IWOB

International Workshop on Optics, Biology and Related Technologies

ISOT 2023

International Conference on Optomechatoronics Technology

@ Nasu, Tochigi

10 (SUN) - 12 (TUE) December 2023

Organized by
Center for Optical Research and Education Utsunomiya Univ

Co-sponsors
Center for Bioscience and Education Utsunomiya Univ

Collaborations
SPIE student chapter, Optica student chapter, JSAP student chapter

ISOT2023/IWOB2023 Program

*show only presenter

ISOT2023

Day 1 (Dec. 10, Sunday)

Session 1 (Presider: Yukitoshi Otani)

13:00 Opening talk, Kazutaka Yokota
13:05 Opening of ISOT2023/IWOB2023, Yukitoshi Otani
13:20 (Invited) Adapting stochastic optical reconstruction microscopy (STORM) for imaging of sub-micron structures in photoresist
Rainer Tutsch (TU Braunschweig, Germany)
13:50 (Invited) A new foundation for geometric phase
Nathan Hegan (Utsunomiya University, Japan)
14:10 (Invited) On-chip optical pulse analyzer using silicon photonics
Keisuke Kondo (Utsunomiya University, Japan)
14:30 (Invited) Polarization Michelson interferometry for fringe projection technique
Amalia Martínez (CIO, Mexico)

15:00 Coffee break

Session 2 (Presider: Rainer Tutsch)

15:20 (Invited) Polarization microscopy with orthogonally polarized illumination
Indrani Bhattacharya (Seacom Skills University, India)
15:50 (Invited) Recent progress in optical transfer matrix: a tribute to late professor Teruji Ose
We Wang (Xi`an Technological University, China, Heriot-Watt University, UK)
16:20 (Invited) Diameter measurement of sub-micrometer optical fiber based on interference signal of Mie scattered light
Masaki Michihata（University of Tokyo)
16:40 (Invited) Point-cloud based 3D Shape Analysis – Parts through Plants -
Shun Kaneko (Kazusa Academy, Japan)
17:10 Break & Hotel Check-in

18:30 Reception (Seated party)

Day 2 (Dec. 11, Monday)

Session 3 (Presider: Amalia Martinez)

8:30 (Plenary) Polarization aberrations in high NA lenses
Russell Chipman (Meta, USA)
9:20 (18:20, USA, CST)
(Invited) Characterization of structural color
Natalia Dushkina (Millersville University, USA)
9:50 Fresnel model and effective medium approximation (EMA) in spin hall effect of light ellipsometry for surface measurement of optics
Naila Zahra (Osaka University)

10:10 *Coffee break*

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Session 4 (Presider: Indrani Bhattacharya)

10:40 (Invited) Polarization modulation to increase the density of holographic data storage
Xiaoji Tan (Fujian Normal University, China)

11:10 (Invited) Focused on preparation and the localized surface plasmon resonance of noble metal nanoparticles which are applied in surface enhanced Raman scattering
Chunfang Wu (Xi`an Technological University, China)

11:40 (Invited) A nonlinear vibrational approach utilizing aerosol-jetted PZT-actuated fiber MEMS scanner for micro-scale imaging
Weichih Wang (University of Washington, USA)

12:10 Lunch

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Session 5 (Presider: Ryuji Fujimura)

13:00 (Invited) DNA damage-triggered cellular reprogramming in the moss Physcomitrium patens
Nan Gu (Utsunomiya University, Japan)

13:20 (Invited) Plasma-assisted reactive magnetron sputtering for optical coatings
Chien-Jen Tang (Feng-chia University, Taiwan)

13:50 Move to poster session (10 minutes)

Poster session with coffee (Conductor: Kota Kumagai)

14:00 Poster session 1 (55 minutes)
Presentation list below

14:55 Poster session 2 (55 minutes)
Presentation list below

15:50 Move to oral session (10 minutes)

Session 6 (Presider: Xiodi Tan)

16:00 (9:00, Finland)
(Invited) Optical detection of microplastics in water
Matthieu Roussey (University of Eastern Finland)

16:30 (8:30, Germany)
(Invited) Optical metrology at the nanoscale
Stephan Reichelt (Institute of Applied Optics (ITO), University of Stuttgart)

17:00 (Invited) Fringe projection profilometry (FPP): theoretical aspects (II)
Lyu Shenzhen (Nanyang Technological University, Singapore)

17:30 Break

18:00 Reception (Standing party)

20:00 End

Day 3 (Dec. 12, Tuesday)

Session 7 (Presider: Nathan Hegan)

8:00 (18:00, Dec. 11, Florida)
(Invited) Emergent Physical Phenomena in Optics
Miguel Bandres (Univ. of Central Florida, USA)

8:30 (16:30, Dec. 11, Tucson)
(Invited) Advancing cancer diagnosis and screening with biomarker-specific multispectral imaging
Travis Sawyer (Univ. Arizona, USA)

9:00 (18:00, Dec. 11, Mexico)
(Invited) Dynamic out-of-plane measurements using a speckle interferometer with a polarization camera
David Serrano (Universidad de Guadalajara, Mexico)

9:30 (Invited) Simulation model for visualization of diffraction property of volume holographic optical elements
Ching-Cherng Sun (National Central University, Taiwan)

10:00 Break (no drink)

Session 8 (Presider: Satoshi Hasegawa)

10:30 (9:30, Philippines)
(Invited) Principles and algorithms for speckle phase retrieval
Percival F. Almoro（University of the Philippines, Philippines）

11:00 (Invited) Tracking, testing, tuning, and topping up the import activity of chloroplast-transit peptides
Chonprakun Thagun (Utsunomiya University, Japan)

11:30 (Invited) Computational imaging with laser-generated light sources
Kota Kumagai (Utsunomiya University, Japan)

11:50 Closing talk, Yoshio Hayasaki

12:00 Workshop Close

Talks

Adapting Stochastic Optical Reconstruction Microscopy (STORM) for imaging of sub-micron structures in photoresist

Madeline Rodenberg,[1] Lukas Jonathan Münker,[2] Rainer Tutsch,[1,*] Peter Jomo Walla,[2] Thomas Weimann,[3]

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The resolution of optical imaging is limited by the well-known Abbe-criterion to more or less λ/2. In life sciences, however, super resolution techniques have been developed that extend this limit by several orders of magnitude. In 2014 Stefan Hell, Eric Betzig and William Moerner were honored with the Nobel Prize for this development. The basic idea is to use fluorescent molecules as markers that can be switched on and off by illumination with a pulse laser. Different types of super resolution imaging are currently applied in life sciences.

In our group we adapted this idea to the measurement of technical submicron structures in photoresist, e.g. photomasks that are used in the lithographic process of chip-making. In a first step we doped a photoresist with a fluorescent dye. A submicron pattern was inscribed and we used an existing STORM (Stochastic Optical Reconstruction Microscopy) setup for imaging the structure. In our presentation we will show early results of this research work.

A new foundation for geometric phase

Nathan Hagen and Luis Garza Soto
Utsunomiya University, Dept. of Optical Engineering, Utsunomiya, Tochigi, 321-8585 Japan

Geometric phase was first discovered by Sivaramakrishnan Pancharatnam in 1956, and rediscovered by Michael Berry in 1984. In the 39 years since geometric phase became widely known, over 10000 research manuscripts have been published dealing with its features, how one can calculate it, and how instruments can be constructed to take advantage of it. However, until this year not one of these papers was able to present a visualization – a physical model – of how geometric phase arises. That is, researchers have been content to work on how one might calculate the geometric phase in a given system, without developing a physical model of it.

We provide an introduction to our work on filling in this gap, and show that despite the overblown mathematical language of so much of the geometric phase literature, the physical mechanism that generates geometric phase is simple: it is an expression of the Harmonic Addition theorem in mathematics, which gives the location of the wave peak for a sum of multiple waves. Not only does this clarify what geometric phase means and how it can be used, but this simple model also allows several features that have never before been possible in the literature: defining geometric phase for any arbitrary wave, and defining the relationship between a wave's geometric phase, and the measured phase shift obtained by an interferogram measurement.

Short Biography:

Nathan Hagen is a Professor of Optical Engineering at Utsunomiya University. He obtained his PhD in Optical Sciences from the University of Arizona in 2007, and worked for 5 years as the principal scientist at the successful startup Rebellion Photonics, Inc. His research focuses on spectral imaging, polarization, and optical system design.

Luis Garza Soto is currently a PhD student in the Dept. of Optical Engineering at Utsunomiya University. He received an MS degree in applied physics from Instituto Tecnologico de Monterrey in 2020.

On-chip optical pulse analyzer using silicon photonics

Keisuke Kondo, Ryo Hayama, and Okihiro Sugihara

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Conventionally, short-pulse lasers have been used only in research laboratories or factories whose environment is clean and stable. In such a case, a pulse measurement equipment used for development of the pulse generators can also be used in the clean and stable environment. Recently, the short-pulse laser begins to be used for some applications such as bioimaging, cataract surgery, and time-of-flight LiDAR operated in usual environment where vibration, temperature change, and human's eyes exist. To monitor the pulses in such environment, a compact, solid-state, and high-sensitive pulse analyzer is desired. Such a demand will not be achieved by conventional pulse analyzers like a frequency resolved optical gating (FROG). In this paper, we demonstrate a fully integrated pulse analyzer fabricated using silicon photonics. This is ultracompact and solid state, and highly sensitive compared to the conventional ones.

Figure 1 shows the schematic of the proposed pulse analyze. A pulse under test is split and launched from both ends of the SiPh chip at the same timing. One pulse is filtered by a micro-ring filter and propagates into the two-photon absorption photodiode (TPA-PD) array embedded on the silicon waveguide. The other pulse propagates into the TPA-PD array from the other side. The cross-correlation of the filtered pulse and the original pulse is obtained by the TPA-PD array [1]. By acquiring the cross-correlation with scanning the filtering frequency over the entire range of pulse spectrum, the spectrogram of the pulse is obtained. Then, pulse waveform is retrieved from the spectrogram.

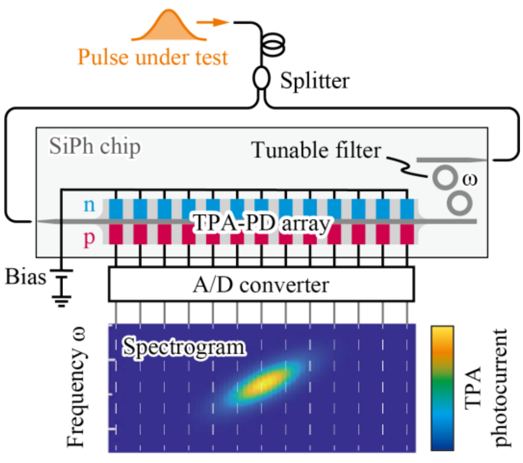

Fig. 1. Schematic of the pulse analyzed integrated on a SiPh chip, and a spectrogram obtained by the analyzer.

[1] K. Kondo and T. Baba, Optica **4**, 1109 (2017).

Keisuke Kondo received the B.E., M.E, and Ph.D. degrees all from the Department of Electrical and Computer Engineering, Yokohama National University, Yokohama, Japan, in 2012, 2013, and 2016, respectively. During his Ph.D., he studied co- and counter-propagating slow-light systems. At present, he is an assistant professor in Utsunomiya University, Graduate Program in Optical Engineering. He is currently working toward silicon photonic optical measurement devices. He is a Member of JSAP.

