Workshop: 3D Reconstruction, Digital Twinning, and Simulation for Virtual Experiences (ReDigiTS 2025)

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ABSTRACT

Currently, Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR) technologies are becoming pivotal across an extensive range of application domains. All these technologies fall within the spectrum of Extended Reality (XR) spectrum. The scope of XR technologies, particularly immersive experiences, is expanding rapidly, shifting from established fields such as entertainment and video game development to emerging sectors such as industry, healthcare, smart cities, and autonomous vehicles. The spread of XR and VR is largely pushed by advancements in technology, which are simplifying and enabling novel methods of interaction within virtual environments. More specifically, the introduction of advanced hardware and software tools has made "3D reconstructions", "digital twins", and "simulations" essential components of numerous XR and VR applications. For instance, the availability of networks with unprecedented bandwidth and reduced latency facilitates the real-time transmission of massive data volumes required for large-scale digital twins. Another example is high-performance hardware, which supports the creation of highly detailed digital objects and environments, as well as the potential to reduce the time required for resource-intensive simulations. The 3D Reconstruction, Digital Twinning, and Simulation for Virtual Experiences (ReDigiTS) workshop aims to engage researchers, practitioners, educators, and students to exchange ideas and foster further research in the field of 3D reconstruction, digital twinning, and simulation within VR and related technologies.

1 MESSAGE FROM THE REDIGITS WORKSHOP ORGANIZERS

We are pleased to welcome you to the fourth edition of the 3D Reconstruction, Digital Twinning, and Simulation for Virtual Experiences (ReDigiTS) 2025 workshop. The workshop is organized in conjunction with the 32nd IEEE Conference on Virtual Reality and 3D User Interfaces (IEEE VR 2025), Saint-Malo, France, March 8-12, 2025. We are honored to present yet another year of this workshop, confirming that the interest of the community in the proposed topics is continuing to grow. Our sincere thanks go to all those whose hard work and dedication have made this edition of the ReDigiTS workshop possible. We would like to extend special appreciation to the reviewers for their invaluable contributions, dedicating their time to ensure thorough reviews despite the tight review period. We also wish to express our deepest gratitude to all the authors for their remarkable submissions, without which this workshop could not have been achieved. Finally, we are grateful to the IEEE VR 2025 workshop chairs for granting us the opportunity to organize the fourth edition of this workshop and for their guidance throughout the entire process. We trust that attendees will find the ReDigiTS program stimulating and inspiring, thus leading them to contribute to the next editions of this workshop in the future. Please enjoy the ReDigiTS 2025 Workshop!

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2 OBJECTIVES

The main objective of this workshop is to bring together researchers, practitioners, educators, and students to stimulate discussion and share ideas. For this reason, the workshop aims to attract a collection of high-quality submissions reporting research activities targeted to the next generation of immersive experiences, reporting the latest ideas, methodologies, applications, evaluations, case studies, prototype implementations, preliminary results and demos concerning 3D reconstruction, digital twinning, and simulation in VR and related technologies. The target audience is characterized by researchers, students and practitioners who are interested in the design, development, and validation of 3D reconstruction-, digital twin-, and simulation-based virtual experiences in the broad fields of, e.g., industry, healthcare, cultural heritage, smart cities, education, etc.

3 ABOUT THE WORKSHOP

This year the workshop received 23 submissions from 12 countries, i.e., Austria, Canada, France, Germany, Greece, Italy, Japan, Portugal, Switzerland, Turkey, United Kingdom, United States. The workshop collected submissions that can be categorized as full/short research papers, work-in-progress, and position papers. Each submission has been reviewed by at least two domain experts. Reviewers were invited to evaluate both the quality and the relevance of the paper to the workshop scope. At the end of the reviewing process, 16 papers were selected. The final program includes the following papers.

In the paper entitled "GeoCROW: Immersive geospatial data visualization and interaction in virtual reality," the authors present GeoCROW, an immersive geospatial data visualization and interaction platform. The VR prototype reported in this work is designed to address challenges posed by the presentation and interaction with geosemantically annotated, crawled data within VR. The outcomes of a user study and stakeholder workshop feedback are also reported in the manuscript.

The work titled "Multiplatform ecosystem for visualizing ocean dynamic formations with virtual choreographies: Oil spill case" presents a solution for visualizing oil spills at sea by combining satellite data with virtual choreographies. The system enables dynamic, interactive visualization of oil slicks, reflecting their shape, movement, and interaction with environmental factors such as currents and wind. The proposed approach promotes independence, interoperability, and multiplatform compatibility in environmental disaster monitoring. The results validate virtual choreographies as effective tools for immersive exploration and analysis, offering structured data narratives beyond passive visualization, especially valuable for MR applications.

The work titled "3D visualization of biological data in ultra-high definition virtual reality" presents an interactive 3D reconstruction and visualization system for biological data in ultra-high-definition VR. The system supports volume rendering, flexible rendering, and

the simultaneous visualization of multiple datasets, all in an 8K VR scene. Intricate cellular and subcellular structures as well as protein folding and tissue density are visualized. Assessing the performance of the system reveals that promising results are observed in terms of loading time, frames per second, and device latency as well as expert feedback.

The authors of "Challenges in enabling industrial end-users to use AR and VR for 3D authoring of digital twins for the factory of the future" report a brief literature overview concerning the authoring of digital twins in AR and VR. The contribution focuses on how these technologies can be used by industrial end-users for 3 common 3D authoring tasks, i.e., mesh segmentation, positioning, and behavior creation. The literature overview reveals that most tools lack three of the most useful and necessary features, i.e., (i) being cross-platform, (ii) being easy to use by industrial end-users, and (iii) being able to support asynchronous and synchronous collaboration between several users.

