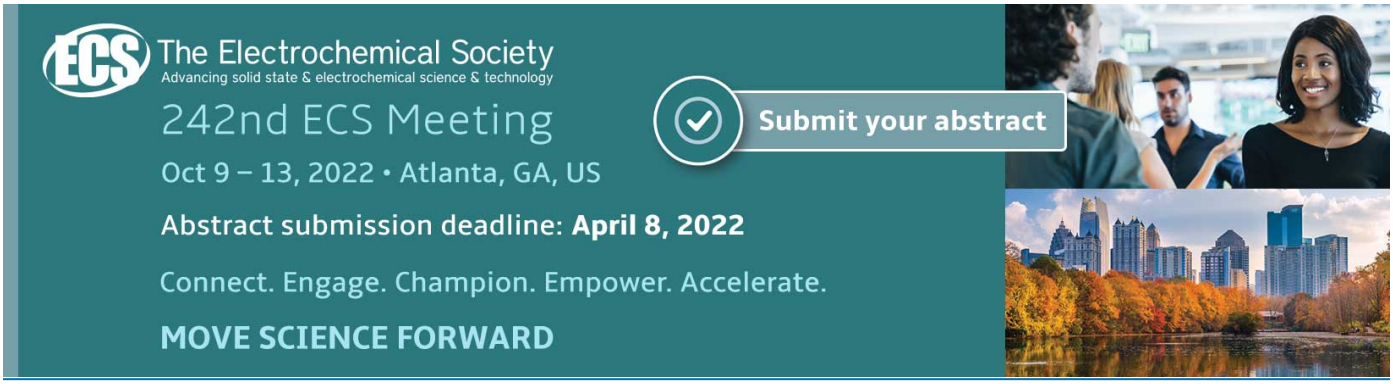
A Review of Mixed Reality Telepresence



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A Review of Mixed Reality Telepresence

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Abstract Mixed Reality MR is a technology to make the combination of physical and digital worlds coexist with one another This paper is about to explore the potential MR technology to be used for telepresence Telepresence is a technology to allow user to feel present in specific place so he remotely transferred in a digital representation However in remote collaboration it is crucial to count when a localhost user can seizure and later transmission in a view of their backdrops This paper reviews about the existing works on video conferencing and discovers the many limitations such as limited shared view low resolution and lack of the realism This paper focuses on realism issue and real-time 3D reconstruction methods using depth sensors and provides a review for MR telepresence MR has the ability when users interact with the virtual objects it can admit the understanding of the real world and feel presence in real world when they interact to the surrounding

1. Introduction

Mixed Reality MR merges the real and virtual worlds and as agreed by [1] the term MR was defined to hold within both Augmented Reality AR and Augmented Virtuality AV Meanwhile Virtual Reality VR and AR are vastly known in the simulation world MR however increasingly getting its spotlight in the field as well MR refers to the user's ability to explore virtual content with the understanding of the real environment seamlessly

As defined by [2] telepresence is a movement from their true location to another without physically go beyond the distance between them This paper observes by integrating MR into a telepresence the virtual objects appears realistic and we can get an experience real-world communication like life we are living now without being really present This display is rendered in real-time and can be presented in 2D or 3D representation in large-scale digital appearance Telepresence becomes recent research area for its high motivation and potential technology to reduce traveling cost since travel getting ever more expensive and cumbersome Moreover this technology aims to save both time and money and also prove to be the next technological wave Next section describes the telepresence in MR which has known as an illusion of the remote person's physical presence in the local space The paper also explains 3D reconstruction can be potential combined with MR technology allows users to see hear and interact in 3D as if they are actually present in the same physical space 3D reconstruction method involves to

reproduce a high-quality 3D models of human to be reconstructed compressed and transmitted anywhere in the world in real time

2. Mixed Reality Telepresence

The definition of telepresence expects the user to view the remote world from the vantage point of the remote device The term teleoperation on the other hand refers to situations where the operator interacts with the environment using a remote device while viewing that device from another point of view or watching the device from an external camera [3] According to Sherman and Craig [4] telepresence is the ability to interact directly with a physically real remote environment experienced from the first-person POV; without the limitations on the position or size of the device used to execute the user's commands at the remote place As presented in Figure 1 the timeline of the progresses of early telepresence system

