Conference Abstract

2024 the 10th International Conference on VIRTUAL REALITY

July 24-26, 2024 | Bournemouth, United Kingdom

Co-sponsored by

Hosted and Technical Sponsored by

Co-hosted by

CONTENS

ORGANIZING COMMITTEE

Honorary Chair
Zhigeng Pan, Nanjing University of Information Science & Technology, China

Conference Chair
Wen Tang, Bournemouth University, UK

Technical Program Committee Chairs
Xiaosong Yang, Bournemouth University, UK
Xuequan Lu, Deakin University, Australia
Hui Yu, University of Portsmouth, the United Kingdom, UK
Meili Wang, Northwest A&F University, China

Local Organizing Committee Chair
Charlie Hargood, Bournemouth University, UK
Xun He, Bournemouth University, UK

Doctor Forum Organizing Chairs
Natalia Adamczewska, Bournemouth University, UK
Zequn Li, Bournemouth University, UK

Publication Chairs
Xi Zhao, Xi'an Jiaotong University, China

Publicity Committee Chair
Anas Bilal, Hainan Normal University, China

Technical Program Committee
Fred Charles, Bournemouth University, UK
Vedad Hulusic, Bournemouth University, UK
Adithya Balasubramanyam, CAVE Labs, Center of Internet of Things, PES University, India
Alberto Cannavò, Politecnico di Torino, Italy
Anum Masood, Norwegian University of Science and Technology
Cesar Alberto Collazos Ordoñez, Universidad del Cauca, Colombia
Cheng Lin, Tecent Games, China
Chenglei Yang, Shandong University, China
Chengtao Ji, Xi'an Jiaotong-Liverpool University, China
Chongwen Wang, Beijing Institute of Technology, China
Chun-Wang Wei, Kaohsiung Medical University
Daniel Thalmann, Ecole Polytechnique Fédérale de Lausanne
Deng Chen, Wuhan Institute of Technology
Desheng Lyu, Harbin Institute of Technology, Nangang District, Harbin City, Heilongjiang Province, China
Dongsheng Zhou, Dalian University, China
Dorota Kamińska, Instytut Mechatroniki i Systemów Informatycznych Politechniki Łódzkiej, Poland
Esra Sİpahİ Dongul, Aksaray University, Turkey
Fabrizio Lamberti, Politecnico di Torino, Italy
Fengting Yan, Shanghai University of Engineering Science, China
Gbolahan Olasina, University of KwaZulu-Natal, South Africa
George Baciu, The Hong Kong Polytechnic University, Hong Kong
Guihuan Feng, State Key Laboratory for Novel Software Technology, Nanjing University, China
Hamid Doost Mohammadian, University of Applied Sciences (FHM), Germany
Han-Wen Tuan, Hungkuang University
Hao-Chiang Koong Lin, National University of Tainan

ORGANIZING COMMITTEE

Helong Shen, Dalian Maritime University, China
Hong Li, Wenzhou University, China
Hongguang Lyu, Dalian Maritime University, China
Hongjun Li, Beijing Forestry University, China
Hui Li, Binjiang College of NUIST, China
Hui Wang, Shijiazhuang Tiedao University, China
Hyungseok Kim, Konkuk University
Jan Egger, Graz University of Technology
Jianhuang Lai, Sun Yat-sen University, China
Jobenilita Cuñado,University of Mindanao, Philippines
Joel C. De Goma, Mapua University, Philippines
Junfeng Yao, SoftWare School of Xiamen University
Junjian Huang, Southwest University, China
Junjun Pan, Beihang University, China
Kazunori Miyata, Japan Advanced Institute of Science and Technology, Japan
Kun Xu, Tsinghua University, China
Kuo-Liang Ou, National Tsing Hua University
Laixiang Wen, Jilin Animation Institute
Lei Zhang, Beijing Institute of Technology
Lei Zhu, CSE in The Chinese University of Hong Kong
Lin Meng, Ritsumeikan University, Japan
Lu Feng, Huazhong University of Science and Technology
Mengjie Huang, Xi'an Jiaotong-Liverpool University, China
Mengxi Xu, Nanjing Institute of Technology, China
Mingzhi Cheng, School of New Media of Beijing Institute of Graphic Communication, China
Muhammad Shahab Siddiqui, Nazeer Hussain University, Pakistan
Nanlin Jin, Xi'an Jiaotong-Liverpool University, China
Nicolas Pronost, Université Claude Bernard Lyon 1
Olarik Surinta, Mahasarakham University, Thailand
Pan Li, Tianjin University of Science and Technology, China
Pengfei Yi, Dalian University, China
Pengwen Xiong, Nanchang University, China
Ponraj Durairaj, Nanyang Polytechnic Singapore, Singapore
Qiu Chen, Kogakuin University, Japan
Quanyu Wang, Beijing Institute of Technology, China
R Tamilselvi, Sethu Institute of Technology, India
Raviraj Nataraj, Stevens Institute of Technology, United States
Renjiao Yi, National University of Defense Technology, China
Seyed Ebrahim Esmaeili, American University of Kuwait, Kuwait
Shanchen Pang, China University of Petroleum (East China), China
Shaojun Hu, Northwest A&F University, China
Shiguang Liu, Tianjin University
Stefanos Kollias, National Technical University of Athens
Takashi Toriu,Osaka City University, Japan
Tak-Lam Wong, Douglas College
Tianhua Xie, Maoming Polytechnic, China
Tilemachos Koliopoulos, Collaborator University of West Attica, Greece
Tolga Capin, TED University
Tsai-Yen Li, National Chengchi University
Wanwan Li, University of South Florida, United States
Wei Gai, Shandong University, China
Wen Zhou, Anhui Normal University
Wencheng Wang, Institute of Software, Chinese Academy of Sciences

ORGANIZING COMMITTEE

Xiangdong Li, Zhejiang University, China
Xiaogang Jin, State Key Lab of CAD\&CG, Zhejiang University
Xiaogang Wang, Southwest University, China
Xiaojing Niu, Northwestern Polytechnical University, China
Xiaoming Chen, Beijing Technology and Business University, China
Xiaoqiang Zhang, Southwest University of Science and Technology, China
Yamin Han, Northwest A&F University, China
Yaqing Hou, Dalian University of Technology, China
Yi Li, Kennesaw State University, United States
Yi Sun, Dalian Naval Academy, China
Yihong Wang, Xi'an Jiaotong-Liverpool University, China
Yixin Zhuang, Peking University, China
Youliang Huang, Beijing University of Chinese Medicine, China
Yue Liu, Beijing Institute Of technology, China
Yuhan Dong, Tsinghua University, China
Yun Tie, Zhengzhou University, China
Zepeng Wang, Northwest A&F University, China
Zhengwei Yao, Hangzhou Normal University, China
Zifei Yan, Harbin Institute of Technology, China
Giuseppe Patanè, CNR-IMATI
Liping Zheng, Hefei University of Technology, China
Porawat Visutsak, King Mongkut's University of Technology North Bangkok, Thailand
Sanghun Nam, Changwon National University, South Korea
Wenjun Hou, Beijing University of Posts & Telecommunications, China
Xi Zhao, Xi'an Jiaotong University, China
Xia Zheng, Zhejiang Univeristy, China
Yachun Fan, Beijing Normal University, China
Yinwei Zhan, Guangdong University of Technology, China
Bo Sun, Rowan University, United States
Mansi Sharma, Indian Institute of Technology, India
Chuan-Po Wang, National Taichung University of Science and Technology
Bikram Jit Singh, Maharishi Markandeshwar University, India
Haitian Sun, Northwest A&F University, China
Huijun Yang, Northwest A&F University, China
Ioannis Fudos, University of Ioannina, Greece
Robert Sablatnig, TU Wien, Austria
S. Indu, Delhi Technological University, India
Sunny Arief Sudiro, STMIK Jakarta STI&K, Indonesia
Theresia Herlina Rochadiani, Pradita University, Indonesia
Thies Pfeiffer, University of Applied Sciences Emden/Leer, Germany
Venu Madhav Kuthadi, BIUST, Botswana
Guosheng Hu, China Academy of Art, China
Wuheng Zuo, Zhejiang University of Technology, China
Xiaoyong Lei, Beihang University, China
Peixian Zhuang, University of Science and Technology Beijing, China
Nongliang Sun, Shandong University of Science and Technology, China
Weijin Jiang, Hunan University Of Technology and Business, China
Xiaojun Chen, Shanghai Jiao Tong University, China
Zhen Liu, Ningbo University, China
Anita Komlodi, University of Maryland, United States
Crs Kumar, Defence Institute Advanced Technology(DIAT), India
Danny Plass, Saxion University of Applied Sciences, the Netherlands
Galina Petrova Mratskova, Trakia University, Stara Zagora, Bulgaria

ORGANIZING COMMITTEE

Gary Ushaw, Newcastle University, United Kingdom
Gyanesh Singh, Shri Mata Vaishno Devi University Katra Jammu and Kashmir, India
Huseyin Dogan, Bournemouth University, United Kingdom
Liew Lee Hung, Universiti Teknologi MARA, Malaysia
Lin Li, Hefei University of Technology, China
R.P.C. Janaka Rajapakse, Tainan National University of the Arts
Samia Loucif, Zayed University, United Arab Emirates
William Hurst, Wageningen University and Research, the Netherlands
Yang Xu, Northwest University, China
Ying Huang, Hangzhou Normal University, China
Zequn Li, Bournemouth University, United Kingdom
Zhidong Xiao, Bournemouth University, United Kingdom
Lei Zhao, Yongjiang Lab, China

WELCOME MESSAGE

Co-sponsored by Bournemouth University, United Kingdom, the 10th International Conference on Virtual Reality (ICVR 2024) is held from July 24th to 26th, 2024, in Bournemouth, Dorset, UK.

ICVR 2024 is a forum designed to foster collaborations and knowledge-sharing of new advances and developments in VR, AR, and XR among researchers, technical people, domain experts, and academics from around the world. ICVR 2024 invites authors to contribute original works that showcase pioneering research results, transformative projects, surveys, and real-world industrial experiences that make advances in VR and its related fields.

This year, ICVR received submissions from members of universities, research institutes, and industries. ICVR 2024 participants come from 13 countries: China, India, the United Kingdom, the Netherlands, Singapore, Germany, the USA, Denmark, Italy, Ireland, Peru, Indonesia, and Belgium. All papers were subject to peer reviews by the conference international committee. The acceptance of the papers is based on their quality and relevance to the conference remits. Accepted papers cover topics ranging from VR display and 360 video technologies to AI in VR to brain-computer interfaces and haptics in VR to Virtual Reality games and UX and culture heritage and VR applications. The ICVR 2024 will be a valuable reference for researchers, educators and developers in Virtual Reality. This year, we are also delighted to have the following invited speakers:

- Tom Durrant, CTO and Co-Founder of VividQ, UK
- Ifigeneia Mavridou, Tilburg University, the Netherlands
- Jian Chang, Bournemouth University, UK

The ICVR 2024 conference is planned in such a way so that researchers can enrich Virtual Reality and its relevant research field through keynotes, tutorials, hybrid presentation sessions, and informal conversations among colleagues from around the world.

On behalf of the conference committee, we thank all the authors, reviewers, and attendees for their contributions and participation in ICVR 2024. Their dedication and expertise enable us to prepare this high-quality programme to make the conference a success. Finally, we wish all the delegates a productive and enjoyable conference.

ICVR 2024 Conference Committee

USEFUL INFORMATION

🕮 Time Zone: UTC+1

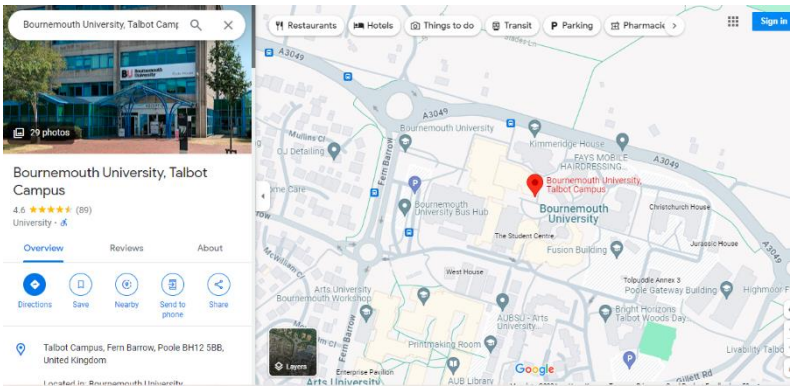
For Onsite Participants

🕮 Conference Venue

Talbot Campus, Bournemouth University, Dorset, England, UK.BH12 5BB

✧ About Bournemouth University | For more information please visit www.bournemouth.ac.uk.

✧ In 2023, BU was 41st in the world and first in the UK in the THE Young University Rankings, and is ranked 29th out of 1,591 universities in the Times Higher Education (THE) Impact Rankings 2023, which measure universities all over the world against the UN's Sustainable Development Goals. BU also ranked first in the UK for Decent Work and Economic Growth. In the most recent Research Excellence Framework (REF) exercise, 94% of BU's research was rated as internationally recognised or higher.



