VirtualHaus : a Collaborative Mixed Reality Application with Tangible Interface

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Figure 1: VR and AR visualisations of VirtualHaus. Both participants may interact with objects and apartment.

ABSTRACT

We present VirtualHaus, a collaborative mixed reality application allowing two participants to recreate Mozart's apartment as it used to be by interactively placing furniture. Each participant has a different role and therefore uses a different application: the visitor uses an immersive virtual reality application, while the supervisor uses an augmented reality application. The two applications are wirelessly synchronized and display the same information with distinct viewpoints and tools.

CCS CONCEPTS

• **Computing methodologies** → **Mixed / augmented reality**;

KEYWORDS

Mixed reality, collaborative applications, cultural heritage

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1 INTRODUCTION AND MOTIVATION

Mixed reality finds a great number of applications in collaborative projects: it allows several participants to visualize and manipulate non-definitive realizations in a convincing way. Although, nearly all collaborative tasks need distinct points of view for each participant, depending on its role. Most often, two types of people are involved: a supervisor who needs a global view of the project, and an actor who uses a local view. To achieve this goal, one could simultaneously use virtual and augmented reality for each role: virtual reality (VR) allows immersive views and interfaces, while augmented reality (AR) allows handling global management by maintaining the link with the real world. Numerous works have already proposed collaborative mixed reality, citing all of them is beyond the scope of this paper so we will limit to the most recent and closest of our work.

Matsukage *et al.* [4]'s installation allows to share desktops and documents with a synchronized video projection on both desks.

Thammathip *et al.* [5] presented the CoVAR application, in which two people work in the same digitized environment using AR and VR. As we suggest in the previous paragraph, the participant with VR may change his point of view by modifying his body's scale.

SharedSphere [3] is a mixed reality application which allows sharing immersive panoramas and enriched collaboration through sharing non-verbal communication cues.

Similarly to our work, the Doll House VR project [2] is a multi-scale mixed reality experience dedicated to architecture-scale design where participants are divided into two groups: visitors, who visit an apartment using VR, and architects who manipulate pieces of furniture in this apartment on a tactile screen.

Our application takes its inspiration from all these projects to achieve a convincing and natural collaboration experience. It uses VR and AR simultaneously with different viewing scales. We added tangible interfaces for more intuitive controls in augmented reality.

2 OUR APPLICATION: VIRTUALHAUS

2.1 Purpose

Mozart's last standing house in Vienna [6] is currently a museum dedicated to the composer. Unfortunately, the residential part is

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completely empty, even though a list of the pieces of furniture was retrieved form legal documents of the time. Therefore, this apartment is an enigma for the historians: the function of each room and the location of the furniture are unknown.

Figure 2: VR interface for choosing and placing furnitures.

We designed VirtualHaus, a mixed reality application to help to solve this problem. Two roles for two participants are defined:

- The visitor is immersed via VR into Mozart's apartment and may place items of furniture where he wants using VR controllers and a dedicated interface, see figure 2.
- Concurrently, the supervisor visualizes a small scale virtual model of the apartment via AR (figure 3), in which the furniture placement is synchronized with the VR application and actualized interactively.
- Additionally, the supervisor may also physically place items of furniture into the model by using tagged markers or 3D printed miniature replicas.

The VR and AR application communicate wirelessly, so the two participants may collaborate locally or remotely.

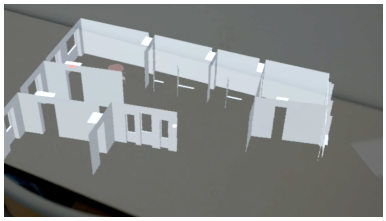

Figure 3: AR visualisation of the reduced apartment model.

2.2 Technical and implementation details

The VR application is deployed on a dedicated desktop PC with an Intel Xeon Processor, 16Go RAM and a Geforce 970 GTX GPU. In the AR application, the supervisor's hands must be free, so Microsoft's Hololens seemed a better choice than smartphones or tablets.

Unity 3D [7] was used for the development of both AR and VR applications. As our application involves architectural design, realistic lighting was required. Unfortunately, since furniture is moving, pre-computed lightmaps were not a viable option. Therefore, we used an experimental plugin for real-time area lights based on a technique by Heitz *et al.*[1].

Vuforia [8] was used for marker recognition, since it is, at least at the time this article is written, the only framework that allows this feature on Hololens. Markers were specifically designed for this application and represent the furniture along with its name (figure 4). The colors and contrasts were engineered for maximum recognition success.

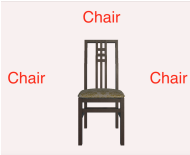

Figure 4: Custom marker for furniture placement

Finally, a custom protocol was designed to synchronize the AR and VR applications. This protocol handles the connection, apartment loading, furniture loading, and furniture position updates.

3 SUMMARY AND PERSPECTIVES

We presented a mixed reality application with efficient collaboration between two participants using different views and tangible interface. Future work includes more than 2 participants and physical objects instead of markers. This work could also easily be transposed to other domains, like gaming applications: for example, in a role-playing game with one (or more) player(s) and a game master, a wargame using map-scale decisions and unit-scale actions and points of view, a racing game with pilots in VR and team leader in AR, etc…

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