Polarization Michelson Interferometry for Fringe Projection Technique

Amalia Martínez-García[1], Juan Antonio Rayas-Alvarez[1], David I. Serrano-García[2], Raúl Ignacio Hernández-Aranda[3], Joel Cervantes-L.[2]

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High-resolution, real-time 3D shape measurement for objects has a huge potential for applications in many areas, including entertainment, security, design and manufacturing, etc. In this work, the implementation of the fringe projection technique in the evaluation of topography is presented. The projected fringes are generated interferometrically using a polarization Michelson interferometer where one of the mirrors is rotated and the fringes are detected by a pixelated polarization camera. The phase of the fringes is obtained using the phase shifting technique in a single shot manner due to the properties of the imaging detector. Polarization techniques and the pixelated camera are used to obtain the phase shift simultaneously. The main advantage is that the highest fringe density achieved with this technique could not be reached with the conventional fringe projection technique, which uses a projector. Experimental results will be presented as well as the operation of the technique. Advantages and disadvantages of this technique are discussed.

Short biography:

Dr. Amalia Martínez-García obtained the BS degree in physics from the Facultad de Ciencias Físico-Matemáticas, Universidad Autónoma de Nuevo León, M. Sc. in Optics at Centro de Investigación Científica y de Educación Superior de Ensenada, B. C. (CICESE) and PhD in Optics at Centro de Investigaciones en Óptica (CIO), México. She has been visiting researcher at Universidad de Santiago de Chile (Chile), University of Basilicata (Italia) and University of Utsunomiya (Japan). In 2002, she became a Titular Researcher at CIO. She had been before a researcher at the Department of Optics, Applied Physics Division, CICESE, from 1987 to 1996. She is member of the National System of Researchers (level III) at México. Her interests in research are in the fields of electronic speckle pattern interferometry, structured light, shearography, interference microscopy and holography. She has been recognized as a senior member at SPIE and OPTICA (Formerly OSA) (August 2022), She has been honored as 2024 OPTICA FELLOW.

Polarization microscopy with Orthogonally Polarized Illumination

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This paper proposes a form of birefringence microscopy where a biological sample is illuminated by two mutually orthogonally polarized and collinearly propagating beams to measure the pixelwise retardance and orientation of fast axis. The proposed simple and full-field technique may find use in evaluation of spatially varying retardation of biological samples for diagnosis of diseased cell and tissue structure.

Short biography:

[1]Indrani Bhattacharya received PhD from Department of Applied Optics and Photonics, University of Calcutta, Kolkata, India in May 2019. She has done her postdoctoral research in the Department of Physics and Mathematics, University of Eastern Finland, Joensuu, Finland under Finnish Flagship Program Photonics Research, and Innovation – PREIN in 2019-2020. She worked as a research engineer in a leading telecommunication company in India from 1990-2010. At present, she is a Professor and Director in Seacom Skills University, Innovation and Incubation Center (IIC). She is an optical system designer in the field of Diffractive Optics and Point Spread Function Engineering. Recently, she is focusing her research in diffractive and polarization optical devices applicable for biological live imaging. She is serving as a Steering Committee member of ISOT since 2016 and as a Program committee member of SPIE Light in Nature Conference OP302 since 2019. She is a regular member of SPIE and a Life Member of Optical Society of India (OSI). She has served as a member of SPIE Scholarship Committee member for 2019-2021 and as a Board Member of Finland Diversity in Physics (FIN DiP), 2020-2022. She 2 was honoured and enlisted by SPIE in Women in Optics Planner in 2016–2017 for her long-term contribution in Optics and Photonics. She is the Convener and Organizer of several International Conferences in Optics and Photonics and Editor of Springer Proceedings in Physics of Volumes 166, 194, 233, 249 and has published several research articles.

[2]Kallol Bhattacharya received his B.Sc. with Physics Hons.(1985), M.Sc.(Tech.) in Optics and Optoelectronics (1988) and doctoral degree (1995) from Calcutta University. He served as Lecturer (1992-1994) in the Department of Instrumentation, Jadavpur University and Scientist at Saha Institute of Nuclear Physics (1994-2001). He joined the Optics and Optoelectronics Section in the Department of Applied Physics as Reader in 2001 and is presently working as Professor in the Department of Applied Optics and Photonics, University of Calcutta. Currently his research interest is in the domain of optical metrology utilizing polarization. He has about seventy publications in national and international journals and takes an active interest in teaching. He is also an avid cyclist and is an active member of the 'cycle-to-work' movement.

Recent progress in Optical Transfer Matrix:

A tribute to late Professor Teruji Ose

Wei Wang,[1,2] Yongqi Zhang,[2] Jianlin Nie,[2] Yicheng Tuo,[2] and Mitsuo Takeda[2,3]

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In this talk, we will review our recent work on the Optical Transfer Matrix (OTM). As frequency analysis of polarization imaging system, OTM is not only useful for the design of polarization-related optical system also valuable to characterize manufactured systems since it specifies how different spatial frequencies are captured and/or transmitted in the optical transmission chain. Based on the auto-correlation of the generalized pupil matrix of the optical system, we provide some examples to demonstrate how the OTM can be calculated numerically when different types of aberrations appear in the system. Furthermore, we also introduce and demonstrate two approaches of OTM measurement with the aid of extended test objects.

All the techniques introduced here can be considered as our home-style fermentation of the knowledge which we learned from late Professor Teruji Ose, who had devoted his whole life to the study of the Optical Transfer Function (OTF). Therefore, we feel much honored to have this chance to give our tribute to Prof. Ose for his early guidance, stimuli and encouragements in the course of this research and for the great efforts he had already made to promote Sino-Japanese scientific exchange at the early age of the reform and opening-up in China.

Short biography:

Wei Wang received his PhD with Summa Cum Laude from University of Electro-Communications (Japan) and DSc from University of Science and Technology of China. He is currently working at Heriot-Watt University (UK) and taking adjunct professor position at Xian Tech. Univ.. He is a Fellow of Higher Education Academy, Senior Member of SPIE and OSA. His research interests and expertise are optical signal processing, statistical optics, polarization optics and optical metrology and sensing. He has contributed 4 book chapters, published more than 80 articles in peer reviewed journals and delivered more than 150 talks in international conferences.

Diameter Measurement of sub-micrometer optical fiber based on interference signal of Mie scattered light

Masaki Michihata

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Nano/micro-optical fibers find applications in various fields owing to their significant properties. Micro-nanofibers, which generate near-field light outside the fiber, are employed for biosensing and optical tweezers, leveraging their near-field characteristics. Furthermore, they serve as waveguides and are integrated into evanescent couplers in the whispering gallery mode. Additionally, they hold considerable promise as wavelength- or sub-wavelength-scale waveguides, facilitating continuous light oscillation and nanocavities in the field of photonics. Their capacity to easily manifest nonlinear phenomena makes them particularly attractive. In recent times, this device has garnered significant attention among researchers for its ability to generate entangled photon pairs. This paper introduces a novel method for measuring the diameter of sub-micrometer fibers with diameters less than 1 μm. The technique employs counter-propagating beams for illumination, creating a standing wave around the fiber. Through active control of the spatial phase of this standing wave, the scattered light intensity distribution from the fiber is modulated. The modulation pattern is influenced by the fiber diameter. Analyzing the modulated scattered light intensity distribution enables the measurement of the sub-micrometer fiber diameter. Experimental validation confirmed the viability of measuring the diameter of a fiber approximately 500 nm in size using the proposed method.

Short biography:

Masaki Michihata received the master's degree and PhD in Mechanical Engineering from Osaka University, Japan, 2007, 2010, respectively. He worked as the research associate of the Department of Mechanical Engineering, Osaka University for 2010 to 2014, and of research center for advanced science and technology (RCAST), the University of Tokyo for 2015 to 2018. He is now an associate professor of Department of Precision Engineering, the University of Tokyo since 2019. His research interest includes three-dimensional measurement, optical metrology, absolute length measurement. He is a member of Japan Society for Precision Engineering (JSPE), Japan Society of Mechanical Engineers (JSME)

Point-cloud based 3D Shape Analysis
– Parts through Plants –

Shun'ichi Kaneko

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Some effective approaches for point-cloud based 3D shape analysis have been surveyed, such as M-ICP, LCPD, DAI-Matching and then HALF analysis, for mechanical solid parts, and then for field plants. They could utilize geo-metrical properties in their point-cloud data and original computational schema based on the distances and/or the densities with strong robustness for imbalance and occlusion between any pair of 3D shapes. M-ICP is an extended version of the original Iterative Closest Point algorithm by the additional scheme based on M-estimation in order to realize robustness for outlying point-cloud data. LCPD, standing for Local Consistency of Point Density, is another robust matching scheme based on the consistency in point density in the neighboring pairs between any two PC data sets. DAI-Matching utilizes 2D appearance-based matching for registration of 3D curved solid objects. Lastly HALF stands for Histogram of Angles in Longer Arm Features which enables region segmentation into the classes, such as stems, leaves, and knots, of many types of plants by a simple but massive computation. Because of their fundamentality, thry must be more helpful and hopeful tools for more complicated shape analysis tasks together with application-oriented methods.

Short biography:

Shun'ichi KANEKO received the B.S. degree in precision engineering and the M.S. degree in information engineering from Hokkaido University, Japan, in 1978 and 1980, respectively, and then the Ph.D degree in systems engineering from the University of Tokyo, Japan, in 1990. He had been a research assistant of the Department of Computer Science since 1980 to 1991, an associate professor of the Department of Electronic Engineering since 1991 to 1995, and an associate professor of the Department of Bio-application and Systems Engineering since 1995 to 1996, in Tokyo University of Agriculture and Technology, Japan. He has been an professor of the Laboratory of System Sensing and Control in the Graduate School of Information Science and Technology in Hokkaido University since 2004 to 2020.

His research interest includes machine vision, image sensing and understanding, robust image registration. He is a member of IEICE, JSPE, IEEJ, SICE and the IEEE computer society.

Polarization aberrations in high NA lenses

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Polarization Aberrations in High NA Lenses Polarization ray tracing provides a straightforward method to understand the effects of multilayer coatings and other systematic polarization effects on the wavefront aberration function, apodization, diattenuation and retardance aberrations. Expanding the Jones pupil into basis functions similar to Seidel and Zernike polynomials provides an alternate method. These polarization aberrations can provide deeper insights into the polarization aberration and the opportunities for aberration compensation.

Short biography:

Russell A. Chipman received his BS from MIT in 1976. He then earned MS and PhD degrees in 1984 and 1987 from the University of Arizona. He has been there since 2002 as a Professor of Optics in the College of Optical Sciences. Chipman is the founder of Airy Optics, an optical design company. He is also a Visiting Professor at the Center for Optics Research and Education (CORE), Utsunomiya University, Japan. Previously, he worked in both industry and academia all across the USA.

He developed, at the University of Arizona, the Polarization Laboratory for coordinated research in polarimetry and polarization in optical design. With his students and research staff, more than ten polarimeters have been built. He is a Co-Investigator on NASA/JPL's Multi-Angle Imager for Aerosols, a polarimeter scheduled for launch into earth orbit around 2021 for monitoring aerosols and pollution in metropolitan areas. He is also developing UV and IR polarimeters for other NASA exoplanet and remote sensing missions. In 2005 he began developing a polarization ray tracing program for analyzing stress birefringence. Later he worked with students on the polarization ray tracing calculus to integrate the many polarization effects into a unified ray tracing algorithm. In 2009, he received a $1.2M grant from the Science Foundation Arizona to develop a research polarization ray tracing program, Polaris-M, to demonstrate this integrated approach to polarization and optical design. Polaris-M underwent further evolution as it was applied to many problems in polarimetry, interferometry, and injection molding. The interest in the Polaris-M software grew beyond what could be supported from an academic laboratory. In 2016 he formed Airy Optics, licensed the software from the University, and has developed a team to commercialize Polaris-M and perform engineering services for a wide variety of markets. The unified development of this polarization platform also led to the textbook Polarized Light and Optical Systems.

