optical Metrology**, Ssu-Chia HE<sup>1</sup>, Chung-Hsuan Huang<sup>2</sup>, Chau-Jern Cheng<sup>1</sup>; <sup>1</sup>*National Taiwan Normal Univ., Taiwan*; <sup>2</sup>*Chinese Culture Univ., Taiwan*. We present a digital holographic method for characterizing wafer-based metalenses, enabling quantitative wavefront recording and numerical reconstruction in digital form of the performance evaluation, including imaging and focusing metrics of the metalenses.

**W5A.4 • 17:00**

**Deep Learning-Enabled Single-Shot HiLo Fluorescence Endomicroscopy With Tunable Moiré Metalens**, Ting-Chen Chang<sup>1</sup>, Cheng Hung Chu<sup>1</sup>, Sunil Vyas<sup>1</sup>, Yu-Hsin Chia<sup>1</sup>, Takuo Tanaka<sup>2</sup>, Din Ping Tsai<sup>3,4</sup>, Yuan Luo<sup>1</sup>; <sup>1</sup>*National Taiwan Univ., Taiwan*; <sup>2</sup>*Metaphotonics Research Team, RIKEN Center for Advanced Photonics, Japan*; <sup>3</sup>*Centre for Biosystems, Neuroscience, and Nanotechnology, City Univ. of Hong Kong, China*; <sup>4</sup>*State Key Laboratory of Terahertz and Millimeter Waves, City Univ. of Hong Kong, China*. This work reports a deep learning-enabled single-shot HiLo fluorescence endomicroscopy system with tunable Moiré metalens, enabling compact telecentric design, rapid acquisition, and achieving high-quality 3D mouse brain imaging with reduced complexity.

**W5A.5 • 17:15**

**3D Feature Recognition of Lateral Ventricle Expansion: Benchmarking UNesT and SynthSeg Across Pathological and Normative Cohorts**, Meng-Hsin Lin<sup>1</sup>, Jui-En Liu<sup>1</sup>, Chao-Ya Yang<sup>2</sup>, Chun-Chih Liao<sup>3</sup>, Kuo-Wei Chen<sup>2</sup>, Furen Xiao<sup>1,2</sup>; <sup>1</sup>*National Taiwan Univ., Taiwan*; <sup>2</sup>*National Taiwan Univ. Hospital, Taiwan*; <sup>3</sup>*Taipei Hospital, Ministry of Health and Welfare, Taiwan*. Evaluating UNesT hierarchical Transformers versus SynthSeg generative CNNs for lateral ventricle segmentation revealed distinct performance profiles. SynthSeg slightly outperformed UNesT in patient age prediction, better handling complex pathological variability.

**W5A.6 • 17:30 (Invited)**

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**Title to be Provided, George Barbastathis<sup>1</sup>; <sup>1</sup>Massachusetts Inst. of Technology, USA.** Abstract not available.

## Room 1003

16:00 -- 18:00

### W5B • Contemporary Topics in Digital Holography and 3D Imaging II

*Presider: Renjie Zhou; Chinese Univ. of Hong Kong, Hong Kong*

#### W5B.1 • 16:00 (Invited)

##### **Holography and Coherent Diffraction Imaging With Electrons,** Tatiana

Latychevskaia<sup>1,2</sup>; <sup>1</sup>Paul Scherrer Institut, Switzerland; <sup>2</sup>Physics Department, Univ. of Zurich, Switzerland. In-line and off-axis holography with electrons will be presented. The similarities and differences between light and electron holography and the related reconstruction algorithms will be discussed. Examples of imaging by electron holography will be shown.

#### W5B.2 • 16:30

Withdrawn

#### W5B.3 • 16:45

**Image-Quality Improvement in Newton-Ring Holography,** Tatsuki Tahara<sup>1</sup>; <sup>1</sup>National Inst of Information & Comm Tech, Japan. Newton-ring holography (NH) is a simple and easily implemented spatially incoherent digital holography technique. In the proceeding, I introduce a way to improve the image quality in NH by using a sequence of the recorded holograms.

#### W5B.4 • 17:00

**Practical Self-Supervised Denoising for Incoherent Digital Holography Without Ground Truth Data,** KiHong Choi<sup>1</sup>, Keehoon Hong<sup>1</sup>, Youngrok Kim<sup>2</sup>, Sung-Wook Min<sup>2</sup>; <sup>1</sup>Electronics and Telecom Research Inst, Korea (the Republic of); <sup>2</sup>Department of Information Display, Kyung Hee Univ., Korea (the Republic of). We propose a practical self-supervised framework for denoising raw incoherent digital holograms. By suppressing sensor noise before bias and conjugating noise elimination, we prevent fourfold amplification without ground truth or paired training data.