🕮 Temperature

Average Temperature in July in Bournemouth

15℃ - 25℃

🕮 Attention Please

♣ Please take care of your belongings in public area. For your personal and property safety, delegates are suggested to wear representative card during conference and not to lend it to those unconcerned to enter event rooms. Conference does not assume any responsibility for loss of personal belongings of participants.

♣ Don't stay too late in the city, don't be alone in the remote area. Be aware of the strangers who offer you service, signature of charity, etc., at scenic spots. You can search more Tourist Information and Security tips online.

🕮 Emergency Call: 999

USEFUL INFORMATION

🕮 Time Zone: UTC+1

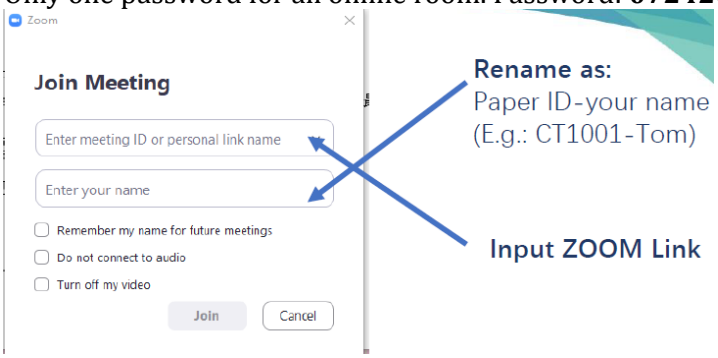
For Online Participants

Note:
Conference rooms will be open 30 mins before scheduled time.
Pls join the zoom 10-15 mins before your session start and be prepared.

ZOOM Download (Oversea): https://zoom.us/
Author in China: https://zoom.com.cn/download

Tips:

- Please unmute audio and start video during your presentation.
- It's suggested to use headset with microphone or earphone with microphone.
- Duration of each Presentation: about 12 Minutes of Presentation and 3 Minutes of Q&A.
- E-certificate will be sent to presenters after conference by email.
- An excellent presentation will be selected from each session and announced on the website after conference.
- Only one password for all online room. Password: **072426**



Rename your screen name before entering the room	Example
Authors: Paper ID-Name	VR0001-San Zhang
Listener: Listener Number-Name	Listener- San Zhang
Keynote Speaker: Keynote-Name	Keynote- San Zhang
Committee Member: Position-Name	Committee- San Zhang

USEFUL INFORMATION

🕮 Devices Provided by the Conference Organizer

- ✧ Laptops (with MS-Office & Adobe Reader)
- ✧ Projectors & Screen

🕮 Materials Prepared by the Presenters

- ✧ Oral Presentation:
  Onsite Presentation: PowerPoint or PDF files. Please copy your slides to the desktop 20 mins before your session start and test it ahead.
  Online Presentation: PowerPoint or PDF files. Please install ZOOM in advance and join our online session on time.

🕮 Duration of Each Presentation

- ✧ Keynote Speech: 60 Minutes of Presentation including Q&A.
- ✧ Regular Oral Presentation: 20 Minutes of Presentation including Q&A (15 minutes for online presentation).

🕮 Online Pre-test Timetable and online sign-in (July 25, 2024)

*Please enter the room 10 minutes before the test session start

Test Time (UTC+1)	Online Test
	Zoom link: https://us02web.zoom.us/j/83595238836 Password: 072426
08:30-09:30	Keynote Speakers & Session Chairs
08:30-09:00	R0011, R0002, R0017, R1041, R2074, R2077, R2079, R1043, R0027, R2070, R2067, R3083, R2078, R0020, R0012, R0030, R1040
09:00-09:30	R1055, R2073, R2066, R0009, R1034, R1037, R1059, R1058, R1039, R2081, R0016, R0003, R0046, R1053, R2071, R3085, R1064

DAILY SCHEDULE

Day 1, July 24, 2024 - Onsite

08:30-09:30	Sign in and Collect Conference Materials **Location: Inspire Lecture Theatre | First Floor | Fusion Building**
Morning Program-Location: Inspire Lecture **Zoom Link: https://us02web.zoom.us/j/83299356632 Password: 072426**	
Morning Session Host: Prof. Wen Tang, Bournemouth University, UK **Prof. Xiaosong Yang, Bournemouth University, UK**	
09:00-09:30	**Welcome Message & Opening Remarks** **Prof. Fred Charles, Bournemouth University, UK**
09:30-10:30	**Keynote Speaker I** **Mr. Tom Durrant, CTO and Co-Founder of VividQ, UK** **(Onsite Talk) Speech Title: Bring VR Experiences to Life with 3D Display**
10:30-11:00	***Group Photo & Coffee Break – F208***
11:00-12:00	**Keynote Speaker II** **Prof. Jian Chang, Bournemouth University, UK** **(Onsite Talk) Speech Title: Tools Serving Innovation in Heritage Applications and Medical Training - VR/AR Solutions**
12:00-13:30	***Break & Lunch - F208***
13:30-15:30	**Onsite Session 1** ..... ***Inspire Lecture*** **Topic: Virtual Reality** **Session Chair: Prof. Xiaosong Yang, Bournemouth University, UK** R0026, R1054, R1060, R1056, R0014, R1044
15:30 -16:00	***Coffee Break – F208***
16:00-18:00	**Onsite Session 2** ..... ***Inspire Lecture*** **Topic: Immersive Experience and Learning** **Session Chair: Assoc. Prof. Mohammad F. Obeid, Shenandoah University, USA** R0025, R2069, R0015, R2082, R1049, R0010-A
18:20-19:30	***Social Drinking – F208***

DAILY SCHEDULE

Day 2, July 25, 2024 - Onsite

08:30-09:30	Sign in and Collect Conference Materials **Location: Inspire Lecture Theatre | First Floor | Fusion Building**
Morning Program- Location: Inspire Lecture **Zoom Link: https://us02web.zoom.us/j/83299356632 Password: 072426**	
Morning Session Host: Dr. Xun He, Bournemouth University, UK	
09:30-10:30	**Keynote Speaker III** **Dr. Ifigeneia Mavridou, Tilburg University, the Netherlands** **(Onsite Talk) Speech Title: From Sensors to Sensitivity: Affective State Detection for Enhancing Human Computer Interaction in Virtual Reality**
10:30-11:00	***Coffee Break – F208***
11:00-12:00	**Tutorial: Extended Reality Design and Research Methods** **Dr. Natalia Adamczewska, Bournemouth University, UK** **Dr. Zequn Li, Bournemouth University, UK**
12:00-13:30	***Break & Lunch – F208***
13:30 -15:10	**Onsite Session 3** ..... ***Inspire Lecture*** **Topic: Augmented Reality and Hybrid Reality** **Session Chair: Dr. Charlie Hargood, Bournemouth University, UK** R0006, R3088, R0008, R1042, R3089
15:30-15:50	***Coffee Break – F208***
15:50-17:50	**Onsite Session 4** ..... ***Inspire Lecture*** **Topic: Virtual Environment and System Simulation** **Session Chair: Assoc. Prof. Anita Komlodi, University of Maryland, USA** R0028, R0013, R0021, R2076, R2080, R1048
18:00-21:00	***Dinner***

DAILY SCHEDULE

Day 3, July 26, 2024 - Online

09:45-11:45	**Online Session A ..... Room A** **Topic: Virtual Reality and Immersive Experience** **Session Chair: Prof. Xi Zhao, Xi'an Jiaotong University, China** R0024, R0011, R0002, R0017, R1041, R2074, R2077, R2079
09:45-11:45	**Online Session B ..... Room B** **Topic: VR Based Visual Experience and Interaction System** **Session Chair: Dr. Roberta Macaluso, Politecnico di Torino, Italy** R1045, R1043, R0027, R2070, R2067, R3083, R2078, R0020
11:45-13:00	***Break***
13:00-14:30	**Online Session C..... Room A** **Topic: Application of Virtual Reality in Information Systems** **Session Chair: Dr. Dorota Kamińska, Instytut Mechatroniki i Systemów Informatycznych Politechniki Łódzkiej, Poland** R0012, R0030, R1040, R1055, R2073, R2066
13:00-14:45	**Online Session D ..... Room B** **Topic: Augmented Reality and Virtual Reality** **Session Chair: Dr. Natalia Adamczewska, Bournemouth University, UK** R0009, R1034, R1037, R1059, R1058, R1039, R2081
14:30-14:45	***Break***
14:45-16:00	**Online Session E..... Room A** **Topic: Image Reconstruction and Simulation** **Session Chair: Dr. Zequn Li, Bournemouth University, UK** R0016, R0003, R0046, R1053, R1064, R2071, R3085

Room A: https://us02web.zoom.us/j/83299356632 ***Room B: https://us02web.zoom.us/j/83595238836***	***Password:*** ***072426***

KEYNOTE SPEAKERS

Mr. Tom Durrant
CTO and Co-Founder of VividQ

09:30-10:30 | July 24, 2024 | Inspire Lecture Theatre | Onsite Talk
Zoom link: https://us02web.zoom.us/j/83299356632
Password: 072426

Tom is CTO and Co-Founder of VividQ, where he leads technology and product development for 3D displays, focusing on computer-generated holography. He was recognised on the Forbes 30 Under 30 list in the field of technology. He holds degrees in mathematics from the University of Cambridge and University of Oxford.

Speech Title: Bring VR Experiences to Life with 3D Display

Abstract: VR has had a promising start, but has as yet failed to hit the consumer mainstream. We will consider whether true 3D display could solve the remaining challenges and produce an experience compelling enough to become as popular as TVs and PCs. As part of this, we will dig into different methods to achieve 3D display, and the relative advantages and disadvantages. We will consider questions of what makes an experience immersive, and what new tools and experiences might be unlocked with the inclusion of depth in the visual output.

KEYNOTE SPEAKERS

Prof. Jian Chang
Bournemouth University, UK

11:00-12:00 | July 24, 2024 | Inspire Lecture Theatre | Onsite Talk
Zoom link: https://us02web.zoom.us/j/83299356632
Password: 072426

Jian Chang is a professor in computer animation at the National Centre for Computer Animation (NCCA), Bournemouth University, UK. The NCCA is recognised as the best UK educational and research base for computer animation. His research has focused on physics-based animation, motion synthesis, novel HCI (eye tracking, gesture control and haptic), serious games, and VR/AR applications. He is keen to exploit the usage of novel computing techniques for cross-disciplinary research and applications, which has led to international research collaboration and joint funding bids. His research has been funded (over £2million) by various funding sources, including EPSRC, the Royal Society, EU FP7, EU H2020, InterReg France (Channel) England, Innovate UK, and HEIF. He is a founder and director of an international postdoctoral research training centre for innovation in creative technologies (CfACTs), funded by EU H2020 Marie Skłodowska-Curie Actions - Cofund Scheme. He has published over 130 peer-reviewed papers (including high-impact CVPR, SIGGRAPH ASIA, TOG, IEEE TVCG & Pattern Recognition), co-edited three books, and have been a program co-chair of Computer Graphics International 2019 and programme committee member for over 20 International conferences.

Speech Title: Tools Serving Innovation in Heritage Applications and Medical Training - VR/AR Solutions

Abstract: A wide range of digital technologies, including Virtual Reality (VR) and Augmented Reality (AR), have many applications to both cultural heritage sites and medical training environments. These technologies offer immersive experiences that enhance the engagement of visitors and educational value for users. In the realm of cultural heritage, VR/AR tools can be used to serve different target groups, designing captivating experiences, and exploring new business models to boost revenue. Similarly, in medical training, VR/AR applications provide realistic and interactive simulations that allow medical professionals to practice and refine their skills in a safe and controlled environment. These technologies support a range of training scenarios, from surgical procedures to patient interaction, enhancing the overall quality and effectiveness of medical education.

KEYNOTE SPEAKERS

Dr. Ifigeneia Mavridou
Tilburg University, the Netherlands

09:30-10:30 | July 25, 2024 | Inspire Lecture Theatre | Onsite Talk
Zoom link: https://us02web.zoom.us/j/83299356632
Password: 072426

Dr. Ifigeneia Mavridou is an Assistant Professor at Tilburg University, the Netherlands. She offers unique perspectives in the field of immersive technologies and embedded sensing for emotion recognition via her experience in both industrial and academic environments. Previously, Dr. Mavridou pioneered and developed innovative multimodal wearables specifically designed for off-the-shelf virtual reality headsets at Emteq Labs, Brighton. Currently, Dr. Mavridou coordinates the Extended Reality Lab at MINDLABS—a dynamic multidisciplinary partnership involving institutions, local municipality, and businesses. Her extensive publications delve into the intersection of extended realities, human factors, and artificial intelligence.