Chipman is a Fellow of the Society and SPIE. He has received NASA's Tech Brief Award, SPIE's G.G. Stokes Award in Polarization, and the Joseph Fraunhofer Award/Robert M. Burley Prize.

Characterization of structural colors

Natalia Dushkina

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Structural colors originate from the scattering of light from ordered microstructures, thin films, and even irregular arrays of electrically small particles, but are not produced by pigments. Structural colors can be implemented industrially to produce structurally colored paints, fabrics, cosmetics, and sensors. A brief description of the properties of structural colors, as well as examples of bio nanostructures which reflect linearly, or circularly polarized light are discussed along with methods of characterization of the structural coloration. The coloration polarization effects are explained with the physical mechanisms of light interaction with the building blocks, cellulose, guanine and reflectin, of these nanostructures and their optical properties.

Short biography:

Natalia Dushkina received M.S. in Quantum Electronics and Lasers from the University of Sofia, Bulgaria in 1993, and Ph.D. in Physics from the Bulgarian Academy of Sciences. She was a teacher in Optics at the High Technical School of Fine Mechanics and Optics in Sofia from 1984 to 1988, and a researcher at the Central Laboratory of Optical Storage and Processing of Information, Sofia in 1988 - 1995. In 1995, she came to Japan as a Monbusho postdoctoral research fellow at the Department of Physics, University of Tokyo, and remained in Japan for five years working as a researcher at the Mechanical Engineering Laboratory, MITI, Tsukuba, and at the Tokyo University of Agriculture and Technology. In August 2000, she relocated to the USA and worked as a visiting researcher at the Department of Physics and Astronomy, Bowling Green State University, Bowling Green, OH. In 2001 she became the Director of the Laboratory for Laser Applications at Gem City Engineering Co., Dayton, OH. At present, she is a professor at the Department of Physics, Millersville University, PA, where she is working since 2004. She has co-authored one patent, one book, three chapters in professional books, 34 publications in refereed scientific journals and conference proceedings, more than 50 conference presentations and 15 seminars and workshops and has reviewed eight physics textbooks. Her areas of professional interests include structural colors; optics, optical properties of nanomaterials and semiconductors, lasers and laser applications, photorefractive effect, total internal reflection, and surface plasmon resonance, diffraction gratings, ultrafast nonlinear optical phenomena, holography; physics education and physics education research. She is a fellow member of American Physical Society (APS), Sigma Xi, The Scientific Research Society, American Association for the Advancement of Science (AAAS), Central Pennsylvania Section of the American Association of Physics Teachers (CPS-AAPT).

Fresnel model and Effective Medium Approximation (EMA) in Spin Hall Effect of Light ellipsometry for surface measurement of optics

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The spin hall effect of light (SHEL) has been receiving spotlight particularly after the demonstration of weak measurements that ease its observation. SHEL is a phenomenon where the reflected light beam split into right and left circularly polarized light due to gradient of refractive index. SHEL observation with weak measurement is realized by a pair of polarizers to define the pre-selected and post-selected state of the light. Then, by recording and detecting the transverse shift distance of the reflected SHEL, the optical properties of the surface can also be measured. In this paper, the SHEL ellipsometry is proposed as surface area measurement. Two models are used for data analysis to draw the surface properties of the sample. The first model is based on the smooth surface assumption called the Fresnel model and draws surface mapping in terms of refractive index. The second model is based on the assumption that the sample has some degree of roughness, so the effective medium approximation (EMA) model is used, which is also commonly used in conventional ellipsometry. In the EMA, the roughness is considered as a fictitious thin layer with different refractive index and effective thickness. The EMA model offers surface mapping in terms of effective thickness. The proposed method shows a promising potential as an alternative for a large area nanoscale surface measurement.

Keyword: Surface measurement, Spin Hall Effect of Light, Refractive Index, Effective Medium Approximation, Fresnel model.

Polarization Modulation to Increase the Density of Holographic Data Storage

Xiaodi Tan[1,2,3], Xianmiao Xu[1], Peiliang Qi[1], Jinyu Wang[1], Shenghui Ke[1], Shujun Zheng[1], Xinyi Yuan[1], Junchao Jin[1], Junhui Wu[1], Yi Yang[1,2], Xiao Lin[1,3], and Yuhong Ren[1]*

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In traditional holography, because the intensity distribution of two interference waves in which include amplitude and phase is recorded, only the same components of polarization state of two interference waves are considered. The actual polarization states of two interference waves are ignored. In polarization holography, not only amplitude and phase of two waves but also the polarization states of two waves, are recorded. As the reason, polarization holography is expected to have more abundant characteristics of reconstruction and a wide range of applications, such as holographic storage technology, multichannel polarization multiplexing, vector beams, and optical functional devices.

The tensor theory of polarization holography, in which the response of recording material to the polarized wave is treated as a tensor, the research of polarized holography has become hot, and has made a lot of new progress. The conditions of the null reconstruction, there is not reconstruction even Bragg condition is satisfied. Another important research target is the condition of faithful reconstruction, in which the polarization state of the reconstructed wave is kept the same as that of the recording wave. In the tensor theory, the condition of faithful reconstruction is that some balance has to be satisfied in the case of linear, circular and elliptical polarization holography.

Linear polarization is the essential state, and any complex polarized state can be combined by linearly polarized state. Polarization holography for high density storage. In this review, the characteristic and behave of linear polarization holography have been introduced. An applications to increase the density of holographic data storage by polarization modulated method is also introduced.

Short biography:

Xiaodi Tan, graduated from the Optical Department of Shandong University in 1984, he obtained Master‘s Degree from the Optical Engineering Department of the Beijing Institute of Technology in 1990. His Doctoral thesis was completed at The University of Tokyo, Institute of Industrial Science in 2001. He was a Senior Engineer of the Technology Division in OPTWARE Corporation, researching and developing the next generation of optical data storage systems. And he was a Senior Technology Analyst, Distinguished Engineer and Optical Technology Manager of Core Device Development Group in Sony Corporation. During 2012 to 2017, he was a professor at the School of Optoelectronics in Beijing Institute of Technology. He is currently a professor at the College of Photonic & Electric Engineering in Fujian Normal University. His research interests are in information optics & photonics: holographic storage, optical information display, optical devices, etc.

Noble metal nanoparticles and applications in surface enhanced Raman scattering

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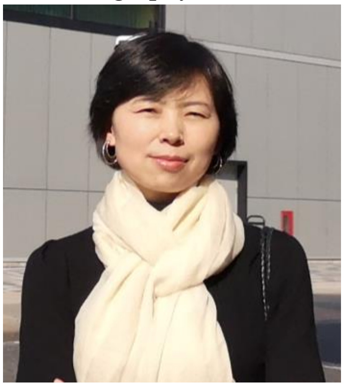
Noble metal materials have negative real part and small imaginary part of the dielectric constant at optical frequencies, so the nanoparticles formed by noble metal materials possess an ability to localize and amplify the incident electromagnetic radiation near the surface of nanoparticles once the plasmonic resonance condition is fulfilled. If a molecule is located near the surface of noble metal nanoparticles, and the wavelength of the incident laser is close to the plasmonic resonance peak of noble metal nanoparticles, the overall Raman scattering intensity of the molecule is significantly magnified due to the double enhancement acting on the incident light and the scattered light. This phenomenon is called surface enhanced Raman scattering (SERS). An ideal SERS substrate constructed from noble metal materials plays a vital role in SERS research. Here two types of SERS substrates are introduced. One is composed of silver nanoparticles by in-situ growth process and its enhancement is originated from the localized surface plasmon resonance (LSPR). The other is gold grating/ gold nanoaprticles hybrid structure in which the coupling between the surface plasmonic resonance (SPP) and LSPR is excited to obtain higher enhancement factor.

Short biography:



Chunfang Wu received PhD degree from Lanzhou University, China in June in 2008. Her doctoral dissertation is focused on the preparation and the photo-luminescent properties of rare earth doped phosphate phosphors. She was an associate professor in Lanzhou University from May 2011 to Sept. 2016 and in Xi'an Technological University from Oct. 2016 to Dec. 2021. From Jan. 2022 to now, she is a professor in Xi'an Technological University. Recently she pay attention to the preparation of noble metal nanoparticles and their applications in SERS (Surface Enhanced Raman Scattering).

Nonlinear Vibration Approach to Aerosol-Jetted PZT-Actuated MEMS Scanner for Imaging and FPGA assisted Display

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Abstract:
This study introduces an innovative advancement in imaging technology through the implementation of a state-of-the-art hybrid MEMS (Microelectromechanical Systems) scanner system designed for compact microscopic imaging. The scanner, featuring a tapered optical fiber waveguide and cutting-edge aerosol-jetted PZT (lead zirconate titanate) bimorph push-pull actuators on a stainless-steel substrate, effectively mitigates issues such as fracture and layer separation commonly associated with PZT on silicon substrates. By harnessing nonlinear vibration, the scanner achieves a spiral scan pattern from a single signal input, alongside the anticipated two-dimensional scanning and target illumination from two phase-shifted inputs.

This capability is further enhanced by a novel process that tapers the optical fiber, reducing illumination scattering and tuning the fiber to the resonant frequencies of the scanner. The specialized tapered tip facilitates large fields of view while enabling independent 2-axis scanning through one degree-of-freedom actuation. Experimental validation demonstrates the successful generation of a spiral scan pattern with a 60 μm diameter scan area and a 10 Hz frame rate. The system effectively reconstructs scanned images of 5 μm lines, cross patterns (15 μm in length with a 5 μm gap), and structures of a Psychodidae wing. Additionally, the study includes the application of micro display using Field-programmable gate array (FPGA).

Short biography:

Wei-Chih Wang* is currently an Associate Professor in Power Mechanical Engineering and Institute of Nanoengineering and Microsystems at the National Tsinghua University and an affiliated Associate Professor in the Department of Mechanical Engineering and an Adjunct Associate Professor in the Department of Electrical Engineering at the University of Washington. His research interests are in the area of developing polymer based micro sensors and actuators for industrial and biomedical applications. More recently, his work has expanded to THz, IR and visible band metamaterials, and amorphous and metamorphous structure and material study for wave manipulation.

DNA damage-triggered cellular reprogramming in the moss *Physcomitrium patens*

Nan Gu

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Genomic DNA constantly faces damage by environmental stresses and cellular activities. DNA damage threatens genome integrity and cell viability. Notably, stem cells exhibit higher sensitivity to DNA damage compared to differentiated cells, and even lower levels of DNA damage can result in stem cell death. However, our research reveals that transiently induced DNA strand breaks can trigger the reprogramming of differentiated leaf cells into stem cells without inducing cell death in the moss *Physcomitrium* (*Physcomitrella*) *patens*. Stem cells induced by DNA strand breaks are able to develop healthy leafy shoots, known as gametophores. *STEM CELL INDUCING FACTORs* (*STEMINs*), which encode AP2/ERF transcription factors and facilitate wounding-triggered reprogramming, were indispensable for DNA strand break-triggered reprogramming. Furthermore, among the DNA damage signal transducers, ATM and ATR, only ATR was essential for the activation of the *STEMIN1* expression and the initiation of reprogramming. These results demonstrate that DNA strand breaks are a novel trigger of cellular reprogramming, which requires the activity of ATR and STEMINs. Here, I will present our current results on the effects of gamma-ray irradiation on the reprogramming of leaf cells in *P. patens* and discuss the molecular mechanisms underpinning DNA damage-triggered reprogramming.

