icOPEN 2024

THE INTERNATIONAL CONFERENCE ON OPTICAL AND PHOTONIC ENGINEERING

Foshan, China ‖ Nov. 15-18, 2024

CONFERENCE PROGRAM

About icOPEN 2024

The International Conference on Optical and Photonic Engineering (icOPEN) stands as a testament to our commitment to this field. Since its inception in 2011, icOPEN has steadily grown to become a prominent fixture in the Optical and Photonic Engineering calendar. icOPEN 2024 will be held in Foshan, China during Nov.15th -18th, 2024, organized by South China Agricultural University; co-organized by Foshan-Zhongke Innovation Research Institute of Intelligent Agriculture and Robotics and Nanjing University of Science and Technology; supported by Guangzhou College of Commerce, Xinjiang University, Jiaying University, Shunde District Industrial Digital Economy Promotion Association of Foshan City

This year's conference will bring together colleagues and friends to discuss and exchange ideas on current trends and technologies in Optical and Photonic Engineering. We look forward to your continued support and participation.

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華南農業大學
South China Agricultural University

Co-Organized by

佛山市中科农业机器人与智慧农业创新研究院
Foshan-Zhongke Innovation Research Institute of Intelligent Agriculture and Robotics

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Dongliang ZHENG, Nanjing University of Science and Technology, China

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Conference Venue

Cordis, Foshan, Lingnan Tiandi
佛山岭南天地康得思酒店

97 Renmin Road, Chenchang District, Foshan, Guangdong Province, China

中国广东省佛山市禅城区人民路 97 号

Level	Venue (EN)	Venue (CN)	Nov. 16	Nov. 17
1 F	Ball Room 1	宴会厅 1	✓	
5 F	Lingnan 1	岭南一厅	✓	
5 F	Lingnan 2&3	岭南二+三厅	✓	✓
5 F	Lingnan 5&6	岭南五+六厅	✓	✓
5 F	Lingnan 8&9	岭南八+九厅	✓	✓

Traffic Information

➢ **Foshan Shadi Airport**

10km, 20mins dirve

➢ **Guangdong Baiyun Internation Airport**

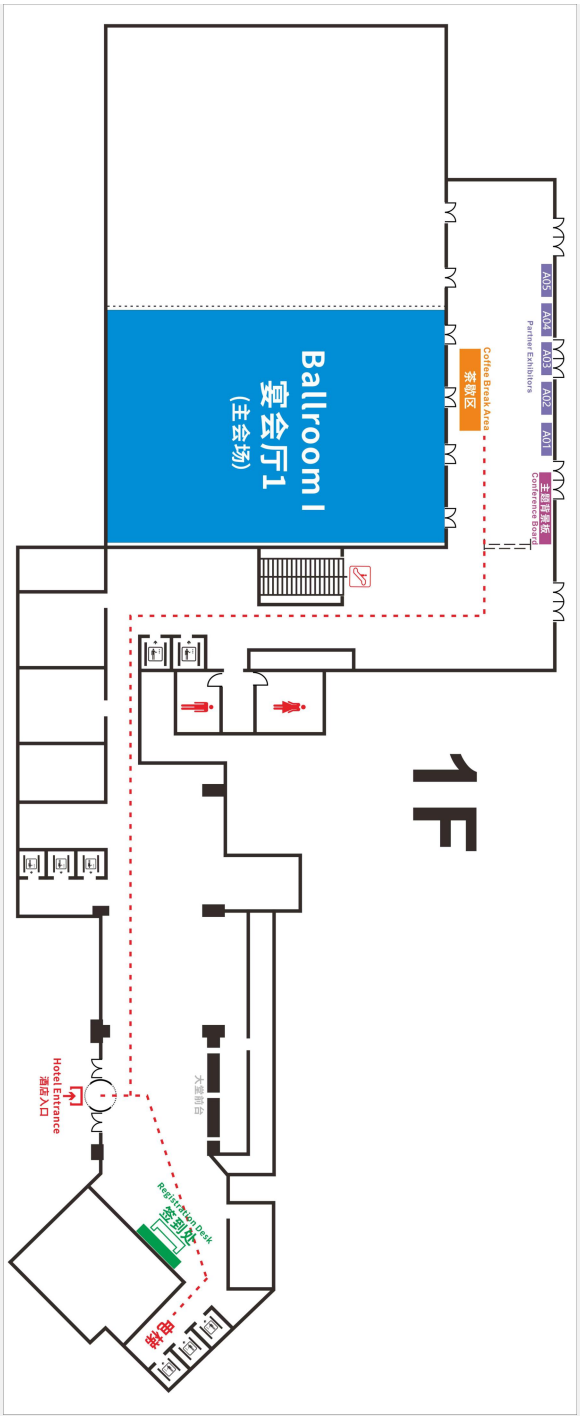
53km, 1hr drive

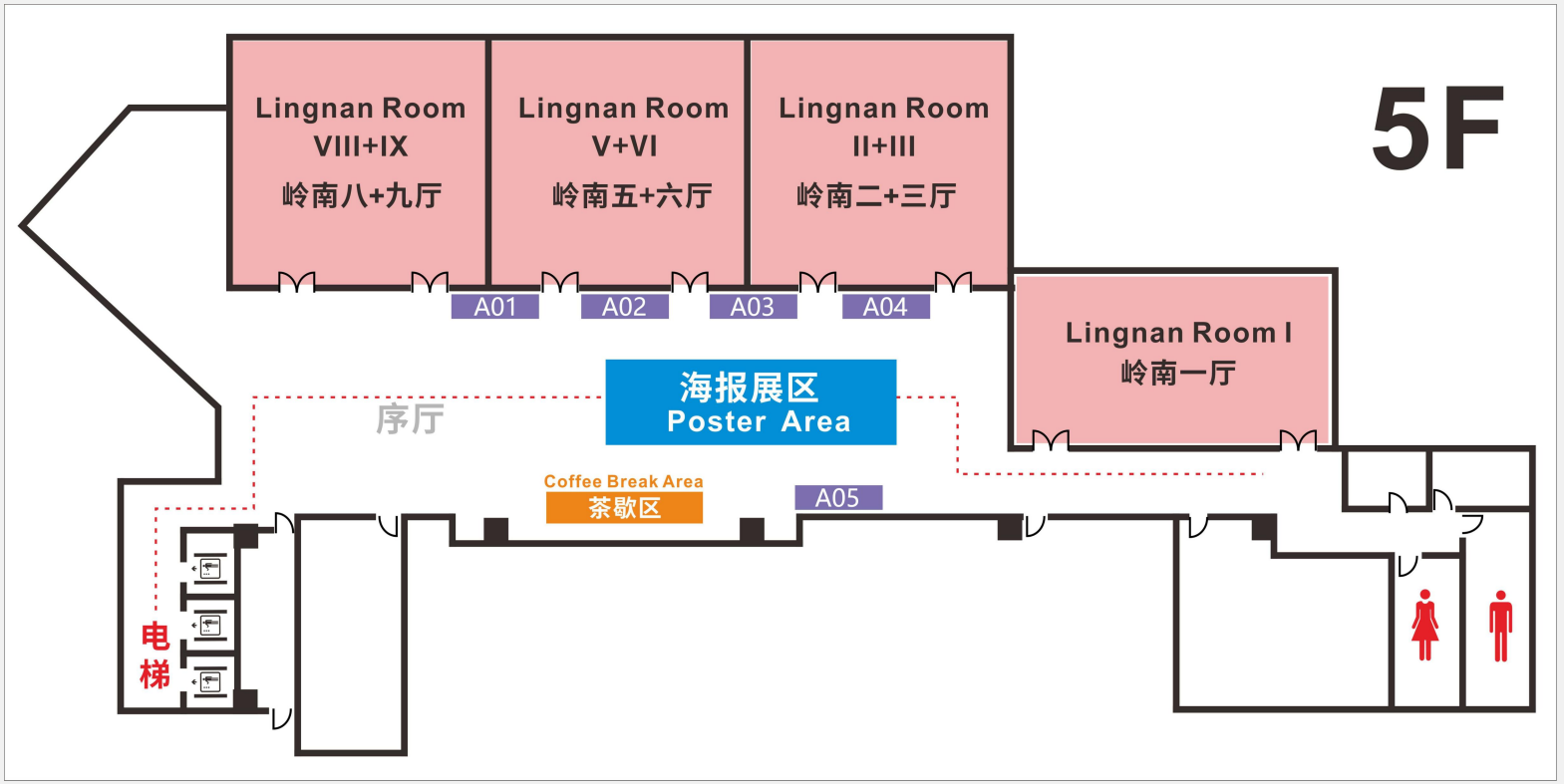
➢ **Foshan Railway Station**

3km, 10mins drive

Conference Venue

Floor Plan





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A04 麓邦光电	Lubang Optoelectronic Technology Co., LTD
A05 联合光科技	Grand Unified Optics (Beijing) Co., Ltd.

Presentation Guide

• Oral Presentation

- Plenary Talk - 40 mins (including Q&A)
- Keynote Talk - 20 mins (including Q&A)
- Invited Talk - 15 mins (including Q&A)
- Oral Presentations at the Student Competition - 15 mins (including Q&A).
- Oral Presentations at the Conference Sessions - 10 mins (including Q&A).

• Best Student Presentation Competition

- Each presentation will be 15mins including 10mins oral presentation and 5mins Q&A
- The judge will evaluate each presentation based on presenting performance, novelty, feasibility, quality of PPT and Q&A performance.
- The competition winners will be announced during the banquet. Scholarships and award certificates will be given as well at the ceremony.

• Best Student Poster Competition

- The conference organizing staff will print the posters and post them on the right boards.
- During your poster session, please be aware that you are required to stay near your poster. The competition judges may approach you to read and discuss your poster. You will be need to explain your research and answer the questions.
- The judge will evaluate each presentation based on novelty, feasibility, quality of poster and Q&A performance.
- The competition winners will be announced during the banquet. Scholarships and award certificates will be given as well at the ceremony.

Attendance Tips

• Tips for Oral Presentations

- Please prepare your slides based on the PPT template on the icOPEN official website.
- All PowerPoint presentation slides must be in the 16:9 ratio format.
- There will be staffs in each session room. If you have any question or technical issue, please find and ask them for help.
- Please arrive 10 to 15 mins before the session starts to upload and test your presentation slides on the laptop computer onsite.
- Get your presentation PPT or PDF files prepared and backed up.
- Please be at your presentation room during the break to test your slides with the laptop and AV systems for compatibility. The organizers will provide the laptops, pointers, microphones and AV systems (HDMI cable) for the presentation.
- Your punctual arrival and active involvement in each session will be highly appreciated.

• Tips for Poster Presentations

- Please prepare your poster based on the poster template on the icOPEN official website and upload the final poster via the link emailed to you.
- The conference organizer will print and mount your poster on the poster section of the right poster board only if you submit your poster before the deadline.
- If you want to recycle your poster, please tear it down only after your poster session ends.

• Security

- Please ensure that you take your belongings with you at all times when leaving a room.
- Do not leave bags or laptops unattended.
- For security purposes, delegates, speakers, exhibitors and staff are required to wear their name badge to all sessions.

Program Overview

Day 1 | *November 15th, Friday*

Time	Activity	Venue
10:00-18:00	Sign-in & Conference Materials Collection	1F/ Hotel Lobby

Day 2 | *November 16th, Saturday / Morning*

Venue: **1F/ Ballroom I (宴会厅 1)**		
Opening Ceremony		
Chair: Jianglei Di, Guangdong University of Technology, China		
08:30-08:35	Opening Remarks	***Kemao Qian,*** OPSS Chair Nanyang Technological University, Singapore
08:35-08:40	Welcome Remarks	Leadership of South China Agricultural University, China
08:40-08:45	Welcome Remarks	***Xiangjun Zou,*** Conference Chair Foshan-Zhongke Innovation Research Institute of Intelligent Agriculture and Robotics, China
Plenary Speeches		
Chair: Jianglei Di, Guangdong University of Technology, China		
08:45-09:25	***Sarun Sumriddetchkajorn,*** National Electronics and Computer Technology Center, Thailand **Title -** Agri-Photonics in Action	
09:25-10:05	***Guoan Zheng,*** University of Connecticut, USA **Title -** Lensless Coded Ptychography for Microscopy, Endoscopy, Metrology, and Non-line-of-sight Imaging	
10:05-10:20	**Coffee Break**	
Chair: Shijie Feng, Nanjing University of Science and Technology, China		
10:20-11:00	***Liangcai Cao,*** Tsinghua University, China **Title -** Exploiting Spatial and Spatiotemporal Priors for High-Throughput Quantitative Phase Imaging	
11:00-11:40	***Liang Gong,*** Shanghai Jiao Tong University, China **Title -** Current Status and Development Strategies of Agricultural Robotics Technology	
11:40-12:20	***Hong Jiang,*** Xinjiang University, China **Title -** The Application of Optics in Engineering	
12:20-13:30	**Lunch @ 3F/ Cordis Market 岭南集市**	

Program Overview

Day 2 | *November 16th, Saturday / Afternoon*

	Lingnan 1 岭南一厅	Lingnan 2&3 岭南二+三厅	Lingnan 5&6 岭南五+六厅	Lingnan 8&9 岭南八+九厅
First Half	**#SC-I**	**#SSA-I**	**#SSC-I**	**#SSN**
Coffee Break				
Second Half	**#SC-II**	**#SSA-II**	**#SSC-II**	**#SSO**

#	Topic	Duration	Venue
Poster	Best Student Poster Competition	14:00-15:00	5F/ Lobby 五楼分会场公区

#	Topic	Duration	Venue
SC-I	Student Competition I	13:30-15:15	5F/ Lingnan 1 岭南一厅
SSA-I	Agricultural Optics and Visual Technology I	14:00-15:40	5F/ Lingnan 2&3 岭南二+三厅
SSC-I	Communication and Education of Optics	14:00-15:15	5F/ Lingnan 5&6 岭南五+六厅
SSN	New Photomechanics Techniques for Extreme Environment Measurements	13:30-15:30	5F/ Lingnan 8&9 岭南八+九厅
Coffee Break			
SC-II	Student Competition II	15:30-17:15	5F/ Lingnan 1 岭南一厅
SSA-II	Agricultural Optics and Visual Technology II	15:55-17:45	5F/ Lingnan 2&3 岭南二+三厅
SSC-II	Communication and Education of Optics	15:30-16:20	5F/ Lingnan 5&6 岭南五+六厅
SSO	Optical Coherence Tomography	15:45-16:45	5F/ Lingnan 8&9 岭南八+九厅
Banquet @ 1F/ Cordis Ballroom II（宴会厅 2） 18:30-20:30			

Program Overview

Day 3 | *November 17th, Sunday / Morning*

	Lingnan 2&3 岭南二+三厅	Lingnan 5&6 岭南五+六厅	Lingnan 8&9 岭南八+九厅
First Half	**#TS-1**	**#TS-2**	**#TS-3**
Coffee Break			
Second Half	**#TS-4**	**#TS-5**	**#TS-6**

#	Topic	Duration	Venue
TS-1	Digital Holography and Quantitative Phase Imaging	09:00-10:00	5F/ Lingnan 2&3 岭南二+三厅
TS-2	3D Image Acquisition and Display &3D Computer Vision &Image Processing and Deep Learning	09:00-10:15	5F/ Lingnan 5&6 岭南五+六厅
TS-3	Image Processing and Deep Learning & Fiber Optics and Sensing Technology	09:00-10:15	5F/ Lingnan 8&9 岭南八+九厅
Coffee Break			
TS-4	Optical Metrology	10:15-11:50	5F/ Lingnan 2&3 岭南二+三厅
TS-5	Advanced Optical Measurement Methods and Techniques & Advanced Laser Processing and Manufacturing	10:30-11:55	5F/ Lingnan 5&6 岭南五+六厅
TS-6	Biomedical Optics and Imaging & Optical Component and System Simulation & Photomechanics	10:30-11:45	5F/ Lingnan 8&9 岭南八+九厅
Lunch @ 3F/ Cordis Market 岭南集市 12:00-13:30			

Plenary Speakers

08:45-09:25, November 16th | Ballroom I

Sarun Sumriddetchkajorn

National Electronics and Computer Technology Center, Thailand

Bio: Dr. Sumriddetchkajorn received his B.Eng in Electrical Engineering (Honors) in 1994 from Khon Kaen University, Thailand. He earned his M.S. (1998) and Ph.D. (2000) in Optical Science and Engineering from University of Central Florida, USA. From 1994-1996, he was with Electro-Optics Lab at National Electronics and Computer Technology Center (NECTEC) under National Science and Technology Development Agency (NSTDA), Thailand, responsible for embossed hologram processing and computer generated holograms. Since 2001, he had rejoined NECTEC where he focused on solving technical issues related to agriculture, public health, security, and industry with optics and photonics. He also played leadership roles as Lab Director, Research Unit Director, Deputy Executive Director of NECTEC, Executive Director of NECTEC, and Acting Executive Vice President of NSTDA. He had also been Board Members of Thailand's Digital Economy Promotion Agency. In addition, he was a Member of Advisory Committee for Thailand's National Security Council on Science, Technology, and Digital and Chair of ASEAN Committee on Science and Technology's Subcommittee on Information and Technology. He received the 2003 Young Technologist Award and the 2004 Young Scientist Award from the Foundation for the Promotion of Science and Technology under the Patronage of H. M. the King of Thailand. In addition, he was awarded the 2005 ICO/ICTP Award (a.k.a. ICO Gallieno Denardo Award) from the International Commission for Optics (ICO) and the ICTP. In 2002, he initiated the formation of the SPIE, Optica, and IPS Thailand Chapters. He is currently a Senior Member of IEEE. He is also a Fellow of SPIE and Optica.

Speech Title

Agri-Photonics in Action

Abstract: Agri-photonics has shown benefits of light exploitation in agriculture. This lecture starts with the overview of photonics sensing in precision agriculture. We then navigate from specific pain points in rice, sericulture, and shrimp farming sectors and present photonic-based prototypes that effectively address these issues with high potentials in scalability and affordability. Additionally, we briefly introduce the concept of combining optical plasmonic sensing with quantum technology, opening doors to future advancements of photonics sensing systems for agriculture and other applications.

Plenary Speakers

09:25-10:05, November 16th | Ballroom I

Guoan Zheng

University of Connecticut, USA

Bio: Dr. Guoan Zheng is the UTC Associate Professor at the University of Connecticut. He is also the Director of the UConn Center for Biomedical and Bioengineering Innovation (CBBI). Dr. Zheng is recognized for his pioneering work on Fourier ptychography, which has been adopted worldwide and become a standard tool in microscopy imaging. Dr. Zheng's contributions have led to the publication of one book and more than 130 peer-reviewed articles, including those in top-tier journals like Nature Photonics, Nature Reviews Physics, Nature Protocols, Light: Science & Applications, and PNAS.

Speech Title

Lensless Coded Ptychography for Microscopy, Endoscopy, Metrology, and Non-line-of-sight Imaging

Abstract: We present the lensless coded ptychography technology and its applications across microscopy, endoscopy, metrology, and non-line-of-sight imaging. Our technique combines coded detection with ptychographic reconstruction to achieve high-resolution, phase-sensitive imaging without complex lens systems. We demonstrate how this approach enhances microscopy with extended depth of field and enables ultra-thin, flexible imaging probes for endoscopy. In metrology, we showcase sub-micron resolution surface profiling using our portable, handheld device. We also explore the application of our technique in non-line-of-sight imaging, reconstructing scenes hidden from direct view.

Plenary Speakers

10:20-11:00, November 16th | Ballroom I

Liangcai Cao

Tsinghua University, China

Bio: Liangcai Cao received his BS/MS and PhD degrees from Harbin Institute of Technology and Tsinghua University, in 1999/2001 and 2005, respectively. Then he became an assistant professor at the Department of Precision Instruments, Tsinghua University. He is now tenured professor and director of the Institute of Opto-electronic Engineering, Tsinghua University. He was a visiting scholar at UC Santa Cruz and MIT in 2009 and 2014, respectively. His research interests are holographic imaging and holographic display. He is a Fellow of the Optica and the SPIE.

Speech Title

Exploiting Spatial and Spatiotemporal Priors for High-Throughput Quantitative Phase Imaging

Abstract: Quantitative phase imaging techniques can reveal the subtle interactions between light and physical objects, providing a powerful tool for biomedical and metrological applications. However, the quality of quantitative phase images is challenged by the phase ambiguities, motion artifacts and optical aberrations. In this talk, I will discuss our recent works on developing computational algorithms that exploit the data priors in both spatial and spatiotemporal domain to improve the reconstruction quality. Based on the proposed computational methods, we experimentally realized single-shot quantitative phase imaging with in-line holography, time-resolved lensless ptychographic microscopy, and high-quality synthetic aperture holographic microscopy, and demonstrated imaging of tissue slides and freely moving organisms.

Plenary Speakers

11:00-11:40, November 16th | Ballroom I

Liang Gong

Shanghai Jiao Tong University, China

Bio: Professor Liang GONG(贡亮) received his Ph.D. in Mechanical Engineering from Shanghai Jiao Tong University (SJTU), 2010. From 2007 to 2008, he worked as a visiting Ph.D. student with the Laboratory of Embedded Internet System, Luleå University of Technology, Sweden. From 2010, he held positions of postdoctoral fellow, associate professor and currently is currently a full professor in SJTU. He was honored as "Shennong Scholar" from Ministry of Agriculture of the PRC, "Oriental Talent" from Shanghai Municipal Government and "Taishan Leading Scholar" from Shandong Municipal Government.

His research interests mainly focus on field robotics and cognitive science. He has taken charge of multiple cross-disciplinary projects from NSF of China, National Key Research and Development Program of China and International Collaborative Project such as Sino-UK Innovation Bridge. Prof. GONG published more than 100 SCI-cited papers and held more than 50 patents in the field of agricultural robotics. Professor GONG's honors, include the Grade-I Award for Science and Technology Progress from Ministry of Agriculture (2021) and from Shanghai Municipal Government (2022).

Prof. GONG is a leading investigator in precision agriculture. He serves as an associate editor of the Science Partner journal Plant Phenomics. He was also invited to deliver presentations in various universities and institutions including The University of Monash (Australia), Michigan University (USA), the University of Nottingham (UK). At Jiao Tong University, Prof. GONG founded and run the "Center for Agricultural Robotics", which aims at developing cutting-edge agricultural robot design, perception, planning and control techniques. Within the Center, Prof. GONG's team invented a spectrum of agricultural robots such as dual-arm fruit picking robot, leafy vegetable harvesting robot . Prof. GONG developed the first "Robotized Modern Plant Factory" in China, and recently his team persists on working for "Robotized Smart Orchard" and "Robotized Smart Farm".

On the topic of agricultural robotics, in recent years Prof. GONG's group has been supported by national/international funds with over 20 million RMB (3 million USD) and he has been selected to serve in the advisory committee for China's national agricultural machinery development strategy.

Speech Title

Current Status and Development Strategies of Agricultural Robotics Technology

Abstract: Delivered by Chair Professor Chengliang Liu at Shanghai Jiao Tong University (SJTU), the presentation titled "Current Status and Development Strategies of Agricultural Robotics Technology" explores the evolving landscape of robotics in agriculture, with a focus on cutting-edge developments. Agricultural robotics increasingly address challenges such as labour shortages, inefficiencies, and harsh working conditions. The presentation reviews global developments and trends in agricultural robotics, including field and greenhouse robots. Key technological advancements comprising “Eye” (intelligent perception), “Brain” (decision control), “Hand” (dexterous operation), and “Foot” (autonomous movement) are summarised, with highlights of their role in revolutionising traditional farming practices. Pioneering work at SJTU, including AI-driven intelligent control systems and smart agricultural facilities—such as unmanned rice seeders, field weeding robots, cotton-picking machines, and smart orchard robots—has been introduced. These systems and facilities integrate AI, cloud computing, and Internet of Things (IoT) technologies, underscoring the transformative potential of robotics in modern agriculture.