Speech Title: From Sensors to Sensitivity: Affective State Detection for Enhancing Human Computer Interaction in Virtual Reality

Abstract: We are navigating an era of rapid technological advances and sensor miniaturisation, yet we face unprecedented challenges. As researchers we are responsible not only for developing novel solutions that meet usability criteria but also for ensuring the reliability, sensitivity, and replicability of these detection systems. In the last six years, there has been a significant push towards expanding the ICT and XR sectors, with efforts to create tools that assist professionals, creators, and researchers in further leveraging these technologies. Detecting the user's state for enhanced human-computer interaction has become a crucial area of focus, especially with the surge in emotion-detecting systems. The implications and challenges of false interpretations has underscored the importance of accuracy in these systems. How can we remain true to our mission of delivering effective and safe detection solutions? This keynote will explore existing solutions and trends in user tracking within virtual reality settings, addressing the challenges of calibration, multimodal synchronisation, and signal artifacts. We will discuss the critical role of context in understanding intent and subjective responses, and why extended reality technologies can serve as the ultimate laboratory tool.

TUTORIAL

Natalia Adamczewska, Bournemouth University, Bournemouth, UK
Zequn Li, Bournemouth University, Bournemouth, UK

11:00-12:00 | July 25, 2024 | Inspire Lecture Theatre | Onsite Talk
Zoom link: https://us02web.zoom.us/j/83299356632
Password: 072426

Brief Introduction

One of the main stages in an extended reality (XR) product evaluation is conducting a research study that enables the researchers to find answers to the questions around their product. There are different types of data and different data collection methods accordingly. However, it may be challenging for researchers to select the most appropriate type of data collection and analysis based on the type of data that is used in the research and the questions posed by the researchers. This workshop aims to provide a comprehensive source for research methods including defining the data collection process and discussing the main types of data. The possible methodologies for gathering data are then explained based on these categories and the advantages and disadvantages of utilising these methods are defined. Furthermore, we present that in the light of the overview of the current standards for evaluation of XR products in terms of methodology applied, in which we list the most common issues related to the application of quantitative and qualitative methods to the evaluation of XR products.

Onsite Session 1

- **Topic: Virtual Reality**
- **Time: 13:30-15:30, UTC+1, July 24, 2024**
- **Location: Inspire Lecture Theatre | First Floor of Fusion Building**
- **Session Chair: Prof. Xiaosong Yang, Bournemouth University, UK**
- **R0026, R1054, R1060, R1056, R0014, R1044**

R0026 **13:30-13:50**	Philosophical perspectives on realism in virtual production and extended reality in contemporary Film and TV Author(s): Aneta Halina Postek - Mioduszewska Presenter: Aneta Halina Postek - Mioduszewska, Bournemouth University, United Kingdom Abstract: This research contributes to a deeper comprehension of real and virtual fusion in virtual production (VP) and extended reality (XR), emphasizing their role in preserving the continuity of dramatic space in film and tv production. It explores the intricate interplay and blending between real and virtual elements on the film set and explores the fundamentals of cinema in concepts like the mise-en-scene, plan sequence, in-camera effects including rear projection, which revolutionized filmmaking by maintaining continuity of the film body. Key questions addressed include factors influencing perspectives and definitions of reality, the distortion and merging of reality in hyperreal, and the use of simulacra in undermining the authenticity of the medium by transcending traditional theoretical framework of the Platonic worldview that values ideas and universals over material particulars and the Cartesian dichotomy that emphasizes the materiality of existence, thereby providing a nuanced understanding of the "realism of the movie set" where simulacra become its own truth. Drawing on Baudrillard's taxonomy of representation, it illustrates how contemporary virtual production techniques, exemplified by George Lucas's experiences on The Mandalorian set, enhance creative autonomy and simulate real-world processes.
R1054 **13:50-14:10**	Is VR Always a Better Choice? Investigating the Effects of Game Modes and Role-Playing on Fire Escape Simulation Training Author(s): Zelin Jiang, Shuhao Zhang, Yue Li, Ka Lok Man, Yong Yue Jeremy Smith Presenter: Shuhao Zhang, Xi'an Jiaotong-Liverpool University, China Abstract: In this paper, we present a multi-user fire escape simulation training system that involves an actionist in Virtual Reality (VR) and a strategist using a desktop. We implemented two game modes (collaboration and competition) and conducted a comparative study to investigate how user experiences and learning outcomes vary between the two game modes, and between the two roles in the gameplay. The learning outcomes using the simulation training were compared against a baseline condition, where participants learned the fire escape knowledge by reading paper instructions. Our results revealed that users reported higher perceived usability and lower workload in the collaboration mode than in the competition mode. In addition, actionists (VR users) reported greater performance but also greater mental workload than strategists (desktop users). In terms of learning outcomes, strategists showed greater improvement than actionists. However, the improvement in learning outcomes did not vary significantly from the baseline condition. We discussed the effects of game modes and role-playing on user experience and learning outcomes and the implications for future interactive educational systems.
R1060 **14:10-14:30**	Pseudo-Haptics for Weight Perception in VR: Controller vs. Bare Hand Interactions with Tracking Delay and Vertical Offset Author(s): Chiwoong Hwang, Tiare Feuchtner, Kaj Grønbæk Presenter: Chiwoong Hwang, Aarhus University, Denmark Abstract: Training in virtual reality (VR) offers advantages such as a safe learning environment, good scalability, and cost saving. However, state-of-the-art simulations are limited in faithfully conveying real-world physical object properties such as weight without complex technologies and instrumentation of the user or environment, which may negatively impact learning. A potential solution is the application of pseudo-haptics: illusory haptic sensations induced by a mismatch

	between real and virtual hand positions. Researchers have proposed various pseudo-haptic techniques to alter the perception of weight in virtual environments, but their effectiveness with hand tracking compared to VR controllers is underexplored. Hence, we investigate impacts of the interaction method for two different types of pseudo-haptic feedback based on Tracking Delay and Vertical Offset. Our results indicate that pseudo-haptics can effectively facilitate the sensation of weight both with controllers and bare hands, whereby each has benefits: hand tracking can enhance body ownership, while controllers may improve perceived responsiveness of virtual environments. Also, pseudo-haptics with Tracking Delay may be preferable for repetitive lifting tasks, as Vertical Offset can be prone to higher physical demand. The current study provides insights into the design of pseudo-haptic feedback and interaction technologies for weight perception in VR.
R1056 **14:30-14:50**	Comparison of Two Novel Environmental Manipulation Methods for Rotating VR Users Author(s): Linda Krueger, Charles Markham, Ralf Bierig Presenter: Linda Krueger, Maynooth University, Ireland Abstract: Redirected walking lets users walk around a small tracking space to move inside a larger virtual world. Segment Addition is a new technique for manipulating the virtual environment to redirect the user inside the tracking space. Segment Addition adds slices to the virtual environment as the user turns in the tracking space, changing the real rotation a user has to complete to reach their goal in the virtual world. Our user study compares Segment Addition to a simpler technique called Moving Goalposts. Moving Goalposts moves the goals inside the environment while keeping the rest of the environment static. It was developed to provide a straightforward means of evaluating Segment Addition. An analysis of the experimental results indicates that users do not notice changes associated with the addition or subtraction of a small number of extra slices. Users' naturalness, comfort and usability scores remained high even after they noticed the change in rotation amount.
R0014 **14:50-15:10**	3D Rendering Impact in Virtual Reality based Architectural Design Collaboration Author(s): Jin Gang Lee Presenter: Jin Gang Lee, Korea University of Technology and Education, South Korea Abstract: Amidst the growing trend of utilizing 3D models for collaborative efforts in architectural design, this study examines the effects of 3D rendering on user experience in architectural visualization across VR and 2D platforms. Through a controlled experiment, it evaluates how rendering elements affect presence and engagement. The research findings underscore a strong preference for rendered models, particularly within the VR environment, where realism, immersion, and user engagement are significantly enhanced. This study highlights rendering's pivotal role in enriching architectural visualization, offering key insights into its contributions to spatial realism and user experience, while also addressing potential areas for improvement in rendering techniques to reduce negative user perceptions like spatial distortion and interface intrusiveness.
R1044 **15:10-15:30**	MO-XR: Method for Observing User Interactions with XR Applications Author(s): Natalia Adamczewska, Wen Tang, Zequn Li, Ethan Southall, Timothy Develin and Alberto De Caro Presenter: Natalia Adamczewska, Bournemouth University, UK Abstract: One of the essential stages of an extended reality (XR) product development is evaluation. It allows researchers assess whether the product meets the requirements of the user and whether it behaves as it was expected by its creators. Many different evaluation methods for XR product development are available to record, describe, quantify, and analyze user experience (UX), with observations being one of them. Observation methods are a flexible tool to perform evaluations, yet they are often poorly applied, lacking description of data collection and data analysis approaches. This paper addresses that issue and proposes a novel approach to performing observation study for extended reality (XR) product development. The proposed method is clearly structured which allows researchers to perform observations in a systematic way to evaluate XR systems. An observation tool is developed and applied to the evaluation for a meditation VR app that we have developed in a European project ASPIRE. We then present the findings of our study in which the tool was applied and explore it with survey data. The results show that insights gained the tool enrich understandings of the survey data, which allows for more in-depth evaluation of an XR application.

Onsite Session 2

- **Topic: Immersive Experience and Learning**
- **Time: 16:00-18:00, UTC+1, July 24, 2024**
- **Location: Inspire Lecture Theatre | First Floor of Fusion Building**
- **Session Chair: Assoc. Prof. Mohammad F. Obeid, Shenandoah University, USA**
- **R0025, R2069, R0015, R2082, R1049, R0010-A**

R0025 **16:00-16:20**	Enhancing Immersive Relaxation: Exploring the Fusion of ASMR Animation and Virtual Reality Author(s): Jiaho Du Presenter: Jiahao Du, Bournemouth University, United Kingdom Abstract: Autonomous sensory meridian response (ASMR) refers to the phenomenon that specific individuals (ASMR-sensitive individuals) experience an extremely pleasant and relaxing tingling sensation in the back of the scalp, neck and even the whole body under a specific visual and auditory trigger, which can relieve insomnia, anxiety and clinical depression. Based on this method, we propose a method of combining ASMR with 3D animation based on VR to enable the audience to experience immersive intimacy. We produced a five-minute VR animation after a survey of the existing literature and video samples. Through this study, we subsequently tested on participants to demonstrate the effectiveness of VR binding to ASMR. During the experiment, we asked the participants about their participation experience and collected their heart rate and electrodermal activity data to analyze the impact of this study on people. The results of this study can have implications for digital mental health, virtual human, and VR multi-sensory experiences.
R2069 **16:20-16:40**	Grasping Objects in Immersive Virtual Reality Environments: Challenges and Current Techniques Author(s): Mingzhao Zhou, Nadine Aburumman Presenter: Mingzhao Zhou, Brunel University London, UK Abstract: In real-life, grasping is one of the fundamental and effective forms of interaction when manipulating objects. This holds true in the physical and virtual world; however, unlike the physical world, virtual reality (VR) is grasped in a complex formulation that includes graphics, physics, and perception. In virtual reality, the user's immersion level depends on realistic haptic feedback and high-quality graphics, which are computationally demanding and hard to achieve in real-time. Current solutions fail to produce plausible visuals and haptic feedback when simulation grasping in VR with a variety of targeted object dynamics. In this paper, we review the existing techniques for grasping in VR and robotics and indicate the main challenges that grasping faces in both domains. We aim to explore and understand the complexity of hand-grasping objects with different dynamics and inspire various ideas to improve and come up with potential solutions suitable for virtual reality applications.
R0015 **16:40-17:00**	Immersive visualisation of point cloud data of railway environments Author(s): Bram Ton, Niek Tempert, Danny Plass Presenter: Bram Ton, Saxion University of Applied Sciences, the Netherlands Abstract: Resilient and reliable rail transport is an important key factor to combat climate change. To guarantee this, the state of the rail network needs to be monitored and tracked. A promising proxy data source to monitor the state of the rail infrastructure is point cloud data. Point cloud data requires significant computational and storage resources due to its intrinsic 3D nature, making it challenging to process and visualise. To face the visualisation challenge, immersive visualisation using head-mounted displays has been proposed. Benefits of immersive visualisation are the reduced time to insight, the intuitive user experience, and the possibility of collaborative viewing. Despite these benefits, immersive visualisation of point cloud data for the rail domain has not been explored yet. To bridge this gap, this work presents a working prototype to immersively visualise railway point cloud data. The prototype enables the user to load a point cloud scene and interact with the scene using natural hand gestures and voice commands. Manual interactions include scaling, rotating and translating the scene. Based on a small user evaluation, it was found that participants had difficulty with the voice commands to control the visibility of objects. Key focus