#### W5B.5 • 17:15

**Numerical Analysis of Sound Field Measurement in the Broadband Range by Angularly Multiplexed Heterodyne Digital Holography,** Nao Sakiyama<sup>1</sup>, Naru Yoneda<sup>1,2</sup>, Osamu Matoba<sup>1,2</sup>; <sup>1</sup>Kobe Univ., Japan; <sup>2</sup>Center of Optical Scattering Image Science, OaSIS, Japan. We conducted simulations of angularly multiplexed heterodyne digital holography for sound field measurement to overcome recordable bandwidth limitations imposed by image sensor frame rates.

#### W5B.6 • 17:30 (Invited)

**Neutron Interferometry, Holography and Tomography.,** Dmitry A. Pushin<sup>1</sup>; <sup>1</sup>Univ. of Waterloo, Canada. The development of advanced spintronics materials necessitates novel characterization tools with the ability to analyze nanometer-scale spin textures. Neutrons, with their angstrom-sized wavelengths, electric neutrality, and controllable spin states, are uniquely suited for this task. Here we provide a concise overview of "neutron toolbox" advancements,

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## Thursday, 04 June

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### Room 1001

08:30 -- 10:00

#### Th1A • Keynote Session III

*Presider: Naveen Nishchal; Indian Inst. of Technology Patna, India*

#### Th1A.1 • 08:30 (Keynote)

**Discontinuity THG Microscopy for Label-Free 3D Imaging and Diagnosis of Intraepidermal Nerve Fibers**, Chi-Kuang Sun<sup>1</sup>; <sup>1</sup>*National Taiwan Univ., Taiwan*. We present discontinuity third harmonic-generation microscopy enabling three-dimensional visualization of intraepidermal nerve fiber endings. This label-free, section-free approach provides a noninvasive tool for diagnosing small-fiber neuropathy, including diabetic peripheral neuropathy.

#### Th1A.2 • 09:00 (Keynote)

**Coherent Array Cameras**, David J. Brady<sup>1</sup>; <sup>1</sup>*Univ. of Arizona, USA*. Array cameras observing coherently illuminated scenes enable aperture synthesis, wavefront reconstruction and 3D imaging. Here we review design strategies for coherent array cameras with application to machine vision, optical testing and wavefront cameras.

#### Th1A.3 • 09:30 (Keynote)

**The Development Trend of AR Glasses, What Key Transformative Technologies Are Driving This Evolution?**, Tom Liang<sup>1</sup>; <sup>1</sup>*Jorjin Technologies Inc., Taiwan*. The AI+AR symbiosis drives spatial computing, transitioning digital intelligence from the cloud into reality. This integration empowers workers with real time environmental perception, establishing advanced AR glasses and platforms as mainstream tools for industrial productivity.

### Room 1002

10:30 -- 12:00

#### Th2A • Metasurface II

*Presider: Hui-Hsin Hsiao; National Taiwan Univ., Taiwan*

#### Th2A.1 • 10:30 (Invited)

**Optical Metamaterial Devices**, Takuo Tanaka<sup>1</sup>; <sup>1</sup>*RIKEN Center for Advanced Photonics, Japan*. Optical metamaterials are artificial subwavelength structures that have attracted significant interest for enabling unprecedented optical phenomena. In this talk, recent progress in metamaterial devices will be presented and discussed.

#### Th2A.2 • 11:00

**Metalens-Based Imaging System for Fourier Ptychographic Microscopy**, Cheng Hung Chu<sup>1</sup>, Hao-Pin Chiu<sup>1</sup>, Sunil Vyas<sup>1</sup>, Yuan Luo<sup>1</sup>; <sup>1</sup>*National Taiwan Univ., Taiwan*. We present a compact metasurface-based Fourier ptychographic microscope integrating metalens optics and programmable illumination to achieve miniaturized, wide-field quantitative phase imaging with nearly twofold resolution improvement and demonstrated performance on biological samples.

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## Th2A.3 • 11:15

**Optimization of Electromagnetic Enhancement and Signal-to-Background Ratio for Large-Scale and Cost-Effective SERS Substrates**, Hui-Hsin Hsiao<sup>1</sup>; <sup>1</sup>*National Taiwan Univ., Taiwan*. We studied the electromagnetic enhancement and signal-to-background ratio of a variety of surface-enhanced Raman scattering (SERS) active substrates, including Ag-nanoparticle (Ag-NP) arrays grown in anodic aluminum oxide (AAO) nanochannels, Ag-NP arrays deposited in AAO/Al grating substrates, and chemically synthesized anisotropic Ag nanoflowers.

## Th2A.4 • 11:30

**Flexible Stickers to Prepare Reconfigurable and Quasi-3D Metasurfaces**, Shunsuke Murai<sup>1</sup>; <sup>1</sup>*OMU, Japan*. We present a strategy for realizing quasi-three-dimensional metasurfaces using flexible and stackable metasurface stickers. The mechanical flexibility and stackability of polymer-embedded metasurface stickers allow facile assembly of multilayer architectures. Potential applications include metasurface holography.