Plenary Speakers

11:40-12:20, November 16th | Ballroom I

Hong Jiang

Xinjiang University, China

Bio: Professor Jiang Hong, Doctor of Engineering, serves as the Secretary of the School of Intelligent Manufacturing Modern Industry at Xinjiang University. His accolades include the Tianshan Talent Award, Outstanding Teacher Award, and recognition as an Outstanding Graduate Supervisor. He holds various leadership roles, including Director of the Rotor Dynamics Professional Committee of the Chinese Society of Vibration Engineering and Chairman of the Xinjiang Mechanical Engineering Society. Professor Jiang has been invited to present keynote speeches at numerous conferences and serves as an expert reviewer for several key journals in his field. He is well-versed in the latest development trends and research priorities. His research portfolio includes hosting two national projects, two natural science foundation projects in Xinjiang, and over ten collaborative research projects with institutions like the Xinjiang Uygur Autonomous Region Special Equipment Inspection and Research Institute. He has applied for six national patents, obtained four national software copyrights, and authored over 100 papers, with more than 30 SCI/EI indexed. His accolades for research and teaching excellence include various national and regional awards, highlighting his profound contribution to science and engineering. With extensive experience, he has led projects focused on intelligent service robot systems and developed 3D reconstruction and printing systems for dental applications. His work lays a solid foundation for advancements in intelligent manufacturing and engineering research.

Speech Title

The Application of Optics in Engineering

Abstract: Optics is a key technology that supports fundamental research and modern technological development. The report discusses the application of optical and visual technologies in intelligent agriculture and intelligent manufacturing equipment in Xinjiang region. Firstly, the intelligent supplementary lighting method for the growth of fruits and vegetables in plant factories, the robot vision model for averaging the illumination of fruit images, and the non-destructive testing of fruits using post harvest multispectral technology were elaborated; In agricultural plant factories, LED lights are used for targeted supplementary lighting, and a smart plant supplementary lighting system is developed to

identify plant species and growth stages, in order to adjust the growth cycle of plants; For visual harvesting robots, they face different lighting changes during field operations, making intelligent perception difficult and prone to errors in recognition and positioning. Therefore, a fruit image lighting averaging model is proposed to complete the fruit image lighting averaging process and solve the problem of lighting changes; For automatic fruit sorting equipment after harvesting, multispectral imaging technology is used to collect backscattered spot images of walnut samples to analyze the impact of strong and weak light on the quality of stone fruit. At the same time, visual inspection is used to detect walnut size and external damage, achieving non-destructive testing. Then, the research on laser cladding, discharge machining process monitoring, welding position recognition, and weld seam tracking technologies in intelligent manufacturing was introduced. By solving key problems such as laser beam material coupling and shape control, efficient and high-quality laser cladding effects were achieved; By utilizing optical detection of narrow gap microsecond discharge processes in electrical discharge machining, the mechanism of material removal in electrical discharge machining is revealed; By using binocular cameras and line structured light sensors, the problem of difficult identification and defect detection of welding positions in complex environments can be overcome. Finally, the future application of optoelectronic technology, the integration of optics, visual perception, and artificial intelligence, was discussed. This technology has broad prospects for application in fields such as agriculture and industry in the future.

Student Competition

Student Competition I

Date	#	Duration	Venue
Nov. 16	SC-I	13:30-15:15	5F/ Lingnan 1 岭南一厅
Session Chair			
Jiasong Sun, Nanjing University of Science and Technology			

Time	Paper ID	Presenter	Affiliation
13:30-13:45	P012	Xinzhao Zhou	Shihezi University
13:45-14:00	P023	Mingxuan Zhou	South China Agriculture University
14:00-14:15	P034	Anqi Li	Shanghai University
14:15-14:30	P060	Ke Xu	Beijing Information Science and Technology University
14:30-14:45	P077	Wanyu Gu	Shenzhen University
14:45-15:00	P078	Xinyun Xie	Beihang University
15:00-15:15	P079	Zuoliang Tang	Sichuan Agricultural University

Presentation Details

Paper ID: P012

Paper Title: Grape Picking Point Decision Method Based on Structural Constraints and Geometric Analysis

Authors: Xinzhao Zhou, Xiangjun Zou, Xiwen Luo, Fengyun Wu, Tianshun Que, Junyan Cai, Hewei Meng

Abstract: Grape ripeness is a crucial factor for orchard management decisions and selective harvesting by robots. Due to factors such as light conditions and leaf coverage, there is a significant difference in ripeness among grapes within a cluster and even within the same cluster. This results in subjective and labor-intensive manual methods for assessing ripeness, which have low accuracy. Therefore, this study combines deep learning methods and color analysis to achieve quantitative classification of ripeness for individual grape clusters. Addressing the impact of light, shadows, and leaf obstruction on fruit recognition in orchards, an optimized YOLOv8-Grape model is designed to differentiate and segment grape cluster regions from irrelevant backgrounds. Based on this, a method has been developed to analyze the color characteristics of grapes at various ripeness levels and establish classification standards. This method enables the classification of individual grape clusters based on the analysis of the proportion of multi-level ripening grape regions. This research aims to

establish a method for simultaneously detecting grapes and classifying ripeness in orchard environments. This will provide the necessary foundation for a thorough assessment of grape ripeness in orchards, assist in orchard planting management decisions, and facilitate selective harvesting by picking robots.

Paper ID: P023

Paper Title: Research on Virtual Fruit Tree Reconstruction Method Based on Multi-view Stereo 3D Reconstruction

Authors: Mingxuan Zhou, Wei Ying, Luchao Bi, Hongjun Wang

Abstract: Aiming at the problems of low fidelity, long time-consuming and high cost of constructing fruit tree models in the virtual orchard scene, this paper proposes a 3D reconstruction method of virtual fruit trees based on Structure from motion-Multi-view stereo (SFM-MVS). First, the fruit tree image acquisition is carried out by using UAV and camera, the SFM algorithm is used to calculate the camera parameters of the fruit tree pictures and the positional relationship between the cameras, the image segmentation is carried out by combining the Convolutional Neural Networks (CNN) of the deep learning, and the segmentation of the fruit tree and the background of the environment in the image is completed by using the DeepLab algorithm. Secondly, the MVS algorithm is used to fuse the segmented fruit tree information and the associated camera position information to automatically construct a high-precision 3D model of the fruit tree. Finally, the mesh information and texture mapping of the 3D model are imported into the Unity3D virtual simulation platform, and the attribute fusion is realized by Albedo, which realizes the rapid digital model construction of real fruit trees. The experiment shows that the fruit tree model constructed in this study can accurately characterize the macro-structures from plant-scale branches, trunks, leaf crowns and other macro-structures to organ-scale micro structures such as fruits, forks and leaves. The overall accuracy of the fruit tree reaches the centimeter level, and the scale consistency error does not exceed 5%. The reconstruction time is around 2 hours, which greatly reduces the reconstruction time of the fruit tree model. The method can construct fruit tree point cloud models with high accuracy and phenological details, laying the foundation for the application of digital fruit tree technology.

Paper ID: P034

Paper Title: Analysis of Microcrack Formation Mechanism in Mural Cultural Relics based on Digital Holography of Large Field of View and Molecular Dynamics Simulation

Authors: Anqi Li,Wenjing Zhou,Huiling Zhang,Yingjie Yu

Abstract: Ancient mural relics in China are facing various erosive deteriorations, with surface and subsurface microcracks formed by internal and external factors being the primary origin. Therefore, the non-destructive detection, formation mechanism, and degradation trend analysis of microcracks are crucial in the restoration and preservation of ancient mural relics. To comprehend the growth process of mural cracks correctly, a large field of view digital holographic imaging system for in-situ detection of large murals was established. Combined with Gaussian 1σ criterion and histogram segmentation method, quantifiable three-dimensional distribution of microcrack structures was obtained. According to the structure of the defective mural, the microscopic molecular dynamics model of the material particles and voids of the defective micro-nano layer in the mural was established to analyse the expansion

mechanism and degradation mechanism of mural microcracks. Results indicate that the large-field digital holographic system can achieve three-dimensional characterization of elongated microcracks with extensive ranges. Molecular dynamics simulations reveal that an increase in temperature and humidity affects stress distribution, leading to the fracture and recombination of atomic bonds. The stress reaching threshold partly triggers secondary fracture of dislocations, serving as the root cause of sub-crack formation. This suggests that the temperature and humidity of the mural environment influence the expansion speed, trend, and direction of microcracks, consistent with the macroscopic evolution trend of pathological cracks. This study, integrating digital holographic detection technology with molecular dynamics simulation technology, provides a new reference for the study of the formation mechanism of ancient mural microcrack damage and the formulation of cultural heritage protection strategies.

Paper ID: P060

Paper Title: Vibration measurement of musical instruments using digital speckle pattern interferometry

Authors: Ke Xu, Sijin Wu, Weixian Li

Abstract: The structure and material of a musical instrument decisively influence its vibration modes. In turn, the precise measurement of vibration aiding in analyzing the structural and material properties of the musical instrument, and ultimately provides a basis for evaluating the performance of the musical instrument. This paper leverages the superiority of the digital speckle pattern interferometry (DSPI) in optical dynamic measurements to determine the vibration distribution of musical instruments using various methods. Firstly, a combination of time-averaged method and finite element modal analysis is used to qualitatively measure the surface vibration modes of a musical instrument under different orders of intrinsic frequency excitation. Then the spatial carrier method is used for the quantitative measurement of vibration distribution. The phase shift introduced by the time-averaged method removes the straight flow to improve contrast and make the modal streaks on the surface of the instrument clearer. Different modes of image subtraction are modulated by various expressions of the Bessel function, reflected in the changes of brightness and darkness of the fringes. The spatial carrier method overcomes the limitation of the time-averaged method, which can only measure stable periodic oscillation modes. As the measurement range of the spatial carrier method is directly determined by the camera's sampling frequency, high-frequency vibration information of the musical instrument can be captured using a high-speed camera. The time-domain waveform signals of the phase distribution, after temporal unwrapping, can be decoupled to achieve precise measurement of high-frequency vibration frequencies. These integrated methods effectively analyze the vibration modes and frequencies of musical instruments, offering new perspectives for understanding instrument characteristics, supporting design, and improving sound quality and performance. This research expands the application of optical dynamic measurements in analyzing musical instrument vibrations and provides theoretical and methodological support for future research, thus introducing new technological tools to the industry.

Paper ID: P077

Paper Title: Light field reconstruction and measurement based on focal stack

Authors: Zhiting Zhang, Wanyu Gu, Zewei Cai, Xiaoli Liu, Xiang Peng

Abstract: Focal stack-based light field imaging first collects images at different focal planes in the image space and then reconstructs the full-resolution light field according to the light field transport-of-intensity property and the propagation distance in the object space. However, the nonlinear depth mapping in object-image space and imaging distortion will cause a discrepancy between the image-space acquisition and object-space reconstruction and thus decrease the reconstruction accuracy. In this paper, we perform a consistency analysis for focal stack-based light field reconstruction. A pre-calibrated light field camera is used to construct the metric mapping relationship in image-object space and the reference light field, based on which the multi-view imaging and depth range of reconstructed light fields are quantitatively analyzed. Sequentially, a focal stack-based consistent light field reconstruction method is proposed. Through camera calibration, the image-object space transformation in the focal scanning space is established and the image distortion are corrected simultaneously. The image-space focal stack is uniformly converted into the object space for consistent light field reconstruction, which can finally be adopted to realize depth measurement in the focal scanning space.

Paper ID: P078

Paper Title: Quantitative Characterization of Slip Damage Evolution in Nickel-Based Single Crystal Superalloy by Sampling Moiré Method

Authors: Xinyun Xie, Qinghua Wang

Abstract: The slip accumulation induces microscale plastic localization, which often causes irreversible damage to single-crystal nickel-based superalloys. Most studies quantitatively described plastic localization via numerical simulations, but few experimental characterized the microscale inhomogeneous strain distribution of slip damage. In this work, high-resolution sampling moiré method was utilized to measure the strain and displacement of single-crystal nickel-based superalloys at the slip trace scale. Quantitatively assessed the formation of slip trace and the evolution of slip bands during mechanical loading, which provides effective inspects for elucidating the slip damage of single-crystal nickel-based superalloys. The sampling moiré method can obtain sufficient high spatial resolution by reducing the pitch of the deformation carrier gratings, with the superiority of microscale deformation measurements and the potential of characterizing material mechanical behaviors.

Paper ID: P079

Paper Title: Application of Path Planning Algorithm Based on Improved Obstacle Projection in Picking Robot

Authors: Lijia Xu, Long Zhou, Qinmao Yang, Hongxiao Jin, Zuoliang Tang, Yuchao Wang, Zhijun Wu

Abstract: Agricultural robots with autonomous mobility encounter challenges in path planning, necessitating optimal route length and time determination for safe traversal from start to finish. Existing algorithms suffer from issues such as excessive redundant path points and limited adaptability across different scales. In response, this paper proposes the Obstacle Projection (OP) algorithm, combining visibility graph and a greedy search. Additionally, the Improved Obstacle Projection (IOP) algorithm addresses complexities in obstacle scenarios. Experimental validation involves simulations in two-dimensional and three-dimensional workspaces, along with practical path planning using a picking robot in a greenhouse. Real-world results indicate the IOP algorithm's superiority: in path length before

smoothing, it outperforms IAPF, RRT*, and LTA* by 27.23%, 18.45%, and 1.2%, respectively, with further improvements of 5.36%, 13.94%, and 5.8% after smoothing. In terms of runtime, the IOP algorithm reduces navigation times by 5.36%, 13.94%, and 5.8% compared to IAPF and RRT*, with respective decreases of 34.5%, 21.5%, and 2.6% throughout the entire process. These results affirm the IOP algorithm's efficacy, showcasing its ability to generate optimal paths, reduce navigation times, and adapt effectively in real-world environments.

Student Competition

Student Competition II

Date	#	Duration	Venue
Nov. 16	SC-II	15:30-17:15	5F/ Lingnan 1 岭南一厅
Session Chair			
Jiasong Sun, Nanjing University of Science and Technology			

Time	Paper ID	Presenter	Affiliation
15:30-15:45	P087	Wenwu Chen	Nanjing University of Science and Technology
15:45-16:00	P106	Haiyu Zhang	Shanghai Jiao Tong University
16:00-16:15	P109	Ran Jia	Sichuan University
16:15-16:30	P129	Yuge Xue	Xi'an Institute of Optics and Precision Mechanics of CAS
16:30-16:45	P139	Wei Li	Zhejiang University of Technology
16:45-17:00	P141	Jianle Chen	Wuyi University
17:00-17:15	P150	Yalin Wang	Jiaying University

Presentation Details

Paper ID: P087

Paper Title: Deep-learning-enabled Temporally Super-Resolved Multiplexed Fringe Projection Profilometry: High-Speed Khz 3D Imaging with Low-Speed Camera

Authors: Wenwu Chen, Shijie Feng, Chao Zuo

Abstract: Recent advances in imaging sensors and digital light projection technology have facilitated rapid progress in 3D optical sensing, enabling 3D surfaces of complex-shaped objects to be captured with high resolution and accuracy. Nevertheless, due to the inherent synchronous pattern projection and image acquisition mechanism, the temporal resolution of conventional structured light or fringe projection profilometry (FPP) based 3D imaging methods is still limited to the native detector frame rates. In this work, we demonstrate a new 3D imaging method, termed deep-learning-enabled multiplexed FPP (DLMFPP), that allows to achieve high-resolution and high-speed 3D imaging at near-one-order of magnitude-higher 3D frame rate with conventional low-speed cameras. By embedding temporal information in one multiplexed fringe pattern, DLMFPP uses deep neural networks to decompose the pattern and analyze separate fringes, furnishing a high signal-to-noise ratio (SNR) and ready implementation solution over conventional computational imaging techniques. We demonstrate this method by measuring different types of transient scenes, including rotating fan blades and bullet fired

from a toy gun, at kHz using cameras of around 100 Hz. Experiential results establish that DLMFPP allows slow-scan cameras with their known advantages in terms of cost and spatial resolution to be used for high-speed 3D imaging tasks.

Paper ID: P106

Paper Title: DIC-assisted Dual-Wavelength Digital Holography for 3D Shape and Displacement Measurement in Single-shot

Authors: Haiyu Zhang, Hao Yan

Abstract: In order to achieve measurement of 3D shape and displacement for curved diffuse objects, existing techniques usually require multiple shots and complex optical systems. In this work, a dual-wavelength digital holography (DWDH) for 3D shape and displacement measurement of curved diffuse objects is proposed. Based on the combination of DWDH and digital imaging correlation (DIC), the proposed technique adopts a simple setup to achieve measurement in single-shot of each status. Specifically, DWDH allows the 3D shape measurement of curved diffused objects with synthetic phase images in single-shot. DIC enables precise position tracking for 3D displacement measurement. Experiments are performed on curved diffuse objects to validate the proposed DIC-assisted DWDH technique for 3D shape and displacement measurement in single-shot. The proposed method would expand DH's applications in dynamic measurements and large displacement measurements.

Paper ID: P109

Paper Title: BD-TNet: Balanced-Density Point Cloud Completion Method Assisted by Trie-like Shape Prior Embedding Dictionary

Authors: Ran Jia, Junpeng Xue, Wenbo Lu, Kelei Wang

Abstract: The task of point cloud completion aims to reconstruct a dense and complete point cloud from an initially sparse and incomplete version. This problem is inherently ill-posed due to the scarcity of point cloud data. Currently, most completion methods adopt the two-stage approach: first generate representative seed points and then upsample them to the target resolution. However, existing two-stage completion schemes often suffer from density imbalance, primarily caused by the uneven seed points generation. To address the issues of missing point cloud information and uneven seed points distribution, this paper proposes BD-TNet, a semi-connected U-Net structure leveraging a Trie-like embedding dictionary. This semi-connected way integrates explicit features of the partial point cloud and abstract features of the missing point cloud to achieve uniform and balanced features of the complete point cloud. Then generates seed point coordinates with balanced density. EmbeddingTrie, a Trie-like embedding dictionary with a root dictionary and a group of leaf dictionaries, is used in the decoding process as a shape prior, which can learn and store the shape features of objects during training and provide missing information during inference. To generate the point cloud with more uniform distribution, this paper designs an elastic potential energy loss, which weakens the influence of local point cloud concentration. The method proposed in this paper can take into account both local details and global distribution of point cloud. A large number of experiments demonstrate that our approach achieves state-of-the-art results in terms of Density Chamfer Distance metric, underscoring its effectiveness in completing point clouds with balanced density.

Paper ID: P129

Paper Title: Triple-wavelength Quantitative Phase Imaging for Precise Measurement of Refractive Index

Authors: Yuge Xue, Junwei Min, Xun Yuan, Jinwei Song, Baoli Yao

Abstract: Refractive index (RI) is an intrinsic optical parameter of materials and related to many physical characteristics such as density, concentration, temperature, pressure, and so forth. Quantitative phase imaging (QPI) is a powerful tool that provides quantitative 2D/3D non-destructive and label-free imaging of structures with great potential in materials science and biomedicine. However, the phase information of samples is the integral product of its RI and the physical thickness distribution, and decoupling RI from phase plays an important role in distinguishing a wide range of materials and material identification. It is a general method that uses techniques like confocal microscopy and atomic force microscopy to get the physical thickness of the sample in advance and then calculate the RI from the phase distribution. However, the whole system is complex and delicate regulated. Measuring the thickness and the RI distribution by changing the surrounding medium of a known RI difference is another decoupling category, but it is sensitive to environmental perturbation and poses challenges in practical implementation. In this work, we proposed a method to simultaneously measure the RI and the physical thickness distribution of the sample with the help of the triple wavelength illumination QPI and Cauchy's dispersion formula. Three quantitative phase images at three different wavelengths are firstly obtained by using a compact QPI method and then the dispersion coefficient and the physical thickness distribution of the sample are independently calculated. From the measured RI, the composition of the sample can be identified besides the topography of the sample. The proposed method with a compact configuration and simple imaging process. It is anticipated to be an effective tool in RI and topography measurement of optical materials and identification of substance sort.

Paper ID: P139

Paper Title: Finger Internal Fingerprint Acquisition System Based on FF-OCT

Authors: Wei Li, Haixia Wang, Qingran Miao

Abstract: Fingerprint is one of the most widely used identification features in biometric recognition. However, fingerprint recognition has the problems of unstable fingerprint quality and susceptibility to forgery attacks. Research has found that fingerprints on the active skin layer inside the fingers are less prone to wear and can more accurately represent fingerprint patterns. The contour information of the active epidermal layer inside the hand can be well obtained using optical coherence tomography (OCT) technology.

Full-field optical coherence tomography (FF-OCT) is an optical technique that utilizes the principle of low coherence interference to image the internal structures of biological tissues with sub micron resolution. It has the characteristics of non-invasive, non-contact, and internal tomography imaging. This article proposes and establishes a finger internal fingerprint acquisition system based on FF-OCT, which can collect and reconstruct finger internal fingerprints in a relatively short period of time. The system is based on the Michelson interferometer and only uses simple optical components such as beam splitters, mirrors, and collimators, supplemented by displacement tables, infrared array cameras, 850nm near-infrared lasers, and other equipment. After passing the laser through Kohler illumination, the uniform light is incident on a beam splitter to obtain two beams of light, which are respectively sent to the reference arm

and the sample arm, and the reference arm is moved to obtain depth scanning of the sample arm at the same optical path position. Real time calculation of scattering rates of internal structures at different depths through multiple steps and images, and ultimately synthesis of fingerprint structure information inside the finger. This system lays a solid foundation for the deployment and application of FF-OCT in the fields of fingerprint recognition and anti-counterfeiting in the future.

Paper ID: P141

Paper Title: A Citrus Variety Detection System based on Deep Learning

Authors: Jianle Chen, Lanhui Fu, Jialong Luo

Abstract: Variety detection provides crucial technical support for selecting XinHui citrus in the production of XinHui dried tangerine peel. However, the mutual occlusion between leaves and fruits poses a significant challenge in object detection. To improve screening efficiency, this paper proposes a YOLO (You Only Look Once) v7-BiGS (BiFormer & GSConv) citrus variety detection method capable of efficiently identifying different citrus varieties. In the YOLOv7-BiGS network model, the BiFormer attention mechanism is introduced into the backbone, enhancing the model's ability to extract citrus features. Additionally, the original convolution in the ELAN(Extended Efficient Layer Aggregation Network) of the head component is replaced with a lightweight GSConv convolution, significantly reducing the model's complexity while maintaining its performance. To verify the effectiveness of this method, this paper compared the proposed YOLOv7-BiGS with YOLOv5, YOLOv7, and YOLOv8. The experimental results showed that the precision, mAP (mean average precision), and recall of YOLOv7-BiGS were 91%, 93.7%, and 87.3%, respectively. Notably, compared to baseline methods, YOLOv7-BiGS improved precision, mAP, and recall by 5.8%, 4.8%, and 5.2%, respectively. Furthermore, to provide farmers with a comprehensive, accurate, and efficient management tool, a XinHui citrus variety detection system based on YOLOv7-BiGS was developed. This system can accurately distinguish between different types of XinHui citrus and provide detailed classification information. By analyzing the visual characteristics of the fruits, the system can identify the specific varieties of XinHui citrus, which is of great significance for farmers in managing varieties and formulating market sales strategies.