	points for a next iteration are dynamically loading large scenes with an adaptive level of detail and expanding hand gesture based interaction.
R2082 **17:00-17:20**	Development of an Immersive Learning Environment for Fundamentals of Nursing Labs Author(s): Mohammad F. Obeid, Ahmad Ewais, Mohammad Asia Presenter: Mohammad F. Obeid, Shenandoah University, USA Abstract: The field of nursing is no stranger to the use of simulation and training systems for education and skill acquisition. Virtual reality (VR) has been utilized as an immersive learning environment (ILV) for many years as it facilitates repetitive training, scenario introduction, and information retention with no disturbance of the real system/clinic. In this work, the development of an ILV for fundamentals of nursing laboratory courses is presented. The project is carried out cross-institutionally to create a modular platform that allows the continuous addition of VR modules for nursing and medical procedures. An initial user study is conducted with faculty and senior nursing students hypothesizing the utility of this platform for efficient, scalable, and effective training; as well as investigating development decisions related to user interface design and user experience.
R1049 **17:20-17:40**	A vision for XR immersion in Cricket Experience and Training The C3 Centre: Games Research Cluster Project Author(s): Lionel Jayaraj, James Wood, Carlton Reeve, Edward Braund Presenter: Lionel Jayaraj, Staffordshire University, UK Abstract: The authors' research covers several fields across computing, human-computer interaction (HCI), creative technologies, games development, virtual reality (VR) and augmented reality (AR), one of the high priority projects is outlined in this document. This project focuses on measuring an extended reality (XR) game's immersion and its potential in serious games (games beyond entertainment purpose). For example, a cricket entertainment game can be played in a living room by holding the motion controllers. Whereas a traditional cricket game must be played in an academy inside the nets by holding the real cricket bat which is motion tracked with maximum level of accuracy of a shot being played to award score or simulate the outcome of the action. Extended reality applications are predominantly made for the entertainment gamification purpose. However, there are potential to be used for a serious purpose due to its immersion with the advanced interactions in these technologies because of the involvement of the motion in the Gamification. Hence, this vision paper discusses the authors' vision for three upcoming years into researching XR aids for cricket experiences.
R0010-A **17:40-18:00**	Virtual Reality Activity-based Training for Preventing Falls among Community-dwelling Older Adults with Mild Cognitive Impairment: A Pilot Randomized Control Trial Study Author(s): Wing Keung Ip, Jeffrey Soar, Christina James, Zoe Wang, Kenneth Fong Presenter: Wing Keung Ip, University of Plymouth, England Abstract: Using a Virtual Reality (VR) games-based application as an innovative falls prevention technology in an aged care service. The study explored and evaluated the effects of VR activity-based training on falls prevention among community-dwelling older adults with mild cognitive impairment. A pilot randomized control trial study was applied to compare the effects on falls prevention between participants who experienced a full-immersive VR training and group-based exercise (Baduanjin) training. Eighteen participants were recruited using convenience sampling and were randomly assigned into the VR group and the exercise group (non-VR). The participants in both groups attended 16 falls prevention training sessions over eight weeks. Eligible participants identified with a higher risk of mild cognitive impairment and early dementia undertook three measurements. The primary outcomes assessed included changes in physical risks factor of falls, and the secondary outcomes assessed included changes in cognition and fall efficacy. The results showed VR group had significantly greater improvement than the exercise group on measures of cognitive-motor performance, such as cognition (HK- MoCA), functional mobility (TUG), balance (BBS) and walk speed (6MWT) across time occasion. There were, however, no significant differences in executive functions (TMTA and TMTB) and the fall efficacy (FES-I) between the two groups. In conclusion, the study provides promising evidence on possible effects of VR training for preventing falls among community dwelling older adults with mild cognitive impairment. But the study does not support the evidence to reduce the fear of falling and executive functions between two groups.

Onsite Session 3

- **Topic: Augmented Reality and Hybrid Reality**
- **Time: 13:30 -15:10, UTC+1, July 25, 2024**
- **Location: Inspire Lecture Theatre | First Floor of Fusion Building**
- **Session Chair: Dr. Charlie Hargood, Bournemouth University, UK**
- **R0006, R3088, R0008, R1042, R3089**

R0006 **13:30-13:50**	The Data Factory: Findings from an Extended Reality-based Hackathon for Data Science Education Author(s): William Hurst, Orestis Spyrou, Caspar Krampe Presenter: Orestis Spyrou, Wageningen University, the Netherlands Abstract: eXtended Reality (XR), an umbrella term referring to augmented, virtual and mixed reality, is a rapidly evolving technology that has the potential to reshape various processes and activities within the educational domain. Over the last five years there has been a significant growing interest in the technology's use by both educators and researchers exploring the applicability for active learning and student engagement. However, an essential consideration for its use in education is engagement with the end users during the design processes. For that reason, a hackathon was organised by Wageningen University to engage with students in order to design and develop XR applications for data science education. Hackathons have become more commonplace over the last 10 years, in particular due to their success for creating innovation and enhancing engagement with students. In this research, the results of the hackathon are presented along with the challenges and opportunities associated with the implementation of such pedagogical activities. Our findings indicate that XR-based gamification of education has the potential valid application for improving the way elements of the data science pipeline are taught, and that a student-led design process demonstrated a preference for the use of virtual reality over augmented reality. The results reveal that the usefulness of XR to foster learning is evaluated positively with a mean score of M=5.82 and SD=0.98 on a 7-point Likert-scale.
R3088 **13:50-14:10**	Augmented Reality Enhanced: 3D Crowd Reconstruction from a Single Viewpoint Author(s): Xiaohan Sun, Xiaosong Yang Presenter: Xiaohan Sun, Trinity College Dublin, Ireland Abstract: Reconstructing human figures from a single viewpoint has long intrigued researchers, particularly for augmented reality (AR) applications. While significant progress has been made in single-human body reconstruction, densely populated scenes with substantial occlusions pose complex challenges. This paper introduces 3DCrowd+, an advanced two-stage methodology for 3D reconstruction of human meshes in crowded environments. Building on the 3DCrowdNet framework, our model refines HRNet 2D pose estimation and integrates Lite-HRNet with Shuffle Block and CoordAttention modules, achieving robust feature extraction and lightweight performance. 3DCrowd+ combines an attention mechanism with a model pruning algorithm, demonstrating high accuracy and efficiency on various datasets. This research bridges the gap between complex crowd scenes and detailed 3D reconstruction, offering a promising solution for precise crowd modeling in AR environments.
R0008 **14:10-14:30**	Deep Reinforcement Learning-based Training for Virtual Table Tennis Agent Author(s): Daqi Jiang, Hock Soon Seah, Budianto Tandianus, Yiliang Sui and Hong Wang Presenter: Daqi Jiang, Nanyang Technological University, Singapore Abstract: The advent of Virtual Reality (VR) has revolutionized various fields, notably by merging digital and physical realities, and has significantly influenced sports like table tennis. This paper introduces a novel VR-based table tennis game, employing Deep Reinforcement Learning (DRL) algorithms to enhance player experience and skill development of the agents. The game features a VR table tennis scene with human models, where the movements are controlled by a neural network trained through DRL. For the ball itself, we employ a physics engine to calculate its trajectory considering collision and gravity. The core contribution of this paper is the

	implementation of DRL algorithms to train the neural network and simulate the behavior of a table tennis player. Comparison experiment with different algorithms validates the efficacy of the proposed method. Additionally, the game includes human models with varied characteristics like speed, force, and active reach, which are trained separately to explore optimal strategies for playing against diverse player profiles. Two training programs including skill mastery and skill generalization are set up to explore the optimal training strategy, which offers valuable lessons in real world for both amateurs and professional athletes. The source codes and trained networks are available at GitHub repository.
R1042 **14:30-14:50**	User Experience Evaluation of AR Assisted Industrial Maintenance and Support Applications Author(s): Akos Nagy, Yannis Spyridis, Gregory J Mills, Vasileios Argyriou Presenter: Akos Nagy, Kingston University, UK Abstract: The paper introduces an innovative approach to industrial maintenance leveraging augmented reality (AR) technology, focusing on enhancing the user experience and efficiency. The shift from traditional to proactive maintenance strategies underscores the significance of maintenance in industrial systems. The proposed solution integrates AR interfaces, particularly through Head-Mounted Display (HMD) devices, to provide expert personnel-aided decision support for maintenance technicians, with the association of Artificial Intelligence (AI) solutions. The study explores the user experience aspect of AR interfaces in a simulated industrial environment, aiming to improve the maintenance processes' intuitiveness and effectiveness. Evaluation metrics such as the NASA Task Load Index (NASA-TLX) and the System Usability Scale (SUS) are employed to assess the usability, performance, and workload implications of the AR maintenance system. Additionally, the paper discusses the technical implementation, methodology, and results of experiments conducted to evaluate the effectiveness of the proposed solution.
R3089 **14:50-15:10**	Advancing Manufacturing Maintenance with Mixed Reality: Integrating HoloLens 2 in the Siemens-Festo Cyber-Physical Factory Author(s): Daniel Delgado-Bellamy, Zeyad Al-Shibaany, Yaseen Zaidi, Abdul Farooq Presenter: Daniel Matias Delgado-Bellamy, University of the West of England, UK Abstract: Globalisation and digitalisation are making digital transformation inevitable, and current workforce skills and artificial intelligence regulations are not ready for the demands of a new era of smart manufacturing. Alternatively, Mixed Reality (MR) technology, which integrates real-world and computer-generated environments, offers digital transformation support by providing immersive digital spaces with unique multimodal interactions. However, the maturity of MR technology requires enhancement, particularly in its software architecture for real manufacturing applications. This study demonstrates the implementation of HoloLens 2 MR interactions within the Siemens-Festo Cyber-Physical Factory system, specifically for the offset calibration of an infrared sensor. The developed software architecture, MR functionalities, and performance data obtained from the Unity profiler suggest that there are significant opportunities for software optimisation to achieve real-time and seamless data visualisation. However, the application-specific nature of the optimisation increases the dependence on software experts thus the cost to design and maintain HoloLens 2-based manufacturing applications. Consequently, this also raises challenges for the standardised development of MR applications in the industry.

Onsite Session 4

- **Topic: Virtual Environment and System Simulation**
- **Time: 15:50-17:50, UTC+1, July 25, 2024**
- **Location: Inspire Lecture Theatre | First Floor of Fusion Building**
- **Session Chair: Assoc. Prof. Anita Komlodi, University of Maryland, USA**
- **R0028, R0013, R0021, R2076, R2080, R1048**

R0028 **15:50-16:10**	Achieving common ground: Collaborative information seeking in an asymmetric virtual environment Author(s): Anita Komlodi, Dalma Geszten, Karoly Hercegfi, Alyson L. Young, Shanna Russ, Wayne G. Lutters Presenter: Anita Komlodi, University of Maryland, USA Abstract: Distance collaborations supported by virtual environments (VE) are often accessed using different interaction platforms with different perspectives. However, most research assumes a single shared platform. Using these different technologies to access the same virtual space concurrently raises interesting cognitive challenges. This research examined collaborative information seeking, mental model development, and problem solving. To investigate these challenges, two geographically separated participants worked together on collaborative information tasks. One participant was in an immersive Cave Automatic Virtual Environment (CAVE) while the other participant navigated the same space on a 2D display of a desktop computer. Participants consisted of 61 pairs of Hungarian students. The asymmetry of the technologies involved exacerbated the usual difficulties in establishing common ground, as well as achieving mutual orientation and joint awareness. Problematic assumptions, particularly mismatches in representation between the physical and virtual world, affected participants' ability to coordinate their actions, leading to creative workarounds. Three key themes of breakdown and repair in collaborative information seeking in the VE were observed: (1) joint discovery of the common information space affordances; (2) joint discovery of the information representations; and (3) creating shared mental model of different affordances and capabilities. These challenges confirm the need for specific design features to better support collaborative information seeking in soon-to-be-commonplace asymmetric VEs. This qualitative study gives a basis to draw up guidelines.
R0013 **156:10-16:30**	Requirements for an AI driven Extended Reality assistance system for assembly tasks Author(s): Kathrin Konkol, Hannah Reusing Presenter: Kathrin Konkol, Fraunhofer IPK, Germany Abstract: Nine qualitative expert interviews were conducted to assess the requirements for an intelligent assistance system for virtual assembly in extended reality applications. The research interest lies in understanding current industry and research needs for assistance features of AR, VR, and MR applications that support manual assembly tasks. Additionally, the use of artificial intelligence as a supporting technology was investigated. We gathered expert opinions on relevant features and grouped them into seven categories: Augmentation of information in-situ, identification of components, provision of data, analysis of user action, analysis of environment, optimization of processes, and Usability improvements. The experts feedback on the concept of a software demonstrator was collected and structured. The research shows a need for adaptive assistance systems that are capable of categorizing the user's actions and intent in order to assist efficiently.
R0021 **16:30-16:50**	Neural Painting based on Image Decomposition Author(s): Yuan Ma, Zhao Wang, Meili Wang Presenter: Zhao Wang, Zhejiang University, China Abstract: Painting is a complex and creative process that involves the use of various drawing techniques, along with brushes dipped in paint, to create beautiful artworks. The concept of training artificial intelligence models to imitate this process is referred to as neural painting. Prior neural painting methods have focused on minimizing the difference between the output image and