In the paper titled "Dense real-time capture of large indoor environments for immersive visualization and telepresence", the authors propose a methodology that creates detailed captures of large indoor environments in real-time. The dual-sensor setup with a mobile LiDAR and an RGB-D sensor (Azure Kinect) works with a dual-layer workflow in which a sparse point cloud capture serves as a basis for the second, dense point cloud reconstruction. The proposed methodology achieves an accuracy below 3 cm.

The user study reported in the paper "Assessing the effects of drone control interfaces on situational awareness and digital twin environment updates", evaluates five methods (two manual and three autonomous) to control drone swarms using a virtual drone simulation. Results showed manual controls are preferred for tracking single targets, while autonomous methods excel in regional monitoring, improving situational awareness. Discussions on trade-offs and design guidelines are also reported in the manuscript.

The work entitled "Mixed Reality and Digital Twin Interface for Robot Collaborative Tasks" presents an MR interface that integrates a digital twin to facilitate intuitive and immersive control of multi-arm robotic systems. By leveraging the digital twin, operators can monitor and interact with robotic systems effectively, enhancing both efficiency and collaboration in complex tasks. The approach provides a promising solution for advancing robotic control in demanding and hazardous environments.

The authors of the work entitled "Assessing the impact of visual and auditory perspectives on performance and pseudo-haptics in a virtual drilling task" investigate how visual and auditory perspectives influence haptic perception and psychomotor performance in a VR drilling task. By exploring the interplay between these modalities, the work aims to enhance immersive training, offering insights into improving psychomotor skill development in scenarios with limited access to high-fidelity haptic technology.

The authors in "Prototype development of a cross-reality digital twin ecosystem: The web, open source and open data" contribute to a broader initiative aiming to transform an industrial port area into a dynamic Knowledge Transfer Space (KTS). To support this initiative, the authors explore the development of a cross-reality (CR) digital twin that integrates user interfaces with varying degrees of virtuality. Different web technologies were evaluated by focusing on the balance between accessibility, immersion, scalability, and performance.

The paper entitled "A web application with multi-input capabilities for AI-driven 3D object generation, designed for XR applications" proposes a platform for multi-input 3D model generation. The platform integrates methods to generate XR-ready 3D objects from three input types: multiple images, a single image, or a text prompt. Each input is managed by a separate service, offered to users either via an API, or via a dedicated intuitive web-application. The web application contains tools that ease the usage of developed services and allow scheduling operations, viewing results, and post-processing of 3D models in a user-friendly manner. Additional features, such as simplification, remeshing, and levels of detail generation, are developed to make the generated models even more suitable for XR applications.

The paper titled "An AI-driven timeless journey to ancient Ephesus" presents a virtual journey to Ephesus, a UNESCO site and Roman metropolis on Türkiye's Aegean coast during the 2nd and 3rd centuries CE. Using advanced technologies like 3D modeling, VR, and AI-powered avatars, the paper revives Ephesus by presenting its architectural marvels, cultural heritage, and preservation efforts through immersive virtual models and AI-guided experiences.

The authors of the paper entitled "Frontiers of the past in the digital world: Multidisciplinary collaboration in the 3D reconstitution of medieval border towns" report on the virtual reconstitution of Castelo de Vide, Portugal, within the FRONTOWNS project. The paper highlights the challenges and successes of multidisciplinary collaboration in heritage preservation through 3D modeling. The project combined archaeological evidence, historical sources, and digital technologies to reconstruct the town's urban evolution. Co-creation workshops aligned diverse knowledge, leading to creative solutions that balanced historical accuracy and technical feasibility.

In the paper titled "Using signed distance fields to achieve temporal compression of mesh-based volumetric video", the authors explore the use of temporal compression of time-varying textured meshes using Signed Distance Fields to support the employ of volumetric videos. The comparison with state-of-the-art techniques reveals that as file sizes decrease, the proposed method's error increases at a slower rate than the state-of-the-art.

The work-in-progress entitled "Triangle-triangle intersections with different numerical representations" introduces a robust C++ template-based tool for triangle-triangle intersections, leveraging lower-dimensional simplex intersections and robust predicates. Supporting multiple numerical systems ensures flexibility and accuracy. The open-source tool proposed in this work will be benchmarked against state-of-the-art methods to advance research and development.

In the paper titled "Implementing the MPAI Metaverse Model architecture", the authors explore the MPAI Metaverse Model (MMM), a standard for creating a unified and interoperable metaverse platform. The work outlines MMM's architecture and its theoretical foundations. Moreover, it provides details on a prototype implementation aimed at fostering an open-source, standard-based, and scalable platform for diverse applications.

The authors in "StudyXR: A Framework to Streamline User Study in Immersive Environments" propose a novel framework, named StudyXR, aimed at conducting user studies when immersive technologies are involved. In addition to technical extensions, an exploratory user study is also conducted based on the user experience and usability of the devised framework. Results demonstrate satisfactory effectiveness, making the framework robust and capable of facilitating user studies in immersive environments.

These papers demonstrate how vibrant this area of research actually is, and we believe they will contribute to raising further awareness of this growing area of research.

This year, we are pleased to include a keynote speaker, Prof. Mel Slater (University of Barcelona, Spain), who discusses the potential of virtual reality for remote meetings. His talk entitled "Meet Yourself, the Police, and Celebrities in Shared VR" emphasizes how VR can enhance interaction through natural gestures, eye contact, and physical movement, offering a more immersive experience than teleconferencing. Prof. Slater also shares insights from the GuestXR project, which integrates machine learning to improve virtual meetings, and explores ideas surrounding the metaverse.