Paper ID: P150

Paper Title: Liquid Refractive Index Measurement Based on Electronically Tunable Lens

Authors: Yalin Wang, Dingnan Deng, Xiaozeng Wang

Abstract: A beam of parallel light irradiates a parallel plate with different refractive index liquids vertically, and the emitted light produces different axial displacements. Different axial displacement values reflect the change in the refractive index of the liquid to be measured. By measuring the axial displacement of the camera position, the refractive index of the liquid can be obtained. However, this method requires determining the axial displacement by moving the camera, and the mechanical movement affects the stability and accuracy of the measurement system. To avoid mechanical movement and improve measurement stability and accuracy, a liquid refractive index measurement method based on an electronically tunable lens is proposed. In this method, the imaging convex lens is replaced by an electronically tunable lens, and the focus spot is kept unchanged before and after placing the sample. At this point, the focal length difference corresponding to the electronically tunable lens is equivalent to the axial displacement of the camera. Numerical simulation was carried out using Zemax. To verify the

effectiveness of the proposed method, the refractive index of water, 75% alcohol, and different concentrations of NaCl solution were measured. The experimental results show that the proposed method can effectively and accurately measure the refractive index of solutions with different concentrations. It offers the advantages of simple operation, high accuracy, and elimination of mechanical movement.

Special Sessions

Agricultural Optics and Visual Technology I

Date	#	Duration	Venue
Nov. 16	SSA-I	14:00-15:40	5F/ Lingnan 2&3 岭南二+三厅
Session Chairs			
Lijia Xu, Sichuan Agricultural University			
Jieli Duan, South China Agricultural University			

Time	Paper ID	Presenter	Affiliation
14:00-14:20	Keynote	Qingchun Feng	Beijing Academy of Agriculture and Forestry Sciences
14:20-14:35	Invited	Lijia Xu	Sichuan Agricultural University
14:35-14:50	Invited	Jieli Duan	South China Agricultural University
14:50-15:00	SSA001	Qingxiang Zhang	Samsun Tech Co., LTD
15:00-15:10	SSA002	Xiaojuan Li	Xinjiang University
15:10-15:20	P116	Lei Ye	Shaoguan University
15:20-15:30	P013	Yunhe Zhou	Beijing Forestry University
15:30-15:40	P151	Xiaojie Lei	Jiangsu University

Keynote Speaker

Qingchun Feng

Beijing Academy of Agriculture and Forestry Sciences

Bio: Dr. Qingchun Feng, Professor, director of the Agricultural Robot Laboratory of the Equipment Center, Beijing Academy of Agricultural and Forestry Sciences. He has presided over 13 research projects, including major national agricultural science and technology projects, National Natural Science Foundation of China projects, national key R&D plan projects, Beijing municipal science and technology plan projects, and Xinjiang Production and Construction Corps science and technology

cooperation projects. He has won 3 provincial and ministerial-level awards, and been selected as Beijing Science and Technology New Star, Outstanding Talent in Beijing, and Young Talent of the China Association for Science and Technology Think Tank.

Speech

Exploration and Trend of Agricultural Robots for Fruit and Vegetable

Abstract: Labor shortage and rising labor costs are common challenges facing the sustainable development of global agriculture. Given the ability of robots to replace humans in performing complex production operations, "robots + agriculture" has become an important development direction for smart agriculture. This report addresses the actual needs of fruit and vegetable production, and introduces the research and industrial application of related agricultural robot technologies both domestically and internationally. Combining the research achievements of the speaker's team in the field of agricultural robots, the report elaborates on the special technical challenges faced by agricultural robots and effective solutions from multiple aspects, including robot information perception, decision-making control, executive components, system integration, and industrial services. It also shares application scenarios of the integration of factory-based agricultural production and robots in China. Based on this, the report summarizes the development trends of core technologies for agricultural robots, analyzes the industrial development prospects of typical agricultural robots, and explores the efficient production new models of "robots + agriculture" suitable for China's characteristics.

Invited Speaker

Lijia Xu
Sichuan Agricultural University

Bio: Lijia Xu, Dean of the college of Mechanical and Electrical Engineering of Sichuan Agricultural University, Director of Sichuan Smart Agriculture Engineering Technology Research Center, Academic and Technical Leader of Sichuan Province. Her main research interests include intelligent agricultural machinery equipment, agricultural robots, agricultural information perception and control technology, etc. She has presided over more than 30 scientific research projects, and published more than 100 SCI journal papers as the first or corresponding author. She has made achievements in the fields of fruit-picking robots, self-propelled intelligent spraying equipment, and small medium-sized agricultural machinery equipment in hilly areas.

Speech Title

Research Progress of Citrus Picking Robots

Abstract: Citrus is one of the important economic crops in the world and is also the crop with the

largest planting area and the highest economic status in southern China. The citrus-related industry has become an important pillar for increasing farmers' income in production areas and assisting in poverty alleviation efforts. Currently, the mechanical harvesting level for citrus in China is below 2%, while the overall mechanization level is only 5.75%. Therefore, achieving rapid and accurate identification of citrus in unstructured orchard environments, and ensuring efficient and precise harvesting operations by robots, is extremely significant for enhancing the intelligence level of agricultural equipment in orchards and promoting the sustainable development of the citrus-related industry. This report addresses the practical needs of citrus harvesting and introduces our team's research progress on intelligent citrus picking robots from the perspectives of visual information perception, decision-making control, and mechanical structure design.

Invited Speaker

Jieli Duan
South China Agricultural University

Bio: Jieli Duan,Female, Chinese Communist Party Member, Doctor of Engineering, Professor, Doctoral Supervisor.She is also a vice-chairman of the Facilities Horticulture and Fruit and Vegetable Machinery Branch of the Chinese Agricultural Machinery Society and a director of the Guangdong Provincial Mechanical Society. She is a post expert on the modern agricultural industry system in Guangdong Province, a visiting scholar at Washington State University and Monash University in Australia, and a reviewer of journals such as COMPAG and Transactions of the Chinese Society of Agricultural Engineering.The research direction is the mechanization and intellectualization of fruit production. It has undertaken more than 10 projects at the provincial and ministerial levels, and has won 4 achievement awards. She has published 68 papers, including 32 SCI papers, 37 authorized invention patents, and 4 published textbooks. She has won the ' National Xu Zhilun Mechanical Excellent Teacher Award ', ' South Guangdong Excellent Teacher ', ' Teacher 's Moral Standard ', ' Teaching and Educating ' Advanced Individuals, ' My Favorite Graduate Tutor ' and other honorary titles.

Speech Title

Banana Hand Image and Crown Visual Detection Technology

Abstract: In the context of the intricate environment of banana orchards and the substantial variability among banana clusters, the task of accurately detecting banana comb structures, counting them, and precisely segmenting fruit stalks poses a significant challenge when relying on a single deep learning or classical image processing algorithm. This paper presents a visual detection method for banana comb

handles and fruit stalks that integrates deep learning and classical image processing algorithms.The proposed method accurately identifies banana comb handles and crown, providing favorable technical support for the intelligentization of weight estimation and de-handing. This is of great significance for promoting the practical application of intelligent comb equipment and the high-quality development of the banana industry. In this paper, the accurate segmentation and counting of banana combs are realized by combining the convolutional neural network DeepLab V3+ model with classical image processing algorithms for the detection of comb numbers in the bud breaking stage.The deep learning algorithm is employed to detect and identify the entire ear, while the edge detection algorithm extracts the centroid point of the fruit finger. The clustering algorithm is utilized to determine the optimal number of banana combs in the harvest period on the visual detection surface, and a prediction model for the comb number, including those hidden bananas, is established. Additionally, an improved segmentation method based on the DeepLab V3+ model, enhanced with YOLOX, is proposed to extract the fruit stalk area. This method is used to segment the fruit stalk area and determine the inner and outer arc position ranges of the fruit stalk contour, enabling the recognition and segmentation of banana fruit stalks. Furthermore, a new banana de-handing end-effector is designed based on a retractable tool, optimizing its design.The results indicated that in the bud breaking stage, the mean intersection over union (MIoU) of target segmentation was 0.878, the mean precision of the area (MPA) was 0.936, and the detection accuracy of banana combs was 86%. In the harvest period, the counting accuracy of banana combs was 93.2%. The MIoU of the banana fruit stalk segmentation model was 0.927, the MPA was 0.955, the total number of model parameters was 5.881 M, and the frames per second (FPS) was 61.05. The experiment verified that the visual detection and counting method of banana handles and fruit stalks proposed in this paper can effectively segment banana handles and fruit stalks, providing a theoretical basis for banana bud breaking, weight estimation, and intelligent de-handing.

Presentation Details

Paper ID: SSA001
Paper Title: Optics + AI: Shaping the Future of Inspection
Authors: Qingxiang Zhang
Abstract: This talk will be focused on the following topics
1.Optical Innovation Technology
2.AI Technology
3.Application of Industry/Agriculture
4.Company Overview

Paper ID: SSA002
Paper Title: Research on Bionic Vision and Adaptive Grasping Method of Humanoid Picking Robot
Authors: Xiaojuan Li
Abstract: Xinjiang is China's only long-staple cotton-producing region. Since the existing cotton-picking equipment cannot meet the quality requirements for long-staple cotton harvesting, picking methods still rely on manual labor, greatly restricting the development of this strategic resource. Therefore,

addressing key issues in bionic vision and adaptive control in the development of humanoid cotton-picking robots for Xinjiang's long-staple cotton, we establish methods for static cotton boll recognition and burst boll state detection under cluttered backgrounds by analyzing the rules of long-staple cotton harvesting. We explore technologies that can accurately and swiftly extract information on the motion direction and kinetic energy of dynamic targets in disturbed environments, establishing methods for dynamic positioning and tracking of target cotton bolls under interference disturbances. By introducing real-time visual feedback of end-effectors and adaptive control theories, we establish a visual servo adaptive trajectory control strategy that can enhance control precision and speed, providing a comprehensive modeling theory and methodology to reveal precise visual positioning and complex nonlinear dynamic adaptive control for humanoid picking robots under full-condition disturbances.

Paper ID: P116

Paper Title: Navigation Path Recognition for Tea Plantation Mobile Harvesting Robots Based on Improved Deeplabv3plus

Authors: Zhipeng Guo, Jin Li, Lei Ye

Abstract: In complex tea plantation environments, efficient navigation path recognition algorithms are essential to guarantee the autonomous operation of mobile harvesting robots. However, the relevant path recognition algorithms are poor in accuracy and real-time, making it difficult to identify complex tea plantation paths quickly and accurately, which affects the efficiency and robustness for autonomous operation of tea plantation mobile harvesting robots. To address the above problems, firstly, this paper selected Deeplabv3plus as the model framework for path recognition, and employed lightweight Mobilenetv2 as the backbone network of the model to optimize the number of arithmetic parameters and the speed of the model. Secondly, an efficient CE_ASPP feature extraction module was designed to construct a multi-scale depthseparable convolutional structure to expand the feature receptive field of the model. In the decoding layer, the shallow features of the initial three bottleneck layers of the fusion backbone network were integrated to enhance the semantic information of the features; and the feature extraction capability was improved by the CBAM attention mechanism and the ECA attention mechanism. Finally, the scanning method was employed to extract the central pixel, while the RANSAC algorithm facilitates the fitting of the navigation path. The experimental results showed that the Accuracy, MPA and MIOU of the improved Deeplabv3plus model were 95.7 %, 97.64 % and 93.51 %, respectively. Compared to the original model, the number of operational parameters and memory footprint of the improved model were 4.35×10^5 and 16.60 MB respectively, which significantly reduces the computational costs. The average inference time and the average detection frame rate were 48.99 ms and 20.44 FPS respectively. The results showed that the improved Deeplabv3plus has better detection accuracy and robustness for complex tea plantation paths, providing important solutions for autonomous operations of tea plantation mobile harvesting robots.

Paper ID: P013

Paper Title: 2D Pose Detection of Litchi'S Main Fruit Bearing Branch in Complex Environments Based on Improved YOLOv8-seg

Authors: Yunhe Zhou, Jiaming Zhang, Jiangming Kan, Yunchao Tang, Xiangjun Zou, Wei Tang,

Zhiwei Yan, Hanyan Liang

Abstract: The intricate growth environment of litchi in orchards, as well as the detection of string-shaped fruits and the main fruit bearing branch (MFBB), are crucial aspects of harvesting robots. Addressing the challenge of locating picking points in complex environments, this paper presents a deep neural network model for two-dimensional pose detection of litchi's main fruit bearing branch based on an enhanced Yolov8-seg. Initially, litchi clusters are segmented in complex environments, and the predicted litchi cluster prediction box is cropped to the picking area. The cropped image is annotated with the MFBB and further trained using the improved Yolov8-seg network. By locating the original litchi cluster image, the position coordinates of the main fruit-bearing branch picking points are obtained. Experiments have demonstrated that training two types of labels separately - litchi cluster and MFBB - yields better results than training both simultaneously. This method accurately and completely extracts the MFBB and locates the picking point, while also meeting real-time detection speed requirements, thus laying a foundation for theoretical automatic litchi picking.

Paper ID: P151

Paper Title: Design and Testing of a Four-arm Apple Harvesting Robot in Tall-Spindle Structured Orchard

Authors: Lei Xiaojie,Liu Jizhan, Wang Jie, Xu Baocheng, Jiang Houkang

Abstract: With the increasing demand for high-speed mechanized operations in apple harvesting, the development of multi-arm harvesting robots for modern orchards has become a major trend in the harvesting robot industry. However, the level of agronomic standardization continues to present challenges to the advancement of existing multi-arm harvesting robots. Therefore, by analyzing the advantages and disadvantages of existing multi-arm harvesting robots and targeting the widely used Tall-Spindle apple orchards in modern China, this paper proposes a design scheme for a mobile four-arm apple harvesting robot. This design not only satisfies the demand for simultaneous four-arm picking in these scenarios, but also optimizes the allocation of tasks among the four cameras and robotic arms, thereby improving the overall picking efficiency. Experimental results indicate that the robot is capable of simultaneous four-arm harvesting in Tall-Spindle apple orchards. It successfully harvests 78.64% of the fruits within the growing range, and the average harvesting efficiency of the four arms is 3.39 fruits/s. This significantly improves the current challenges associated with the high labor intensity of manual picking.

Special Sessions

Agricultural Optics and Visual Technology II

Date	#	Duration	Venue
Nov. 16	SSA-II	15:55-17:45	5F/ Lingnan 2&3 岭南二+三厅
Session Chairs			
Ping Liu, Shandong Agricultural University			
Hongjun Wang, South China Agricultural University			

Time	Paper ID	Presenter	Affiliation
15:55-16:15	Keynote	Zhonghua Miao	Shanghai University
16:15-16:30	Invited	Ping Liu	Shandong Agricultural University
16:30-16:45	Invited	Hongjun Wang	South China Agricultural University
16:45-16:55	P103	Fengyun Wu	Guangzhou College of Commerce
16:55-17:05	P105	Mingyou Chen	Foshan University
17:05-17:15	P152	Houkang Jiang	Jiangsu University
17:15-17:25	P026	Tianyu Han	Beijing Forestry University
17:25-17:35	P138	Zhi Liang	Xinjiang University
17:35-17:45	P140	Junwei Li	Wuyi University

Keynote Speaker

Zhonghua Miao
Shanghai University

Bio: Miao Zhonghua, the Deputy Dean of Research at the School of Mechanical and Electrical Engineering and Automation at Shanghai University, is also the leader of a key innovation team focused on "Cross-domain Collaboration and Decision Making in Intelligent Autonomous Systems" under the auspices of the Shanghai Municipal Education Commission. He spearheads the field of intelligent robotics within the national first-class discipline of mechanical engineering. In 2020, he was named one of Shanghai's leading agricultural talents. And in 2024, he was awarded the prestigious title

of "Changjiang Scholar".

Engaged in research on the basic theory, key technologies and engineering practice of intelligent equipment and robot control. The main directions include: 1. Intelligent Robot Technology Vision Perception, Trajectory Planning, Decision Control, etc., 2. Intelligent Equipment Control and Safety Operation Monitoring, Fault Diagnosis, Precision Control, etc., 3. Multi-robot Coordination Control Cross-domain Collaboration, Regional Control, Formation, etc. A series of achievements have been made in the fields of intelligent agricultural machinery equipment, agricultural robots, autonomous operation control of underwater robots and other areas. It has undertaken 2 major national agricultural science and technology projects, 2 key national research and development plan projects, 3 general programs of the National Natural Science Foundation of China, and 8 national-level projects such as the 863 High-tech Plan; It has undertaken more than 10 provincial and ministerial-level projects, including the key basic research project of Shanghai Science and Technology Commission, the key agricultural development project of Shanghai Agriculture Committee, and the major natural science project of Shanghai Education Commission. He has published more than 194 SCI/EI papers in internationally renowned journals such as Automatica, ASME Trans, Computers and Electronics in Agriculture, IEEE/ACM Trans, and the domestic journal Science China. The achievements won the first prize of Shennong Zhonghua Agricultural Science and Technology of Ministry of Agriculture and Rural Affairs in 2021. In 2020, he led the team to win the collective honor of "Workers Pioneer" from Shanghai Federation of Trade Unions. In 2021, he was awarded the "Excellent Communist Party Member of Shanghai" by the Education and Health Committee System. In 2022, he received the "Wang Kuan Cheng Yucai Award" for his significant contributions to the Education Commission System in Shanghai.

Speech Title

The Active Sensing Technology for Harvesting Robots

Abstract: Agricultural robots are rapidly becoming more advanced with the development of relevant technologies and in great demand to guarantee food supply. As such, they are slated to play an important role in precision agriculture. For tomato production, harvesting employs over 40% of the total workforce. Therefore, it is meaningful to develop a robot harvester to assist workers. However, the predominance of branch and leaf shade in agricultural environments presents a barrier for accurate target recognition. Particularly for picking robots, precise localization of the picking object is essential. Most of them require vision to locate the target, however, occlusion is common in agricultural environment, which restricts the accuracy of visual target recognition, and even leads to failure in serious cases. The active perception method is an effective means, but how to efficiently find the best observation position remains difficult to avoid the waste of time caused by repeated invalid motion. Targeting these problems, an active deep sensing method is proposed for harvesting clustered and single fruits. First, the region of interest of the target is extracted by a segmentation network, and then the occlusion status of it is obtained by image processing methods. Taking the current observation position as the starting point, the camera is moved within a matrix to form confidence and occlusion rate distribution maps. After establishing a series of occlusion rate and confidence matrix datasets, a designed deep network has been trained, which is used to predict the maximum confidence/minimum

occlusion rate position after the current occlusion status is estimated. To verify the reli ability of the method, laboratory and field experiments were carried out for apples and clustered tomatoes. After 1000 times of verification, results show that the successful pick/recognition rate is increased by 38.7 %, and the average successful recognition time is 5.2 s, which is 63.1 % and 46.4 % faster than that of a fixed movement method and a simple heuristic method.

Invited Speaker

Ping Liu
Shandong Agricultural University

Bio: Liu Ping, Professor, Doctoral Supervisor, is the Chair of the Professor Committee at the College of Mechanical and Electrical Engineering, Shandong Agricultural University. She serves as the Director of the Shandong Provincial Engineering Research Center for Agricultural Equipment Intelligence and leads the "Automation" specialty in Shandong's first-class undergraduate program. Recognized as a Zibo Talent Plan Technology Innovation Professional, she is also a part-time member of the Grape Industry Technology Service Team of the Chinese Agricultural Engineering Society and a Standing Director of the Shandong Agricultural Machinery Society. Her primary research focuses on key technologies and applications of agricultural robots and intelligent assisted breeding. She has led 13 research projects, including those funded by the National Natural Science Foundation, Postdoctoral Science Foundation Special Support Project, Shandong Provincial Key Research and Development Plan, and Shandong Provincial Natural Science Foundation, with cumulative financial support exceeding 20 million yuan. Professor Liu has published over 60 SCI papers, been granted 19 invention patents, registered 9 software copyrights, and assisted in developing a new wheat variety. She has received 9 awards, including the First Prize in Scientific and Technological Achievement from the Shandong Automation Society.

Speech Title

Research and Application of Key Technology of Grape Flower-thinning Robot

Abstract: Scientific and reasonable inflorescence shaping is an important factor affecting the quality of grape. At present, the inflorescence shaping of grape mainly relies on manual labor, which is high labor intensity and low efficiency. Aiming at these problems, a grape inflorescence-thinning robot was developed to realize the whole process automation and intelligence of grapes from inflorescence identification to support point positioning to intelligent inflorescence-thinning decision and automatic inflorescence-thinning at the end-effector. Firstly, the improved Mask RCNN algorithm and lightweight YOLOV7-TP were used to achieve rapid detection of grape inflorescence and precise localization of holding points. Secondly, a fast inflorescence-thinning decision algorithm based on HRNet was

designed, and the inflorescence-thinning distance was measured according to the proportion of the key points between the root and the tip of the inflorescence, so as to realize the intelligent decision of inflorescence-thinning of grapes. Finally, based on the artificial inflorescence thinning method, the end-effector of inflorescence thinning was designed to realize automatic and non-destructive inflorescence thinning of grapes. This study carried out a comprehensive exploration from the detection and localization of grape inflorescence, intelligent decision algorithm and the end-effector of grape inflorescence thinning, realized the automation and intelligent operation of the whole process of grape inflorescence thinning, and provided a solid theoretical foundation and hardware support for the inflorescence thinning of grape.

Invited Speaker

Hongjun Wang
South China Agricultural University

Bio: She received the B.S. degree in Chongqing University in 1987, M.S. degree in University of Electronic Science and Technology of China in 1994, and Ph.D. degree in mechanical and electronic engineering from Guangdong university of Technology in 2003.

From 2003, she was a teacher in college of engineering, South China Agricultural University. Since 2013, she has been Professor with Mechanical Engineering Department, college of engineering, South China Agricultural University. She is author of more than 60 articles, and more than 10 inventions. Her research interests include intelligent agriculture, machine vision and robotics, intelligent design.

Speech Title

A Model for Detecting Litchi in Nighttime Environments

Abstract: The accurate detection of litchi fruit cluster is the key technology of litchi picking robot.In the natural environment during the day, due to the unstable light intensity, uncertain light angle,background clutter and other factors, the identification and positioning accuracy of litchi fruit cluster is greatly affected. Therefore, we proposed a method to detect litchi fruit cluster in the night environment. The use of artificial light source and fixed angle can effectively improve the identification and positioning accuracy of litchi fruit cluster. In view of the weak light intensity and reduced image features in the nighttime environment, we proposed the YOLOv8n-CSE model.we use YOLOv8n as the initial model, and introduce the CPA-Enhancer module with chain thinking prompt mechanism in the neck part of the model, so that the network can alleviate problems such as image feature degradation in the night environment. In addition, the VoVGSCSP design pattern in Slimneck was adopted for the neck part, which made the model more lightweight. The multi-scale linear attention mechanism and the EfficientViT module, which can be deeply divided, further improved the detection accuracy and

detection rate of YOLOv8n-CSE. The experimental results show that the proposed YOLOv8n-CSE model can not only recognize litchi clusters in the night scene, but also has a significant improvement over previous models.

Presentation Details

Paper ID: P103

Paper Title: Research on Nighttime Pineapple Detection with Limited Samples based on Enhanced Cycle Generative Adversarial Network Approach

Authors: Fengyun Wu, Rong Zhu, Fan Meng, Jiajun Qiu, Jinhui Li, Xiangjun Zou

Abstract: The study tackles the challenge of automated nighttime pineapple harvesting, which is hindered by the difficulty of collecting diverse nighttime pineapple images due to unstructured planting and limited accessibility in plantations. The CycleGAN model is an end-to-end style transfer model that can transform easily obtainable daytime pineapple images into more challenging nighttime pineapple images, addressing the issue of insufficient nighttime pineapple images. Yet it had issues such as inadequate nighttime detail restoration, slight color distortion, checkerboard artifacts, and local pattern collapse. To address these, the study enhanced the original CycleGAN model through generator structure improvements and hyperparameter optimization. The enhanced CycleGAN model achieved a 29.7% reduction in FID score, outperforming the original. For the small-sample nighttime pineapple detection task, the detection model based on the improved CycleGAN-generated dataset exhibited substantial performance improvements. Specifically, the precision, recall, average precision, and F1 score increased by 13.34%, 45.11%, 56.52%, and 30.52% respectively, outperforming other style transfer models. This indicates the improved CycleGAN model's superior generalization capability and optimal performance. These findings demonstrate the ability of the enhanced CycleGAN approach to effectively expand the nighttime pineapple dataset and enable efficient detection of pineapples at night, thereby supporting the automation of nighttime pineapple harvesting.