	the original image. However, such methods often produce strokes with multiple colors, failing to accurately capture the human choice of paints during the creation process. To address this limitation, the paper presents a layer-based neural painting model. Our model decomposes the input image into several layers, each consisting of a single paint and being painted by a fixed color stroke. We propose a lightweight network that uses a series of stroke parameters as input and an alpha map as output, with colors predetermined. This method avoids the stroke parameter coupling problem that has been encountered in previous methods. The layer-based neural painting model allows for greater control over the painting process, enabling the generation of high-quality artwork with a more authentic look and feel. Experiments demonstrate that the paintings generated by our proposed method are more realistic and vivid.
R2076 **16:50-17:10**	Machine Learning-Driven Traffic Flow Prediction using cloud control Big Data Analysis Author(s): Khurrum Jalil, Qian Chen, Muhammad Noaman Zahid and Fazila Jalil Presenter: Khurrum Jalil, University of Shanghai for Science and Technology, China Abstract: Due to the increasing number of intelligent vehicles (IVs) on existing roads, IVs present several challenges, such as congestion, CO2 emissions, idling, and travel delays. Transportation departments rely on forecasting methods using traffic flow data to address issues before implementing new plans for smooth traffic flow. To achieve this, managing the vast amounts of intelligent transportation system (ITS) data necessitates the adoption of cloud computing for data storage capabilities and machine learning methods to facilitate efficient traffic prediction analysis. In addition, real-time data analysis is crucial for evaluating the effectiveness of the on-going implementation of the ITS plans and identifying gaps for improvement. In this paper, the proposed method integrates a machine learning-based traffic flow prediction model that uses cloud computing for traffic data analytics. Then, the efficiency ratio of the proposed method is evaluated. Through experimentation, we demonstrate the effectiveness of our method, achieving a prediction accuracy of up to 90%. This result suggests that the proposed approach is highly competitive compared to existing solutions.
R2080 **17:10-17:30**	A Visuo-Haptic Feedback Surgical Simulator for Twin-to-Twin Transfusion Syndrome Author(s): Michael Kasman, Tristan Alkis, Kenneth J. Moise, Michael Bebbington, Ann Majewicz Fey Presenter: Michael Kasman, The University of Texas at Austin, United States Abstract: Twin-to-twin transfusion syndrome (TTTS) presents complex challenges in maternal-fetal medicine, primarily due to the unequal blood flow between fetuses sharing a single placenta. Despite its clinical importance, the complexity of TTTS and the necessity for intricate interventions have highlighted a gap in effective training simulations. This paper presents an advanced TTTS surgery simulation developed in Unity incorporating visuo- haptic feedback via GeoMagic Touch and HoloLens assistance. The simulation mimics the in-utero environment with floating twins, amniotic particles, laser ablation effects, and a realistic placenta with anastomoses–connected blood vessels on the surface of the placenta. Six training assistance cases were tested: (1) No Assistance, (2) Haptic Guidance, (3) Visual Guidance, (4) Mini-Map Guidance, (5) Combined Guidance (Visual, Haptic, and Mini-Map Guidance), and (6) HoloLens Guidance. In our study, thirty novice subjects were separated equally into the six assistance cases, and one expert surgeon tested on all six assistance cases. The participants performed three tasks: identifying anastomosis sites, laser ablating the sites, and creating a laser path between the points. We computed metrics for case comparison, including the number of waypoints placed, laser path deviation from marked points, path velocity, path acceleration, path jerk, task time efficiency, waypoint error based on expert waypoints set, and laser error based on expert laser path trajectory. Although not statistically significant, these metrics showed that there is an improvement of using the assistance cases for anastomosis marking and path ablation. This work demonstrates the potential of simulations in enhancing TTTS surgery training, providing a realistic, hands-on platform for practitioners to enhance their skills.
R1048 **17:30-17:50**	Improving the immersion in VR with Real-time Full body Performance tracked Avatars in a Football free kick simulation The C3 Centre: Games Research Cluster Project Author(s): Lionel Jayaraj, James Wood, Carlton Reeve, Edward Braund Presenter: Lionel Jayaraj, Staffordshire University, UK

	Abstract: The primary objective of this research was to enhance immersion in Virtual Reality (VR) technology and bridge the user-experience gaps. In sports-oriented simulation environments, there are prefabricated technologies that could be implemented to enhance immersion. According to [19] Petri, K., Bandow, N., & Witte, Sports tasks such as running, jumping, batting, catching, throwing, kicking, rowing, cycling, swimming, etc., have been emulated in VR since the simulation could completely immerse a user in a digital environment. However, current commercial VR systems and applications are limited to tracking and could influence immersion in the technology. In this study, we simulate a Football penalty kick game in a Virtual Environment (VE) to test the hypothesis that complete performance capture can enhance immersion by manipulating the interaction with game objects during game play. Handheld activities are the main use of controllers in commercial VR systems. However, there are limitations to tracking the entire body's performances during the simulation. Most commercial systems, for example, avoid tracking the lower body because there is a general assumption that players are more focused on the task rather than on how they perform it. This research, therefore, tests this assumption to explore whether it applies to all simulations and to gain an understanding of whether user avatar plays an important role in a kicking simulation's immersion. Here, we examine conventional approaches to designing immersive commercial VR systems. A Microsoft Kinect sensor was used for real-time motion capture in VR gameplay and compared with a version including a commercial VR game mechanic. The pilot-study data from 42 adult participants were statistically analysed to study the immersion in this technology. Studies were conducted to validate the simulations' immersion, collecting various metrics and measures, and by observing the in-game recordings along with a subjective questionnaire.

Online Session A

- **Topic: Virtual Reality and Immersive Experience**
- **Time: 09:45-11:45, UTC+1, July 26, 2024**
- **Zoom Link: https://us02web.zoom.us/j/83299356632 | Password: 072426**
- **Session Chair: Prof. Xi Zhao, Xi'an Jiaotong University, China**
- **R0024, R0011, R0002, R0017, R1041, R2074, R2077, R2079**

R0024 **09:45-10:00**	User Experience Research Play Card in Augmented Reality: A sensemaking case study on designing Visibility and Modality Author(s): Sha Liang; Huseyin Dogan; Stephen Giff; Renée Barsoum Presenter: Sha Liang, Bournemouth University, UK Abstract: Despite the existence of high-level guidelines and frameworks in Human-Computer Interaction (HCI), there is a lack of specific user experience principles for designing augmented reality (AR). This paper proposed the creation of a series of user experience research (UXR) play cards aimed at providing UX practitioners concrete, AR-specific UX design based on The Point of view (POV) UXR playbook. Through the development of a series of 'Hidden Reality' and 'Modality' play cards, we propose a tool that not only enhances the design process but also enriches the overall AR experience for users, paving the way for more meaningful and engaging AR applications. At the heart of this process is the concept of sensemaking, a key method that clarifies the way forward, simplifies the upward journey of the UX's POV pyramid and offers profound insights into user needs and behaviours.
R0011 **10:00-10:15**	Lulu Timeline: VR Video Timeline with Expanded Interactive Scope and Fine-tuning Function Author(s): Jiaao Yu , Wenjun Hou Presenter: Jiaao Yu, Beijing University of Posts and Telecommunications, China Abstract: With the growing market of virtual reality(VR) during these years, watching immersive videos in VR headset has become more and more popular, which demands more convenient video player design in immersive environment. Timeline control, as an important part of video player, enabling users to seek to particular time of video, however has no mature design established in VR yet. We propose Lulu Timeline, a VR video timeline design to enhance users' ability of controlling video play time and reduce work load, which utilizes space that is often overlooked in general design, and would adjust the scaling of timeline playhead movement based on video duration. To determine the actual effect of this new timeline, we conducted a user study with 19 participants, in which we compared our design with the most popular design currently within two tasks. Based on the analysis of subjective and objective data, our design performs higher accuracy, speed, and can significantly reduce users' workload, helping them focus their attention on areas-ofinterest.
R0002 **10:15-10:30**	Aspherical Micro-Optical Simulation and Design for Enhancing Image Quality at Large FOV in Lenslet Array Near-eye Display Author(s): Ye Bi, Tianwen Hou, Lei Zhao, Chaohao Wang and Xinzhu Sang，Chengrui Le, Presenter: Ye Bi, Yongjiang Lab, China Abstract: Lenslet array near-eye displays (LA-NEDs) generate virtual images that appear within the observer's field of view (FOV). While this innovation is pivotal in creating lightweight NEDs, the intricacies of parameter performance during the design process introduce complexities to system development. Additionally, LA-NEDs, a type of pupil-forming technology, entail intricate imaging optical paths, which amplify design challenges and incur high costs for custom-made aspherical lens arrays (ALA). This paper addresses these challenges through a comprehensive exploration of ALA-NEDs. Focusing on simulation-based insights and performance evaluations, it aims to deepen understanding of their applications and capabilities. Through simulation, nuanced performance characteristics are uncovered, providing a foundational knowledge base for informed decision-making in integrating these arrays into immersive visual systems. The study further investigates the impact of various parameters on the imaging quality of ALA-NEDs. Assigning appropriate weights to these parameters, quantifies their influence, enabling optimization and

	customization of systems for enhanced visual experiences. Additionally, practical guidance for ALA-NEDs design is offered by identifying key parameters crucial to imaging quality, serving as a roadmap for future developments and fostering advancements in NEDs. This research significantly contributes to the field by guiding system design. The insights gained pave the way for advancements in immersive visual experiences, providing a solid foundation for the ongoing evolution of near-eye display systems.
R0017 **10:30-10:45**	2.5D Immersive Representation of Chinese Claborate-Style Painting in Virtual Reality Author(s): Yuting Cheng, Mengjie Huang, Jiashu Yang, Wenxin Sun Presenter: Yuting Cheng, Xi'an Jiaotong-Liverpool University, China Abstract: As a crucial medium for showcasing human civilization, museums' exhibition of cultural artifacts significantly impacts audiences' experiences and the information they glean. Claborate-style paintings, a prominent category within traditional Chinese art, are predominantly presented in static exhibition modes and placed in windows alongside dreary text descriptions in museums. This exhibiting method impedes audience engagement and their comprehensive comprehension of the artwork. The fusion of immersive technology and claborate-style painting is a promising approach to preserving cultural relics by promoting it. With its immersive experience, virtual reality (VR) can enhance the audience's appreciation and understanding of traditional Chinese paintings by creating a new virtual atmosphere. In this paper, the authors propose a method for introducing the 2.5D display of claborate-style painting in VR. A case study based on a well-known claborate-style painting, Bamboo Courtyard Pin Gu Tu by Qiu Ying from the Ming Dynasty was presented with focuses on the 2.5D representation method and the user test. With the display in VR, audiences can enjoy a visual experience that captures the essence of the painting and elevates the representation of the claborate-style painting. This study offers a practical reference for combining VR technology with claborate-style painting that gives the audience a more immersive experience to appreciate, which can contribute to the evolution of Chinese claborate-style painting in the modern era.
R1041 **10:45-11:00**	Role-Specific Physiological Responses and Quality of Experience in Collaborative Virtual Reality Tasks: A Comparative Study of Leaders and Followers Author(s): Bhagyabati Moharana, Dr Conor Keighrey, Dr Niall Murray Presenter: Bhagyabati Moharana, TUS, Ireland Abstract: The emergence of Collaborative Virtual Reality (CVR) technology has transformed team-based interactions across diverse fields, offering immersive and interactive environments that enhance collaborative efforts. However, there remains a critical gap in understanding the Quality of Experience (QoE) from a role-specific perspective within these environments. This study addresses this gap by evaluating the QoE differences between leaders and followers in CVR settings, using both subjective assessments and objective physiological measures. Utilizing advanced biosensors, including eye-tracking and physiological monitoring devices, the research examines how distinct roles influence cognitive load, emotional states, and overall user satisfaction. Participants engaged in a collaborative 'pick and place' task within a VR environment, with data collected on electrodermal activity (EDA), heart rate (HR), blood volume pulse (BVP), inter-beat interval (IBI), skin temperature, and pupil dilation (PD). Findings reveal significant differences in physiological responses between leaders and followers, underscoring higher cognitive and physical demands on leaders. The results suggest that role-specific QoE evaluations can inform the design of more equitable and effective CVR systems, enhancing user satisfaction and collaboration outcomes. This study advances the field by integrating multimodal data acquisition and providing insights into optimizing CVR environments for diverse collaborative roles.
R2074 **11:00-11:15**	Towards Automated Hesitation Detection During Support-System Enhanced Industrial Assembly Author(s): Jamil Joundi, Jonas De Bruyne, Aleksandra Zheleva, Wouter Durnez, Jelle Saldien, Klaas Bombeke Presenter: Jamil Joundi, imec-mict-UGent, Belgium Abstract: Modern factories have to accommodate high flexibility, extreme customization and short product life cycles in a cost-effective way. This requires that the operators are provided with sufficient system support to aid their decision-making and hesitation. To investigate how the level of support can affect the operators' behavior, the current study immersed 27 participants in a

