On the Impact of Interactive eXtended Reality: Challenges and Opportunities for Multimedia Research

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ABSTRACT

Extended Reality (XR) has been hailed as the new frontier of media, ushering new possibilities for societal areas such as communications, training, entertainment, gaming, and cultural heritage. However, despite the remarkable technical advances, current XR applications are in their majority local and individual experiences. In fact, three great barriers stand between current technology and remote immersive interactive life-like experiences, namely content realism, by means of Artificial Intelligence (AI) techniques, motion-to-photon latency, and accurate human-centric driven experiences able to map real and virtual worlds seamlessly. Overcoming these barriers will require novel solutions at all elements of the end-to-end transmission chain. In this panel, together with the leading experts of the SIGMM community, we will explore the challenges and opportunities to unlock the next generation of interactive XR applications and services.

CCS CONCEPTS

• **Human-centered computing** → **Virtual reality**; **Mixed / augmented reality**; **Collaborative interaction**; • **Networks** → *Network performance analysis*; • **Information systems** → *Multimedia streaming*.

KEYWORDS

eXtended reality, interactive experiences, XR interfaces, immersive experiences

1 INTRODUCTION

Over the course of time, multimedia systems have evolved from conventional media, including static 2D images and 2D videos, to the realm of immersive media with manipulable 3D content, enabling, among others, remote communication scenarios with enhanced

realism and immersion. This shift has played a pivotal role in intensifying the feeling of presence and engagement for the end users, who are no longer passive recipients but actively participate in interactions and decision-making in eXtended Reality (XR) experiences. This subject has garnered significant attention from both the academic and industrial sectors. Every year, numerous publications and patents are issued on this topic, alongside standardization initiatives by renowned organizations like ITU, JPEG, and MPEG.

The current development of Extended Reality (XR) applications presents both challenges and opportunities for multimedia research. From content realism and Artificial Intelligence (AI)-driven interactions to network latency and human-centric interfaces, the complexities of achieving immersive and seamless XR experiences need to be explored.

In the sphere of AI, the pursuit of lifelike XR encounters demands AI techniques to fabricate realistic environments, characters, and objects. AI-powered procedural generation is instrumental in constructing intricate virtual worlds. Moreover, achieving genuine real-time interactions necessitates sophisticated AI algorithms capable of comprehending gestures, voice inputs, and context-aware responses, seamlessly translating them into user experiences. AI's potential extends further, offering a pathway to personalized XR encounters by tailoring content to individual preferences through learning models.

Meanwhile, multimedia systems face challenges inherent to XR's data-intensive nature. Efficient data compression methods become pivotal for the efficient transmission of rich XR content over networks, particularly in the context of remote interactivity. Simultaneously, in order to avoid motion sickness, the motion-to-photon latency, i.e., the total delay between a change in the user's actions (e.g., looking in a different direction) and the reflection of this change in the displayed content, should not exceed 20 milliseconds (ms). Thus, the quest for low latency to sustain immersion requires multimedia systems to balance between fast responsiveness and accommodating bandwidth needs for real-time transmission of high-resolution content. The confluence of diverse modalities - encompassing audio, video, haptic feedback, and more - accentuates the complexity of seamless integration and synchronization within XR experiences.

Within the domain of human-centric experiences, XR's success hinges on bridging the gap between physical and virtual worlds. Designing natural and intuitive interactions within XR environments challenges researchers to develop interfaces that transcend the conventional and embrace the new possibilities offered by the medium. Furthermore, mitigating issues like motion sickness and visual fatigue inherent to prolonged XR usage involves the marriage of human-centric expertise with ergonomic design and adaptive

rendering technologies. Ensuring inclusivity in XR spaces requires innovative design solutions, targeting interfaces that are accessible and accommodating for users with diverse abilities.

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