Paper ID: P105

Paper Title: Improved RPMNet for 3D Feature Extraction Based on DGCNN

Authors: Jiahui Huang,Lufeng Luo,Mingyou Chen

Abstract: Feature extraction is a critical step in point cloud registration networks, determining how effectively point cloud data is represented. The feature extraction module in RPMNet uses fixed-range local features as input, whereas DGCNN dynamically constructs adjacency graphs and uses graph convolutions for feature updates, better capturing both local and global features of the point cloud. This study aims to explore the application of the Dynamic Graph Convolutional Neural Network (DGCNN) in RPMNet’s feature module to address the inadequacies in local and global feature extraction and improve its registration accuracy in point cloud data processing, particularly on the ModelNet40 dataset.

The study conducted training and testing on the ModelNet40 dataset, comprising 5112 training point clouds, 1202 validation point clouds, and 1266 test point clouds. Through performance comparison analysis, various evaluation metrics such as rotation error and translation error were used to assess the

model's performance. The results show that the DGCNN-enhanced RPMNet reduced the isotropic rotation error from 0.056 to 0.053 and the translation error from 0.00028 to 0.00026. This indicates that applying DGCNN to RPMNet can dynamically capture local and global features of point clouds, improving feature representation accuracy and model robustness. These findings are significant for the field of point cloud data processing, validating the effectiveness of DGCNN and providing new directions for future research. This advancement promotes the application of graph neural networks in practical problems, enhancing the technical level of the related field.

Paper ID: P152

Paper Title: Research on Target Recognition, Segmentation, and Accurate Positioning Methods for Obscured Apple Fruits Under Dense Canopies

Authors: Jiang Houkang, Liu Jizhan,Lei Xiaojie, Xu Baocheng, Wang Jie

Abstract: In robotic harvesting, recognizing and locating target apple fruits, as well as detecting obstacles in complex environments like dense canopies, poses significant challenges. This paper presents a method for recognizing, segmenting, and accurately localizing obscured fruits. We employ instance segmentation to extract edge contours of fruits and branches, leveraging two-dimensional features for precise localization under occlusion and correcting picking point errors. Experimental results indicate that at a 10% occlusion ratio, the model achieves an average precision of 96.8%, an F1 Score for edge detection of 0.91, and a 3D reconstruction error of 3.1 mm. Even at 50% occlusion, average precision remains at 88.3%, with an F1 Score of 0.80 and a reconstruction error of 7.6 mm. These findings demonstrate that while occlusion significantly impacts 3D reconstruction, the algorithm retains high accuracy, fulfilling the precision requirements for fruit harvesting.

Paper ID: P026

Paper Title: Pixel2gaussian: Generating Surface-Aligned Gaussian Splatting for 3D Mesh Reconstruction and Rendering from Images

Authors: Tianyu Han, Jiangming Kan

Abstract: This paper introduces an innovative end-to-end deep learning approach that generates 3D Gaussians aligned with the surfaces of 3D shapes and constructs corresponding 3D mesh models directly from images. Traditional methods typically represent 3D shapes using volumetric models or point clouds, which are incapable of synthesizing images from new perspectives, thereby limiting the practical applications of the models. Moreover, converting these conventional representations into the more versatile mesh models is not straightforward.

Our proposed method utilizes anisotropic 3D Gaussians as an unstructured representation of radiance fields, which not only preserves the essential properties required for volumetric rendering optimization but also supports fast, splat based rasterization. The alignment of 3D Gaussians with the shape surfaces facilitates straightforward mesh model generation by connecting the centers of Gaussians in a specific manner.

Distinct from existing methods that use 3D Gaussians, our framework employs a graph-based convolutional neural network to represent these Gaussians, enabling the accurate formation of geometry through progressive deformation of an ellipsoid. This process leverages perceptual features extracted from the input image and incorporates loss correction computed using images from multiple

viewpoints. A coarse-to-fine strategy is implemented to stabilize the deformation process, and an adaptive graph unpooling layer is designed to ensure a logical distribution of Gaussians, thus enhancing overall performance.

Our methodology also introduces several Gaussian-related losses to capture different level properties, with particular emphasis on opacity and flatten losses designed to convert initially semi-transparent 3D Gaussians into an opaque, flattened state uniformly distributed across the shape's surface. Additionally, we utilize positional encoding to optimize parameters and address high-frequency variations in opacity and scale factors of the Gaussians. Extensive experimental results demonstrate that our method achieves superior detail and high-quality rendering of novel views in the resultant mesh models.

Paper ID: P138

Paper Title: A Bionic Vision Method for Extracting Motion Information of Small-Target in Cotton Field Backgrounds

Authors: Zhi Liang, Zhonglong Lin, Xiaojuan Li*

Abstract: Visual localization of long-staple cotton picking robots is challenged by many interfering factors. Due to dynamic uncertainties during mechanical picking, cotton bolls undergo small wobbles or oscillations, resulting in the loss of their shape, color, texture, and structural information within a few pixel points. The low signal-to-noise ratio and background clutter further degrade the performance of traditional motion target detection techniques, making the vision system prone to miss detection and inaccurate localization during search and tracking. In addition, due to the dense plantation, there is severe occlusion during cotton boll picking, which makes stable detection of dynamic targets difficult. Aiming at the problem of high plant density in real cotton fields, this paper proposes a neural visual pathway model based on the drosophila visual system to realize high-precision localization and dynamic tracking of cotton bolls. Neural activation is modeled specifically for weak motion targets by mathematically modeling a small target motion detector to respond to weak motion in a cluttered background. These responses are then fused to simulate the sensitivity of the drosophila neurovisual pathway. In addition, an orientation-selective suppression algorithm is proposed to suppress target features in a motion background, effectively reducing interference from background motion. Experimental data show that the model exhibits stable performance in detecting small targets with large sizes and a wide range of velocities, outperforming other bio-inspired models. In addition, the model can accurately and quickly extract motion direction and motion energy information.

Paper ID: P140

Paper Title: CNFA: ConvNeXt Fusion Attention Module for Age Recognition of The Tangerine Peel

Authors: Junwei Li, Lanhui Fu, Jianle Chen

Abstract: Xinhui tangerine peel has valuable medicinal value, and the longer it is stored in a suitable environment, its medicinal value will be higher. In order to correctly identify age of the tangerine peel, previous studies have mostly used manual identification or physical and chemical analysis, which is a tedious and costly process. This work investigates the automatic age recognition of the tangerine peel based on deep learning and attention mechanisms. We proposed an effective ConvNeXt fusion attention module (CNFA), which consists of three parts, a ConvNeXt block for extracting low-level

features information and aggregating hierarchical features, a channel Squeeze-and-Excitation (cSE) block and a spatial Squeeze-and-Excitation (sSE) block for generating sufficient high-level feature information from both channel and spatial dimensions. To analyze the features of tangerine peel in different ages and evaluate the performance of CNFA module, we conducted comparative experiments using the CNFA-integrated network on the Xinhui tangerine peel dataset. The proposed algorithm is compared with related models of the proposed structure and other attention mechanisms. The experimental results showed that the proposed algorithm had an accuracy of 97.17%, precision of 96.18%, recall of 96.09% and F1 score of 96.13% for age recognition of the tangerine peel, providing a visual solution for the intelligent development of the tangerine peel industry.

Special Sessions

Communication and Education of Optics I

Date	#	Duration	Venue
Nov. 16	SSC-I	14:00-15:15	5F/ Lingnan 5&6 岭南五+六厅
Session Chair			
Shuming Jiao, Great Bay University			

Time	Paper ID	Presenter	Affiliation
14:00-14:15	Invited	Xiangming Kong	Hebei University of Technology
14:15-14:30	Invited	Shuo Wang	Beijing Institute of Graphic Communication
14:30-14:45	Invited	Shuming Jiao	Great Bay University
14:45-14:55	P041	Yue Guan	Beijing Institute Of Graphic Communication
14:55-15:05	P045	Shurui Wei	Beijing Institute of Graphic Communication
15:05-15:15	P046	Ye Li	Beijing Institute of Graphic Communication

Invited Speaker

Xiangming Kong

Hebei University of Technology

Bio: Kong Xiangming, associate professor of Hebei University of Technology, director of Tianjin Physical Society, chairman of Experimental Physics Working Committee, member of Hebei Optical Society, person in charge of physics Science popularization base of Hebei University of Technology. The first prize of the 11th National Physical Experiment Teaching Seminar in 2022, and the 2019 Hebei Province Teaching Achievement Award, etc.

Speech

Application of Card-Type Interactive Learning Tools in Optics Teaching

Abstract: In order to improve the teaching performance of optics and develop new teaching tools, we conducted extensive research works including rigorous interview and survey, fine design and trial production, performance evaluation and feedback collection, and iterative enhancement. For two core

topics in optics, i.e. grating diffraction and light polarization, we developed grating card and polarization card as two card-type interactive tools. In addition, we developed a series of demonstration experiments, including emission spectrum of thin bar mercury lamp, identification of fake ruby with absorption spectrum, true and false yellow colors for colorimetry, polarization painting, polarization wrench for stress birefringence, etc. These two categories of learning tools have advantages of low cost, impressive experience and strong interactivity. Our teaching tools have been adopted in practice for more than four years. They have significantly improved our teaching performance and gained widespread recognition by teachers and students. The successful application of our card-type interactive learning tools in optics teaching opens up a new way for classroom teaching and popular science activities.

Invited Speaker

Shuo Wang
Beijing Institute of Graphic Communication

Bio: Dr. Wang Shuo, Holo artist and designer, an Associate Professor and Supervisor for both Master's and Doctoral candidates, holds the position of Director at the Holographic Arts Center of Beijing Institute of Graphic Communication. Concurrently, he is engaged as a holography researcher at the Ultra Realistic Imaging Center in United Kingdom. Additionally, Dr. Wang Shuo assumed a leadership role as the Chief Visual Effects Coordinator, overseeing the visual effects for the opening and closing ceremonies of the Beijing 2022 Winter Olympic and Paralympic Games.

Speech Title

Constructing a Holographic Arts Center for Interdisciplinary Talent Cultivation

Abstract: This paper examines the system construction and the development of a novel talent cultivation model within the holographic arts center from an interdisciplinary perspective. It begins by discussing the importance of interdisciplinarity in contemporary education. The experimental and avant-garde nature of holographic arts center are also discussed in this context. It then explores the creation of a comprehensive and interactive experimental platform to facilitate deep collaboration and exchange among disciplines such as optics, design, and art. Additionally, it details the systematic construction for building holographic arts center, including basic technological infrastructure, innovative research platforms, creative spaces, academic exchange environments, industry linkages, and career trajectories for graduates.

This paper proposes a novel Interdisciplinary I3(Integration Interaction & Innovation) Model for talent cultivation. It is designed to enhance students' abilities to integrate interdisciplinary knowledge, foster innovative thinking, and develop practical skills. It emphasizes the center's role in providing practical

opportunities, stimulating creative thinking, and advancing technological applications. The article also discusses historical models of integration between holographic artists and scientists, and the rise and fall of holographic arts courses, adapting historical insights to current educational methods to meet contemporary needs and characteristics.

Furthermore, this paper analyzes challenges that may arise in constructing holographic arts center and cultivating talent, such as the technological change, the depth of discipline integration, and the teaching resource allocation, offering corresponding strategies for addressing these issues. Finally, it envisions the future development of holographic art laboratories as significant reference points for talent training and innovative research in the intersection of arts and technology.

Invited Speaker

Shuming Jiao
Great Bay University

Bio: Dr. Shuming Jiao is currently an assistant professor in Great Bay University, Dongguan, Guangdong, China. He received his PhD degree in electronic engineering from City University of Hong Kong in 2016. He has been actively engaged in the interdisciplinary investigation between optics and computer algorithms. His research interest includes holographic three-dimensional (3D) display, single-pixel imaging and optical computing.

Speech Title

Image Hiding Magic Tricks for Explaining Optics

Abstract: Some optical principles are adopted for playing magic tricks, which even appear in stage shows of professional magicians. These magic tricks can be effectively used in the teaching and presentation of optical principles as well. As a combination of science and art, they can bring entertainment to the audience and inspire the curiosity of listeners. A typical example of optical magic trick is image hiding (or steganography). A hidden image is embedded into a cover image (or host image) with certain optical techniques. After embedding, the hidden image cannot be perceived from the cover image by naked eyes. However, the hidden image can still be revealed under certain conditions (e.g. wearing special glasses). Magicians can “read your mind” and “see through” a poker card from the secret information hidden in the back side. Various fundamental optical principles can be leveraged to design image hiding magic tricks including light wavelength, light polarization, moiré pattern, visual cryptography, fluorescence and stereoscopic three-dimensional (3D) display. The magic props can be made at a low cost and have a small size, unlike a bulky optical experimental setup in a laboratory. If the magic tricks are used in a lecture about optics, the audience can better learn optical knowledge and have fun at the same time. As part of popular culture, optical magic tricks can also be

found in science fiction, television shows and movies. In this oral presentation, the speaker will show how optical magic tricks can be designed and performed in the communication and education of optics.

Presentation Details

Paper ID: P041

Paper Title: Experimental Art of Holography in the Context of Human-Pet Emotional Memories

Authors: Xuechun Wang, Jie Yang, Shuo Wang

Abstract: This study focuses on human-pet emotional memories, discussing the potential application of experimental holographic art in this field. As holographic technology matures, it offers new opportunities for the representation of emotional memories in artistic creation. The research involves experimental art practices to analyze how holographic art impacts individuals' memories and emotional experiences with pets. Initially, the study reviews the theoretical foundations of emotional memory and its expression in artistic creations. Furthermore, this paper introduces the creation process of interactive design of holographic art pieces. Additionally, an experiment is described where participants observe hologram of their pets. Their responses data are collected to examine the human-pet emotional memories. Finally, experimental results reveal the positive role of holograms in evoking emotional memories and enhancing emotional experiences, providing a prospect application in emotional education and memory healing for future.

Paper ID: P045

Paper Title: Emotional Effects of Various Display Lightings on Holograms

Authors: Shurui Wei, Jie Yang, Shuo Wang

Abstract: This study investigates the emotional effects of varying display lighting conditions on viewer responses to holograms, focusing on how color temperature affects emotional reactions. An experimental design was implemented, where participants viewed the consistent hologram under diverse lighting conditions. Both qualitative and quantitative methods were conducted to generate participants' emotional responses.

The findings reveal that specific lighting conditions can influence these emotional responses. The analysis reveals that appropriate lighting enhances the holographic experience by modifying viewer emotional states. The results offer vital insights for optimizing holographic display design to improve viewer engagement and emotional experiences.

Recommendations are presented for the strategic adjustment of display lighting to optimize the emotional impact, crucial for improving the efficacy of holographic displays within both entertainment and educational contexts. The study's findings contribute significantly to the scholarly discourse by elucidating the crucial influence of display lighting on the emotional interactions experienced by viewers of holograms.

Paper ID: P046

Paper Title: Hologram Application for Innovative Funeral Product Design

Authors: Ye Li, Shuo Wang, Xiaofan Liu

Abstract: Chinese funeral products serve as vital carriers of cultural heritage, bearing the living's commemoration and mourning for the deceased, and possessing profound significance on historical, social, and cultural perspectives. Innovation in funeral products is showing new trends with the advancement of technology and the diversification of artistic expression. Hologram, as an artistic medium, can replicate virtually everything with light, offering a strong sense of space and emotional impact, thus providing new possibilities and methods for innovative expression of objects.

With societal progress, there is an increasing emphasis on the environmental sustainability and emotional value of funeral products. Based on market research on current funeral products, this study has completed a series of experimental holographic funeral products. It explores the potential integration of funeral products with holography and provide new modes of expression for traditional funeral culture

Special Sessions

Communication and Education of Optics II

Date	#	Duration	Venue
Nov. 16	SSC-II	15:30-16:20	5F/ Lingnan 5&6 岭南五+六厅

Session Chair

Shuo Wang, Beijing Institute of Graphic Communication

Time	Paper ID	Presenter	Affiliation
15:30-15:40	P047	Yang Gao	Beijing Institute of Graphic Communication
15:40-15:50	P049	Zicheng Liang	Beijing Institute of Graphic Communication
15:50-16:00	P051	Jiahui Li	Beijing Institute of Graphic Communication
16:00-16:10	P052	Jie Yang	Beijing Institute of Graphic Communication
16:10-16:20	P042	Zhilin Zhu	Beijing Institute of Graphic Communication

Presentation Details

Paper ID: P047

Paper Title: Integrating Holographic Art into Sci-Tech Arts Education: A Comprehensive Framework for Interdisciplinary Talent Development

Authors: Yang Gao, Shuo Wang, Zhilin Zhu

Abstract: Science-Technology Arts (Sci-Tech Arts) is an interdisciplinary field that plays a crucial role in stimulating human creativity and advancing technological innovation. As a burgeoning discipline within art education, Sci-Tech Arts profoundly influences various sectors including art, science, technology, engineering, and industry.

This paper anchors itself in the innovative educational theories of Sci-Tech Arts, incorporating case studies from holographic art to provide an in-depth analysis and periodic review of the higher education teaching system for this major. The paper is divided into five sections: it starts by tracing the emergence and development of Sci-Tech Arts, analyzing the strengths and weaknesses of international talent cultivation models and innovative practices in this field. It then discusses the disciplinary value and role of Sci-Tech Arts from multiple perspectives including science, technology, art, education, culture, and society. The third section compares and analyzes teaching philosophies, faculty structures, curriculum settings, postgraduate cultivation aims, and career trajectories within the discipline, summarizing the main characteristics of its teaching model; the fourth chapter describes the innovative practice paths at the Holographic Arts Center at the Beijing Institute of Graphic Communication, integrating aspects of research, creation, communication, industry, and science

popularization to propose a development framework for the development of Sci-Tech Arts. Finally, the paper forecasts future trends in Sci-Tech Arts and offers targeted strategies and recommendations.

Paper ID: P049

Paper Title: Educational Holographic Cultural and Creative Product Design for Museums

Authors: Zicheng Liang, Jian Wu, Shuo Wang, Xiaoshuang Ma

Abstract: As technology advances and cultural consumption evolves, museum cultural and creative products have increasingly become important vehicles for cultural dissemination and education. This study aims to explore the design of educational and engaging museum cultural and creative products using hologram. Initially, the paper outlines the principles and developmental history of holography in the field of designed product, analyzing its potential applications in museum cultural and creative products. Following market research and user needs analysis, the design direction and target user groups for cultural and creative products were identified.

This study proposes a design scheme for holographic-based cultural and creative products, a Bronze Sitting Dragon from Capital Museum of China is used as a prototype for the design of holographic cultural and creative products, including aspects of functional modules, interaction methods, and visual presentation. A designed prototype is developed, and usability testing is conducted to validate the feasibility of the design and user experience. The findings suggest that holograms can provide a new interactive experience and visual enjoyment for museum cultural and creative products, enhancing public awareness and interest in cultural heritage with broad application prospects.

Paper ID: P051

Paper Title: Design and Application of Holography in Mobile Museums

Authors: Jiahui Li, Shuo Wang, Ardie Osanlou, Jie Yang, Yang Gao, Xiaoshuang Ma

Abstract: Recently, mobile museums have gained popularity by transcending traditional geographical limitations and delivering cultural artifacts directly to communities. Integrating holograpy into mobile museums allows vistors to view exhibits in detail from multiple angles without physical contact. This increase the interactivity and immersive quality of the exhibition.

This study is dedicated to utilizing holographic display combined with flexible mobile exhibition design to present a novel viewing experience that transcends traditional museum interactions. The study not only showcases the practical applications of this technology but also develops a systematic approach to holographic mobile museum design thinking. Furthermore, it explores the potential applications of holography in future museum displays, including its ability to deliver immersive and interactive cultural experiences, pioneer innovative display methods, preserve cultural heritage, thus expanding the dimensions of public education and cultural dissemination.

Paper ID: P052

Paper Title: Exploring the Educational Potential: Application of Hologram in Interactive Card Game Design for Preschoolers

Authors: Guanyu Liu, Shuo Wang, Yue Guan, Jie Yang

Abstract: This paper focuses on the field of educational games targeting children aged 3 to 6, exploring the application of hologram in interactive card game design. It first examines the potential

applications of holography in children's education, emphasizing the crucial role of interactive games in promoting children's cognitive development. Furthermore, the paper elaborates on the core principles of game design, including educational value, interactivity, entertainment, and safety, while highlighting the importance of considering children's psychological and cognitive characteristics in the design process.

This study demonstrates the integration of hologram with children's educational games by introducing interactive mechanisms, visual design, narrative techniques, and educational objectives, creating game content that is both educational and entertaining. Through preliminary user testing, feedback was collected from child users and the game's impact on their cognitive abilities, creativity, and problem-solving skills was evaluated, with results supporting the potential of games in promoting children's development.

Finally, the paper provides prospects for the future development of holographic interactive card games and proposes further design improvements and research directions based on testing feedback, aiming to bring innovative educational tools to the field of children's educational games.

Paper ID: P042

Paper Title: Anti-War Themes in Holographic Art

Authors: Zhilin Zhu, Shuo Wang, Zicheng Liang

Abstract: War is a major issue of widespread societal concern, with its destructive impacts resonating deeply across the globe. Historically, numerous anti-war art pieces have not only delivered significant visual impact but have also provoked audience attention, reflection, and emotional resonance. Holography, as an innovative artistic medium, not only offers new ways of presenting content but also provides artists with a novel language for expression. This paper first examines the impact of war on humanity, then reviews historical anti-war artworks created by various artists. Finally, the author's team has created two sets of anti-war themed artworks using holograms. The two holographic artworks “Afterward” and “Aftermath”, represents the authors’ reinterpretation of anti-war themes, following in-depth research into the subject. These artworks provide viewers with new spatial and perceptual perspectives on the anti-war narrative.

Special Sessions

New Photomechanics Techniques for Extreme Environment Measurements

Date	#	Duration	Venue
Nov. 16	SSN	13:30-15:30	5F/ Lingnan 8&9 岭南八+九厅
Session Chair			
Wei He, Hunan University			
Zhenyu Jiang, South China University of Technology			

Time	Paper ID	Presenter	Affiliation
13:30-13:50	Keynote	Shaopeng Ma	Shanghai Jiaotong University
13:50-14:05	Invited	Zhenyu Jiang	South China University of Technology
14:05-14:20	Invited	Qinghua Wang	Beihang University
14:20-14:35	Invited	Zhang Li	National University of Defense Technology
14:35-14:50	Invited	Xinxing Shao	Southeast University
14:50-15:05	Invited	Baoqiao Guo	Beijing Institute of Technology
15:05-15:20	Invited	Hongye Zhang	Beijing Forestry University
15:20-15:30	P040	Hanwen Xue	Tsinghua University

Keynote Speaker

Shaopeng Ma

Shanghai Jiaotong University

Bio: Shaopeng Ma is a tenured professor in the Department of Engineering Mechanics at the School of Ocean and Civil Engineering at Shanghai Jiao Tong University. He also serves as the Secretary-general of the Experimental Mechanics Committee of the Chinese Society of Theoretical and Applied Mechanics, the Secretary-general of the Teaching Guidance Committee for Mechanics Professions in Higher Education under the Ministry of Education, and the Chairman of the Experimental

Mechanics Committee of the Shanghai Society of Theoretical and Applied Mechanics, among other academic part-time job. He has long been committed to the research of advanced experimental mechanics methods, technologies, instruments, and their applications in major engineering projects. He has successively presided over more than ten major national projects, including the Special Fund for Research on National Major Research Instrument and Key Project of the National Natural Science Foundation of China, as well as the National Key R&D Program of China. The developed detection methods, technologies, and instruments have been successfully applied to multiple major engineering projects.

