Cross Reality Application

Mixed Reality Project Proposal
Supervised by: Mathieu Lutfallah, Long Cheng
October 7 2024

GROUP MEMBERS

Laura Nydegger Simon Ebner Jeremy Bitar Stefan Bjelajac

I. DESCRIPTION OF THE PROJECT

We want to develop a cross-reality application prototype which helps the user to make informed choices about their indoor design. In particular we are thinking of two areas where the use of Virtual Reality (VR) in addition to Augmented Reality (AR) can be beneficial. First, visualizing lighting conditions in a room resulting from adding light sources or obstructing windows (e.g. curtains) due to privacy reasons [1]. To achieve this, the prototype will allow the user to create and interact with various light sources in a VR replication of the room. Furthermore, the user will be able to switch to AR, so that they can see the placed objects in a high-fidelity version of the room. Here, it could also be interesting to simulate changing lighting conditions over the course of a day by simulating the trajectory of the sun. The second use case we want to explore is privacy. Especially in modern housing where windows are often large and curtains are seldomly used, it is of interest to arrange furniture in a way where privacy is still guaranteed. For example one might want to check if screens can be seen from the street or neighbouring houses. Here, the user will be able to move outside the room in VR to confirm privacy from different points of view and time of day. To validate our prototype, we will perform and evaluate a user study which will include A/B testing on different locomotion techniques [2] as well as other features.

II. WORK PACKAGES AND TIMELINE

We plan to develop the project for the Meta Quest 3 in Unity. As a result coding will be done in C#. The Quest 3 currently does not support access to the passthrough camera. Therefore any features that would be dependent on estimating the current lighting condition [3][4] will be impossible without a workaround. But with being able to switch to VR completely we can simulate any lighting conditions [5]. We plan on using the Quest 3's feature to capture the surrounding scene and plan to use that feature to create a simplified but accurate VR representation of the room that the user is located in. For this VR version we will first create two basic lighting modes (day and night). Ideally the global lighting will be expanded later to include lighting changes over the course of the day. Once the switch between AR and VR is implemented, we need to enable the adding of items, specifically light sources and potentially curtains to the scene, such that their placement is consistent in both VR and AR. Finally we need to enable the user to move around in the VR version of the scene, this should include moving outside the confines of the room for the "privacy" part of the project. Below you see a rough estimated timeline of our project.

Estimated time	**Task**	**Who**
1 Week	Familiarising with Unity and Quest 3	Everybody
1 Week	Concretization of Project and First Experiments with automatic room scanning	Everybody
2 Week	Switch between MR and VR Environment Switch between Day and Night	Jeremy, Stefan Simon, Laura
1 Week	Preparation for Midterm presentation Locomotion	Simon, Stefan Laura, Jeremy
1 Week	Light source placement	Everybody
1 Week	User Study and Experiments	Everybody
1 Week	Finish user study and analyse results	Everybody
1 Week	Preparation for final presentation	Everybody
1 Week	buffer	Everybody

III. Outcomes and Demonstration

At the end of our project we plan to have a usable prototype where one can experiment with different lighting conditions and view that from both the inside of the scene as well as the outside. Ideally we would want to present a live demonstration of this prototype at the end of the semester. Towards the end we want to conduct a small user study, where we A/B test different features. Aside from the already mentioned modes of VR locomotion another option that we could test is the difference between a pure Mixed-Reality version of our prototype, and the cross-reality application.

References

[1] