



Mixed Reality Based Immersive Communication Platform for Enabling Telepresence

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Traditional video conferencing systems offer limited telepresence due to restricted spatial awareness, reduced non-verbal communication, and minimal interaction capabilities. The primary research objective of this study is to design and implement a Mixed Reality (MR)-based immersive communication platform that enhances situational awareness and co-presence through a unified Augmented Reality (AR) and Virtual Reality (VR) ecosystem, compared to conventional video-based communication tools. The proposed platform supports real-time audio-visual communication and immersive spatial interaction through synchronized facial expressions and gestures. Unlike existing communication systems that rely primarily on 2D video or focus on either AR or VR in isolation, the platform offers a novel approach to remote communication through spatially grounded interaction within an MR environment. The system architecture is developed using a Unity-based framework on the Meta Quest 3, integrating WebRTC for low-latency streaming and AI-driven animation for real-time avatar synchronization. This enables more natural interaction through shared spatial anchors and expressive humanoid avatars. A human-computer interaction (HCI)-oriented usability evaluation conducted with 20 participants reported a System Usability Scale (SUS) score of 78.5, indicating good usability, while participants also reported high perceived immersion (76%) and moderate to high avatar-mediated social presence (72%). Compared to traditional video conferencing systems, users experienced improved engagement, more natural interaction, and a stronger sense of shared presence. The current implementation targets MR-capable head-mounted devices and requires stable network connectivity, which may limit accessibility in resource-constrained environments. Nevertheless, the platform demonstrates strong potential for applications in collaborative virtual environments, remote communication, education, and social interaction, highlighting the effectiveness of Mixed Reality technologies in advancing immersive telepresence.

Keywords: Avatar-mediated communication, Collaborative virtual environments, Human-computer interaction, Immersive telepresence, Mixed reality