Speech

Ultra-spatiotemporal Resolution Photogrammetry for Large-scale Engineering Structures

Abstract: Experiments involving large-scale engineering structures, such as aerospace components and bridge structures, are characterized by their large spatial scales and rapid rates of motion or deformation, which demand ultra-spatiotemporal resolution in photogrammetric techniques. This report presents a series of ultra-spatiotemporal resolution photogrammetric techniques suitable for engineering applications, including CCD moiré super-resolution measurement and camera array-based ultra-spatiotemporal resolution measurement techniques. The CCD moiré, due to its deformation amplification effect, enables the measurement of a larger range of motion and deformation while maintaining measurement accuracy. After achieving temporal error correction and large-scale spatial calibration for the cameras, the camera array can complete Ultra-spatiotemporal resolution measurements through temporal and spatial stitching. These photogrammetric technologies have been applied in various applications, such as the buckling of rocket casings, the unfolding of large truss antennas, and bridge deformation monitoring, demonstrating their capabilities in ultra-spatiotemporal resolution measurement.

Invited Speaker

Zhenyu Jiang
South China University of Technology

Bio: Dr. Zhenyu Jiang is a professor of South China University of Technology, China. He received his bachelor and doctor degrees in the University of Science and Technology of China. His research interests include experimental mechanics, image based non-destructive deformation measurement, and mechanical behavior of advanced engineering composites. He has authored and co-authored over 120 research articles in academic journals and 9 patents. He creates OpenCorr, the first open-source software library with full functions of digital image/volume correlation

Speech Title

Image feature based self-adaptive subset for digital image correlation

Abstract: Digital image correlation (DIC) has been widely used nowadays to measure the deformation field or reconstruct the three-dimensional profile in a non-contact way. Configuration of subset (including shape and size) plays a critical role in measurement as it considerably influences the registration between the two images. Proper configuration helps to achieves good accuracy, resolution, efficiency and robustness of measurement. But it generally requires skillful users or trial-and-error procedure. Moreover, fixed configuration is insufficient to fit well the situations in different regions of view field. Those tricky issues became a barrier for common DIC users to get reliable results. We propose a novel method to configure subset automatically. In this method, image features extracted through scale invariant feature transform (SIFT) algorithm are used as the indicators of speckle image quality for registration. A coarsely estimated deformation field is constructed based on the matched image features between the two images. Afterwards, the shape and size of subset at each point of interest (POI) is set according to the local image feature number and displacement gradients. Experimental study shows that the subset determined through our method can adapt well various speckle patterns. It gives excellent results without any manual intervention in some challenging cases of deformation field measurement and three-dimensional reconstruction.

Invited Speaker

Qinghua Wang
Beihang University

Bio: Qinghua Wang, Blue Sky Scholar Distinguished Professor in Beihang University, National Level Talents. Served as a Tenured Senior Researcher at National Institute of Advanced Industrial Science and Technology in Japan. Published over 80 journal papers, and contributed several chapters to English books. Holding 18 authorized invention patents (with 2 technology transfers) both domestically and internationally. Presided over more than 10 national and industrial projects, and won multiple academic awards. The research interests include Experimental Solid Mechanics, Deformation Measurement, Shape Measurement, Optical Methods, Image Processing, Structural Health Monitoring, Defect Detection, Material Evaluation, etc..

Speech Title

Sampling Moire Method for Deformation Field Measurement in Extreme Environments

Abstract: The sampling moire method is a non-destructive deformation field measurement method based on digital images, which has been used for deformation measurement of various materials and structures. This presentation introduces several typical applications of deformation measurement in

extreme environments, including micro/nano-scale, huge-scale, high-temperature environments, etc. The applications include defect detection and strain field measurement of semiconductor atomic structures, residual thermal strain/stress measurement of flip chip packaging materials, strain monitoring before and after microcrack initiation and crack propagation in titanium alloys for aircraft engines, 3D displacement and strain field measurement of carbon fiber reinforced composites, deflection measurement of huge bridges, etc. The advantages and disadvantages of this method will be discussed.

Invited Speaker

Zhang Li
National University of Defense Technology

Bio: Zhang Li received the B.S. degree in communication engineering from National University of Defense Technology, China, in 2008 and the Ph.D. degree in biomedical engineering from Delft University of Technology, Netherlands, in 2015.

He is currently an associate professor at College of Aerospace Science and Engineering, National University of Defense Technology. His research interests lie in computer vision and machine learning, particularly multi-modal image analysis. He is also interested in the applications of deep learning in remote sensing and biomedical image analysis. He has published over 60 papers in high-ranking journals and conferences, including IEEE TGRS, IEEE TCVST, IEEE TAES, IEEE JBHI, IEEE TMI, CVPR, ECCV, etc.

He is currently a Topical Editor of Laser & Optoelectronics Progress, Junior Editor of Acta Mechanica Sinica, and Journal of Applied Optics. He is the guest editor of special issue on multi-source joint learning in healthcare imaging of IEEE JBHI. He initiated the ACDC challenge in conjunction with ISBI 2019 and MICCAI 2020. He also co-organized COMPAY Workshop in MICCAI 2019 and 2021.

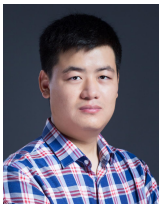
Speech Title

UAV Visual Localization under Low-Altitude and Multi-view Observation Conditions--A Benchmark

Abstract: Absolute Visual Localization (AVL) enables UAV to know its position in GNSS-denied environments. This method primarily establishes geometric relationships between UAV images and existing geo-tagged reference maps through image retrieval and matching techniques. While most previous works were conducted under high-altitude nadir-view conditions, research in low-altitude multi-view scenarios remains limited. Low-altitude multi-view conditions presents greater challenges due to viewpoint differences and nonlinear deformations caused by the terrain. To explore the best UAV AVL approach in such conditions, we have proposed this benchmark. We built a large-scale

Low-Altitude Multi-view dataset, which includes 18,000 images captured at Multi-scenes, Multi-altitudes and Multi-views, along with optional 2.5D reference maps. Additionally, we tested state-of-the-art AVL methods and thoroughly discussed their performance. Overall, this benchmark provides unified implementation for UAV AVL task as well as some valuable guidance for future research.

Invited Speaker



Xinxing Shao
Southeast University

Bio: Xinxing Shao received his BS and PhD degree in Experimental Solid Mechanics from Southeast University, China. Currently, he is an associate professor in the School of Civil Engineering at Southeast University. His current works are focus on real-time, high-accuracy and fully automatic deformation measurement for engineering applications and development of scientific instruments. He has published more than 70 journal and conference papers in the field of optical deformation measurement. Now, He is the Deputy leader of Optical Measurement Group in CSTAM.

Speech Title

Calibration of Stereo-Digital Image Correlation for Deformation Measurement of Large Structures

Abstract: Calibration of a stereo-digital image correlation (stereo-DIC) system is essential for three-dimensional (3D) shape and deformation measurement. Although the traditional planar calibration method is flexible in most application scenarios, it still has difficulties in large field of view (FOV) calibration due to the limited size of calibration board and difficulty of on-site operation. To meet these challenges, the stereo-vision calibration methods are proposed for large FOV measurement. Specifically, accurate camera intrinsic parameters and extrinsic parameters are calibrated separately by calibration board, close-range photogrammetry or epipolar constraints for different applications. Compared to traditional planar calibration methods, the proposed methods don not require high-quality or large-sized calibration objects, and even all parameters can be calibrated on-site. Two typical site experiments demonstrated the potential of these methods in the field of engineering measurements.

Invited Speaker

Baoqiao Guo
Beijing Institute of Technology

Bio: Baoqiao Guo, is an associate professor at the State Key Laboratory of Explosion Science and Safety Protection, Beijing Institute of Technology. He got his PhD from the Arts et Métiers ParisTech in 2007. His research is focused on the testing techniques at high strain-rate, material parameter identification based on the virtual field methods, and impact dynamics.

Speech Title

Measurement of Displacement Field of Vibrating Plate Based on Deflectometry

Abstract: The bending deformation field of thin plates under excitation is closely related to the material mechanical properties. Usually, the 3D-DIC method is difficult to accurately measure the deformation field of thin plate at high frequencies. Based on the principle of deflection, the slope fields of thin plates during vibration can be directly measures by deflectometry, which can amplify the very small bending deformation. The bending displacement field of is calculated through two-dimensional integration from slope fields. The results show that this technique has high sensitivity in measuring the bending deformation of thin plates, which can be used to measure small bending deformation of thin plates with high precision.

Invited Speaker

Hongye Zhang
Beijing Forestry University

Bio: Hongye Zhang is an associate professor at the School of Technology, Beijing Forestry University. He graduated with a PhD from Beijing Institute of Technology in June 2019, has received the title of "Excellent Graduate of Common Colleges and Universities in Beijing", the "Outstanding Doctoral Dissertation of Beijing Institute of Technology", the National Scholarship*2, the Excellent Academic Paper Award of Beijing Force Association, the Second Prize of the 18th Basic Teaching Skills Competition for Young Teachers of Beijing Forestry University, the "Party Pioneer Post" of Beijing Forestry University in 2023, and has been recognized as an IOP Trusted Reviewer. He hosted 5

provincial and ministerial-level projects or above, including 1 National Natural Science Foundation of China (NSFC) Young Scientist Fund project, 1 Beijing Natural Science Foundation Young Scientist Fund project, 1 Postdoctoral Science Foundation General Program and 2 projects from the Beijing Forestry University's Scientific and Technological Innovation Plan as well as 4 horizontal research projects.

Speech Title

Experimental Study on Microscopic Mechanical Behavior of Dendritic and Inter-dendritic Phase Interface in Ni-Based Superalloy

Abstract: Ni-based single-crystal superalloys have been widely used in aerospace, marine, and special manufacturing industries due to their excellent high-temperature strength, structural stability, operational reliability, and high-temperature creep performance. In this paper, the second-generation Ni-based singlecrystal superalloy DD6 was selected as the raw material, and transmission electron microscopy, spherical aberration correction transmission electron microscopy, nanoindentation instruments, and other equipment were used to systematically investigate the relationship among the interface width, the lattice mismatch and the strain field in the interface transition region before and after solid solution treatment in the DD6 alloy. The influence of elements was analysed and discussed using X-ray energy dispersive spectroscopy. At the same time, nanoindentation experiments were used to calculate the elastic modulus and hardness of the inter-dendritic and dendritic regions of the DD6 alloy before and after solid solution treatment, and the effect of solid solution treatment on the improvement of micro-mechanical parameters was discussed.

Presentation Details

Paper ID: P040

Paper Title: From Strain to Temperature: Application And Functional Expansion of DIC Methods in Extreme Temperature Environments

Authors: Hanwen Xue, Chuanqing Geng, Chenghao Zhang, Yangyang Li, Wenxiong Shi, Lifu Wu, Huimin Xie*

Abstract: The Digital Image Correlation (DIC) method offers significant advantages, including non-contact measurement, simplicity, and robustness, making it extensively utilized in both research and engineering applications. In this study, we detail the ongoing research progress and the application of the DIC method in extreme environment measurements at Photomechanics Lab, Tsinghua University. Additionally, we illustrate the method's capability for integrating three-dimensional thermal-mechanical information, highlighting its potential for comprehensive data extraction.

To address the full-field measurement challenges in cryogenic environments, we proposed an effective method for preparing cryogenically-stable deformation carriers. This method, combined with the Virtual Field Method (VFM), facilitated the characterization of crack tip stress intensity factors (SIF) and modulus distribution in additively manufactured specimens at -180°C. Furthermore, merging the 3D-DIC method with photoluminescence temperature measurement has led to the development of a novel approach based on the solid surface photoluminescence thermometry model, targeting

synchronous spatial-temporal extraction of 3D surface temperature and deformation fields in cryogenic environments. In high-temperature environments, we developed a platform for synchronous thermal-mechanical measurements based on radiation colorimetry. Utilizing a doubly telecentric multispectral imaging system, this platform ensures minimal emissivity dependence and excellent control of geometric distortions on the measured surfaces. Thermal expansion experiments demonstrate that this method enables synchronous 2D-DIC measurement and temperature field extraction across the entire field at temperatures up to 1000°C.

The above research results show that the DIC method offers excellent measurement performance and good application prospect for 2D/3D displacement and temperature measurements in extreme environments.

Special Sessions

Optical Coherence Tomography

Date	#	Duration	Venue
Nov. 16	SSO	15:45-16:45	5F/ Lingnan 8&9 岭南八+九厅

Session Chair

Haixia Wang, Zhejiang University of Technology

Time	Paper ID	Presenter	Affiliation
15:45-16:00	Invited	Cuiru Sun	Tianjin University
16:00-16:15	Invited	Cuixia Guo	Fuzhou University
16:15-16:30	Invited	Yilong Zhang	Zhejiang University of Technology
16:30-16:45	Invited	Haixia Wang	Zhejiang University of Technology

Invited Speaker

Cuiru Sun
Tianjin University

Bio: Dr. Sun is an associate professor in the school of Mechanical Engineering at Tianjin University. Her research interests include optomechatronics, OCT and their applications in biomedicine. She has published over 70 peer reviewed papers. She is an associate editor for Biomedical Optics Express, a steering committee member of International Symposium on Optomechatronic Technology (ISOT), a committee member of Tianjin Society of Biomedical Engineering.

Speech Title

The Synergy of OCT and Elastography in Vascular Mechanics Analysis

Abstract: Optical Coherence Tomography (OCT) has revolutionized the visualization of arterial microstructures, providing detailed insights into atherosclerotic plaques in cardiology. To assess the risk of plaque rupture, a comprehensive understanding of the biomechanical properties of blood vessels is essential. In this presentation, we will discuss the collaborative advancement of Doppler OCT, Optical Coherence Elastography (OCE), and intravascular OCT image reconstruction

techniques, in conjunction with numerical simulations. These synergistic developments aim to characterize the hemodynamics and vascular wall properties of blood vessels both ex vivo and in vivo. The talk will emphasize the innovative role of OCE as an integral component of intravascular OCT, highlighting its potential as a transformative tool for the diagnosis and treatment of cardiovascular diseases.

Invited Speaker

Cuixia Guo
Fuzhou University

Bio: Cuixia Guo is an associate Professor at School of Mechanical Engineering and Automation, Fuzhou University, Fuzhou 350108, China. Her current research area is optical coherence tomography and their applications in the biosensing.

Speech Title

Thickness Encoded Suspension Array and Corresponding OCT-based Decoding System

Abstract: High-throughput biomolecular detection, which has the advantages of small sample requirement and high detection efficiency, is in wide demand in areas such as disease diagnosis and environmental monitoring. Suspension array (SA) based on fluorescent microsphere encoding is the most widely used high-throughput detection technique, but faces the shortcomings of low encoding stability and limited number of encodings induced by fluorescence quenching, wide bandwidth of fluorescence spectra, and spectral aliasing. We propose a novel SA using glass microchips as detection carriers and a corresponding OCT-based decoding system, which utilizes the thickness and shape of the microchip itself as well as the grafted digitized fluorescence spectral information as the encoding signals of the sample species to improve the encoding stability while the composite encoding method increases the total number of encodings exponentially. The decoding system based on optical coherence

Invited Speaker

Yilong Zhang
Zhejiang University of Technology

Bio: Yilong Zhang is an associate professor at Zhejiang University of Technology. He has been in charge of several projects of the National Natural Science Foundation of China and Zhejiang Province. His major research fields include biomedical optical imaging and pattern recognition.

Speech Title

Fingerprints Presentation Attack Detection with Optical Coherence Tomography

Abstract: As a non-invasive optical imaging technology, optical coherence tomography (OCT) can effectively collect internal fingerprints. Internal fingerprints have become an important basis for fingerprint presentation attack detection (PAD) due to their excellent anti-interference and anti-forgery properties. However, some fingerprint attack detection technologies based on OCT mainly rely on local information, ignoring the overall continuity and correlation of physiological structures. Considering the complexity and diversity of forgery attack (PA) samples, it is also a huge challenge to improve the generalization ability of the model using limited PA datasets. To this end, this study proposes a fingerprint acquisition system that can simultaneously use TIR and OCT technology to collect external fingerprints and internal fingerprints respectively. In this presentation, we proposed two OCT fingerprint anti-counterfeiting methods. Through the dual-branch architecture, not only can the global features be learned from the OCT images, but also the hierarchical structural features from the internal structure attention module (ISAM) can be focused on learning.

Invited Speaker

Haixia Wang
Zhejiang University of Technology

Bio: Haixia Wang received her B.S. and Ph.D. degree in Computer Engineering from Nanyang Technological University, Singapore, in 2007 and 2012, respectively. She is currently a professor in College of Computer Science & Technology, Zhejiang University of Technology, China. She has

published several papers on journals such as Optics Letters, IEEE Transactions on Information Forensics and Security, etc. Her research interests include optical metrology, 3D shape measurement, image processing and pattern recognition.

Speech Title

A Synchronously Collected External and Internal Fingerprint Database based on Total Internal Reflection and Optical Coherence Tomography

Abstract: Fingerprint recognition systems relying solely on surface-level details are susceptible to spoofing and poor skin conditions. To address these issues, internal fingerprints (IFs), captured using optical coherence tomography (OCT), have emerged as a promising solution. However, progress in this field is hindered by a scarcity of in-depth studies on IFs and their integration with external fingerprints (EFs), exacerbated by the absence of a public OCT database. This gap has prompted us to introduce ZJUT-EIFD, a novel fingerprint database that integrates OCT and total internal reflection (TIR) imaging. This work outlines the database's makeup, assesses the quality and verification accuracy of EFs and IFs, and explores potential applications for ZJUT-EIFD. As the first of its kind, ZJUT-EIFD aims to facilitate benchmarking and interoperability in EF-IF research, advancing the field of fingerprint recognition technology.

Technical Sessions

Digital Holography and Quantitative Phase Imaging

Date	#	Duration	Venue
Nov. 17	TS-1	09:00-10:00	5F/ Lingnan 2&3 岭南二+三厅
Session Chair			
Hao Yan, Shanghai Jiao Tong University			

Time	Paper ID	Presenter	Affiliation
09:00-09:15	Invited	Junwei Min	Xi'an Institute of Optics and Precision Mechanics, CAS
09:15-09:30	Invited	Jiasong Sun	Nanjing University of Science and Technology
09:30-09:45	Invited	Hao Yan	Shanghai Jiao Tong University
09:45-10:00	Invited	Ping Su	Tsinghua Shenzhen International Graduate School

Invited Speaker

Junwei Min

Xi'an Institute of Optics and Precision Mechanics, CAS

Bio: Prof. Dr. Min Junwei is from the State Key Laboratory of Transient Optics and Photonics, Xi'an Institute of Optics and Precision Mechanics, Chinese Academy of Sciences, Xi'an, Shaanxi, P. R. China. His research primarily focuses on quantitative phase imaging (QPI) as well as optical three-dimensional imaging and measurement. He has developed various dual-wavelength quantitative phase imaging techniques and compact QPI devices, which have been successfully applied in biomedical research and industrial inspection fields. Prof. Dr. Min has extensively collaborated with scientists from Germany and Egypt, resulting in numerous noteworthy technological achievements. He has received grants from National Natural Science Foundation of China and Shaanxi Nova program etc. while also being honored with the second prize of Shaanxi Provincial Natural Science Award.

Speech Title

Shearing based Compact Quantitative Phase Imaging and Its Application in Cells and Flows Visualization

Abstract: Quantitative phase imaging (QPI) enables non-contact and high-precision observation of the three-dimensional morphology or refractive index distribution of unlabeled samples, providing unique advantages in transparent sample observation, material surface characterization, and flow field detection. Over the years, various types of quantitative phase imaging devices and equipment have been developed and applied in many fields. However, the translation of QPI into biological and clinical laboratories still suffers from bulky and complicated optical setup, expensive cost and maintenance, and incompatibility with existing microscopes. The integration and application of different imaging methods have become one of the important directions for the development of imaging field. Therefore, we have developed shearing based compact quantitative phase imaging modules and cameras to meet the needs of emerging technological research and high-precision production processing testing. Whether transplanting integrated modules into existing imaging equipment or directly using quantitative phase imaging cameras for image recording can add quantitative phase imaging functions to devices. By utilizing this new technology, we can not only quantitatively observe and analyze the composition and motion characteristics of transparent cells without labeling, but also achieve visualization research on temperature and airflow fields. The modularization of quantitative phase imaging technology can not only help improves the imaging capabilities of existing equipment but also promotes further popularization and dissemination of quantitative phase imaging technology.

Invited Speaker

Jiasong Sun

Nanjing University of Science and Technology

Bio: Dr. Jiasong Sun is an associate professor at Nanjing University of Science and Technology (NJUST). He earned his Ph.D. in Optical Engineering from NJUST in 2019 and has since been actively engaged in research at the Smart Computational Imaging Laboratory. His research focuses on computational microscopy, quantitative phase retrieval, and superresolution microscopy. Dr. Sun has made significant contributions to the field of Fourier ptychographic imaging for large-field, high-resolution quantitative phase microscopy. His work has been recognized through numerous publications that showcase his innovative approaches and findings in computational imaging technologies.

Speech Title

Single-shot Differential Phase Contrast Microscopy for Living Cells Based on Optimal Phase Transfer Function

Abstract: Differential phase contrast microscopy is a quantitative phase imaging technique based on asymmetric illumination, which can achieve efficient phase recovery of weak phase objects without invasive labeling. Usually, differential phase contrast technology uses a dual-axis asymmetric illumination mode, takes four frames of images as input, and then reconstructs the sample phase using a one-step deconvolution. However, according to information theory, these four raw images contain twice the redundant information. Therefore, we use incoherent bright field illumination and semi-annular illumination scheme, and add non-negative support constraints to the iterative algorithm. Only two frames of raw images can be used to accurately reconstruct and decouple the amplitude and phase of the sample. Furthermore, since living cells are approximately pure phase objects, there is no need for incoherent bright-field illumination, and only a single frame of differential phase contrast image should be taken to achieve quantitative phase imaging of living cells. In addition, by quantitatively comparing the amplitude and distribution uniformity of different differential phase transfer functions, we also analyzed and determined that uniform semi-annular illumination is the optimal single-frame illumination scheme. This will promote the further application of single-frame quantitative phase imaging technology based on differential phase contrast in multiple fields such as life sciences and biomedical dynamic imaging.

Invited Speaker

Hao Yan

Shanghai Jiao Tong University

Bio: Yan Hao is an associate professor and PhD supervisor at Shanghai Jiao Tong University. She received her master's degree from Tianjin University and her doctor's degree from Nanyang Technological University in Singapore. Research direction: digital holography, complex wavefront retrieval technology based on deep learning. She has presided over the National Natural Science Foundation project, the National Natural Gold Youth Project, and the Shanghai Natural Science Foundation Project. As a significant participant to participate in the national key research and development project, and develop high-precision deformation measuring instruments. So far, she has published more than 50 papers, including more than 20 SCI articles as the first author and corresponding author, and 8 patents.

Speech Title

3D Shape and Deformation Measurement by Digital Holography and Complex Wavefront Retrieval Techniques

Abstract: Digital holography and complex wavefront retrieval (CWR) based on deep learning are techniques which are capable to obtain the complex wavefront (including the amplitude and phase of the light wave). With the help of laser, digital camera, computer-based digital reconstruction, image processing algorithm, computer parallel acceleration, deep learning and other technologies, digital holography and CWR can quickly obtain quantitative complex wavefront. The complex wavefront obtained by digital holography and CWR could be digitally focused at any spatial depth, and the focused image at different spatial depths can be obtained without moving the sample or any optical element, which is an important advantage of such technique. This report introduces the research and progress of our team based on digital holography and techniques in dynamic full-field 3D shape measurement, deformation measurement, vibration measurement, small-modulus gear parameter evaluation, full-field standard deformer development, ultra-depth of field automatic focusing, integrated system development, etc. We hope to continuously improve the application level of digital holography and CWR techniques.

Invited Speaker

Ping Su

Tsinghua Shenzhen International Graduate School

Bio: Dr. Ping Su is an associate professor in Tsinghua Shenzhen International Graduate School, Tsinghua University. She mainly engages in research on holographic display and imaging. She has published more than 100 papers in well-known peer-reviewed journals, including more than 50 papers indexed by SCI. She has been granted more than 20 invention patents in China. She serves as a young editorial board member of the ESCI-indexed journal “Laser & Optoelectronics Progress”. She is the Deputy Secretary-General of the Computational Imaging Committee of the Chinese Optical Engineering Society, an executive committee member of the Photonic Information Committee of the Shenzhen Computer Association, a committee member of the Optical Display Committee of the Chinese Optical Engineering Society, the Holography Committee of the Chinese Optical Society, and the Three-Dimensional Display Committee of the Chinese Society for Graphical Images. She is also a member of the international professional society IEEE/OPTICA.

Speech Title

Lensless on-Chip Super-Resolution Microscopy Based on Array Illumination and Phase Recovery Algorithm

Abstract: The resolution of lensless on-chip microscopy is limited by the pixel size of the image sensor, which restricts its applications. Existing pixel super-resolution techniques either rely on precise translation stages for hundreds of high-precision displacements or rotations, or on expensive tunable lasers to generate diffraction diversity. Furthermore, conventional ptychography imaging reconstruction algorithms are prone to oscillations in the early stages of iteration. In this paper, we propose a ptychography imaging technique based on scattering multiplexing, which involves coating the surface of the image sensor with a layer of polystyrene microspheres with diameters far smaller than the sensor pixel, and utilizing a 4×3 LED array to sequentially illuminate the scattering layer with small displacements, thereby obtaining 12 holograms with minute differences without any moving parts. A ptychography reconstruction algorithm based on dual amplitude gradient descent (DAGD) is designed for the reconstruction from the holograms, which uses the diffraction intensity maps of the scattering layer and the holograms as dual constraints. This algorithm effectively avoids the problems of slow convergence speed and obvious oscillation in conventional ptychography reconstruction algorithms. Compared with other similar technologies, our system has no moving parts and uses inexpensive partially coherent light illumination.

Technical Sessions

3D Image Acquisition and Display &3D Computer Vision &Image Processing and Deep Learning

Date	#	Duration	Venue
Nov. 17	TS-2	09:00-10:15	5F/ Lingnan 5&6 岭南五+六厅
Session Chair			
Peng Gao, Xidian University			

Time	Paper ID	Presenter	Affiliation
09:00-09:15	Invited	Chenxing Wang	Southeast University
09:15-09:25	P011	Huisi Miao	XiangTan University
09:25-09:35	P044	Hongxing Peng	South China Agricultural University
09:35-09:45	P062	Yan Hu	Nanjing University of Science and Technology
09:45-09:55	P063	Wenfeng Guo	ShenZhen Technology University
09:55-10:05	P080	Haopeng Yang	Nanjing University of Science and Technology
10:05-10:15	P025	Zhihan Xu	The Hong Kong Polytechnic University

Invited Speaker

Chenxing Wang
Southeast University

Bio: She is an associate Professor at the School of Automation, Southeast University. She has presided over multiple National Natural Science Foundation and provincial/ministerial level funds, published many papers in the top Journals and CCF Conferences, authorized more than 20 patents, and served as a letter evaluation expert and technology consulting evaluation expert for the National Natural Science Foundation and multiple provincial/municipal Natural Science Foundation. Her main research directions include optical imaging, 3D perception, signal/information processing and detection, graphics, pattern recognition, etc.

Speech Title

A 3D Information Steganography Technique Using DiffStega

Abstract: Optical 3D measurement and imaging have always been a research focus in the industry, and many application technologies and products have been developed. Some technologies capture the light field through optical design and combine it with intelligent computing and related algorithms to achieve imaging, such as 3D single pixel imaging. Before the rise of deep learning, we worked hard to develop various signal processing and computational algorithms to solve various problems in measurement and imaging. In recent years, most work introduce artificial intelligence techniques to solve various imaging problems. This report will discuss the problems based on some recent work with computing techniques in the research group. It is expected that more flexible technologies can be integrated and infiltrated into each other in the future, generating a wider range of intelligent applications.

Presentation Details

Paper ID: P011

Paper Title: Frequency Shift-Based 3D Shape Measurement in the Presence of Strong Inter-Reflection

Authors: Huisi Miao, Ziyu Yan, Wei Huang, Weidong Xu, Dongbo Zhang

Abstract: The traditional fringe projection profilometry is unable to achieve highly robust imaging and high-precision three-dimensional (3D) reconstruction of objects under complex environmental illumination, such as strong interreflection. In this paper, a method combining frequency-shifted fringe projection and polar constraints is proposed, which is capable of achieving high-precision 3D contouring in strong interreflective scenes. Firstly, the signal sequence is processed by window function analysis and a four-step phase-shift method to eliminate the interference of ambient light and reduce the highest fringe frequency. Subsequently, the direct and indirect light are separated based on the Fourier transform. This is followed by the application of threshold segmentation and geometric constraints on poles, which are utilized to locate the position generated by the direct light. This process improves the robustness of the imaging in the strong interreflective scene. The experimental results demonstrate that the method constructs direct and indirect illumination feature models, accurately obtains direct illumination information, and thus eliminates multipath illumination interference. Furthermore, the imaging efficiency and robustness are significantly improved in the test of complex geometric surface objects. The proportion of effective point cloud data is increased by more than 30%, and the planar accuracy is improved by 50%.

Paper ID: P044

Paper Title: Research on Visual Odometry Scheme Based on Semi-Feature Method

Authors: Hongxing Peng, Hu Chen, Shuji Chen

Abstract: Aiming to the excessive computation while extracting ORB feature and computing descriptors in the front-end of the visual SLAM system based on feature-based method, and the poor real-time performance of construction and localization of the map, we purpose a visual odometry scheme based on semi-feature method in this paper, which combines the advantages of the direct

method and feature-based method, using direct method and feature-based method in concert for solving camera pose. By designing the front-end tracking strategy, the system is able to choose the tracking method autonomously. Firstly, the direct method is used to replace the pose estimation method in the original ORB-SLAM2 visual odometry scheme to improve the tracking efficiency of the front-end of the system. Secondly, the feature-based method is used to cope with the tracking failure of the direct method and two situations of pose estimation of the key frame, in order to ensure the accuracy of the key localization information. Thirdly, the PnP (Perspective-n Point) method is used to realize the estimation of camera motion state. Finally, in the localization process of the global SLAM system, the sliding window method is chosen to reduce the scale of the optimization problem, and at the same time, the method of graph optimization on pose is introduced to further reduce the computational scale of the system in the global map construction and improve the real-time performance of the system. To validate the effect of the proposed method on the overall visual SLAM system performance, experiments are designed based on two public datasets, EUROC and TUM, and the experimental results show that the visual odometry scheme proposed in this paper can significantly improve the front-end tracking speed at the low loss of camera pose estimation accuracy in the visual SLAM framework.

Paper ID: P062

Paper Title: High-Efficiency Infrared 3D Reconstruction with Hybrid SFM-MVS for Large Scenes

Authors: Mengnan Yang, Lizhaoxuan Liu, Liuyao Zhou, Shijie Feng, Yan Hu

Abstract: Fringe projection profilometry (FPP) stands out as a popular 3D measurement technique, prized for its non-contact nature, high precision, affordability, and efficiency. However, measuring objects with significant reflectance variations, such as biological tissues, presents a formidable challenge: image saturation. This saturation can introduce errors during phase unwrapping, leading to incomplete or erroneous 3D reconstructions. To address this issue, we propose a novel adaptive fringe projection method tailored explicitly for the highlighted surfaces of biological tissues. This method employs an iterative approach to adjust the intensity of locally connected regions within the projection pattern, ensuring that the captured image is free of overexposed areas. Through rigorous experimentation, we demonstrate the method's ability to accurately measure the highlighted surfaces of biological tissues, ultimately yielding complete and exact 3D profiles. This breakthrough addresses a critical limitation in FPP, expanding its applicability for detailed analysis of biological structures.

Paper ID: P063

Paper Title: Robust Structured Light Field Depth Estimation via Spinning Line Operator

Authors: Wenfeng Guo, Qingyang Wu, Yifeng Zou

Abstract: Light fields can simultaneously capture the intensity and direction of each light ray, offering enhanced information for depth estimation. Currently, accurately extracting the epipolar plane lines and handling occlusion are the tough problems of the epipolar plane image depth estimation for light field. Passive depth estimation algorithms only relying on texture information from reconstructed object surfaces struggle to reconstruct texture-free areas, and exhibit poor noise resilience and low accuracy. To address these problems, this paper introduces structured light projection to add accurate and stable texture information, thereby improving the measurement accuracy and robustness, and proposes an

epipolar plane line extraction algorithm suitable for structured light field data. This paper designs a spinning line operator based on Structured Light Field characteristics, and uses the variance of the points on the epipolar plane line as the cost of measuring the extraction accuracy. It judges and handles the occlusion problem by gradually removing abnormal points to make the variance converge. This paper measures and reconstructs objects such as standard blocks, standard balls, and portraits, and achieves satisfactory reconstruction results.

Paper ID: P080

Paper Title: A Three-Dimensional Imaging Method Based on Multi-View Scheimpflug Projection

Authors: Haopeng Yang, Chong Zhou, Yan Hu, Chao Zuo, Qian Chen

Abstract: Precise and comprehensive three-dimensional (3D) measurement of intricate microstructures remains a significant challenge. This paper introduces a microscopic 3D imaging method based on multi-view Scheimpflug projection. To overcome the limitations of limited depth of field and occlusion inherent in microscopic measurements, we employ a telecentric camera and four Scheimpflug projectors. We optimize system calibration accuracy by constructing a model based on the phase-height mapping relationship under complex optical paths. This approach enhances point cloud fusion accuracy through a multi-view data error compensation model. To further improve imaging quality for surfaces with high dynamic range and high reflectivity, we propose an intelligent dynamic noise cancellation method. Experimental results demonstrate that the system calibration achieves a reverse projection error within ±1μm, with an absolute accuracy of 3 μm and a repeatability of 1 μm over a volume range of 10(H)mm × 45(W)mm × 45(D)mm.

Paper ID: P025

Paper Title: Correspondence Imaging through Scattering Media

Authors: Zhihan Xu, Wen Chen

Abstract: Conventional correspondence imaging (CI) achieves object reconstruction by conditionally averaging projected random patterns depending on a constant threshold which is generated from the average value of light intensities recorded by a single-pixel detector. However, object reconstruction in conventional CI meets its challenge in complex scattering media where recorded light intensities fluctuate significantly due to intrinsic dynamic scaling factors in the optical channel. In addition, conventional CI suffers from poor quality because of the conditional averaging among random patterns. Here, we report a varying thresholds-based CI that enables object reconstruction with high quality through complex scattering media. To eliminate dynamic scaling factors caused by complex scattering media, varying thresholds are estimated by building an optimization model to optimize consistency between estimations and recorded light intensities. Then, the estimated varying thresholds can be utilized to binarize the recorded light intensities. In addition, to improve reconstruction quality, another optimization model is built by minimizing L1 norm and total variation (TV) norm of object reconstruction. We demonstrate the method in optical experiments. It is experimentally verified that the method can effectively eliminate dynamic scaling factors and achieve object reconstruction with high quality through complex scattering media.

Technical Sessions

Image Processing and Deep Learning & Fiber Optics and Sensing Technology

Date	#	Duration	Venue
Nov. 17	TS-3	09:00-10:15	5F/ Lingnan 8&9 岭南八+九厅
Session Chair			
Zhenyu Jiang, South China University of Technology			

Time	Paper ID	Presenter	Affiliation
09:00-09:20	Keynote	Guohai Situ	Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences
09:20-09:35	Invited	Wen Chen	The Hong Kong Polytechnic University
09:35-09:45	P024	Yin Xiao	The Hong Kong Polytechnic University
09:45-09:55	P088	Liankun Lai	Universiti Sains Malaysia
09:55-10:05	P096	Yukai Lao	Guangdong University of Technology
10:05-10:15	P009	Kun Xiao	Zhejiang University of Technology

Keynote Speaker

Guohai Situ

Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences

Bio: Guohai Situ is the director of Shanghai Institute of Laser Technology. Before this appointment, he was affiliated with the Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences. His research interests encompass a broad spectrum of computational optical imaging, particularly leveraging deep learning. Currently, his focus is on imaging through optically thick scattering media, computational ghost imaging, and phase imaging. To date, he has published 100 papers in leading journals. He is a Fellow of Optica and a National Science Fund for Distinguished Young Scholars (NSFC) recipient. He also serves on the editorial boards of Advanced Photonics and Advanced Photonics Nexus.

Speech Title

On the Use of Deep Neural Networks for Computational Imaging: from Data-Driven to Physics Driven

Abstract: Recently deep neural networks~(DNN) has shown the great capability of solving various inverse problems in computational optical imaging. Conventionally, DNN should be trained by a large set of paired or unpaired data. The most critical issue with this paradigm is that the neural network inference has no physical interpretation or limited generalization. In order to resolve these issues, one solution is to incorporate the physics of the problems in hand into the training of DNN, resulting in a novel framework that is called physics-enhanced deep neural networks or, PhysenNet, for short. Here we present a brief review of recent works in this regard with the use cases of ghost imaging, phase imaging, and imaging through scatters. We will show that PhysenNet does not need any data to train. Instead, it learns from the physics of the given problem. Therefore, the output of PhysenNet is naturally satisfied with the constrain imposed by the corresponding physical model. We would also like to emphasize that the concept of PhysenNet is quite generic, and can be used to solve many other inverse problems other than optical imaging.

Invited Speaker

Wen Chen

The Hong Kong Polytechnic University

Bio: Wen Chen received Ph.D. degree from National University of Singapore. Dr. Chen conducted extensive research related to computational optics and information photonics as Research Associate (2010) and Research Fellow (2011-2015) in National University of Singapore. Dr. Chen was a visiting scholar in Harvard University in 2013. Dr. Chen joined The Hong Kong Polytechnic University as an Assistant Professor in Dec. 2015. Since 1 July 2021, Dr. Chen is currently an Associate Professor at The Hong Kong Polytechnic University. Dr. Chen has authored more than 160 top-tier journal and conference papers on his field of specialization. Dr. Chen is listed among the top 2% of the world's most highly cited scientists by Stanford University. Dr. Chen serves as an Associate Editor for several academic journals (e.g., Optics and Lasers in Engineering (Elsevier), Optics Express (Optica Publishing Group)). Dr. Chen's current research interests focus on computational optics, information photonics, optical imaging, optical encoding, free-space optical data transmission, deep learning in optics and photonics.

Speech Title

High-resolution Computational Imaging through Dynamic and Complex Scattering Media

Abstract: Computational optics is the science and technology of light (photon) generation, illumination, manipulation, modulation, transmission and detection combined with computing platforms and advanced algorithms. Computational optics is focused on approaches, models and technologies for sensing, measurement, interpretation and visualization of information, and is widely studied and applied in recent years. In this invited talk, Dr. Chen will present his research work about single-pixel optical imaging through dynamic and complex scattering media. This invited talk will focus particularly on the theories, characteristics and performance of computational imaging with single-pixel detection. The applications are presented and discussed.

Presentation Details

Paper ID: P024

Paper Title: Single-pixel Imaging using Reweighted Amplitude Flow Optimization

Authors: Yin Xiao, Wen Chen

Abstract: When random patterns are applied, correlation reconstruction is widely used in single-pixel imaging (SPI). However, the performance of the correlation algorithm still needs to improve in achieving high-quality object reconstruction, although some improved methods have been developed (e.g., Gerchberg-Saxton-like ghost imaging). Here, we present an approach to enhancing SPI performance by integrating the reweighted amplitude flow (RAF) strategy. The proposed method optimizes the object reconstruction process by weighting the measurement data adaptively to improve noise robustness and reconstruction accuracy. Initially, an efficient estimation of the target object is obtained through weighted maximal correlation initialization. Subsequently, iterative updates refine the estimate using reweighted gradient descent. This approach significantly improves SPI performance, providing high-quality object reconstructions. The results demonstrate the effectiveness of the RAF-enhanced SPI, highlighting its potential for practical applications.

Paper ID: P088

Paper Title: Development and Performance Evaluation of a Novel OTDR-Based Distributed Optical Fiber Sensor Using Superabsorbent Polymers for Precision Soil Moisture Monitoring

Authors: Liankun Lai, Mohd Rizal Arshad, Junting Zou

Abstract: As the global population grows and climate change intensifies, sustainable water management and agricultural practices face serious challenges. This paper introduces an innovative distributed optical fiber sensor based on Optical Time Domain Reflectometry (OTDR) and employing superabsorbent polymers (SAPs) as humidity-sensitive materials. SAPs, known for their high water absorption and retention capacities, are utilized here not only to amend soil properties but also to facilitate precision in soil moisture and water retention monitoring. The sensor system comprises an OTDR device connected to fiber optics integrated with SAPs through a novel structural setup where each node contains sliding blocks sandwiched between upper slots filled with SAPs and lower slots housing the fiber optics in an 'n' shape configuration. This design enables the detection of humidity

variations through the SAP-induced expansion or contraction, which drives the sliders to press or release the fiber optics, altering the fiber's bend and hence its light attenuation properties. These changes are precisely recorded by the OTDR, with different attenuation levels translated into moisture levels via a calibration chart. The sensor demonstrates high accuracy and spatial resolution in laboratory settings, achieving moisture monitoring with a resolution up to the meter-level, suitable for detailed field applications. Additionally, the system's real-time data transmission capabilities allow for rapid response to moisture changes, supporting real-time decision-making for precision irrigation. This technology shows potential in enhancing irrigation strategies, improving crop yields, and conserving water resources, indicating a promising avenue for broader application in precision agriculture.

Paper ID: P096

Paper Title: Saliency Guided Progressive Fusion of Infrared and Visible Images with Complex Backgrounds

Authors: Yukai Lao, Jianglei Di

Abstract: Thermal targets are prominent in infrared light images, yet infrared imaging is susceptible to thermal noise, often resulting in blurred edges of targets. Conversely, visible images offer rich background texture features and enhance the edge details of targets. To address these complementary strengths, we propose a saliency-guided end-to-end fusion framework called SGfusionNet for fusing infrared and visible images. This framework aims to preserve comprehensive and informative fusion images. Firstly, we introduce a feature extraction module with dual branches that incorporate gradient filters to enhance the capture of robust features. Secondly, an adaptive feature fusion module is introduced to achieve complementary fusion by learning to select dominant features from multi-modal images progressively. Lastly, we design a saliency-weighted loss function that assigns higher weights to semantically salient regions. This approach guides feature extraction and fusion to prioritize salient regions while retaining rich information in non-salient areas. Extensive experiments validate that our fusion method yields high-quality results with natural and superior visual effects. This demonstrates the effectiveness of SGfusionNet in enhancing the fusion of infrared and visible images, leveraging saliency guidance to achieve optimal fusion outcomes.

Paper ID: P009

Paper Title: Reconstruction-based OCT Fingerprint Presentation Attack Detection

Authors: Kun Xiao, Haixia Wang, Jianru Zhou

Abstract: The advent of Optical Coherence Tomography (OCT) as a non-invasive imaging modality has heralded novel opportunities for research in automated fingerprint recognition systems (AFRS). Numerous fingerprint presentation attack detection (PAD) strategies have been advanced using OCT. Nonetheless, the detection of novel, unknown presentation attacks (PAs) poses an intractable challenge. A reconstruction-based approach, which relies solely on genuine data for training, has been posited as a solution to mitigate the problem of data dependency. This method detects unknown PAs by comparing the input image with its reconstructed counterpart. Two challenges arise with reconstruction-based PAD, including the style discrepancies during reconstruction and the limited reconstruction accuracy when handling PA samples, both of which impact detection efficacy. To address these challenges, this study introduces a reconstruction-based PAD method, specifically

designed for fingerprints imaged using OCT. The method bolsters the network's reconstruction capabilities for genuine fingerprints, and introduces a style difference loss function to neutralize biases stemming from image style variations. The proposed approach achieves an Equal Error Rate (EER) of 2.19% for B-Scan and 0.89% for Instance, outperforming other methods. Ablation experiments show the dual-branch structure reduces EER by 4.73%, demonstrating its effectiveness in enhancing reconstruction ability and mitigating style differences caused by reconstruction

Technical Sessions

Optical Metrology

Date	#	Duration	Venue
Nov. 17	TS-4	10:15-11:50	5F/ Lingnan 2&3 岭南二+三厅
Session Chair			
Wen Chen, The Hong Kong Polytechnic University			

Time	Paper ID	Presenter	Affiliation
10:15-10:35	Keynote	Anand Asundi	d'Optron Pte Ltd
10:35-10:50	Invited	Wei Yin	Nanjing University of Science and Technology
10:50-11:05	Invited	Zhenqi Niu	Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences
11:05-11:20	Invited	Shijie Feng	Nanjing University of Science and Technology
11:20-11:30	P001	Longhui Li	Changchun University of Science and Technology
11:30-11:40	P094	Jiong Tang	China Electronic Produce Reliability and Environmental Testing Research Institute
11:40-11:50	P145	Yi Tang	Guilin University of Electronic Technology

Keynote Speaker

Anand Asundi
d'Optron Pte Ltd

Bio: Anand Asundi (安顺泰) has over 40 years of experience in the field of Optical Engineering/Metrology, Photomechanics and Optical NDT. He got his PhD from Stony Brook University and was research fellow at Virginia Tech. He was Professor at the University of Hong Kong (HKU) (1983-1996) and Nanyang Technological University (NTU) (1996-2019). He has published over 450 SCI indexed papers with over 15,000 citations and H-Index of 55. He has also chaired and organized numerous international conferences held in Asia, USA and Europe, notably the icOPEN series which he initiated. He was Editor of Optics and Lasers in Engineering for over 20 years and is Fellow of SPIE

and was on their board for two years. He is the recipient of the 2024 SPIE, Chandra Vikram award for Optical Metrology. He was founding Director of the Centre for Optical and Laser Engineering, NTU and founding Chairman of Optics and Photonics Society of Singapore. He is currently founding director and CEO of d'Optron Pte Ltd, one of three companies that he founded.

Speech Title

Light Duality in Optical Metrology

Abstract: Light has a dual nature – sometimes it behaves as a particle and sometimes exhibits wavelike properties. Historically, the particle nature of light preceded the wave characterization. As a particle, it has two main features: reflection and refraction, while as a wave, light can interfere, diffract, and polarize. In general, if the features are of the order of the wavelength of light, wave optics prevails, while for features much greater than the wavelength of light, geometric optics can be used. In this talk, we explore some of the similarities in setup and results with differences in interpretation and analysis of various metrological methods used. Firstly, we compare the prism and grating, and then we delve into moiré versus interferometry, holography and light field, depth from focus and transport of intensity, and photometric stereo and Fourier ptychographic microscopy. We will showcase our All-in-One (AIO) scopes, which incorporate some of these methodologies in a single instrument. Finally, as metrologists who quantify measurements, we ask: what does "much greater than wavelength of light" mean, and when can we change the interpretation method from geometric to wave optics.

Invited Speaker

Wei Yin

Nanjing University of Science and Technology

Bio: Dr. Wei Yin is an associate professor in optical engineering, Nanjing University of Science and Technology (NJUST), China. His research interests include optical metrology, optical 3D measurement and imaging, fringe projection profilometry, speckle projection profilometry, and deep learning. He is an author of more than 20 journal papers and 10 proceedings conferences related to 3D imaging and high-level tasks directly to optical metrology. Recently, he developed real-time, high-accuracy, long-range, and miniaturized 3D sensors with a VCSEL projector array or a MEMS projector.