Short biography:

Nan Gu earned her PhD from Huazhong Agricultural University, China in August 2020. Currently, she serves as a postdoctoral researcher at Utsunomiya University, starting from October 2020. Specializing in plant cell research, she is dedicated to unraveling the mechanism of DNA damage-triggered cellular reprogramming and exploring its universality. She holds membership of the Botanical Society of Japan.

Plasma-assisted Reactive Magnetron Sputtering for Optical Coatings

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In the optical coating area, efforts have been made to improve the performance of optical thin-film filters that are needed in optical and optoelectronic devices. These optical thin film filters must be made by alternating high and low refractive index materials. The standards that these filters must meet have also become stricter. Therefore, there are two critical issues with optical coatings. First, we have to develop new and improved processes for the deposition of thin film materials, which were highly stable, mechanically strong, low absorption, and, last but not least, low cost. Second, we need to develop new methods to design optical multilayer coatings. Recently, HIPIMS has attracted considerable attention to thin film sputtering, and it has been widely applied in various industrial sectors. The reactive HiPIMS process also has potential applications for optical coatings and provides an alternative method to solve the abovementioned issues.

In this presentation, we will discuss the optical properties of aluminum nitride and aluminum oxide films prepared by reactive HiPIMS, superimposed HiPIMS-MF sputtering, and plasma-assisted reactive HIPMS, and study graded-index-like rugate filters prepared by reactive HiPIMS and DOMS process with PEM control.

Short biography:

Dr. Chien-Jen Tang received his Ph. D. degree in the Institute of Optical Science at National Central University, Taiwan, in 2007. From 2006 to 2008, he served as a Principal Engineer at the R&D center of Paragon Technologies Co., Ltd., where he was responsible for research and development related to magnetron sputtering systems for functional coatings. Subsequently, he joined the Department and Institute of Opto-Electronic System Engineering at Minghsin University of Science and Technology as an assistant professor from 2008 to 2012 and then as an associate professor from 2012 to 2014. In 2014, he joined the faculty of the Department of Photonics at Feng Chia University. His research interests are primarily involved in the design, fabrication, and measurements of optical thin films by using magnetron sputtering technology. More recently, He focused on the plasma-assisted reactive magnetron sputtering (PARMS) process and its application in optical coatings, especially in highly wear-resistant anti-reflective coatings, low-temperature deposited thermochromic vanadium-tungsten oxide film, and gradient index films. He consistently engages in technology innovation with an industry-oriented approach, providing technical consulting and training courses to various companies.

Optical detection of microplastics in water

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Among pollutants invading waters, microplastics (MPs) have gained a large place. Coming from either industrial water or from discarded degraded pieces of plastics in oceans, MPs are finding a path back to soil and river. Monitoring MPs is important, and we propose optical techniques and methods for this purpose. Robust methods such as Raman and Fourier Transform Infrared spectroscopies are the most reliable methods, but they are often expensive and require a long filtering and sample preparation process. We present here alternatives using a combination of different optical phenomena that we implemented to achieve a portable device. The first device to be presented is based on ultra-high-definition imaging using a commercial device originally conceived for the analysis of pulp in paper factories. The second method is based on hyperspectral imaging allowing us to identify the plastic type directly in water, without pretreatment or filtering. Finally, we will discuss the possibility of integration of methods and extend the scope of the presentation to water monitoring in general using on-chip devices. This collaborative work belongs partly to several projects, namely, Research Council of Finland flagship PREIN, Horizon Europe project IBAIA, and Business Finland project CEIWA.

Short biography:

Matthieu Roussey is leading the integrated optics and sensing group (about 15 researchers) of the Center for Photonics Sciences at UEF in Joensuu. He obtained his PhD from the FEMTO-ST institute (Besançon, France) in 2007. He was team leader in the Optics & Photonics Technology Lab at EPFL (Neuchâtel, Switzerland) from 2007 to 2011. Since 2011, he has been working as a senior researcher at UEF, from which he obtained a tenure track position in experimental photonics in October 2016. In October 2020, he obtained the position of full professor. His research topics include dielectric surface waves, novel platforms for integrated optics, complex integrated devices, environmental monitoring. He is in the board of directors of the European Optical Society since 2017.

Optical metrology at the nanoscale

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Nanotechnology is one of today's key technologies, enabling a wide range of applications. The most prominent example of the ongoing trend towards further miniaturization is undoubtedly optical lithography, which is used to manufacture highly integrated circuits and leading-edge microchips. The advances in nanotechnology are closely related to the progress in nanometrology. As with any technology, reliable processes and mass production are only possible if structures and objects can be measured with a high degree of reliability and if traceability is provided. In general, nanometrology involves all the structural, chemical, electronic or optical properties of a nanostructure. A structure or object is said to be nanoscale if it is between one and 100 nanometers in at least one dimension. This contribution presents three optical methods related to the structural and dimensional characterization of features or objects at the nanoscale. In particular, we discuss advanced model-based optical scatterometry, absolute interferometric measurements of structuring errors in computer-generated holograms and explore new concepts for 3D nanometrology over a large measurement volume of 200 mm × 200 mm × 25 mm using the capabilities of the Nanopositioning and Nanomeasuring Machine (NPMM-200) installed at ITO.

Short biography:

Stephan Reichelt received his Ph.D. in interferometric testing of aspherical optics and computer-generated holograms from the University of Stuttgart, Germany, in 2004. From 2003 to 2006, he was a postdoctoral researcher at the Microoptics Laboratory, Department of Microsystems Engineering (IMTEK), University of Freiburg (Germany), where his interests included biomedical imaging and physiological sensing, as well as the design, fabrication and testing of micro-optical elements and systems.
From 2007 to 2021 he worked in the optical industry in Germany and Switzerland developing 3D holographic display solutions and customized high-precision OEM products for the semiconductor, metrology, medical and general photonics markets. Since October 2021 he is full professor at the University of Stuttgart and director of the Institute of Applied Optics (ITO). He has authored or co-authored more than 60 technical publications in the areas of optical design and metrology, biomedical sensing and imaging, and 3D holographic imaging and visual perception. He holds several patents. His current research focuses on optical metrology, inspection and sensing for industrial and biomedical applications. He is a member of OPTICA, SPIE, the European Optical Society (EOS) and the German Society for Applied Optics (DGaO).

Fringe projection profilometry (FPP): theoretical aspects (II)

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Lyu Shenzhen and Qian Kemao

Abstract

Due to its high-precision, high-speed and low-cost, FPP is one of the most powerful non-contact and non-interferometric optical three-dimensional (3D) measurement techniques. Based on our earlier study on phase measurement, correspondence, and 3D reconstruction, we further investigated the following theoretical aspects, which have rarely been explored in the past: (i) how to establish a complete theoretical noise model; and (ii) how to approximate complex theoretical model for practical engineering applications. Answers to these questions enable the provision of theoretical guidance for development of FPP, addressing hardware selection, error tolerance, and precision estimation.

Biography:

Dr. Lyu Shenzhen is a Research Fellow at School of Computer Science and Engineering, Nanyang Technology University, Singapore. He received PhD. degree from Changchun Institute of Optics, Fine Mechanics and Physics (CIOMP), Chinese Academy of Sciences in 2021. From 2021 to 2022, he was an assistant researcher at CIOMP. His research interests include optical metrology, optical image, and computer vision.

Lyu Shenzhen

Emergent Physical Phenomena in Optics

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Optics provides an excellent platform to explore and observe novel phenomena in physics. By bringing new physical phenomena into optics, we not only learn novel ways to control and manipulate light, but optics also aids in exploring these phenomena in unprecedented ways beyond the reach of other realms of physics. In this talk, I will present the observation of two unique physical phenomena in optics. The first one is branched flow. When waves propagate through a weakly disordered potential with a correlation length larger than the wavelength, they form channels (branches) of enhanced intensity that continue dividing as the waves propagate. This fundamental wave phenomenon, known as branched flow, was first observed in electrons in semiconductor heterostructures and later in microwave cavities, but it can occur for any kind of wave, regardless of wavelength. I will demonstrate how we observed branched flow of light for the first time by propagating light through thin liquid films. For the second phenomenon, I will present the observation of a new family of fundamental laser modes in stable resonators: the Boyer-Wolf Gaussian modes. We discovered these new modes by studying the isomorphism between stable laser resonator cavities and quadratic Hamiltonians and observed them by constructing a laser resonator equivalent to a quantum two-dimensional anisotropic harmonic oscillator with a 2:1 frequency ratio.

Short biography:

Dr. Bandres is an Assistant Professor at the College of Optics & Photonics (CREOL) at the University of Central Florida. He received his Ph.D. in Physics from the California Institute of Technology. He was a postdoctoral research fellow at the Technion, Israel Institute of Technology, in the group of Moti Segev. He is the recipient of the Marie Curie Fellowship, the SPIE John Kiel Scholarship, the SPIE Laser Technology Scholarship, and the Premio Nacional de la Juventud, which is awarded by the Mexican government to outstanding young professionals. His research focuses on finding and observing new fundamental phenomena that allow us to control light in nontrivial ways, such as photonic topological insulators, artificial gauge fields in optics, and non-Hermitian photonics, and on studying how these phenomena and platforms can be applied to improve or realize new photonic systems such as lasers, waveguides, photonic lattices, and optical fibers. For example, he has theoretically and experimentally observed new families of nondiffractive beams and accelerating beams, ultrafast tailored spatio-temporal pulses, and a new fundamental family of laser modes, the Ince Gaussian modes. His collaborative work launched the field of topological insulator lasers.

Title: Advancing cancer diagnosis and screening with biomarker-specific multispectral imaging

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Abstract:
White light imaging (WLI) remains indispensable as the standard of care during surgery and therapy, from ophthalmoscopy to endoscopy. The primary purpose of WLI is to guide the operator by faithfully replicating the human vision system. Yet in doing so, valuable biological information about the tissue is subsequently lost, with tissue contrast perceived solely by the human eye. Multispectral imaging (MSI) captures spatial information across a number of spectral (or color) bands. Selecting spectral bands to target specific spectral biomarkers could enhance the sensitivity and specificity of imaging diagnostic methods. Multispectral filter arrays (MSFAs) based on thin-film optical components can be monolithically integrated with image sensors and are proposed as a key enabler for MSI in biomedical imaging. In this presentation, I will discuss ongoing work focused on biomarker-specific MSFAs including computational methods to design MSFAs, fabricate techniques for manufacturing, and preliminary prototypes of MSFAs for medical imaging applications including cancer diagnosis and screening.