	virtual reality factory where they were asked to complete three different assemblies with varying levels of system support (low, medium, or high). The support was provided by a collaborative robot (cobot). The participants' experience was measured via a subjective marker of difficulty and an objective eye-tracking feature (gaze switches). The results showed that when the level of cobot support was low, participants found the assembly step more difficult and were gazing at the instruction screen more often compared to the medium and high support conditions. This suggests that the number of times operators look back at the instruction screen during a step could be a promising marker to automatically detect hesitation behavior in instruction-based assemblies. This study, therefore, presents the initial effort toward validating a behavioral marker of hesitation within this context.
R2077 **11:15-11:30**	Virtual Reality-Based Emergency Fire-Fighting on Methanol-Fueled Ship During Bunkering Operation Author(s): Pinar Bilgin, Eric Lim Presenter: Pinar Bilgin, Singapore Polytechnic, Singapore Abstract: The increasing adoption of methanol as a sustainable marine fuel in the maritime industry highlights the need to address safety concerns. As comprehensive training for ship crews is now gaining importance, one particular area of concern is emergency response to fire during bunkering operations. Methanol fires present unique challenges due to their low visibility, rapid spread, and high flammability. Understanding these characteristics is crucial for effective fire-fighting, making specialized training essential. Real-life fire-fighting experiences, while invaluable, are inherently carry significant risks. Therefore, theoretical and computer-based training (CBT) are essential precursors to real-life scenarios. In recent years, virtual reality (VR) training has emerged as a preferred method due to its immersive nature, controlled environment, and the ability for repetitive practice. In this study, we explore the use of Virtual Reality (VR) simulations to train ship crews in responding to methanol-related fire emergencies during bunkering operations. Trainees engage in immersive scenarios requiring situational awareness, decision-making, and action execution. The VR scenario evaluates their ability to detect and assess fire incidents, determine the optimal response, and implement effective fire mitigation measures. Real-time feedback and detailed assessment reports are provided to enhance the trainees' understanding and proficiency in emergency procedures. The primary aim of this study is to enhance safety standards and protocols for methanol-fueled ship bunkering activities by equipping ship crews with the requisite skills to manage methanol-related fire emergencies. The anticipated outcomes are expected to support safer and more sustainable methanol bunkering operations, aligning with the maritime industry's objectives for a greener and safer future.
R2079 **11:30-11:45**	A Cross-Platform Guidance System for Virtual Reality-Based Upper Limb Rehabilitation Author(s): Jiashu Yang, Wendi Wang, Mengjie Huang, Wenxin Sun, Rui Yang Presenter: Jiashu Yang, Xi'an Jiaotong-Liverpool University, China Abstract: The development of virtual reality (VR)-based rehabilitation offers new healthcare programme to patients with upper limb motor deficits. VR head-mounted displays (HMDs) provide patients with not only enhanced engagement and motivation, but better therapeutic performance. In the immersive environment, therapists that are important to rehabilitation sometimes provide guidance to patients as avatars in the game scene. To enhance the guidance efficiency and reduce the cost, this study aims to introduce a new cross-platform rehabilitation system, with patients taking rehabilitation through VR platform and therapists offer guidance through personal computer (PC) platform. The system involves visual and tactile guidance modalities as aids and extensions. To evaluate the cross-platform system, user experience and performance, two essential factors in a digital rehabilitation system are taken into consideration for the experiment. Subjective and objective data are collected during the experiment for healthy participants. Based on experience and performance analysis, this study generally achieved good user feedback and summarized the optimal guidance methods for cross-platform rehabilitation. Finally, this study contributes to the existing literature by proposing suggestions on the design considerations of cross-platform rehabilitation system, especially for the guidance included.

Online Session B

- **Topic: VR Based Visual Experience and Interaction System**
- **Time: 09:45-11:45, UTC+1, July 26, 2024**
- **Zoom Link: https://us02web.zoom.us/j/83595238836 | Password: 072426**
- **Session Chair: Dr. Roberta Macaluso, Politecnico di Torino, Italy**
- **R1045, R1043, R0027, R2070, R2067, R3083, R2078, R0020**

R1045 **09:45-10:00**	A Review Study: Using Serious Games and Virtual Reality to Support Mental Health and Cognitive Behavioral Therapy Author(s): Mashael Bin Sabbar, Rich Davison and Gary Ushaw Presenter: Mashael Bin Sabbar, Newcastle University, UK Abstract: This paper represents a review study about how Serious Games and Virtual Reality support mental health especially focused on the effect of using Virtual Reality to support Cognitive Behavioral Therapy (CBT). The study is based on a scoping review by considering 14 papers and targeting to answer a set of questions to align with our research objectives and address the gaps. The finding shows that Serious Games and Virtual Reality have a significant impact in supporting mental health interventions. The selected papers explored many mental health issues like depression, anxiety, and phobias. In the conclusion, we highlighted the effectiveness of using serious games and virtual reality to support mental health and addressed some limitations of the reviewed studies such as the need for further research with large-scale samples and more quality papers.
R1043 **10:00-10:15**	Application of 360° Panoramic VR and Eye Tracking in the Study of Spatial Visual Perception in Traditional Chinese Gardens: A Case Study of the Humble Administrator's Garden Author(s): Jinni Huang, Yongtao Zhang, Xingyi He, Cheng Zhang Presenter: Xinyi He, Beijing University of Civil Engineering and Architecture, China Abstract: As a model of human spatial visual art, it is necessary for traditional Chinese gardens to reveal their visual perception patterns through scientific quantitative methods in order to promote the contemporary translation of garden space in the field of contemporary architecture. In this paper, we take the Humble Administrator's Garden as an example and use 360° panoramic VR combined with eye movement experiments to analyze the visual attention and perception patterns of visitors in the space of the Humble Administrator's Garden. In addition, during the experiment, we found that there are many problems in the current combination of eye-tracking technology and virtual reality immersive scene, and the integration of the two technologies needs to be further strengthened. Therefore, this study reveals the limitations of the combination of 360° panoramic VR and eye-tracking technology as well as the direction of future development from three aspects: sample presentation, data collection, data processing and analysis, in order to provide relevant insights for the combination of VR technology and eye-tracking technology at present.
R0027 **10:15-10:30**	Evaluating Stereo and Head-Coupled Perspective Cues in Collaborative Immersive Environments Author(s): Maximilian Schulze, Sebastian Keppler, Bozana Meinhardt-Injac, Johann Habakuk Israel Presenter: Johann Habakuk Israel, HTW Berlin, Germany Abstract: The concept of virtual reality relies heavily on stereoscopic and perspective-correct vision. While their importance for single-user setups has been well studied, there is a need to investigate their importance for collaborative immersive environments, especially as multi-user virtual environments become more prevalent. Both stereoscopy, which refers to 3D depth perception through binocular disparity of images in the two eyes, and head-coupled perspective, which is generated by motion and temporal changes in retinal images, provide robust cues for depth perception, figure-ground separation, and 3D shape perception. In our study with 60 participants, we manipulated stereo and perspective cues in a two-user scenario (decision-maker and helper) and measured performance (i.e. accuracy and reaction time) and cyber-sickness in four constellations: both stereo and head-coupled perspective are offered vs. only stereo vs. only head-

	coupled perspective vs. neither cue is offered. Our results show a differentiated picture: performance in terms of accuracy and reaction time was best when both cues were provided. Stereoscopy had a greater impact on accuracy, while head-coupled perspective had a greater impact on reaction times. Cyber sickness depended on the user's role, with the decision-maker role presenting significantly more difficulty than the helper role. The simultaneous presence of cues from both the stereo and head-coupled perspectives was associated with the least amount of cyber sickness compared to all other constellations.
R2070 **10:30-10:45**	Exploring Emotional Responses of Immersive VR Video Content Across Genres Author(s): Kunyan Li, Shuxuan Yu, Chen Zuo, Yiyang Teng, Jinwu Wei, Xiaojie Wang, Ruitao Ma, Xiongwei Jia, Xiaojun Mu and Shiqi Zhao Presenter: Kunyan Li,China United Network Communications Group Company Limited, China Abstract: In the burgeoning metaverse, Virtual Reality (VR) videos offer an unprecedented level of immersion, surpassing traditional flat screen videos. This study investigates whether this heightened immersion triggers stronger emotional responses in viewers. Employing a meticulously constructed dataset comprising questionnaires, this study investigates emotional variances through comparative analyses of two viewing modalities—panoramic videos on a screen (No-HMD) versus through VR glasses (HMD)—across multiple genres including horror, adventure, scenic, singing shows, chinese crosstalk, and talkshows. Results indicate that viewers exposed to horror, adventure, singing shows, chinese crosstalk, and talkshow videos via HMD reported heightened emotional responses compared to the No-HMD condition. However, emotional disparities between HMD and No-HMD conditions were negligible for scenic videos. In conclusion, this research enhances our understanding of the emotional impact of highly immersive VR across diverse video content genres, contributing to both subjective and objective evaluations of VR video content within the metaverse.
R2067 **10:45-11:00**	Touchable Colors—Research on interactive product service system based on tactile experience of visually impaired people Author(s): Shuxiao Zhong, Jinjun Xia, Zhengyan Fan, Rongyu Zhang, Yuan Sun Presenter: Shuxiao Zhong, Tongji University, China Abstract: The touchscreen technology has revolutionized ways of modern social interaction, with a wider use of gesture-based user interfaces. However, this technology is still hardly accessible as far as the visually impaired are concerned, who often have difficulty navigating interfaces via visual cues. Considering the physiological characteristics of the visually impaired children, and their psychological impact, this paper, in the light of multimodal perceptual substitution and multisensory interaction, proposes a design of mapping color cues to temperature which aims to enable the visually impaired to perceive color changes through tactile feedback and to participate in such digital activities as artistic creation like painting. The sensory substitution device TouchableColors, designed to convert tactile information into visual one, is expected To help visually impaired children express emotions through color-based artistic creation and thus promote the independence of and social inclusion for the visually impaired children. This kind of more inclusive digital and physical device can potentially make up the visual cues for them and at the same time have a positive impact on their feelings, self-realization, and quality of life.
R3083 **11:00-11:15**	Dynamic Day and Night Cycle Impact in a Serious VR Game Author(s): Fardani Annisa Damastuti, Kenan Firmansyah, Yunifa Miftachul Arif, Ali Ridho Barakbah and Mochamad Hariadi Presenter: Fardani Annisa Damastuti, Institut Teknologi Sepuluh Nopember, Indonesia Abstract: The immersive nature of virtual reality (VR) gaming is significantly improved by the implementation of dynamic environmental systems. This paper focuses on the development and impact of a dynamic day and night cycle in a serious VR game. This feature is intended to simulate a full 24-hour cycle within a 10-minute gameplay session, resulting in a seamless transition between different times of day that impacts both the visual aesthetics and gameplay mechanics. The day and night cycle introduces strategic depth by requiring players to adjust their management strategies according to the time of day, which affects resource availability, operational efficiency, and conditions. This system not only enhances visual fidelity but also directly impacts gameplay, necessitating that player modify their strategies in response to the changing environment. Visual

	aesthetics are expected to increase by 15%, strategic profundity will be improved by 20%, and player immersion will be enhanced by 25%, according to the research findings. This investigation underscores the importance of natural cycles in enhancing the strategic complexity, interactivity, and realism of virtual reality environments, thereby offering valuable insights for the creation of future virtual reality games.
R2078 **11:15-11:30**	Enhancing Usability with Virtual Imagery: Insights into Feedback Mechanism from a BCI-VR Integrated System Author(s): Annan Lu, Mengjie Huang, Luyao Tang, Rui Yang Presenter: Annan Lu, Xi'an Jiaotong-Liverpool University, China Abstract: The integration of brain-computer interface (BCI) and virtual reality (VR) technologies has fostered innovative applications in medical rehabilitation, education, and entertainment. One prominent application is the motor imagery (MI)-based BCI-VR system, which allows users to control the system through imagined movements without physical motion. Despite these advancements, the usability of a such system remains a significant challenge, primarily due to limited user feedback mechanisms. This study addresses this gap by designing and evaluating four haptic feedback modes to enhance user interaction in MI-based BCI-VR systems. Specifically, the research introduces a novel approach by integrating pseudo-haptic feedback—the illusion of touch created through visual and auditory stimuli—alongside traditional physical feedback. Using a within-subjects experimental design, the study assesses the impact of different combinations of physical and pseudo-haptic feedback on haptic perception, user workload, and satisfaction. The results indicate that the combination of both pseudo-haptic and physical feedback significantly enhances user satisfaction (M=2.25, SD=0.46) and perceived vibration level (M=9.25, SD=1.03), although it also increases the workload. These findings suggest that carefully balanced haptic feedback can improve the usability and overall user experience of MI-based BCI-VR systems, providing practical insights for system optimization.
R0020 **11:30-11:45**	Embodied Cognition and MR-Based Interactive Narrative Design: The Case of 'Encountering Sanmao' at the Former Residence of Zhang Leping Author(s): Yun Liu, Shasha Liao, Yunshui Jin, Minhua Ma, Wenxun Tang Presenter: Yunshui Jin, Tongji University, China Abstract: This research examines interactive narratives within museum contexts utilizing Mixed Reality (MR) technology and introduces two design strategies inspired by the theory of embodied cognition: multisensory experiences and embodied interaction models, with an emphasis on both verbal and non-verbal interactions with virtual characters. Utilizing these strategies, the MR interactive narrative application Encountering Sanmao was developed for the Former Residence of Zhang Leping in Shanghai. To assess the effectiveness of these design strategies, a controlled experiment with a within-group design was performed on-site, involving 32 participants. Analysis of the collected interview data confirmed the efficacy of the strategies, providing valuable guidance for the implementation of MR interactive narrative experiences in small to medium-sized museums.