Speech Title

Real-time, High-Precision, and Miniaturized 3D Imaging Techniques and Their ApplicationS Based on Structured Light Projection

Abstract: Due to the merits of non-contact, high accuracy, and full-field measurement, three-dimensional (3D) measurement techniques based on structured light projection are gradually applied in emerging fields, such as intelligent manufacturing and medical plastic surgery. Common

projected patterns mainly include fringe patterns and speckle patterns, which have been developed into two mainstream techniques: fringe projection profilometry (FPP) and speckle projection profilometry (SPP). For FPP, we introduce a physics-informed deep learning method for fringe pattern analysis (PI-FPA) by integrating a lightweight DNN with a learning-enhanced Fourier transform profilometry (LeFTP) module. By parameterizing conventional phase retrieval methods, the LeFTP module embeds the prior knowledge in the network structure and the loss function to directly provide reliable phase results for new types of samples. The proposed PI-FPA presents that challenging issues in optical metrology can be potentially overcome through the synergy of physics-priors-based traditional tools and data-driven learning approaches, opening new avenues to achieve fast and accurate single-shot 3D imaging. For SPP, we present a high-resolution, wide-field-of-view, and real-time 3D imaging method using spatial-temporal speckle projection profilometry (ST-SPP). A spatial-temporal matching strategy using digital image correlation is proposed to overcome the difficulty of applying speckle matching to complex surfaces, enabling high-precision and efficient subpixel disparity estimation. The proposed ST-SPP is feasible for fast 3D modeling of dynamic scenes and large-scale objects with complex shapes, further enhancing the performance of optical metrology instruments based on SPP in terms of accuracy, resolution, measurement range, and portability.

Invited Speaker

Zhenqi Niu

Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences

Bio: Zhenqi Niu, assistant researcher at Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences, is selected in Shanghai "Super Postdoctoral" incentive program and Shanghai "Starting Star Plan-Sailing Special" talent program. His research interests are micro/nano Optics and computational imaging (including neural nanooptics imaging and ultra-precision deflectometry of optical surfaces), and he has made a series of innovative achievements, especially in high-precision optical measurement. He has published more than 10 academic papers in optical measurement journals such as Optics Letters, and presided over several projects such as National Natural Science Foundation of China - Youth Project and JKW Fundings.

Speech Title

High-dynamic Monoscopic Deflectometry Research and Application for Optical Complex Surfaces

Abstract: Aspherical and freeform surfaces are widely used in various cutting-edge equipments and high-precision instruments. The low-spatial-frequency and mid-spatial-frequency errors of their surfaces directly affect the performance and service life of optoelectronic equipment, thus posing higher requirements for ultra-precision optical manufacturing. The manufacturing quality of optical

freeform largely depends on surface measurement accuracy, and ultra-precision surface measurement technology is the foundation for improving the quality and efficiency of ultra-precision optical manufacturing. The current measurement instruments are mainly aimed at offline measurement environments, which cause problems such as low fabrication efficiency and safety hazards in the manufacturing of large-aperture freeform surfaces. Therefore, it is urgent to develop in-situ optical surface measurement technology for freeform surfaces. Deflectometry is a non-coherent gradient measurement method with advantages such as high measurement accuracy, strong anti-interference ability, and large measurement dynamic range. It is a promising in-situ measurement method for complex optical surfaces. Theoretical research and development have been carried out to meet the major requirements of in-situ measurement of large-aperture optics, and a series of innovative theories characterized by wavefront coding and computation decoding have been formed. A theoretical framework has been established for fast measurement, off-axis system calibration, aberration correction, and extreme depth-of-field measurement. A series of algorithms such as light-field-analysis system response and phase adaptive compensation have been proposed to effectively improve the measurement accuracy of complex freeform surfaces, and extend the measurable object from the specular surface to the high-gloss reflective surface. We propose passive inversion measurement theories and methods such as structural-constrained phase unwrapping, adaptive iterative spatial spherical model, and wavefront encoding and so on. Those works systematically break through the inherent measurement uncertainty problem of deflectometry, and synergistically overcome the limitations of measurement efficiency and measurement accuracy. The developed technologies achieve universal high-dynamic measurement, including efficient measurement, focus-free measurement, prior-model-free measurement, and specular/high-gloss reflective surface measurement.

Invited Speaker

Shijie Feng
Nanjing University of Science and Technology

Bio: Shijie Feng is a professor at the School of Electronic and Optical Engineering of Nanjing University of Science and Technology (NJUST). He was a research assistant at Centre for Optical and Laser Engineering, Nanyang Technological University from 2015 to 2016. He received his PhD in optical engineering at NJUST in 2017. He was a postdoctoral researcher at NJUST from 2017 to 2019 and was an associate professor at NJUST from 2019 to 2024. Currently, he has published more than 60 journal papers. His research interests include phase measurement, high-speed 3D imaging, fringe projection, machine learning, and computer vision.

Speech Title

Intelligent Structured Light Illumination 3D Imaging Based on Physical Priors

Abstract: Deep neural networks have been successfully applied to various tasks in optical metrology. For structured light illumination 3D imaging, most current deep learning methods focus on training a general "all-purpose" end-to-end network, learning from scratch using a large amount of training data to establish an accurate global transformation from input images to output images. Due to the heavy reliance on input training data, the stability of predictions can be affected when handling rare samples. To address this, we propose a series of structured light 3D imaging methods that integrate physical models with deep learning. By incorporating a Fourier transform module and a Fourier transform-based frequency domain loss function, we achieve ultra-fast, high-precision, and temporally super-resolved structured light illumination 3D imaging. Experimental results show that, compared to traditional data-driven neural networks, methods based on physical priors significantly improve generalization performance for complex topographies and different systems.

Presentation Details

Paper ID: P001

Paper Title: Study on Surface Shape Detection of X-Ray Micro Pore Optics Based on Fringe Reflection Method

Authors: Longhui Li, Jian Wang, Xiaoqing Cong, Mingzhao Ouyang, Yuegang Fu

Abstract: This work developed a fringe reflection measurement system with a simple structure and easy operation to investigate the surface shape of Angel Lobster eye X-ray micro pore optics. Fringe reflection images of X-ray micro pore optics were captured using a CCD camera, and the slope error distribution of the lobster eye optics' surface shape was calculated. The resulting root mean square error and peak-to-valley value for the lobster eye lens were determined as 0.81 μm and 6.34 μm, respectively. Comparison with Zygo interferometer measurements revealed similar distributions in surface patterns. The fringe reflection method yielded a mean square error of 0.017 μm and a standard deviation of peak-to-valley values at 0.11 μm, radius of curvature of about 752.3 mm, which confirming its feasibility for surface shape measurement of lobster eye optics. Establishing this optical measurement system provides valuable guidance for spherical thermoforming processes of lobster eye optics.

Paper ID: P094

Paper Title: Improving the Sensitivity of Diamond NV Center Ensemble Magnetometer Based on Microsphere

Authors: Yangyang Zhou, Jiong Tang, Bingxu Ma,and Jian Qiu

Abstract: Diamond nitrogen-vacancy (NV) center ensemble magnetometer is a novel solid quantum magnetometer with high sensitivity and high spatial resolution, which can be used at normal temperature and pressure. However, the low fluorescence collection efficiency of the magnetometer in confocal optical system hinders further improvement in sensitivity. To solve the problem, based on

silica microspheres, we propose a method to enhance the excitation and collection efficiency of NV center ensemble in massive diamond. Experimental results show, compared with the NV diamond magnetometer without microspheres, the photon collection efficiency of NV diamond magnetometer coated with a layer of microspheres is increased by 110%. Thus, the sensitivity of the NV center magnetometer is increased by 4 times to 5.3 $\mu T/\sqrt{Hz}$.

Paper ID: P145

Paper Title: A New Preparation Method for an FPI Sensor with a PDMS Film

Authors: Yi Tang, Yang Li, Yu Cheng, Yiming Xiao, Houquan Liu, Libo Yuan

Abstract: Small-sized, highly sensitive pressure sensors are crucial in the field of turbomachinery application. In this paper, we present a l low-cost and user-friendly method for producing PDMS films with thicknesses about 10 μm and the preparation method and process are described in detail. The PDMS films we fabricated have thicknesses of 11.5 μm and 9.2 μm. After the prepared FPI was cured and packaged, the characteristics of the sensor were studied theoretically and experimentally. The pressure sensitivity of the two groups with similar cavity length is 23.04 nm/Mpa and 29.64 nm/Mpa. This method provides a novel approach for the large-scale, low-cost production of 10-micron-level PDMS thin-film FPI.

Technical Sessions

Advanced Optical Measurement Methods and Techniques & Advanced Laser Processing and Manufacturing

Date	#	Duration	Venue
Nov. 17	TS-5	10:30-11:55	5F/ Lingnan 5&6 岭南五+六厅
Session Chair			
Qinghua Wang, Beihang University			

Time	Paper ID	Presenter	Affiliation
10:30-10:45	Invited	Xiangchao Zhang	Fudan University
10:45-11:00	Invited	Steve Cuong Dang	Nanyang Technological University
11:00-11:15	Invited	Jingang Zhong	Jinan University
11:15-11:30	Invited	Zhoujie Wu	Sichuan University
11:30-11:45	Invited	Dongliang Zheng	Nanjing University of Science and Technology
11:45-11:55	P075	Xiaowei Feng	Tianjin university

Invited Speaker

Xiangchao Zhang
Fudan University

Bio: Xiangchao Zhang is currently a full professor at Fudan University, China. He is a Senior Member of SPIE, and a committee member of ISO TC 213 and IMEKO TC 21. He serves as a trustee of Shanghai Society of Inertia Technology, Precision Machinery Sub-society and IC Measurement and Instrumentation Sub-society of China Instrument and Control Society, and Vision Measurement Sub-society of China Society of Image and Graphics. He graduated from University of Science and Technology of China in 2005 and received his PhD degree at University of Huddersfield, UK in 2009. Prof Zhang's research interests include precision optical measurement and computational imaging. He has published more than 200 papers. He won a second prize of Science and Technology Development of Ministry of Education of China, a golden award of the Geneva Invention Exhibition, and a second

prize of Technical Progress of Chinese Society of Optical Engineering. He is an editor of Surface Topography:Metrology and Properties, Optics and Precision Engineering etc and a peer reviewer of more than 30 international journals and a project reviewer of NSFC of China and EPSRC of UK.

Speech Title

Deflectometric Measurement of Optical Surfaces-From Rays to Beams

Abstract: High precision measurement of complex optics is of great challenge. Deflectometry has high flexibility, stability and efficiency, but it is based on the law of reflection, and applies to specular surfaces only. This talk systematically investigates the main issues governing the measurement accuracy, namely the camera model inconsistency, the height-slope ambiguity, the angle-position uncertainty and rank-deficiency. A flexible camera model and an automatic calibration method are developed from the ray deflection to beam deflection. The geometrical pose and location of the workpiece are solved by minimizing the re-projection error of beam tracing, and an automatic positioning method is proposed by combining the bundle adjustment and Gaussian process regression. The phase error resulting from the defocus, aberrations and scattering are compensated by forward convolution. The superimposed fringes reflected from transparent elements can be separated by the empirical curvelet transform assisted by deep learning. The measurement accuracy can be improved up to 20 nm RMS from microns, which have found widespread applications in different fields.

Invited Speaker

Steve Cuong Dang
Nanyang Technological University

Bio: Assoc. Prof. Steve Cuong Dang at the School of Electrical and Electronic Engineering, Nanyang Technological University, received his Ph.D. from Brown University, USA. Dr. Dang's research is on photonics, complex media, optoelectronics with advanced nanotechnologies and nanomaterials. His results have been published and highlighted in many peer-reviewed journals, including Nature Nanotechnology, Nature Photonics, Nature Communications, Science Advances, and Advanced Materials. His technological developments of quantum dots (QDs) at QD-Vision Inc., USA were demonstrated in two pioneering QD products: "Quantum LightTM Optics" the first QD product for lighting, and "Color IQ," the world's first high-volume QD product for LCD televisions. Sony's "BRAVIA" LCD television with Color IQ (commercialized as Triluminos technology) was named the Best of Show at the Consumer Electronics Show (CES 2013).

Speech Title

Super-Resolution Imaging Through Dynamic Scattering Media

Abstract: Since the discovery of the “memory effect” phenomenon in the 1980s, imaging through strongly scattering media has seen significant development and application, primarily in astronomy and recently showing potential in biology. While most studies have focused on micro-scale or larger objects, achieving super-resolution imaging, which breaks the fundamental diffraction limit, offers superior benefits. Here, we proposed and experimentally demonstrated two novel super-resolution imaging techniques to see through scattering media at nanometer-scale resolution: Stochastic Optical Scattering Localization Imaging (SOSLI) and Non-Invasive Super-Resolution Speckle Fluctuation Imaging (NISSFI). SOSLI relies on blinking emitters that constitute the object, while NISSFI only requires the fluctuation of these emitters, making it more practical. Our computational approaches to post-process multi-speckle images revealed the super-resolution image of the object, breaking the diffraction limit by very high factors (~5 to 8). More interestingly, the resolution is now limited by signal to noise ratio (SNR), not the fundamental optics. Imaging through dynamic scattering media has been also demonstrated.

Invited Speaker

Jingang Zhong
Jinan University

Bio: Jingang Zhong received the B. S. degree in 1985 from Hefei University of Technology, and the M. S. degree in 1991 from University of Science and Technology of China, and Ph. D. degree in 2006 from Jinan University. He is currently a professor of Department of Optoelectronic Engineering and head of Smart & Computational Imaging group, Jinan University. His research interests are computational imaging, computational sensing, biomedical optics and machine vision. His pioneering work in Fourier single-pixel imaging has become one of the most commonly used techniques in single-pixel imaging.

Speech Title

Single-Pixel Imaging for High-Speed Rotating Objects

Abstract: High-speed rotating objects are widely seen in industrial machines, aero engines, etc. However, conventional high-speed camera cannot work for long periods of time because of the contradiction between the high throughput of the camera and the limited capacity for data storage and transmission. The data throughput in single-pixel imaging is much less than that in conventional high-speed imaging, which makes long periods of time imaging applicable. Recently, single-pixel imaging methods for high-speed rotating object were proposed, but the methods require the object should rotate at a constant speed, which limits their practical use. Here we report an improved method

that adopts synchronized rotation angle detection to ease the requirement of constant rotation speed. With the synchronized rotation angle detection, the single-pixel measurements at the same rotation angle can be extracted in the data post-processing, so that the target object and the structured patterns remain relatively motionless. We successfully demonstrate the reported method in imaging a central-process-unit cooling fan whose average rotation speed is 14,402 revolutions per minute (rpm) with a varying speed from 14,357.50 to 14,436.96 rpm. The method provides continuous and high-resolution imaging of high-speed rotating object with a practical and robust solution. It might find various potential applications such as health monitoring of high-speed rotating machines in operation.

Invited Speaker

Zhoujie Wu
Sichuan University

Bio: Dr. Wu is an associate research fellow at department of electronics and information, Sichuan University (SCU). He received his Ph. D and B. S. from SCU in 2021 and 2016. His research interests include computational optical measurement and photomechanics. He has published more than 20 SCI-indexed papers and 10 EI-indexed papers, which have been cited more than 1000 times. Three papers were selected as cover papers of Optics Express, two were featured as "Image of the Week" by the Optica publishing. He was awarded the "Wang Daheng Optical Award" by Chinese Optical Society in 2020, awarded the fellowship of Postdoctoral Program for Innovative Talents of China in 2021 and won the innovative paper nomination Award by Chinese Optical Engineering Society in 2023.

Speech Title

Dynamic 3D Reconstruction under Complex Reflection and Transmission Conditions using Multi-Scale Parallel Single-Pixel Imaging

Abstract: Depth measurement and three-dimensional (3D) imaging under complex reflection and transmission conditions are challenging and even impossible for traditional structured light techniques, owing to the precondition of point-to-point triangulation. Despite recent progress in addressing this problem, there is still no efficient and general solution. Herein, a Fourier dual-slice projection with depth-constrained localization is presented to separate and utilize different illumination and reflection components efficiently, which can significantly decrease the number of projection patterns in each sequence from thousands to fifteen. Subsequently, multi-scale parallel single-pixel imaging (MS-PSI) is proposed based on the established and proven position-invariant theorem, which breaks the local regional assumption and enables dynamic 3D reconstruction. Our methodology successfully unveils unseen-before capabilities such as (1) accurate depth measurement under interreflection and subsurface scattering conditions, (2) dynamic measurement of the time-varying high-dynamic-range

scene and through thin volumetric scattering media at a rate of 333 frames per second; (3) two-layer 3D imaging of the semitransparent surface and the object hidden behind it. The experimental results confirm that the proposed method paves the way for dynamic 3D reconstruction under complex optical field reflection and transmission conditions, benefiting imaging and sensing applications in advanced manufacturing, autonomous driving, and biomedical imaging.

Invited Speaker

Dongliang Zheng
Nanjing University of Science and Technology

Bio: Dr. Dongliang Zheng is an associate professor in optical engineering, Nanjing UniversityfScience and Technology (NJUST), China. His research direction is 3D perceiving and interaction based on SLS. Specifically, while improving SLS-based 3D imaging capabilities, he will expand its applications in indoor SLAM, human digitization, and AR/VR. He has authored about 100 peer-reviewed publications in prestigious journals.

Speech Title

3D Digitization of Ancient City Wall Based on Structured Light Scanning Technique

Abstract: With the intent to improve the management and conservation of ancient city walls, digital information should be thoroughly collected and accurately reconstructed. 3D digitization is increasingly pivotal in cultural heritage endeavors, encompassing tasks such as digital archiving, annual damage assessment, and reverse recovery. However, the results are influenced by the quality of the data scanned. The allure of high-definition 3D scanning, characterized by its attributes of high-accuracy, high-resolution, and low-noise, has significantly heightened cultural heritage preservation. Structured Light Scanning (SLS), among the most promising optical 3D measurement techniques, offers sub-millimeter accuracy and resolution, presenting significant potential for the high-definition 3D digitization of ancient city walls. This study introduces SLS to city wall applications for data acquisition and accordingly proposes suitable registration algorithms, which enable high-definition and large-scale ancient city wall 3D digitization. Taking the Nanjing City Wall as an example, we demonstrate the effectiveness of the proposed method in real-world applications.

Presentation Details

Paper ID: P075
Paper Title: Study on Microdeformation Mechanism of TC4/TC11 Gradient Titanium Alloy by Additive Manufacturing

Authors: Xiaowei Feng, Jinlong Chen, Cuiru Sun

Abstract: The emergence of additive manufacturing technology provides a new possibility to process heterogeneous gradient titanium alloys. However, the micromechanical properties and deformation mechanisms of heterogeneous gradient titanium alloys prepared by this method are still unclear. We prepared TC4/TC11 alloy using electron beam melting method, and studied its tensile micro mechanical properties and deformation behaviors by SEM-DIC method. The results indicate that the heterogeneous gradient titanium alloys fabricated by this method has excellent tensile properties. Dislocation slip is the main deformation mode of this alloy. The more secondary α-phases and the finer the grain size, the more difficult it is for dislocations to initiate, and the less likely the material is to undergo microcrack nucleation and extension. Strain concentration occurs at the TC4 alloy region that is the soft phase, and fracture also occurs on the TC4 side. The strain incompatibility is compensated by geometrically necessary dislocations(GNDs), and the strain gradient further leads to hetero-deformation induced(HDI) strengthening, which increases the strength of the heterogeneous material.Overall, this study provides valuable insights into the process optimization and engineering practice of 3D printing of heterogeneous gradient titanium alloys, and can serve as a useful reference for future research in this area.

Technical Sessions

Biomedical Optics and Imaging & Optical Component and System Simulation & Photomechanics

Date	#	Duration	Venue
Nov. 17	TS-6	10:30-11:45	5F/ Lingnan 8&9 岭南八+九厅

Session Chair

Guohai Situ, Shanghai Institute of Optics and Fine Mechanics, CAS

Time	Paper ID	Presenter	Affiliation
10:30-10:45	Invited	Peng Gao	Xidian University
10:45-10:55	P053	Tongxin Liao	Shenzhen University
10:55-11:05	P020	Quanyan He	Tianjin University
11:05-11:15	P130	Agbéssignalé LATO	Laboratoire de Physique des Matériaux et Composants à Semi-Conducteurs (LPMCS)
11:15-11:25	P136	Yang Fujun	Southeast University
11:25-11:35	P030	Wu Yue	Beijing Forestry University
11:35-11:45	P135	Junzheng Peng	Jinan University

Invited Speaker

Peng Gao
Xidian University

Bio: Prof. Dr. Peng Gao, studied Physics and received his Ph.D. at the Xi'an Institute of Optics and Precision Mechanics (XIOPM), CAS, in 2011. He was a "Humboldt Fellow" in University Stuttgart (2012-2014) and Marie-Curie Fellow (IEF) in KIT (2014-2018). His group focuses on developing super-resolution optical microscopy and quantitative phase microscopy techniques for biology. So far, he has authored over 100 peer-reviewed papers published in journals, including Nat. Photonics, Adv. Opt. Photon. Some of his publications were highlighted by tens of international media, such as Science Daily, Physics News, and so on. He is currently one of the associate editors of Optics and Laser Technology (OLT) and Frontiers in Physics,

Speech Title

Super-resolution Fluorescence Microscopy and Quantitative Phase Microscopy

Abstract: Optical three-dimensional (3D) microscopy is of great importance in many fields, especially in biology. In this talk, two 3D optical microscopic technique, namely, sparse scanning structured illumination microscopy (SS-SIM) and quantitative phase contrast tomography (QPCT), will be presented. Both the SS-SIM and QPCT were utilized to obtain 3D subcellular organelles inside live COS7 cells. The comparison of the two imaging modalities tells that SS-SIM enables visualization of specific subcellular organelles in virtue of fluorescence tagging. While, QPCT can visualize up to ten types of subcellular organelles once for all, for that nearly all the subcellular organelles have different refractive index above the cytosol. The combination of the 3D fluorescence and phase images provide complementary information for the same sample, contributing to revealing the mechanisms of many life events.

Presentation Details

Paper ID: P053

Paper Title: Application of Event Cameras in Blood Flow Imaging

Authors: Tongxin Liao*, Zeren Gao, Yu Fu

Abstract: Abnormal blood supply is highly correlated with the occurrence and development of various diseases such as cerebral infarction, varicose veins, and vascular tumors. Real-time quantitative detection of full-field blood flow changes in lesion areas holds significant scientific and clinical importance for the early diagnosis, intraoperative monitoring, and postoperative follow-up of these diseases. Existing blood flow imaging technologies, such as Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), Laser Doppler Imaging (LDI), and Optical Coherence Tomography (OCT), each have their advantages but also limitations, failing to simultaneously achieve high spatiotemporal resolution, real-time capability, and quantitative analysis. Based on speckle measurement technology, this paper proposes a laser speckle blood flow imaging method using event cameras, leveraging their high temporal resolution, low latency, low power consumption, high dynamic range, and asynchronous dynamic sensing capabilities. The proposed method enables real-time blood flow imaging and flow velocity calculation. The research content of this paper includes quantitative measurement of blood flow velocity using laser speckle imaging based on event cameras, development of feature signal analysis algorithms for event stream data, and exploration of the technology's application in experiments with biomimetic skin, blood vessels, and live animals. This study is the first to apply event cameras to the field of blood flow imaging, achieving global, real-time, and quantitative blood flow imaging, providing an efficient and cost-effective blood flow imaging solution, and offering an effective tool for the diagnosis and treatment of related diseases.