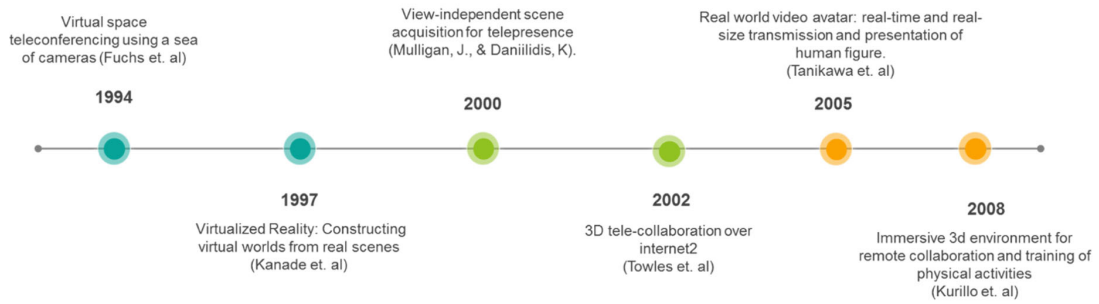


Figure 1 Timeline of the progress of early telepresence system

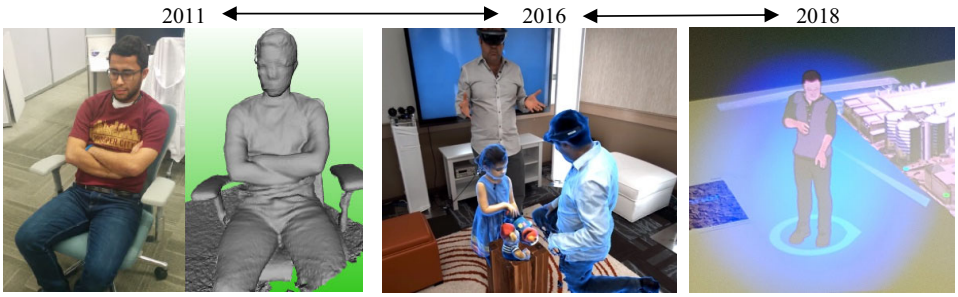
Fuchs et al [5] introduced an approach to telepresence presented in which a multitude of stationary cameras are used to acquire both photometric and depth information Virtualized Reality [6] a virtual reconstruction of real-world events where the viewer expects to see continuous motion in the virtual image sequence but there are occasional discontinuities with the actual virtual image motion In contrast Mulligan et al [7] suggested a method for combining motion and stereo to increase speed and robustness however it required the transmission of a rendered 3D-world from a remote location Towles et al [8] provided the user with a true sense of presence by assembling the best of available hardware and software technologies in scene reconstruction However with the hardware restriction and limitation on the display setup there was difficulty making a full-duplex system Tanikawa et al [9] proposed an approach that captured a person's images from all over using multiple cameras transmitted over a network and displayed on a revolving flat panel display capable of displaying different images according to the viewing position orientation But there was an issue when a viewer moves around the display system due to the display panel feature several positions overlapped each other Kurillo et al [10] introduced a framework for immersive virtual environment designed for remote collaboration and training of physical activities The multi-camera system performs real-time full-body 3D reconstruction of user But one of the system's major bottlenecks is the speed of the reconstruction

3. 3D Reconstruction in MR Telepresence

After the availability of affordable commodity depth sensors such as Microsoft Kinect the number of researches and projects regarding 3D reconstruction implemented in telepresence system increased exponentially KinectFusion [11] as in Figure 2 a it allows a user to hold and move a standard Kinect camera to rapidly generate detailed 3D reconstructions of an indoor scene The system extracts live depth

data from a moving Kinect camera and generate a single high-quality geometrically precise 3D model in real-time The system continuously tracks the 6 degrees-of-freedom DOF pose of the camera and fuses new viewpoints of the scene into a global surface-based representation A proof-of-concept telepresence system proposed by [12] offers fully dynamic real-time 3D scene capture and continuous-viewpoint head-tracked stereo 3D display without requiring the user to wear any tracking or viewing apparatus However multi-Kinect interference problem occurred as each Kinect device projects the same dot pattern at the same wavelength each Kinect unit can see the projected patterns of all other units and may have difficulty distinguishing patterns of other units apart from their own [12] Detailed 3D reconstruction method has been explored in their works was to optimize the real-time 3D meshing and point cloud rendering for a room-scale telepresence