Online Session C

- **Topic: Application of Virtual Reality in Information Systems**
- **Time: 13:00-14:30, UTC+1, July 26, 2024**
- **Zoom Link: https://us02web.zoom.us/j/83299356632 | Password: 072426**
- **Session Chair: Dr. Dorota Kamińska, Instytut Mechatroniki i Systemów Informatycznych Politechniki Łódzkiej, Poland**
- **R0012, R0030, R1040, R1055, R2073, R2066**

R0012 **13:00-13:15**	Gaze-Adaptive Subtitles for 360° Videos in Virtual Reality Author(s): Tianrui Hu, Wenjun Hou Presenter: Tianrui Hu, Beijing University of Posts and Telecommunications, China Abstract: Subtitles (captions displayed on the screen) play a crucial role in cross-lingual multimedia content, serving as valuable aids for individuals who are deaf or hearing-impaired, as well as in situations involving unknown languages or loud environments. Subtitles are equally indispensable when viewing 360° immersive videos in virtual reality (VR). However, the experience of watching 360° videos in VR differs significantly from that on desktop screens. Hence, we propose a method for presenting VR 360° video subtitles that leverages users' gaze data as indirect input to dynamically adjust subtitle positions in real-time. Our research investigates the impact of adaptive subtitles compared to traditional subtitles on users' experiences when viewing 360° videos in VR environments. Research findings suggest that the proposed adaptive subtitle placement method is more effective than traditional subtitles located below the field of view in reducing visual fatigue and enhancing the watching experience for users. Furthermore, in comparison to conversational 360° videos featuring speaking subjects, adaptive subtitles offer greater optimization and improvement in scene-oriented videos with voice-overs.
R0030 **13:15-13:30**	Immersive Learning: Exploring Learning Management Systems in Virtual Reality Author(s): Lijo P Thomas, Juby Thomas, Sateesh Kumar Tk and Vishnu Achutha Menon Presenter: Lijo P Thomas, Kristu Jayanti College, India Abstract: This experiment involved 66 undergraduate participants recruited through purposive sampling. Participants, predominantly male (40) and from semi-urban areas (34), engaged in the Virtual Reality (VR) study from November 2023 to January 2024. Using VR headsets, they accessed an LMS portal to review study materials and complete a quiz. Data were collected using the Virtual Experience Questionnaire. The study aimed to understand the relationships between emotions, engagement, presence, skill development, and judgment in VR. Results showed that these factors collectively influenced the virtual experience, with higher levels correlating with increased skill requirements. Skill levels positively impacted respondents' judgment of virtual experiences. The validation of latent variables demonstrated strong internal consistency and satisfactory convergent validity within the structural equation model.
R1040 **13:30-13:45**	Integrating Design Psychology in VR Scenarios to Improve Virtual Reality Experiences Author(s): Hui Liang, Haoming Xu, Yi Wang and Junjun Pan Presenter: Haoming Xu,Zhengzhou University of Light Industry,China Abstract: The application of virtual reality (VR) across various sectors is becoming more widespread, playing a pivotal role in the advancement of the metaverse. However, the prevalence of VR sickness undermines user experiences, indicating a pressing need for optimization. Current research primarily focuses on enhancing VR hardware and investigating the relationship between human factors and VR sickness, overlooking the critical aspect of VR content. This article proposes design standards for VR scenarios, grounded in established design psychology theories, and develops six sets of VR scenarios to examine how VR content influences user experiences. We enlisted 150 college students suffering from VR sickness to participate in a study. The findings reveal that incorporating design psychology principles into VR scenarios beneficially affects participants' physiological and emotional responses. Nonetheless, the proposed design standards require further refinement, and future research is needed to validate their effectiveness.

R1055 **13:45-14:00**	HSM:Hand Surface Menu Solution for Interaction in VR Author(s): Hailong Zhang,Lin Li,Chang Xue,XiaoCai Wei,Yin Zhou Presenter: Hailong Zhang, Hefei University of Technology, China Abstract: The menu interaction methods in VR, such as floating menus, are still considered unnatural. A solution is proposed in this paper where menus are tightly attached to the user's palm. Firstly, use UV mapping technology to attach the menu to the palm. Secondly, optimal layout parameters for the hand surface menu were determined through user experiments. Finally, a dataset was built to train the interaction error detection model, aiming to improve interaction success rates under various hand poses in VR. Experimental results demonstrate that compared to other VR menu methods, HSM reduces the average interaction error rate by 30.1% and shortens the average completion time by 12.4% under the optimal hand pose.
R2073 **14:00-14:15**	GuardianVR: Fostering Empathy Through Virtual Reality Author(s): Tania Vasquez Sal y Rosas; Renato Castillo Rengifo; Ivan Bautista Fuentes Presenter: Tania Vasquez S, Universidad Peruana de Ciencias Aplicadas, Peru Abstract: Facing the global challenge of bullying, this study explores using virtual reality (VR) to promote empathy and prosocial behaviors among students. Utilizing a game designed for this purpose, incorporating advanced empathic models, our work focuses on improving the understanding and practice of affective and cognitive empathy. The game, developed in a VR environment, offers an immersive and emotionally enriching experience that allows users to experience situations from multiple perspectives, which is essential for preventing bullying. Through a series of interactive mini-games, students face decisions that directly impact social dynamics and their capacity for empathy. Results from previous research indicate a significant increase in understanding and empathetic response, underlining the feasibility and necessity of such interventions in educational settings. This approach offers new directions for instructional design and the development of educational games, emphasizing the importance of technological solutions in emotional and social education.
R2066 **14:15-14:30**	Enhancing Immersive Representation in Building Information Modelling: Towards a Framework for Effective Integration of Immersive Technology in the AEC Sector Author(s): Simone Balin, Cecilia Maria Bolognesi, Paolo Borin Presenter: Simone Balin, Politecnico di Milano, Italy Abstract: The digitalization of information processes has become a standard practice in the construction sector, especially in the context of Building Information Modelling (BIM). With the advent of immersive technologies such as Virtual Reality (VR) and Augmented Reality (AR), we now can enrich the representation of information in BIM, offering an interaction with the data that goes beyond simple visualization. Despite this, current standards and guidelines for BIM tend to focus on the structuring and organization of data in a traditional digital environment, overshadowing immersive aspects like representation and interaction in virtual ecosystems. This article, through the analysis of a case study, explores the issues arising from the lack of a structured information framework for immersive representation in a BIM environment. It emphasizes the need to define specific information requirements for an effective implementation of immersive simulations. Based on the observations collected, a structured information plan is proposed, complete with prerequisites and criteria for immersive simulation, and its practical application in a scenario is illustrated. The study continues with a comparison between structured and unstructured scenarios, discussing the implications and potential future developments. In conclusion, this research highlights the possibility of creating immersive models, with informational content, that are aligned with BIM coordination. This alignment prevents informational inconsistencies and ambiguities that could invalidate the immersive representations and compromise a potential contractual agreement.

Online Session D

- **Topic: Augmented Reality and Virtual Reality**
- **Time: 13:00-14:45, UTC+1, July 26, 2024**
- **Zoom Link: https://us02web.zoom.us/j/83595238836 | Password: 072426**
- **Session Chair: Dr. Natalia Adamczewska, Bournemouth University, UK**
- **R0009, R1034, R1037, R1059, R1058, R1039, R2081**

R0009 **13:00-13:15**	A Conceptual Framework of Surgical Education VR Tool Design Under the Sudden Changes Perspective Author(s): Ming Zhu, Yang Shi Presenter: Ming Zhu, Beijing Jiaotong University, China Abstract: Many studies have demonstrated the benefits of VR technology in surgical education, yet its actual adoption remains low. This pa-per, through investigating the practical needs in surgical educa-tion and comparing existing VR educational tools, identified a common lack of storytelling design. The research structured and proposed a storytelling design model for VR educational tools. In the field of surgical education, it was found that a perspective emphasizing sudden changes could effectively convey the story of surgical education and training. Therefore, based on this, a con-ceptual framework for the design of surgical education VR tools is proposed, along with relevant suggestions for the application of AI. The goal is to not only provide training tools for medical stu-dents' knowledge and skills but also to foster their clinical think-ing. It is aimed to offer new perspectives and approaches for the application of VR, providing both design science and surgical education training aspects.
R1034 **13:15-13:30**	Digital Exhibition of Traditional Chinese Water Measurement Instruments Based on Augmented Reality Technology Author(s): Yang Liu, Baolu Fan, Guojun Yin, Jianyong Wu Presenter: Yang Liu, Huaiyin Institute of Technology, China Abstract: Traditional Chinese water measurement instruments, as direTraditional Chinese water measurement instruments, as direct outcomes of China's hydraulic engineering and river management practices, serve as crucial artifacts embodying ancient measurement techniques. They reflect the intuitive and precise methods employed in ancient times. This paper aims to explore the path and methods of digitally preserving traditional instruments through new media technology. Focusing on traditional water measurement instruments, the study delves into their morphological characteristics and functional principles, utilizing historical records and museum artifacts. Leveraging digital technology, the instruments are digitally reconstructed. Using Unity as the development engine, a seamless integration of instruments into the real environment is achieved, coupled with code writing to form an AR interactive digital display solution. This approach effectively safeguards hydraulic cultural heritage, aiming to pass on the cultural value of water resources.ct outcomes of China's hydraulic engineering and river management practices, serve as crucial artifacts embodying ancient measurement techniques. They reflect the intuitive and precise methods employed in ancient times. This paper aims to explore the path and methods of digitally preserving traditional instruments through new media technology. Focusing on traditional water measurement instruments, the study delves into their morphological characteristics and functional principles, utilizing historical records and museum artifacts. Leveraging digital technology, the instruments are digitally reconstructed. Using Unity as the development engine, a seamless integration of instruments into the real environment is achieved, coupled with code writing to form an AR interactive digital display solution. This approach effectively safeguards hydraulic cultural heritage, aiming to pass on the cultural value of water resources.
R1037 **13:30-13:45**	Mixed Reality for Elderly Care: Ergonomic Hand Motion and AR Rehabilitation Author(s): Jeanne Xinjun Li, Brad Zhenhong Lei Presenter: Xinjun Li, Cornell University, United States Abstract: This research introduces a cutting-edge mixed reality (MR) intervention to enhance hand