## Th2A.5 • 11:45

**Agentic AI Framework With Rapid Planar Permittivity-to-Field Surrogate Model for Metalens Design**, Wang Yu-Xiang<sup>1</sup>, Cheng Hung Chu<sup>1</sup>, Sunil Vyas<sup>1</sup>, Yuan Luo<sup>1</sup>; <sup>1</sup>*National Taiwan Univ., Taiwan*. We present an agentic AI framework for inverse metasurface design using a planar permittivity-to-complex-field surrogate with differentiable angular-spectrum propagation and lithography-aware constraints. Surrogate predictions match FDTD and greatly accelerate evaluation. We demonstrate split-and-focus metalenses.

## Room 1003

10:30 -- 12:00

## Th2B • Multi-photon II

*Presider: Tzu-Ming Liu; Univ. of Macau*

## Th2B.1 • 10:30 (Invited)

**DIY Light Sheet Microscopes for Deskside 3D Histology and Histopathology Researches**, Kohei Otomo<sup>1</sup>; <sup>1</sup>*Faculty of Medicine, Juntendo Univ., Japan*. We proposed an open-sourced, compact and easy-to-build selective plane illumination microscope, descSPIM (Otomo+ Nat. Commun. 2024). This affordable setup enables whole 3D imaging of cleared tissue specimens for deskside 3D histology and histopathology research.

## Th2B.2 • 11:00

Withdrawn

## Th2B.3 • 11:15

**In Vivo two-Photon Blood Fluorescence Imaging via Nailfold**, Moxin LI<sup>1</sup>, Tzu-Ming Liu<sup>1</sup>; <sup>1</sup>*Univ. of Macau, Macao*. Label-free autofluorescence imaging can be achieved by using two-photon microscopy. We excited the nail fold of humans with different wavelengths to show the vascular anatomical structure and detect the autofluorescence signal in blood.

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**10:30 -- 12:00**

## **Th2C • Applications of Digital Holography and 3D Imaging III**

*Presider: Chau-Jern Cheng; National Taiwan Normal Univ., Taiwan*

### **Th2C.1 • 10:30**

**Real Time Calculation and Display of 14K Image Hologram on Transmission Liquid Crystal Panel**, Hiroshi Yoshikawa<sup>1</sup>, Makoto Oikawa<sup>1</sup>, Takeshi Yamaguchi<sup>1</sup>; <sup>1</sup>*Nihon Univ., Japan*. It is realized that over ten frames per second 14K (13,320 x 5,120 pixel) image hologram calculation and display with a transmission liquid crystal panel, which is originally designed for 3D printer.

### **Th2C.2 • 10:45**

**Bragg Condition Matching Technique Between Volume Holographic Optical Elements in Light Field Near-Eye Displays**, ShiYao Lin<sup>1</sup>, Sheng-Min Shen<sup>1</sup>, Yeh-Wei Yu<sup>1</sup>, Tsung-Hsun Yang<sup>1</sup>, Ching-Cherng Sun<sup>1</sup>; <sup>1</sup>*National Central Univ., Taiwan*. We propose a Bragg condition matching technique using the VOHIL framework for VHOE-based light-field displays. Accounting for material shrinkage significantly improves angular selectivity and image precision, effectively resolving vergence-accommodation conflict.

### **Th2C.3 • 11:00**

**Multi-View 3D Reconstruction in Holographic Near-eye Display Using Spatial Multiplexing Method**, Ya-Chun Tsao<sup>1</sup>, Tzu-Teng Chen<sup>1</sup>, Wei-Hsuan Yeh<sup>1</sup>, Wei-Feng Hsu<sup>1</sup>; <sup>1</sup>*National Taipei Univ. of Technology, Taiwan*. We demonstrate a holographic near-eye display integrating a spatial light modulator (SLM) and a holographic optical element (HOE) recorded with three lens functions. By projecting computer-generated holograms (CGH) through the HOE, we achieved multi-view 3D image display.

### **Th2C.4 • 11:15**

**Background Images Enhancement via Diffraction Suppression and Brightness Stabilization in Automotive Head-Up Displays**, Yu Wen Wang<sup>1</sup>, Nehemiah Chuanfeng Kuo<sup>1</sup>, Hoang-Yan Lin<sup>1</sup>; <sup>1</sup>*National Taiwan Univ., Taiwan*. This work integrates an inverse propagation phase retrieval algorithm with a customized simulated annealing (SA) algorithm, to suppress diffraction and brightness loss in background image caused by transparent displays, offering a better driving experience.

### **Th2C.5 • 11:30**

Withdrawn

### **Th2C.6 • 11:45**

**A Full-Color Holographic Near-Eye Display Using Spatial Multiplexing Method**, Yu-Chang Chen<sup>1</sup>, Ya-Chun Tsao<sup>1</sup>, Zi Yao Wong<sup>1</sup>, Wei-Feng Hsu<sup>1</sup>; <sup>1</sup>*National Taipei Univ. of Technology, Taiwan*. A full-color holographic near-eye display using the spatial multiplexing method constructed by holographic optical elements and spatial light modulator is demonstrated. A wavelength-selective diffractive optical element enables independent RGB diffraction and spatial combination without temporal color sequencing.