As shown in Figure 2 b Holoportation [13] is an end-to-end system for AR and VR telepresence which demonstrates high-quality real-time 3D reconstructions of an entire space including people and surrounding using a set of new depth cameras These 3D models can also be transmitted to remote users in real-time and allow users who wear virtual or augmented reality headset to see hear and interact with remote participants in 3D almost as if they were actually in the same physical space Recent systems like Fusion4D [14] and Holoportation [13] tackle some crucial issues in the real-time fusion of multi-view depth maps into volumetric and deformable representations resulting in a lack of realism Nonetheless the stitching of dynamic meshes with multi-view video textures remains challenging because of imprecise geometries occlusion seams and critical time constraints For dynamic multi-view reconstruction the Montage4D algorithm [15] present a practical solution seamless texture montage in real time Even though a real-time pipeline for seamlessly fusing multi-view videos with dynamic meshes has demonstrated Montage4D system is not without limitations which were inaccurate geometries and missing texture fields



a KinectFusion [13] b Holoportation [15] c Mini-me [18]

Figure 2 Timeline of the progress of 3D reconstruction in telepresence system

Figure 2 c shows the Mini-me [16] was an adaptive avatar for MR remote collaboration it has reproduced a tiny telepresence The telepresence MR workspace has been proposed by [17] which would provide an environment in the user's reality where the user can interact with the person on the other side of the conversation with the help of a wearable MR headset The user will get a feeling of coexistence with the emote objects and people

Recent works in real-time MR telepresence that performs real-time 3D reconstruction of a user or an object and transmits the reconstructions to Microsoft's HoloLens head mounted display HMD wirelessly have demonstrated by [18] was aimed to low-cost telepresence system at the acceptable frame rates perceived as smooth A reconstructed frame is represented as a polygonal mesh with polygons textured with high definition data obtained from RGB cameras Telepresence system based on simulated holographic display has been proposed by [19] which they had attempted to achieve the high-fidelity 3D telepresence that commoditized depth sensors such as projectors without the need for HMD They have continued their work to develop a low-cost low-bandwidth visual telepresence system using

commodity depth sensors [20] Telepresence system by mixing 360 video and 3D reconstruction together has been described by [21] for remote collaboration Real-time 3D scene reconstruction from RGB-D sensor data [22] as well as the exploration of such data in VR/AR settings has seen tremendous progress in recent years The combination of both these components into telepresence systems however comes with significant technical challenges

4. Conclusion

With the parallel advent and wide availability of depth controllers such as Microsoft's Kinect and HoloLens the integration of real-time 3D reconstruction technologies with mixed reality HMD can now create a new generation of telepresence system Such combination allows users to interact with remote user or control remote devices by perceiving their three-dimensional virtual representations as part of their direct environment The potential MR technology to be used for telepresence has been discussed in this paper Telepresence is the perception of presence within a physically remote or simulated site However in remote collaboration it is significant to study and define the way on how the localhost user can capture and broadcast a view of their backgrounds In order to increase the realism when in projection of broadcast user with their backdrops appear in a largescale and lifelike In conventional way the video conferencing project the flat output of lights on flat surface or wall The existing works on video conferencing has been reviewed and many limitations such as limited shared view low resolution and imprecise geometries causes lack of realism has been discovered This paper focuses on the realism issue and provides a review for telepresence in MR The other remaining issues need to be considered the acceptable bandwidth to carry amount of data since when we about to increase realism we might need to scarify the speed Further study is required to reconsider on how balance the tradeoff between realism and speed in producing MR Telepresence

Acknowledgement

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