Paper ID: P020

Paper Title: Multi-wavelength Infrared Photoelastic Method

Authors: Quanyan He, Huadan Xing, Wei Qiu

Abstract: In this work, a multi-wavelength infrared photoelastic method was developed, which was

expected to realize the on-line evaluation of the internal stress of semiconductor structures in their manufacturing process. A multi-wavelength infrared photoelastic instrument was established, whose wavelength was quickly switchable by combining tungsten halogen lamp and narrow band filter. Experiments were carried out, including four-point bending and three-point bending, on monocrystalline silicon specimens to calibrate the stress-optical coefficients at different wavelengths and then to verify the feasibility of the proposed method. In addition, the results of infrared photoelastic experiments with two wavelengths and three wavelengths were compared and discussed, showing that the two-wavelength scheme had relative advantages in efficiency, accuracy, and automation

Paper ID: P130

Paper Title: Simulation study of the Self Phase Modulation effect in 30 km optical link of a metropolitan backbone network

Authors: Barèrèm-Mêlgueba MAO

Abstract: Since the advent of optical fiber communications systems performances are evolving at high speed. Its use in telecommunications networks effectively contributes to overcome the ever-increasing demand for bandwidth.

The optical media that carry the light pulses are the site of nonlinear phenomena that degrade the data transmission when the electrical field becomes intense.

Among these nonlinear phenomena, the Self Phase Modulation (SPM) effect induced by nonlinear refraction, results from the interaction between the optical pulses transmitted and the nonlinear response of the propagation medium. It causes phase and frequency distortions and produces a broadening of the signal spectrum.

In this paper, we study by simulation and then analyse the nonlinear SPM effect of a light source propagating in a single mode fiber. We consider a 30 km optical link of a metropolitan backbone network. A comparative analysis is carried out through several optical signals. A broadening of the signal spectrum as the injected power increases independently of the modulation format is observed.

Paper ID: P136

Paper Title: Simultaneous Measurement of 3D Deformation and Strain Evaluation Using the Tri-wavelength and 3-sensor Camera

Authors: Fujun Yang, Minyang Wu, Yingbiao An, Hanyang Jiang

Abstract: In this work, a comprehensive speckle pattern interferometry system is firstly employed to measure 3D deformation information, and six components regarding to the first derivative of deformation, i.e., strain information are then obtained by using single-pixel step numerical differential method. Two conventional symmetric dual-beam systems and one classical Michelson-interferometric setup are simultaneously used for respective measurement of in-plane and out-of-plane deformation based on tri-color illumination and 3-sensor camera imaging. Quantitative phases related to three deformation components are retrieved by utilizing four-step phase-shifting technique. Generally, deformation and strain can be converted into each other. Strain can be obtained from deformation by derivation. Deformation can also be gotten by numerical integration calculation. However, owing to speckle noise, mathematical derivations easily accumulate errors, thereby the calculated deformation gradients scarcely agree with the practical distribution. To eliminate speckle noise in phase fringes as

much as possible, a size of 3×3 pixels mean filter is applied 30-100 times on noisy wrapped phase fringe patterns, and the same size of 3×3 pixels mean filter is multiply applied on unwrapped phase with a tested sample contour guide. A single-pixel-step numerical differential method is operated on the filtered phase pattern along x- y- and z-axis, respectively. The same size of 3×3 pixels mean filter is multiply applied on the gradient map to reduce the errors.

A size of 160×24×6 mm3 aluminum beam with a 10mm-length slit on its edge was employed as the test object. The specimen is placed on a three-bending loading frame and one surface of the specimen is illuminated simultaneously by three color lasers (with wavelengths of 473nm, 532nm and 671nm). Figure 1 exhibits the wrapped phase fringe patterns related to three deformation components (u v and w).

Paper ID: P030

Paper Title: Fruit Picking Manipulator Obstacle Avoidance Path Planning Research

Authors: Pengyu Zhang, Yue Wu, Jiangming Kan

Abstract: The automation of fruit harvesting is currently a pressing issue that needs to be addressed in the Chinese fruit industry. Therefore, this paper presents a fruit picking robot and its visual processing and obstacle avoidance system. The system used RealSense D435i camera to capture the picking environment image, after processing the color map applied YOLOv5s network for the detection of target fruits, and then calculated the location of target fruits from the aligned depth map. At the same time, the depth information of the picking environment was converted into 3D position information to generate a point cloud model of the obstacle environment. In order to facilitate collision detection, the point cloud model is also converted into an octree model. Aiming at the Rapidly exploring Random Tree (RRT) series of algorithms that rely heavily on the initial path, an improved RRT algorithm, Gauss Depth RRT* (GD-RRT*) algorithm, is proposed to obtain a high-quality initial path quickly. Simulated obstacle avoidance experiments are carried out in two-dimensional space, the average value of the path cost of the GD-RRT* algorithm is smaller than that of the RRT* algorithm at the same time as the planning time is reduced by 67.04%, and the combination with the Informed RRT* (I-RRT*) algorithm in different maps to find the suboptimal path time is reduced by 95.75%, which proves that the algorithm has good performance and versatility. This research builds a fruit picking robot and a specialized manipulation software based on Qt. Picking experiments were carried out indoors and in the orchard to verify the function of the fruit picking robot, the success rate of indoor picking was 92%, while the orchard was 84%, which proved that the robot can reliably fulfill the task of automated picking.

Paper ID: P135

Paper Title: Confocal structured illumination microscopy

Authors: Junzheng Peng, Weishuai Zhou, Xi Lin, Jingang Zhong

Abstract: Light scattering from the sample is an unavoidable problem in fluorescence imaging. Compared with laser scanning confocal scanning microscopy, although optical-sectioning structured illumination microscopy (OS-SIM) has the advantages of fast imaging speed and low phototoxicity, it faces the challenge of removing the scattering noise particularly when imaging thick and densely labeled sampling. To improve the imaging performance of OS-SIM, we introduce the concept of confocal imaging to OS-SIM and propose confocal structured illumination microscopy (CSIM). CSIM

exploits the principle of dual imaging to reconstruct a dual image from each pixel of the camera. The scattered light signal and the unscattered light signal of the conjugate object point recorded by the camera pixel are separated in the reconstructed dual image. By extracting the unscattered light signal of the conjugate point from each dual image based on the conjugate relationship between the camera and the spatial light modulator, we can reject the scattered light signal and reconstruct a confocal image. Experimental results of fluorescent optical-sectioning demonstrate that CSIM can reconstruct the image with superior signal-to-noise ratio (SNR) and greater imaging depth compared with existing OS-SIM. CSIM is expected to broaden the application range of OS-SIM.

Poster Session

Board#	Paper Information
Posters @ Student Competition **| 14:00-15:00 | 5F/ Lobby (五楼分会场公区)**	
B001	**Paper ID:** P028 **Title:** Vision-Based Self-Calibrating Measurement Method for Structural Settlement Using Gravity Balance **Authors:** Jian Zhang, Biao Hu, Xiao Tan, Mingjing Dai, Ming Zeng, Wenjun Chen, Yihe Yin, Xiaolin Liu, Qifeng Yu **Presenter:** Jian Zhang **Affiliation:** Shenzhen University
B002	**Paper ID:** P074 **Title:** Self-supervised Holographic Phase Reconstruction Based on Complex-Valued Neural Network**Authors:** Qiming An, Jiazhen Dou, Jianglei Di **Presenter:** Qiming An **Affiliation:** Hebei University of Engineering
B003	**Paper ID:** P091 **Title:** Nonlinear Spectral Fusion Super-resolution Imaging based on progressive Saturated Upconversion Nanoparticles **Authors:** Tianxiao Wu;Yongtao Liu;Chao Zuo **Presenter:** Tianxiao Wu **Affiliation:** Nanjing University of Science and Technology
B004	**Paper ID:** P095 **Title:** An Adaptive Inference Framework for Coherent Beam Combining Using Deep Reinforcement Learning **Authors:** Guiyuan Tan, Jianglei Di **Presenter:** Guiyuan Tan **Affiliation:** Guangdong University of Technology
B005	**Paper ID:** P097 **Title:** MFSS-YOLO for Small Object Detection in Remote Sensing Images **Authors:** Genghuan Liu, Jianglei Di,Zhenbo Ren **Presenter:** Genghuan Liu **Affiliation:** Guangdong University of Technology
B006	**Paper ID:** P098 **Title:** Spatio-temporal Wavefront Prediction Using Frequency Graph Neural Network for Adaptive Optics **Authors:** Zhijian Qin, Jianglei Di **Presenter:** Zhijian Qin **Affiliation:** Guangdong University of Technology

Board#	Paper Information
B007	**Paper ID:** P100 **Title:** A Single Object Tracking Model with Hierarchical RGBT Feature Interaction **Authors:** Dingjian Li, Jianglei Di, Zhenbo Ren **Presenter:** Dingjian Li **Affiliation:** Guangdong University of Technology
B008	**Paper ID:** P101 **Title:** Staged adaptive optimization of SPGD algorithm in Coherent Beam Combining **Authors:** Wenhui Zheng, Jianglei Di, Yuwen Qin **Presenter:** Wenhui Zheng **Affiliation:** Guangdong University of Technology
B009	**Paper ID:** P123 **Title:** Research on 3D Reconstruction Technology of Fruit Trees Based on Incremental Analytical Motion Recovery Technology **Authors:** Bo Liu, Weihua Fu, YingLiu, Xiangjun Zou, Xiaojuan Li **Presenter:** Bo Liu **Affiliation:** Xinjiang university
B010	**Paper ID:** P144 **Title:** Deep Subwavelength Focusing and Steering of Light in Oblique Layered Metamaterial **Authors:** Jingxuan Duan, Jiao Jiao, Na Yao, Qian Chen **Presenter:** Jingxuan Duan **Affiliation:** University of Electronic Science and Technology of China
B011	**Paper ID:** P149 **Title:** Transmission Digital Holographic Microscopic Phase Measurement System **Authors:** Chenxuan Kong, Dingnan Deng, Xiaozeng Wang **Presenter:** Chenxuan Kong **Affiliation:** Jiaying University
Posters @ Technical Sessions	
B012	**Paper ID:** P003 **Title:** Two-Wavelength Polarization-Encoded Structured Light Technique for Fast 3d Reconstruction of High-Reflective Objects **Authors:** Xin Liu, Haotian Yu, Jing Han, Lianfa Bai, Dongliang Zheng **Presenter:** Xin Liu **Affiliation:** Nanjing University of Science and Technology
B013	**Paper ID:** P089 **Title:** Research on 3D Point Cloud Registration Algorithm Based on FPFH and ColorICP **Authors:** Junjie Pan, Xu Zhang **Presenter:** Junjie Pan **Affiliation:** Shanghai University

Board#	Paper Information
B014	**Paper ID:** P117 **Title:** A Novel Scanning Micro Phase Mesuring Profilometry **Authors:** Wang Siyuan, Liu Yuankun, Yu Xin **Presenter:** Yuankun Liu **Affiliation:** Sichuan University
B015	**Paper ID:** P148 **Title:** A 3D Information Steganography Technique using DiffStega **Authors:** Liuwenjie Li, Enzhi Xu, Chenxing Wang **Presenter:** Chenxing Wang **Affiliation:** Southeast University
B016	**Paper ID:** P039 **Title:** Visual-photoelectric Multi-Mode Data Fusion and Feature Analysis of High-Power Disc Laser Welding **Authors:** Yijie Haung, Bo Ma, Weiwei Huang, Chaochao Wang, Xiaoman Cao, Yi Chen, Yi Liu **Presenter:** Yijie Huang **Affiliation:** Guangdong Polytechnic of Industry and Commerce
B017	**Paper ID:** P015 **Title:** Measurement of Axial And Radial Error Motions Rotating Shaft Three-Channel Laser Doppler Vibrometer on a Rotating Shaft by a Axial and Radial Error Motions Rotating Shaft Three-Channel Laser Doppler Vibrometer **Authors:** Yongsheng Huang, Zhan Huang, Shizhan Chen, Bing Chen, Zeren Gao and Yu Fu **Presenter:** Yongsheng Huang **Affiliation:** Shenzhen Key Laboratory of Intelligent Optical Measurement and Detection
B018	**Paper ID:** P022 **Title:** Sub-pixel Detection and Localization of Circular Diagonal Markers in Complex Field Imaging Environments **Authors:** Yiqiu Cai, Xiaolin Liu, Zhiqiang Li, Biao Hu, Wenjun Chen, Yihe Yin, Qifeng Yu **Presenter:** Yiqiu Cai **Affiliation:** Shenzhen University
B019	**Paper ID:** P027 **Title:** 3D Measurement of Scattering Media viaScattering Media Self-Supervised Fringe Domain Transformation **Authors:** Ji Tan, Haipeng Niu, Suofan Luo, Jia Liu, Zhaoshui He **Presenter:** Ji Tan **Affiliation:** Guangdong University of Technology
B020	**Paper ID:** P033 **Title:** Monocular Digital Image Correlation 3D Panoramic Measurement Based on Plane Mirror Imaging

Board#	Paper Information
	Authors: Ge Pengxiang, Zhangqian, Gao Haoran **Presenter:** Pengxiang Ge **Affiliation:** Anhui Jianzhu University
B021	**Paper ID:** P036 **Title:** Line Laser Road Leveling Detection Method Based on Image Enhancement **Authors:** Wanyuan Cai, Zhenyu Li, Te Wen, Wei Tao* **Presenter:** Wanyuan Cai **Affiliation:** Shanghai Jiao Tong University
B022	**Paper ID:** P059 **Title:** A Visual Recognition Method for Structural Deformation and Foreign Objects in Operational Subway Tunnels **Authors:** Bai Wenfeng, Zhao Ru, Lin Liangdai, Luo Haitao, Liu Zhifeng, Sun Dianjun, Zhang Qiang, Chen Wenjun, Hu Biao **Presenter:** Biao Hu **Affiliation:** Shenzhen University
B023	**Paper ID:** P071 **Title:** Laser Doppler Vibrometer at 1064-nm **Authors:** Chen Qiu, Saiyu Luo, Xingchen Jiang, Yu Tian, Li Li **Presenter:** Chen Qiu **Affiliation:** Nanjing University of Science and Technology
B024	**Paper ID:** P082 **Title:** A method for Measuring Urban Road Subsidence based on Optical Images **Authors:** Junjie Su, Yihe Yin, Lihao Liu, Biao Hu, Xiaolin Liu, Qifeng Yu **Presenter:** Junjie Su **Affiliation:** Shenzhen University
B025	**Paper ID:** P084 **Title:** In-Plane Rotation-Displacement Cooperative-Relay Videometric Method of Long Structures **Authors:** Lihao Liu, Yihe Yin, Wenjun Chen , Biao Hu, Xiaolin Liu, Qifeng Yu **Presenter:** Lihao Liu **Affiliation:** Shenzhen University
B026	**Paper ID:** P099 **Title:** Efficient Distributed Architecture and Optimized Subarray Control Strategy Facilitate Large-scale Coherent Beam Combination **Authors:** Jiaqin Qi, Jianglei Di **Presenter:** Jiaqin Qi **Affiliation:** Guangdong University of Technology
B027	**Paper ID:** P153 **Title:** Sensitivity Enhancement of Surface Plasmon Resonance Biosensor with Ti3C2Tx

Board#	Paper Information
	Nanosheets **Authors:** Shuhan Chen, Zixuan Huang **Presenter:** Shuhan Chen **Affiliation:** Jiaying University
B028	**Paper ID:** P104 **Title:** BoT-PSPNet: Bottleneck Transformer Enhanced PSPNet for Fruit Damage Recognition and Orchard Monitoring;Improved RPMNet for 3D feature extraction based on DGCNN **Authors:** Xinming Ding, Lufeng Luo, Mingyou Chen, Shaoming Luo **Presenter:** Lufeng Luo **Affiliation:** Foshan University
B029	**Paper ID:** P128 **Title:** Phenotypic Detection of Rice in Paddy Field using Simulated 3D Plants and Real Image Data Sets: Rice Leaf Counting in Seedling Stage **Authors:** Zhongxian Wu, Xiaochan Wang, Yinyan Shi **Presenter:** Zhongxian Wu **Affiliation:** Nanjing Agricultural University
B030	**Paper ID:** P006 **Title:** Application Research of Outdoor Cherry Tomato Recognition Based on YOLOv9 **Authors:** Xiaoman Cao, Mingtao Huang, Yihao Huang, Hansheng Yan, Lingye Kong, Tianlong Zou, Xiangjun Zou **Presenter:** Xiaoman Cao **Affiliation:** Guangdong Polytechnic of Industry and Commerce
B031	**Paper ID:** P010 **Title:** Research on Virtual-Real Coordination Control System of Litchi Picking Robot Based on Unity3D **Authors:** Juntao Xiong, Chang Lu, Zhaoshen Yao **Presenter:** Juntao Xiong **Affiliation:** South China Agricultural University
B032	**Paper ID:** P017 **Title:** A Method for Nighttime Tomato Fruit Detection and Occlusion Judgment Based on Deep Learning and Image Processing; Trajectory Planning and Tracking of Six-Axis Robot Arm **Authors:** Zhonglong Lin, Caihong Zhang, Zhi Liang, Xiangjun Zou, Xiaojuan Li **Presenter:** Bo Liu **Affiliation:** Xinjiang University
B033	**Paper ID:** P031 **Title:** Research on Interactive Virtual Assembly Technology of Components Agricultural Machinery Parts based on OpenPose **Authors:** Xiaona Cai , Zeqin Zeng, Po Zhang, Youbin Chen, Yijie Huang, Hongjun Wang

Board#	Paper Information
	Presenter: Xiaona Cai **Affiliation:** Guangdong Polytechnic of Industry and Commerce
B034	**Paper ID:** P038 **Title:** Enhancing Safety during Harvesting with a Deep Learning based Action Determination Method for Picking Robots **Authors:** Teng Sun, Haofei Zuo, Zifei Zhou, Yifan Wang, Zhonghua Miao **Presenter:** Haofei Zuo **Affiliation:** Shanghai University
B035	**Paper ID:** P133 **Title:** Trajectory Planning and Tracking of Six-Axis Robot Arm under Visual Guidance **Authors:** Jianxuan Liu, Tao Chen, Zhi Liang, Xiangjun Zou, Xiaojuan Li **Presenter:** Zhi Liang **Affiliation:** Xinjiang University
B036	**Paper ID:** P154 **Title:** Scoliosis Detection Method Based on Fringe Projection Profilometry and Deep Learning **Authors:** Meng Wang, Dong He, Qijian Tang, Xiang Peng, Xiaoli Liu* **Presenter:** Shaolei Xu **Affiliation:** Shenzhen University
B037	**Paper ID:** P050 **Title:** Exploring the Application of Natural Light Variations in Holographic Art Installation **Authors:** Shasha Xie, Chang Liu, Shuo Wang, Yang Gao, Jie Yang **Presenter:** Shasha Xie **Affiliation:** Beijing Institute of Graphic Communication
B038	**Paper ID:** P113 **Title:** Complex Optical Component Measurement with Ptychography **Authors:** Qiongyong Wei, Xingyu Lin, Yingjie Yu **Presenter:** Qingyong Wei **Affiliation:** Shanghai University
B039	**Paper ID:** P090 **Title:** The Dot-Matrix Assisted Focusing Method for Parallel Phase-Shifting Digital Holographic Microscopy **Authors:** Hanjie Zheng, Zhijie Hua, Xu Zhang **Presenter:** Hanjie Zheng **Affiliation:** Shanghai University
B040	**Paper ID:** P121 **Title:** Multi-pixel Parallel Search Algorithm for Binary Hologram Generation **Authors:** Yongan Zhang, Yunhao Zhang, Fei Ye, Qinghe Song, Yaping Zhang **Presenter:** Yunhao Zhang **Affiliation:** Kunming University of Science and Technology

Board#	Paper Information
B041	**Paper ID:** P070 **Title:** The Measurement of Brillouin Gain Spectrum with Ultra-Short Optical Fibers **Authors:** Yu Tian, Saiyu Luo, Xingchen Jiang, Chen Qiu, Li Li **Presenter:** Yu Tian **Affiliation:** Nanjing University of Science and Technology
B042	**Paper ID:** P143 **Title:** Analysis of Network Fault Location and Treatment Method of Optical Fiber Broadband System **Authors:** Youcheng Liang, Haitao Chen **Presenter:** Youcheng Liang **Affiliation:** Guangzhou Civil Aviation College
B043	**Paper ID:** P057 **Title:** Prediction of Laser Far-Field Intensity Distribution through Imaging using Deep Learning **Authors:** He Hao, Qiushi Wang, Jiabin Bai, Hongrui Wang, Shuiliang Zhou **Presenter:** He Hao **Affiliation:** Manufacturing Technology Institute, Aviation Industry Corporation of China
B044	**Paper ID:** P111 **Title:** An Accurate Recognition and Localization Algorithm for Strawberry Picking Robots **Authors:** Jiqing Chen, Lixiang Huang, Yang Huang **Presenter:** Chen Jiqing **Affiliation:** Guangxi University
B045	**Paper ID:** P132 **Title:** Smartphone-based Fruit Counting for Early Capsicum Yield Estimation **Authors:** Chendi Yu, Huiyao Zhang, Yiqin Huang, Minshuo Sun, Fuhao Qin **Presenter:** Hongwei Li **Affiliation:** Guangxi University
B046	**Paper ID:** P146 **Title:** Underwater Polarization De-Scattering Imaging Method Based on Polarization Characteristics and Global Transmittance Estimation **Authors:** Zhenxiang Zhu, Haotian Yu, Jing Han and Dongliang Zheng **Presenter:** Dongliang Zheng **Affiliation:** Nanjing University of Science and Technology
B047	**Paper ID:** P155 **Title:** DefoGAN: An End-to-End Single Defocus Image Deblurring Method **Authors:** Xixuan Zhao, Ningchen Ma, Jiangming Kan **Presenter:** Xixuan Zhao **Affiliation:** Beijing Forestry University

Board#	Paper Information
B048	**Paper ID:** P055 **Title:** Determination of dEfect Size for Composites using Derivative Images in Pulse Thermography、IRT-Diffusion: Combined Denoising Diffusion Probabilistic Models with Thermal Signal Processing Methods for Automated Defect Detection in Composites Using Infrared Thermography **Authors:** Yanjie Wei, Yuhang Zhang, Yao Xiao, Xiaohui Gu **Presenter:** Yanjie Wei **Affiliation:** Shijiazhuang Tiedao University
B049	**Paper ID:** P056 **Title:** Determination of Defect Size for Composites Using Derivative Images in Pulse Thermography **Authors:** Yanjie Wei, Jiashuo Lu, Xiaohui Gu **Presenter:** Yanjie Wei **Affiliation:** Shijiazhuang Tiedao University
B050	**Paper ID:** P073 **Title:** Laser Simulation and Reinforcement Learning Mode Locking **Authors:** Junhao Xue,Tianyue Wang,Hanyu Wang,Saiyu Luo **Presenter:** Tianyue Wang **Affiliation:** Nanjing University of Science and Technology
B051	**Paper ID:** P021 **Title:** Bending Strain Measurement of Flexible Screen Display Layer Based on Digital Image Correlation **Authors:** Haipan Wu, Zeren Gao, Yuchen Wei, Zihong Chen and Yu Fu **Presenter:** Haipan Wu **Affiliation:** Shenzhen University
B052	**Paper ID:** P067 **Title:** Design and Application of Chirped Mirrors in the Visible Light Band **Authors:** Tianyue Wang, Junhao Xue, Hanyu Wang, Saiyu Luo **Presenter:** Tianyue Wang **Affiliation:** Nanjing University of Science and Technology
B053	**Paper ID:** P068 **Title:** A Comparative Study of Deep Reinforcement Learning Algorithms in Ultrafast Mode-Locked Fiber Lasers **Authors:** Shiyi Pan, Gezhi Chen, Yu Tian, Chen Qiu, Sanyu Luo, Li Li **Presenter:** Shiyi Pan **Affiliation:** Nanjing University of Science and Technology

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