	dexterity and mobility among the elderly. The proposed system merges ergonomic hand motion support with an augmented reality (AR) rehabilitation framework, adhering to the principles of Diversity, Equity, and Inclusion (DEI). The device, adaptable to a wide range of hand sizes, provides customized physical assistance alongside an AR platform accessible through smartphones. This platform is designed to deliver individualized rehabilitation exercises supplemented with interactive tutorials and telehealth functionalities, enabling remote oversight by medical practitioners. The development of the device followed an iterative design methodology, incorporating inputs from a diverse group of stakeholders, including elderly participants, healthcare professionals, and design experts. Preliminary results indicate significant enhancements in users' hand dexterity and mobility, alongside improvements in task execution capabilities. Furthermore, the intervention promotes user autonomy and satisfaction, effectively addressing the limitations of conventional mobility aids for the elderly. Integrating physical support mechanisms with virtual rehabilitation exercises, this DEI-centric innovation marks a significant progression in elderly care technology. It presents a multifaceted, user-friendly solution within the extended reality (XR) healthcare domain, demonstrating widespread adoption and application potential.
R1059 **13:45-14:00**	WSUS: A novel usability metric based on SUS for VR-based tasks in cultural heritage contexts Author(s): Marco Raoul Marini, Ludovica Mocerino, Laura Leopardi, Saverio Giulio Malatesta, Luigi Cinque Presenter: Marco Raoul Marini, University of Rome, Italy Abstract: The proliferation of Virtual Reality (VR) technologies has significantly transformed the landscape of cultural heritage experiences, offering immersive and interactive access to historical and cultural content. However, the effective evaluation of user experience and system usability within these VR environments remains a challenge, primarily due to the unique demands and interaction paradigms they present. This paper introduces the Weighted System Usability Scale (WSUS), a novel adaptation of the traditional System Usability Scale (SUS) methodology, specifically tailored for assessing VR-based experiences in cultural heritage contexts. The WSUS method incorporates a weighted scoring system that accounts for the distinct aspects of user engagement based on the specific content of the experience, which conventional SUS does not adequately capture. Through a comprehensive study involving different groups of participants on a specific VR cultural heritage application, the WSUS methodology demonstrated a heightened sensitivity to usability issues related to cultural heritage contents. The results revealed that WSUS scores correlated significantly with users' overall satisfaction and perceived learning outcomes, highlighting the method's effectiveness in evaluating the nuanced dimensions of VR usability.
R1058 **14:00-14:15**	Physically-based Virtual Picking System for Hand-Fruit Interaction Using Data Gloves Author(s): Shicheng Qiu, Yong Zhao, Zhengrong Li, Zhiyi Zhang and Shaojun Hu Presenter: Shicheng Qiu, Northwest A&F University, China Abstract: Virtual picking has wide applications in the fields of agricultural training, remote robotic picking, video games and popularization of science. The traditional virtual picking systems largely rely on VR controllers to complete the picking action. Although they provide a basic interactive experience, they cannot meet the demand for immersive finger joint movements in a virtual environment. Integrating the delicate motions of human finger joints during picking with the physical movement of the fruit and branches is a challenge. In this paper, we design a physically-based virtual fruit picking system using data gloves to satisfy the immersive need for finger joint movements during picking. First, we animate the process of branch movements generated during the picking action to enhance the experience of virtual picking. Furthermore, an efficient collision detection method is presented for interactive picking with data gloves in the virtual environment. We have conducted performance and accuracy tests and a user study on a virtual picking system containing 3 kinds of fruit trees, the results showed that the developed virtual fruit picking system not only meets the hand interaction requirements of users in the virtual picking experience but also has good entertainment and educational performance.
R1039 **14:15-14:30**	Advancing Augmented Reality at World Heritage Sites through an Affordance Lens: A Case Study of the Archaeological Ruins of Liangzhu City Author(s): Wen-yi Fan Presenter: Wen-yi Fan, Zhejiang International Studies University, China

	Abstract: Augmented Reality (AR) presents distinctive advantages in enhancing tourism experiences at World Heritage Sites (WHS). While the tourism industry is commonly presumed to actively embrace technological advancements, there remains an inadequacy in the theoretical understanding of AR behind its adoption, particularly regarding why and how AR is applied in specific tourism context such as WHS. This preliminary study employs affordance theory to provide a richer theoretical explanation of AR in tourism from a novel perspective. Using the Archaeological Ruins of Liangzhu City as a case study, it focuses on AR in the WHS setting to examine human-environment interactions on two levels. The first level, user-object/artifact interaction, centers on individual engagement with AR, reflecting the current situation at the case WHS. Adopting an affordance perspective, this study further argues that sequential human-physical environment interaction at the second level is imperative for realizing the collective objective of sustainable tourism development at the WHS. This work advances the theoretical understanding of AR in tourism context, offering insights into affordance that can enrich the understanding of the relationship between visitors and AR at WHS .
R2081 **14:30-14:45**	Enhancing Scoliosis Rehabilitation through Muscle Activity Visualization Author(s): Xinyi Tang, Xuan Wu, Lakshay Sharma, Siddharth UR, Yiqi Yan Presenter: Xinyi Tang, Harvard University, United States Abstract: Scoliosis, marked by abnormal spinal curvature, significantly impacts millions globally. This study evaluates an integrated system combining surface electromyography (sEMG) and motion capture instruments to enhance scoliosis-specific exercise accuracy and engagement. The system monitors muscle activity via EMG and provides real-time visual feedback using an avatar created in Unity, allowing participants to correct their posture during exercises. Results indicate improved exercise execution and adherence, with EMG data showing muscle engagement and OptiTrack facilitating precise movement correction. Participants also reported increased motivation and engagement due to the interactive nature of the feedback. This innovative approach ensures accurate exercise performance and enhances user engagement, suggesting a promising enhancement for scoliosis rehabilitation.

Online Session E

- **Topic: Image Reconstruction and Simulation**
- **Time: 15:00-16:45, UTC+1, July 26, 2024**
- **Zoom Link: https://us02web.zoom.us/j/83299356632 | Password: 072426**
- **Session Chair: Dr. Zequn Li, Bournemouth University, UK**
- **R0016, R0003, R0046, R1053, R1064, R2071, R3085**

R0016 **15:00-15:15**	3D Remote Scene Reconstruction via Graph Convolution Author(s): Xing Li, Mingyu Sun, Qiaofeng Ou, Yan Mo, Sikun Liu, Zhibo Rao Presenter: Xing Li, Nanchang Hangkong University, China Abstract: 3D urban scene reconstruction is a significant remote sensing topic that provides enriched context on 3D spatial information. However, obtaining a watertight, lightweight, and detailed mesh object from remote sensing images is challenging due to sparse point clouds and inaccurate normals. This paper introduces a 3D mesh reconstruction framework to recover 3D scene information from pairwise remote sensing images, comprising three main stages. Firstly, our previous multi-task network (BGA-Net) is employed to predict the disparity maps from pairwise remote sensing images. Next, we utilize camera parameters and interpolation to reconstruct and fill point clouds, mitigating sparse point clouds (e.g., building edges or unsmooth areas). Finally, a graph convolution network (GCN) is adopted to recover the mesh object from the filled point clouds, reducing the dependency on precise normals. Extensive experiments demonstrate that our framework can qualitatively produce watertight, lightweight, and detailed mesh models.
R0003 **15:15-15:30**	Piece-wise planar reconstruction of indoor scenes based on Laplace depth residuals Author(s): Jie Yan, Jun Miao, Lei Li and Ronghua Du Presenter: Jun Miao, Nanchang Hangkong University, China Abstract: Reconstructing 3D scenes from single indoor images using piece-wise planes presents a significant challenge. Factors such as texture interference and scale variation complicate the segmentation of individual image planes, making it difficult to capture detailed scene structural information. This paper introduces a novel end-to-end reconstruction algorithm tailored for indoor scenes, employing piece-wise planes and utilizing Laplace depth residuals. In the encoding stage, a high-resolution receptive field module (HR-RFM) is introduced, enhancing the classifier's ability to identify objects with limited pixel coverage in the input image. This is achieved by extracting low-level, high- resolution detail features from the ResNet-101 network, resulting in more stable feature extraction, the retention of edge features, and strengthened recovery of planar segmentation edge effects. The decoding stage features the implementation of a Laplacian pyramid decoder, effectively distinguishing object boundaries and restoring local details of depth boundaries. This leads to a more continuous estimation of edge depth, addressing challenges associated with boundary localization. The 3D model of the indoor scene is reconstructed by combining it with the planar segmentation mask. Experimental results on the ScanNet and NYU-V2 datasets demonstrate that our algorithm achieves state- of-the-art performance, notably improving reconstruction quality.
R0046 **15:30-15:45**	Pop-up World: Synthesis of 2.5D Models Based on Monocular Images Author(s): Jingyao Cai, Boyuan Cheng, Yuqian He, Zhidong Xiao, Jian J Zhang and Xiaosong Yang Presenter: Jingyao Cai, Bournemouth University, United Kingdom Abstract: For current VR technology, stereoscopic scenes are crucial for an immersive experience. However, the representation of vast 3D scenes in VR poses a significant challenge due to the extensive memory usage and consumption associated with large 3D models. To address this, we propose the use of 2.5D models as a substitute for traditional 3D models in the construction of distant scenes. The method leverages unsupervised clustering algorithm to segment the depth map of the input image. Users can decide the number of segmented layers according to the complexity of the input images and their demands. Each layer is refined using inpainting techniques, especially pre-trained mask-aware transformer models, to ensure a seamless and realistic visual experience.

	This approach not only reduces the size of the scenes but also maintains the fidelity of the VR experience, striking a balance between technical efficiency and user immersion. The system can effectively handle complex scenes and can be integrated into tools such as Maya for model customization. The source code is available at https://github.com/XChengCode/Synthesis-of-2.5D-Models-Based-on-Monocular-Images.
R1053 **15:45-16:00**	Target-specific and Temporal Transformer for Visual Tracking Author(s): Jiapeng Hu, He Zhao, Jiong Jia, Youming Chen, Liang Zhao, Yamin Han, Meili Wang Presenter: Jiapeng Hu, Northwest A&F University, China Abstract: Visual tracking can obtain the location of the interest objects, which is beneficial for 3-D reconstruction in different VR applications. With the progress of deep learning, transformer-based trackers have achieved a remarkable performance gain. However, most existing transformer-based trackers only consider the per-frame localization accuracy, neglecting the potential temporal dependencies among multiple video frames. To address the above issues, we propose a target-specific and temporal transformer for visual tracking. It propagates preceding target-background dynamics into succeeding frames for more coherent tracking results. Firstly, we propose a target-specific candidate generation module to detect target candidates, which enables generated target candidates containing more targetspecific information by selecting appropriate search tokens to interact with template tokens. Then, a spatio-temporal correlation transformer is designed to model the temporal evolution of target candidates' trajectories. It can effectively model the historical temporal target and background information during the tracking for increasing the discriminability and robustness. Extensive experiments have shown that our tracker outperforms previous state-of-the-art trackers on three tracking benchmarks including LaSOT, UAV123, and NFS30.
R1064 **16:00-16:15**	The facial expression dataset in VR game Author(s): Tianhua Xie, Junhuai Liang, Guohua Yang, Jingjia Deng.Weixin Zheng and Jinliang Gan Presenter: Weixin Zheng, Department of Mechanical and Electrical Information Maoming, China Abstract: This study introduces the Virtual Reality Gaming Facial Expression (VRGameF) dataset, a novel collection of facial expressions from users captured during VR gameplay. Utilizing a deep convolutional classification network, this dataset was trained with the aid of activation maps (CAMs), which revealed that the key features of expressions are predominantly concentrated in the lower regions of the nose on the face. The research further extends to creating a dataset that mimics the conditions of wearing head-mounted displays (HMDs) by masking ocular features. This modified dataset is then used to train a neural network to recognize expressions based on jawline cues within VR settings. Comprising 2170 images, the VRGameF dataset represents four distinct emotions: neutral, surprise, happiness, and disgust. A deep convolutional neural network has been trained to serve as a baseline for this dataset, and YOLO-V5 has been employed to develop a model specialized in detecting facial expressions within VR gaming scenarios. Demonstration tests have shown that tracking facial expressions in VR games is an effective method for assessing immersion levels in virtual experiences. This contribution represents advancement in understanding and enhancing user engagement in VR gaming environments.
R2071 **16:15-16:30**	Point HorNet: Higher-Order Spatial Interaction Network for Point Clouds Author(s): Hao Yuan，Linqing Liu, Tingting Yan, Wenjing Zhang, Qinghe Liu, Juanjie Wei, Ziang Wu, Huijun Yang Presenter: Linqing Liu, Northwest A&F University, China Abstract: The progression of 3D scanning technology has am-plified the importance of point cloud data in computer vision, robotics navigation, and virtual reality. Point clouds, consisting of discrete points in space, harbor rich geometric and structural information. The rise of deep learning has ushered in innovative methods for point cloud processing, improving the efficiency and precision of tasks such as feature extraction, classification, segmentation, and reconstruction. The introduction of HorNet and Recursive Gated Convolution has facilitated spatial interacti-ons of any order, addressing issues of feature loss inherent in low-order interactions. This has resulted in significant advancements in image analysis tasks, including image classification, object detection, and semantic segmentation. Drawing inspiration from this success, we have investigated the application of HorNet and Recursive Gated Convolution to point clouds, constructing a network

	specifically designed for semantic segmentation tasks. Point HorNet has achieved commendable results in semantic segmentation, attaining a mIoU of 68.1% in Area 5 and 73.6% in a six-fold cross-validation on the S3DIS dataset.
R3085 **16:30-16:45**	Research on the influencing factors of users' participation behavior on cultural tourism meta-universe platform: The Chain Mediating Effect of Immersive experience and Perceived value Author(s): Yu Shu,Wen Jinghan Presenter: Jinghan Wen, Dalian Polytechnic University, China Abstract: The cultural tourism meta-universe is the next new stage in the development of existing digital cultural tourism, and it is of great significance to explore the influencing factors of user engagement behaviour for an in-depth understanding of this information behaviour. Based on the technology acceptance model, the article combines relevant variables in immersive theory and consumer behaviour theory to construct a model of influencing factors of user engagement behaviour in the cultural tourism meta-universe, and investigates 348 relevant users with digital cultural tourism experience through questionnaires, followed by empirical analysis. The results found that: perceived ease of use, perceived usefulness, immersive experience and perceived value all positively affect engagement behaviour; immersive experience and perceived value all play a partial mediating role in perceived ease of use and engagement behaviour, and perceived usefulness and engagement behaviour, respectively; immersive experience and perceived value play a chain mediating role between perceived ease of use and perceived usefulness and engagement behaviour.