Biography: Travis Sawyer is an Assistant Professor of Optical Sciences at the University of Arizona (UA). He received his BS in Optical Sciences from the UA (2017) before attending the University of Cambridge to receive his MPhil in Physics (2019). He then returned to the UA to obtain his PhD in Optical Sciences (2021) where he focused on developing novel imaging techniques for ovarian cancer detection. He joined the faculty at the College of Optical Sciences, where his team's research interests include developing optical imaging technology for applications in gastrointestinal and pancreatic cancers, as well as brain imaging. His lab primarily applies optical imaging modalities including optical coherence tomography, multi- and hyperspectral imaging, fluorescence imaging, and polarized light imaging, with a focus on image analysis through machine learning techniques. Previously, he developed visual recognition software for detailed image capture, enabling discoveries in astronomy, art preservation, and the biomedical sciences.

Dynamic Out-of-Plane Measurements Using a Speckle Interferometer with a Polarization Camera

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[3] Cuerpo Académico de Ingeniería Ciencias e Innovación Tecnológica, Universidad Tecnológica de Tulancingo, Hgo. 43645, México.

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We implemented a dynamic electronic speckle pattern interferometer with out-of-plane sensitivity using a pixelated polarization camera. The system is based on polarization phase shift techniques that, combined with the polarization imaging sensor, can follow temporary deformation fields caused by mechanical stress. The optical instrument have potential implementations of characterizing information such as hardness and malleability of steel samples. The implemented system captures four simultaneous patterns with comparable intensities, from which the optical phase is calculated using a frequency phase demodulation algorithm and subsequently, the out-of-plane deformation field. We present experimental results and implementation of the optical system measuring a galvanized steel plate, showing the feasibility of our proposal.

Short biography of Presenter:

David Serrano received his Phd. in optics from the Centro de Investigaciones en Optica (CIO) in Mexico in 2014. From 2014 to 2017 He was working as a postdoctoral researcher in Japan at the Center for Optica Research and Education (CORE) in Utsunomiya, Japan. Since 2017 he works as a researcher professor at Guadalajara University and his main research field involves dynamic interferometry techniques and polarization sensing instruments.

Simulation model for visualization of diffraction property of volume holographic optical elements

Ching-Cherng Sun

Holography is a widely recognized technique for generating a new wavefront from an existing one through a diffraction medium[1]. In the case of a thin hologram, the phase-match condition permits the occurrence of multi-order diffraction lights, resulting in relatively low diffraction efficiency. However, a notable advantage lies in the absence of significant Bragg selectivity in both spatial and wavelength domains. In contrast, a volume hologram adheres to stringent Bragg conditions, reflecting energy and momentum conservation in k-space[2]. This characteristic renders a volume hologram highly sensitive to the reading conditions[2]. Deviation from the Bragg condition, either in incident angle or reading wavelength, leads to ineffective diffraction. Volume holograms can be categorized into two types: transmission and reflection. Both types can achieve 100% diffraction efficiency, albeit with distinct behaviors. For a transmission volume hologram, the diffraction efficiency oscillates as the coupling strength increases. Conversely, the diffraction efficiency of a reflection volume hologram exhibits a different behavior, approaching 100% as the coupling strength reaches a sufficiently large value. In the case of a transmission volume hologram, it attains the status of a strong volume hologram upon reaching the first 100% diffraction efficiency. Consequently, when designing a volume holographic optical element (VHOE), it is imperative to meticulously consider the Bragg condition and other incident conditions.

One of the notable advantages of VHOE is their ability to efficiently transform one wavefront into a desired form with 100% efficiency. However, a significant challenge arises when designing VHOEs for arbitrary wavefronts, as an effective method for calculating diffraction efficiency was lacking.

Existing calculation models, such as the couple mode equation for holograms with two plane waves, and methods like Born's approximation and VOHIL, are suitable for scenarios with small coupling strength, i.e., when diffraction efficiency is limited [3-4]. When dealing with intricate diffraction efficiency calculations and determining the Bragg condition for a local field, VOHIL proves to be a particularly effective and clever approach. Its utilization of a phase mismatch factor facilitates the handling of the Bragg condition in real space rather than in k-space.

In our proposed approach, we introduce a novel method to calculate the phase mismatch factor throughout the entire volume of a VHOE. As illustrated in Figure 1, varying phase mismatch factors exist across the VHOE when the reading light deviates slightly from the direction of the reference light. When the difference in the phase mismatch factor along a specific diffraction direction exceeds 2π, effective diffraction along that direction is impeded. This approach proves valuable in determining the Bragg condition for designing a VHOE, especially when the reading light must deviate from the reference light.

Figure 2 presents a more complex scenario where two spherical writing lights counter-propagate. The spherical reading light deviates slightly from the reference light, inducing a Bragg mismatch in the VHOE. Each cube in the figure corresponds to a certain diffraction light with a spherical wavefront propagating along a direction linked to the deviation between the reading light and the reference light. By examining the phase deviation map, a designer can ascertain the existence of effective diffraction. This scheme proves instrumental in the development of intricate VHOEs, particularly those intended for use in Augmented Reality/Mixed Reality near-eye glasses [5-6].

Acknowledgment This study has been supported by the National Council of Science and Technology of ROC with the contract number MOST 111-2218-E-008-004 –MBK and NSTC 112-2218-E-008-008 -MBK. The simulation shown in Figs. 1-2 was made by Chi Sun.

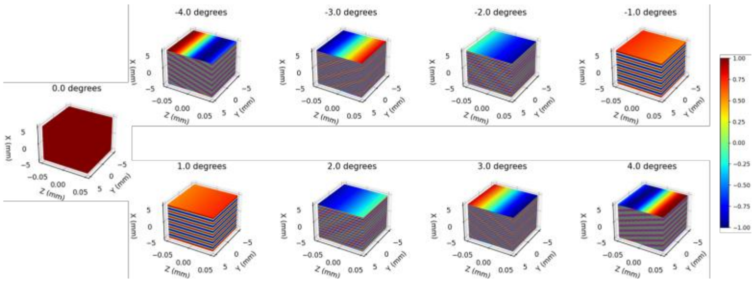

Fig. 1 The Diffraction behaviors for a 2K reflection volume hologram. The phase deviation map comes from the reading light deviating from the reference light.

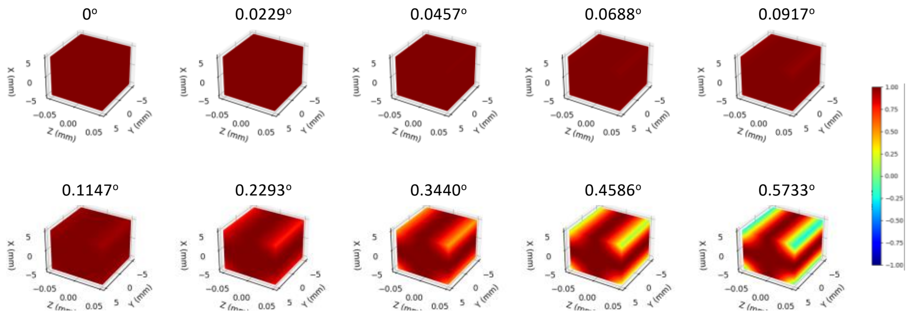

Fig. 2 The Diffraction behaviors for a 2K reflection volume hologram. The phase deviation map comes from the reading light deviating from the reference light and diffracted light has the same deviation from the other writing light. All lights in the simulation are spherical waves.

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Principles and Algorithms for Speckle Phase Retrieval

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The main advantage of speckle phase retrieval is the sufficient intensity variation which is essential for a non-stagnating iterative wavefront reconstruction. The method utilizes diffuse illumination of test objects and a reconstruction algorithm based on a wave propagation equation. The first part of the presentation will cover the method's basic principles, step-by-step implementation, as well as some applications in optical metrology. Due to object-related factors and sampling issues especially for smooth test objects, the convergence of the iterative algorithm may still be slowed down. The second part will discuss novel algorithms that maximize the utilization of the available intensity variation. Finally, possible topics for collaboration will be presented.

OCIS codes: (100.5070) Phase Retrieval; (100.3010) Image reconstruction techniques; (030.6140) Speckle; (060.5060) Phase Modulation; (230.1980) Diffusers.

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Tracking, Testing, Tuning, and Topping Up the Import Activity of Chloroplast-Transit Peptides

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Plastids, including chloroplasts, are specialized organelles crucial for the regulation of photosynthesis and the provision of essential nutrients to plant cells. These organelles contain plastidial proteins primarily encoded by nuclear genomes, which are later transported into the stroma through an integrated import complex located within the membrane layers of plastids. The efficiency of this import process varies among different plastid-targeting proteins and is rigorously controlled by chloroplast-transit peptides (cTPs) predominantly positioned at the N-terminus of each protein. However, a systematic classification of the import activities of cTPs has not been previously established. In this research, we undertook a comprehensive approach that integrated computational prediction, *in planta* expression, fluorescence tracking, and *in vitro* import assays to systematically categorize 89 sequences of combinatorial cTPs collected from a chloroplast protein library based on their distinct import activities. Notably, we discovered a remarkable cTP with high import efficiency, surpassing other candidates in facilitating the translocation of green fluorescent protein into chloroplasts. Intriguingly, our experimental optimization unveiled the significant roles of specific amino acid sequences and the cleavage site of this cTP in enhancing the import efficiencies of key metabolic enzymes and RNA processing proteins associated with photosynthesis within the chloroplast. Our findings present valuable insights into the potential application of biotechnological strategies in chloroplast engineering by manipulating cTPs in specialized plastidial proteins. Moreover, the identified cTP holds promise for enabling the nanostructure-based biomolecules targeting within the plastids of cultivated plants, marking a significant advancement in plant molecular biology.

Short biography:

Chonprakun Thagun obtained his PhD from the Nara Institute of Science and Technology (NAIST), Japan, in 2016. Following this, he worked as a postdoctoral researcher at RIKEN from 2017 to 2021 and later as a program-specific assistant professor at Kyoto University from 2021 to 2022. Currently, he holds the position of a specially-appointed assistant professor at C-Bio, Utsunomiya University. Primarily a plant biotechnologist, he focuses on the biotechnological engineering of commercially-significant traits in crops, with a particular emphasis on tomatoes, potatoes, and strawberries. His current research centers on enhancing the economic characteristics of Tochigi's commercial strawberry cultivars and Japan's wild strawberries, utilizing genetic engineering and gene-editing technologies.

Computational imaging with laser-generated light sources

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The fusion of imaging and computational processing has expanded the wavelength range that can be imaged. However, the ability to image a wide range of wavelengths, including non-visible light, with a single system is still a challenge due to limitations in the wavelengths that can be supported by devices, such as an illumination light source and an image sensor. In this research, femtosecond-laser-driven light sources on a water film have been applied for computational broadband imaging. The spatial position of the light source was controlled by beam deflection using a galvanometer scanner. The spatially selective generated light sources form a coded illumination pattern with a broadband wavelength including visible and non-visible region. Femtosecond laser-driven light sources function as ultra-broadband illumination light, including the non-visible region, depending on the excitation target and pulse energy. In particular, liquid-state targets such as water films can produce a broad emission spectrum that includes X-rays and terahertz waves in addition to the visible region. We have demonstrated X-ray and visible imaging by using the femtosecond-laser-driven light sources which was two-dimensionally generated on a water film. Furthermore, the imaging time was reduced while maintaining the number of pixels in the reconstructed image by using compressed sensing algorithms and coded illumination patterns.

Short Bio:

Kota Kumagai is an assistant professor in Center for Optical Research and Education (CORE) of Utsunomiya University since 2020. He received a Ph.D. in Engineering from Utsunomiya University with a President's Award in 2019 via JSPS Research Fellow DC1 and research inter at Swinburne University of Technology. From 2019 to 2020, he has worked for R&D Center of Sony Corporation. His research interest is an intersection of optics and information engineering, and recently, focused on volumetric display and computational imaging with femtosecond laser-matter interactions. He received a Good Design Award 2015 and a JSPS Ikushi Prize in 2018.

Posters

Theoretical model for surface position estimation for 3-dimensional measurement by autofluorescence confocal detection

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In recent years, products have become increasingly miniaturized and complex, and many micro components with high aspect ratio structures have become widespread. Simultaneously, there is a growing demand for a method to measure such shapes with less than submicron accuracy. However, measurement of steep and smooth surfaces has general problems such as probe contact angle and light reflection angle. Therefore, we focused on fluorescence as a measurement principle that is not limited by such geometrical constraints. Fluorescence is a phenomenon in which an excited molecule emits the differential energy as light in all directions when it returns to its ground state. Fluorescence emitted from the object itself is particularly called autofluorescence, which is known to be emitted from many materials such as glass and ceramics when UV light is incident. In this study, we propose a method to detect autofluorescence using a confocal system and to estimate the surface position by fitting a model that takes absorption by a sample itself into account. Results of measuring a fluorescent plate show that the method is capable of measurement with residuals of less than 1 μm even on smooth slopes that exceed the focusing angle of the objective lens.

Short biography:

Motoya Yoshikawa graduated from the University of Tokyo in March 2023. He went on to pursue a master's degree at the same university. He is a member of the Japan Society for Precision Engineering. His research topic is geometric measurement using fluorescence.

Improvement of aquatic display system and preliminary behavioral experiments of fish toward VR Biology

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Aquatic display optical system has been improved to avoid distortion of images due to disturbances at the interface. The developed aquatic display was utilized for preliminary behavioral experiment of a medaka using a light grid on the wall. We have developed the world's first aquatic display that forms images underwater by use of aerial imaging by retro-reflection (AIRR). Taking advantage of the aquatic display, we are considering the use of this display instead of conventional displays for VR biology experiments, where fish behavioral experiments are conducted using visual stimuli and virtual reality environments are constructed for the experiments.

There are two problems that be caused when conventional displays are placed underwater. One problem is that the display is disturbed by water flow. The aquatic display does not require hardware to be installed at the location where the image is presented. Moreover, we have succeeded in eliminating distortion of the presented images by placing the optical components of the AIRR, the beam splitter and retro-reflector. Therefore, it is possible to present stimuli using only pure optical information as experimental cues without disturbing the flow of water. Another problem is that the display limits the observational area, making it impossible to take a photograph of fish facing the display from the front. To solve of this problem, by using polarization modulation and installing a camera on the optical pass of optical see-through AIRR, we realized an optical system that can capture the behavior of fish from the front while presenting aquatic display as visual stimuli. This system enables the entire surface of the water tank to be surrounded by the image while capturing the fish's behavior.

In addition to these fundamental researches, we also propose the application of aquatic display to the aquarium or aquaculture. We are conducting a behavioral experiment of a small fish using a light grid on the wall.

Short biography:
Ryosuke Ichikawa is a senior undergraduate student in the Department of Fundamental Engineering, Faculty of Engineering, Utsunomiya University. He will plan to enter Master's Course in Graduate School of Regional Development and Creativity at Utsunomiya University in 2024. His research interest includes an aquatic display using aerial imaging by retro-reflection (AIRR).

Compact MTF Measurement of Fisheye Lens

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Key words: Modulation Transfer Function, Fisheye Lens, Relay Lens

In this study, we present a novel approach for the measurement of modulation transfer function (MTF) in fisheye lenses. Fisheye lenses, known for their extreme wide-angle views, pose unique challenges for MTF testing due to their complex optical properties, and the need for a large space for testing. The object of this research is to devise a compact testing setup that enables MTF analysis of fisheye lenses within a controlled environment. To achieve this objective, we designed a setup using a relay lens system that reduces the required testing space from a full room to a compact 0.5m x 0.5m x 0.5m enclosure. We show an MTF analysis on one fisheye lens within this controlled environment.

The widespread use of fisheye lenses has become a reality in modern optics, making accurate evaluation of their performance critical. However, traditional test methods for fisheye lenses often require large test benches and complex laboratory environments, which makes testing expensive and less practical. Previously there were test devices that were a cylindrical structure with a radius of 75 centimeters on which the target was placed [1] [2], the size of the test device now being used is width of at least 3 meters, height of at least 2 meters [3].

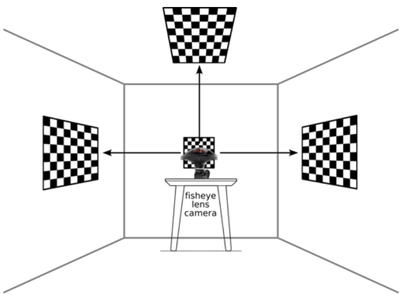

Fig 1 The current test method requires a larger space for testing with a fisheye lens.

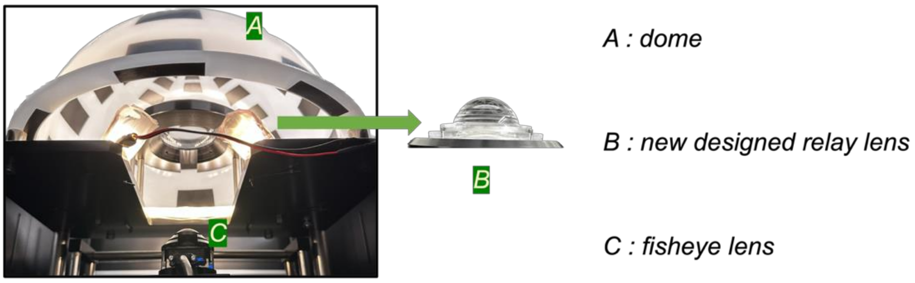

Fig 2 This is the fisheye lens experimental setup with Relay Lens already in place, and the upper dome is used to set up the test charts for the experiment.

We provide a comprehensive explanation of the Modulation Transfer Function theory, including the underlying mathematical formulas. MTF [4][5] (Modulation Transfer Function) is a capability or parameter employed to assess the performance of optical systems, such as lenses, cameras, telescopes, and similar devices.

In conclusion, our research not only addresses the specific challenges associated with fisheye lens testing but also contributes to the broader landscape of optical engineering by introducing a compact and adaptable testing solution.

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Drawing range and voxel emission characteristics of volumetric display with femtosecond-laser excitation of air

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A volumetric display generates voxels in three-dimensional physical space. A user can directly observe the volumetric image. A volumetric display with the voxels generated by a focused pulsed laser in air is developed. It achieves touch interaction using a seamless relationship between the user and the image. The first objective of our study is to enlarge the display size.

In this presentation, we demonstrate the evaluation of the image rendering range and the voxel emission characteristics of the volumetric display when the image size of centimeter order is realized by reconstructing the optical system.

Figure 1 shows the experimental system for the volumetric display. Mainly it consists of a femtosecond laser with a central wavelength of 1030 nm, a repetition rate of 1k-100 MHz, and a pulse width of 155 fs, a galvano scanner to adjust the light focusing position in the lateral direction, a varifocal lens to adjust the light focusing position in the optical axis, and an Fθ lens. The luminescence generated by the focused femtosecond laser irradiation was observed by a CCD image sensor.

Figure 2 shows drawing range of the display system. The voxels were generated in most areas of the operating range of the device, no voxel generation was observed at the corner position around z = 4.2 cm. This is because the variable focus lens acts as a concave lens, causing some of the laser incident on the galvanometer scanner to be larger than the mirror, and due to the lower NA.

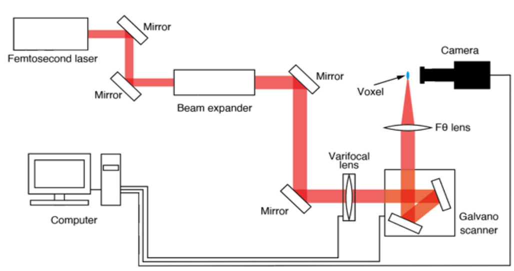

Fig. 1 Experimental seup.

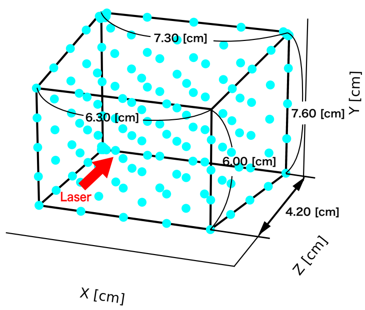

Fig. 2 Drawing range of volumetric display.

Short biography:

Tatsuki Mori received bachelor's degree in Utsunomiya University (UU), Japan, in March 2018. He is a master course student in UU. Now he is belonging in Optical System Design Laboratory (Hayasaki Lab) in Center for Optical Research and Education, UU. His study is a volumetric display based on femtosecond laser excitation. He is a vice president of The Japan Society of Applied Physics (JSAP) UU Student Chapter and a member of OPTICA UU Student Chapter.

Compact Grating-Based NIR Free-Electron-Laser Design

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Abstract:
The dielectric-based free electron laser (FEL) is a breakthrough in compact, high-performance laser technology, offering potential applications in diverse fields. With an innovative design and dielectric materials, it ensures exceptional laser performance in a compact form suitable for industrial and medical use. The enhanced design, employing COMSOL techniques and CST software, enhances electron-grating interaction, leading to notable coupling effects.

Observing resonant coupling phenomena in interactions between a 50 keV electron and a 400 nm waveguide thickness, coupled with grating periods of 290 nm, 300 nm, and 310 nm, the FEL device demonstrated radiation emission within a resonant frequency range of 0.192 PHz to 0.194 PHz, accompanied by an electric field intensity of 10-10 V/m.

The fabrication process followed a tripartite iterative procedure, creating distinct mesa, waveguide, and grating layers. Iterative lithography and Deep Reactive Ion Etching (DRIE) operations resulted in precise dimensions, positioning the dielectric-based FEL device as a promising solution for advancing laser technology applications.

Short biography:

Wei-Chih Wang* is currently an Associate Professor in Power Mechanical Engineering and Institute of Nanoengineering and Microsystems at the National Tsinghua University and an affiliated Associate Professor in the Department of Mechanical Engineering and an Adjunct Associate Professor in the Department of Electrical Engineering at the University of Washington. His research interests are in the area of developing polymer based micro sensors and actuators for industrial and biomedical applications. More recently, his work has expanded to THz, IR and visible band metamaterials, and amorphous and metamorphous structure and material study for wave manipulation.

Visibility estimation of rotationally sampled super-resolution display by use of PredNet

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This paper proposes a novel visibility estimation method of subjective super-resolution display by use of a deep neural network. Subjective super-resolution display is an information display method to present a higher resolution than that of a high frame-rate LED display. In the subjective super-resolution display, sampled pixel information is displayed at a high speed on the LED panel, resulting in the perception of an image with a higher resolution than the actual physical number of pixels. The purpose of this study is to clarify whether a deep neural network can be used to estimate the visibility of subjective super-resolution displays composed of rotational sampling.

We used Predictive Coding Network (PredNet) for experiments. PredNet is a deep neural network built for estimating human perception, and imitates the process of prediction in the cerebral cortex of the human brain. PredNet has been proposed as a model for learning generic features and predicting future images from given video images. After training the network using video camera images of natural scenes, the constructed PredNet was used to predict the rotation-sampled subjective super-resolution display from the video images of the subjective super-resolution display. The prediction was incorrect when the number of input images was small, but as the number of input images was increased, the prediction accuracy was improved.

For the estimation of visibility using PredNet for rotation-sampled subjective super-resolution displays, the prediction results from the input image show that it is possible to predict one frame ahead with an accuracy that enables the discrimination of characters.

Short biography:

Kaito Shimamura is a second-year student at the Graduate School of Regional Development Science, Utsunomiya University. He is working the estimation of visibility for subjective super-resolution displays using PredNet.

Nondestructive Evaluation of Semi-insulating Compound Semiconductor Wafer using Terahertz Time Domain Spectroscopy

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ABSTRACT

Terahertz Time-Domain Spectroscopy (THz-TDS) is a well-known application of the Terahertz spectrum (0.1 THz to 10 THz) for non-destructive material characterization. The THz-TDS system has been widely used for measuring the optical and electrical properties of conductive and non-conductive samples. The increasing demand for high-performance integrated circuits in a variety of applications, including electric vehicles, renewable energy, and 6G communications, has led to the development of semi-insulating compound semiconductor materials. In this paper, we have non-destructively measured the electrical properties such as resistivity and carrier concentration of semi-insulating (SI) Silicon Carbide (SiC) and Indium Phosphide (InP) wafers using the THz-TDS in transmission mode. The Nelder-Mead algorithm is utilized to estimate the electrical properties based on the transmission (S21) measurement data and the simplified Drude model. The estimated resistivity of the SiC and InP samples from the THz TDS measurements are (1.42 ± 0.15) × 105 Ω · cm and (3.0 ± 0.1) × 107 Ω · cm, respectively, and are consistent with the manufacturer specifications. The feasibility of THz-TDS in the transmission mode for non-destructive electrical evaluation of semi-insulating SiC and InP is demonstrated and offering a promising tomographic inspection approach for online monitoring with the potential to enhance production yields in the semiconductor industry.

Keywords: THz-TDS, non-destructive, semiconductor, spectroscopy

Short biography:

Wei-Chih Wang* is currently an Associate Professor in Power Mechanical Engineering and Institute of Nanoengineering and Microsystems at the National Tsinghua University and an affiliated Associate Professor in the Department of Mechanical Engineering and an Adjunct Associate Professor in the Department of Electrical Engineering at the University of Washington. His research interests are in the area of developing polymer based micro sensors and actuators for industrial and biomedical applications. More recently, his work has expanded to THz, IR and visible band metamaterials, and amorphous and metamorphous structure and material study for wave manipulation.

Full-viewing or Underwater Arc 3D display and Arial-image DFD display for VR biology

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Masaki Yasugi and Hirotsugu Yamamoto

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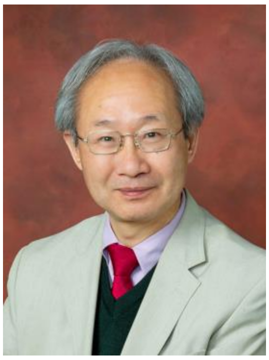
We want to develop "aquatic display" that does not interfere with the flow of water or the movement of fish by utilizing the aerial display that forms images in mid-air in Grant-in-Aid for Scientific Research (S). By using this "aquatic display", a new biological experiment method using VR biology and monitoring the breeding status of fish in aquaculture without stressing the fish will be achieved. For developing "aquatic display", we have proposed 3D displays for candidates, such as (A) Full-viewing Arc 3D display, (B) Underwater Arc 3D display and (C) DFD display with aerial image. (A) Full-viewing Arc 3D display can be simply constructed by using circular-shaped scratches and illumination perpendicular to scratches. Bright spot positions to each eye autonomously change according to the eye movement. This leads to binocular disparity to both eyes, and autonomous change according to eye movement results in continuous motion parallax. Moreover, circular symmetry structure provides full-viewing 3D images with small blind positions. (B) Underwater Arc 3D display has a problem of small difference of refractive index between substrate material (~1.5) and water (~1.3) as compared to air (1.0) because Arc 3D image is caused by refracted or reflected light in the scratches. However, even in water, Arc 3D images can be observed and bright spot position change by observation point is the same as in air. Moreover, higher brightness is obtained by using comparatively hard substrate and increasing scratching strength. (C) Aerial-image DFD display is composed of conventional LCD and aerial image. Perceived depth of aerial-image DFD display is almost linearly changed by luminance ratio between front and rear image as same as one of conventional DFD display.

Short biography:



Shiro Suyama received the M.E. degrees from Kyushu University in 1981. Since joining NTT Electrical Communication Laboratories in 1981, he has been engaged in research and development on transistor and liquid-crystal devices. He received the PhD degree from Kyushu University in 1990. He was a Professor at Tokushima University from April 2007 to March 2021 and is currently a Project Professor at Utsunomiya University from April 2021. He is engaged in research on 3D display systems; e.g. DFD (Depth-fused 3-D) display, Arc 3D display, Aerial display, Enhancing image reconstruction in Brain, Three-dimensional perceptions and Liquid-crystal varifocal lens.

Shape measurement based on a combination of one-dimensional digital holography and lateral sample scanning

Yuma Sato and Yoshio Hayasaki

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Digital holography is used in a wide range of fields, including medical science and biology, and one application is industrial measurement. Digital holography is a suitable technology for factory line inspection due to its non-detective property, micrometer-order accuracy, and real-time performance. However, the measurement of shape using this technology in factories is time-consuming, which affects the speed of quality inspection on the production line. Therefore, we propose a method to reduce unnecessary point measurements by using one-dimensional image instead of two-dimensional image. This approach increases calculation speed and thus solves the inspection speed problem. In this study, we used a Michelson interferometer as the optical system. We provide an overview of the process. First, one-dimensional information is acquired using an image sensor. Next, we moved on to in-calculator processing. Here, we selected the Fourie transform method. The acquired one-dimensional interference fringe data is Fourier transformed to obtain a spectrum. After acquiring the first-order light, inverse Fourier transform is performed to obtain amplitude and phase information. By repeating this series of processes, a single image is finally acquired. Compared to two-dimensional input, the amount of data to be processed is overwhelmingly small.

Short biography:

Yuma Sato was born in 2001 in Oshu, Iwate Prefecture. Then he grew up in Iwate Prefecture until the age of 18. He graduated from Iwate Prefectural Mizusawa High School in March 2020 and entered the Faculty of Engineering at Utsunomiya University in April of that year. In 2021, he moved on to the Information Electronics and Optics Course in the Faculty of Engineering. He has been a member of Hayasaki Laboratory, Utsunomiya University's Center for Optical Research and Education (CORE) since this April. His research field is optical measurement using digital holography.

Identification of novel regulators involved in stem cell fate transition in the moss *Physcomitrium patens*

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Stem cell fate transition is crucial for the development of both land plants and metazoans. In the moss *Physcomitrium patens*, transition from vegetative gametophore stem cell to reproductive antheridium initial stem cells can be triggered by low temperature and short daylength conditions. This feature is suitable to elucidate the molecular mechanism underlying the stem cell fate transition triggered by environmental cues. Here, we first analyzed whether low temperature or short daylength can independently trigger the stem cell fate transition. Next, we asked the involvement of EARLY FLOWERING 3 (ELF3), PHYTOCHROME INTERACTING FACTOR 4 (PIF4) and the histone variant H2A.Z, which have been reported as thermosensors or clock regulators in flowering plants, in the stem cell fate transition. In *P. patens*, four *ELF3*, four *PIF4*, and three *H2A.Z* orthologs were identified through our phylogenetic analysis. To investigate their role in the transition process, multiple higher-order mutants have been obtained by CRISPR-Cas9 system. Observation of these mutant phenotype during the stem cell fate transition is now ongoing. Establishment of knock-in lines of *mCitrine* into each of *PpELF3*, *PpPIF4* and *PpH2A.Z* loci is also in progress for understanding the spatiotemporal dynamics. In this presentation, we will report our latest results.

Short biography:

Changxiu Yu is now a PhD student in Graduate School of Regional Development and Creativity, Utsunomiya University. She received her master degree of cell biology from Huazhong Agricultural University, China in June 2019. Her research interest is understanding the molecular mechanisms underlying the fate transition from vegetative stem cell to reproductive stem cell in moss *Physcomitrium patens*.

Design and Fabrication of Plasmonic Metal Nanostructures for Green Photonics

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Our research group aims to develop plasmon metal nanostructures for photothermal response. Surface Plasmon resonance is a phenomenon in which electrons in a metal interact with light and vibrate collectively. Semi-shell is metal nanostructures in which dielectric microsphere is partially covered with metal. It can cause surface plasmon resonance and efficiently absorb light. Semi-shell can be fabricated in large areas by colloidal lithography in a simpler process than conventional metal nanostructures and is expected to have a variety of applications. Selective emitter, which controls the wavelength of thermal radiation using the selective absorption properties of semi-shell, can be used to improve the power generation efficiency of Solar-thermophotovoltaics (STPV) that generate electrical energy from sunlight. Photothermal deformation of the half-shell by laser irradiation can be used in memory systems and color filters.

Short biography:

He is a master student in Utsunomiya University. He is focused to integrate Metal nanostructure with Surface Plasmon resonance.

Contrast ratio between aerial image and ambient light at varying ambient illuminance in an optical system with a mirror as the interface

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Perceptual visibility of an aerial image is affected by the ambient light, especially on an aerial mirror interface that shows aerial image on a mirror. This paper reports experimental results of the contrast ratio between the luminance of the aerial image and the mirrored image of an ambient environment.

In recent years, aerial display technology such as AIRR (aerial imaging by retro-reflection) is attracting attention as an output destination for the metaverse or so, as the interface between cyberspace and real space. In our previous research, we have proposed an optical system that forms a light-field 3D aerial image between an observer and a mirror by using retro-reflector slits and a polarization modulation optical system. Since the contrast ratio is considered to have a significant effect on the visibility of aerial images, we attempted to identify the optimal design that maximizes the luminance contrast of aerial images relative to the reflection by using the reflectance, transmittance, and absorptance of the mirror as parameters.

This measurement experiment was performed under the same ambient light conditions with the expectation that the contrast ratio values would change in response to changes in the optical characteristics of the beam splitter. The optical system consists of a light source, a beam splitter, a magic mirror, and a retro-reflector. In constructing the optical system, three optical patterns were prepared using beam splitters with reflectance of 30%, 40%, and 50%, respectively. The contrast ratio between the aerial image by the AIRR and the mirror image by the magic mirror was measured in each of the eight ambient light patterns. The contrast ratio was derived as the value of the luminance of the ambient light relative to the luminance of the aerial image by measuring the luminance of the aerial image and the mirror image, respectively.

The measurement experiments showed that the optical characteristics of the beam splitter have little effect on the contrast ratio, and that the intensity of ambient light has a significant effect.

Short biography:

Kyoya Hino is a graduate student in Master's Course in Graduate School of Regional Development and Creativity at Utsunomiya University. He graduated Department of Mathematical Science and Electrical-Electronic-Computer Engineering, Faculty of Engineering Science, Akita University in 2023. He is working on about study of Augmented Reality (AR) Display without Glasses Using Aerial Imaging by Retroreflective Reflection (AIRR).

Simulation for multimode fiber towaveguide interconnection based on Near-field and far-field pattern

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Abstract: For optical interconnection in the short distance information transmission systems, a loss test of the fiber-waveguide connector is performed to guarantee that the loss budget satisfies the requirement before the implementation. We propose a simulation model that can be adapted to practical application. The model is using measured data of near and far field patterns, and the interconnection loss is becoming predictable.

1. Introduction

Multimode fiber (MMF), especially graded-index multimode fiber (GI-MMF), has received widespread attention in the field of short-distance optical communication as one of the promising applications, with its characteristics of light in weight, free from electromagnetic interference, and higher bandwidth. For an optical transmission system to operate effectively, the loss of the fiber link must meet the loss budget. It is important to predict losses through simulation to reduce cost and time before integrating fiber into actual systems. Therefore, a practical simulation method needs to be established to accurately estimate the MMF connection loss. A calculation model of connection loss applicable to SI-MMFs and GI-MMFs has been demonstrated successfully [1]. In practical applications, we will encounter the case where the multimode fiber is connected to the optical waveguide, and the rectangular optical waveguide is especially used in this study. Different end face shapes may limit and affect applicability. Our purpose is to use the measured data of near field pattern (NFP) and far field pattern (FFP), and use NFP and FFP as the light source to simulate and finally get the connection loss.

2. Method

The simulation is based on the optical design software, OpticStudio. Using the nonsequential component editor to operate geometric optics, and calculate the connection loss by numerical analysis. Figure 1 shows the geometric model of the proposed simulation. In this case, the graded index fiber has a core diameter of 50μm, and has 1.482 refractive index; the rectangular waveguide has an end face size of 50μm×50μm, and has 1.54 and 1.51 refractive index of core and cladding respectively; the wavelength is set to be 850nm.

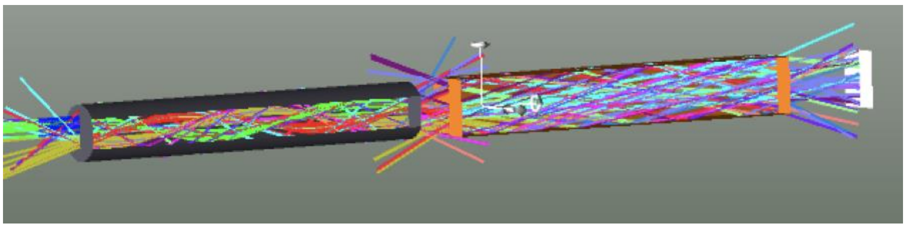

Fig.1 Schematic diagram of the light tracing for optical fiber and optical waveguide

Unlike geometric modeling mentioned above, only the situation between the two end faces needs to be considered so it is necessary to use the measured data of NFP and FFP as the plane light source to analyze the light intensity distribution and the spatial position changes of two end faces, such as distance and axial misalignment. In addition, the occur of Fresnel reflections needs to be considered into account in the total loss.

3. Conclusion

A simple simulation model of interconnection for multimode fiber and rectangular has been actualized. By measuring NFP and FFP and applying them to the simulation, the connection loss due to spatial variation between the fiber and the rectangular waveguide can be analyzed, calculated, and predicted. We will simulate more models for different types of waveguides, such as graded index types or step-graded index composite types, in the future.

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Flat-top beam shaping with increased depth of focus

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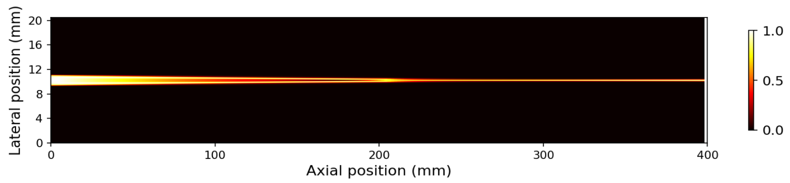
Beam shaping technology for shaping Gaussian beams into flat-top beams has been applied in materials processing and medical fields. There are various methods to shape the flat-top beam, such as using an aspherical optical system and a diffractive optical system. The method of displaying a computer-generated hologram (CGH) on a spatial light modulator (SLM) enables a high degree of freedom in beam shaping with high diffraction efficiency. The issue of the generated flat-top beam is its short depth of focus. In general, after the flat-top beam propagates over a long distance, the intensity distribution is distorted and deviates from a flat-top beam. The short depth of focus is due to the non-flat phase of the flat-top beam. Therefore, in order to increase the depth of focus, the phase distribution of the flat-top beam should be flat.

In this paper, we demonstrated the flat-top beam shaping with increased depth of focus using two SLMs. The CGH displayed on the first SLM shaped the Gaussian beam into the flat-top beam. The CGH was calculated using the weighting iterative Fourier transform algorithm [3]. The CGH displayed on the second SLM flattened phase of the generated flat-top beam. The CGH was equivalent to the phase conjugate of the flat-top beam generated by the first SLM. To validate the effectiveness of our proposed method, we implemented the method in simulation. Figure 1(a) shows the conventional flat-top beam with the short depth of focus. Figure 1(b) shows the improved flat-top beam with the long depth of focus.

(a)



(b)

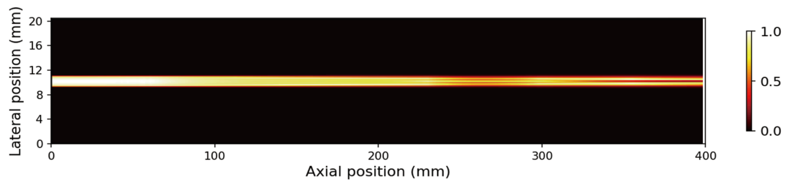


Fig. 1 (a) Conventional flat-top beam with the short depth of focus. (b) Improved flat-top beam with the long depth of focus.

Short biography:

Kasumi Kawasaki was born in Kitakami City, Iwate Prefecture on March15, 2002. After graduating from Iwate Prefectural Kurosawajiri Kita High School, she entered Utsunomiya University. She currently belongs to the Hasegawa laboratory. Her research fields are laser material processing using computer-generated holography.

Observation of ultrasound using coaxial interferometer for control of femtosecond laser drilling

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The laser drilling of micro holes is used for plastics to make electric conductivity between both surfaces of printed circuit boards, for thin glasses and plastics to increase the density of circuits in integrated semiconductor circuits, and for stainless steel tubes such as nozzles and injection needles in medical devices. The hole drilling is always required high density, high precision, and mass production in the industry. Femtosecond laser processing is suitable for the micro laser drilling, because it has no thermal effect.
The optimal laser parameters are determined through prior experiments and the accumulated results depending on the type and shape of the workpiece. An in-process measurement and the real-time feedback control of the laser parameters will reduce the amount of the prior experiments. The in-process measurement is performed with an ultrasound measurement. The use of the ultrasound has the advantages for optical measurements: non-contact and deep part for opaque material. The observation of the ultrasound generated by a femtosecond laser pulse irradiation to a material and the use of the observed signals for an in-process control of laser parameter in the femtosecond laser drilling. The sounds generated during femtosecond laser processing has wide frequency range. The sound with the range up to several hundreds of killohertz can be observed with a microphone and the signal will be use for the control of laser parameter, because the magnitude of the sound has a monotonical relation of the amount of laser ablation. According to Webster's Horn equation, the sound with higher frequency should be measured to know the depth of the processed hole from the generated sound. In this study, an optical microphone implemented with a coaxial interferometer is used to detect the high-frequency sound. The coaxial interferometer is adopted from its external vibration resistance.

Short biography:

Kaede Yamauchi was born in Kanagawa in April 2001. she graduated from Atsugi High School in March 2020. She entered Utsunomiya University, Faculty of Engineering in April 2020. She currently he is a student in Utsunomiya University, Center for Optical Research & Education (CORE). He is a fellow member of SPIE. Recently, she is focused to Laser processing using sound measurement.

Evaluation of an ultrasonic liquid crystal lens

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New technologies for adaptive optics are becoming increasingly important for miniature devices such as cell-phone cameras. The human eye is an example of adaptive optical system, comprising of cornea, pupil and lens. The cornea is responsible for most of the optical power. The pupil acts as an aperture that controls the amount of light that forms images on the retina, and the eye lens can adjust its shape via the ciliary muscles, working as a variable focus lens. Conventional optical systems are based on mechanically moving parts of glass or plastic lenses to adjust focus, magnification, and field of view. Miniature adaptive lens, however, is an alternative to change focal lengths while eliminating the need to mechanical moving parts. Many adaptive lenses that mimic eyes have been developed to replace the multiple solid elements in optical systems. Among these approaches, liquid crystal material is an attractive alternative to replace this conventional optical system based on solid elements, because of its easy controllability by using an external field. The light traveling through the liquid crystal medium bends at different angle depending on the orientation of the liquid crystal molecules in response to a control signal. The combination of nematic liquid crystals and their technology to focus light, in combination with ultrasound actuation to improve the lens efficiency and flexibility presents a promising alternative for tunable lenses. For ultrasonic liquid crystal lenses, the geometry of the lens and the design of the piezoelectric transducer are critical factors.

Short biography:

Jessica Onaka received the B.S. degree in electrical engineering from the Federal University of Amapa, Amapa, Brazil, in 2018, and the M.S. degree and PhD degree in electrical and electronic engineering from Doshisha University, Kyoto, Japan, in 2020 and 2022, respectively. She was selected as the Receiver of the Japanese Government (MEXT) Scholarship from 2018 to 2022. She worked as an Optical Design Researcher at Huawei Research Center, Optical & Quantum Communications Laboratory – Jena Office, Thuringia, Germany from 2022 to 2023. Currently, she is an Assistant Professor in Utsunomiya University, Center for Optical Research & Education (CORE), Tochigi, Japan.

Research project for polarization engineering at UU-CORE

（大谷・偏光工学研究拠点プロジェクト）

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D.Serrano（Guadalajara Univ.）, M.Ebisawa (Tokyo Metro. Industrial Tech. Res. Institute),
S.Kawabata（Tokyo Polytech Univ）, K.Oka（Hirosaki Univ）, T.Oonuma (Photonic Lattice）

Students : M.Sun, Y.Suzuki, R.Fujita, R.Hakoda, S.Nakui,
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We have started “Research Project for Polarization Engineering” in the Center for Optical Research and Education, Utsunomiya University since April 2022. The propose of this group is set as,

1) Formation of a Strategic Base for research of polarization engineering
2) Educational campaign for polarization technology through reskilling and consultancy
3) To establish technique for polarization theory, especially for interface for optical design and quantum optics
4) Application area for polarization imaging, especially spectrum snapshot channeled imaging for Stokes parameters and Mueller matrices and its application for automobile and environmental; sensing
5) Polarization standard: Proposal of standard sample, calibration method and polarization calibration service

Our goal after 5 years is pointed out as,

1) International collaboration paper is 1 paper per year.
2) International funding is 2 projects per year.
3) To establish a startup company, a polarization consortium for polarization standardization.

Short biography:

Yukitoshi OTANI is the director of Center for Optical Research and Education (CORE), a professor and head of Department of Optical Engineering and, Utsunomiya University, JAPAN. He received his master's degree from Tokyo University of Agriculture and Technology in 1990 and his doctor's degree from the University of Tokyo in 1995. After working at HOYA Corp., an associate professor at Tokyo University of Agriculture and Technology until 2010, he joined the CORE from April 2010. His current interests include polarization engineering, optical measurement and optomechatoronics. He is a fellow of SPIE and Optica(OSA), Editor-in-Chief of Optical Review, an associate editor of OSA continuum and Precision Engineering, a board member of Optik-International Journal for Light and Electron Optics and an Editorial Board of International Journal of Optimechatornics.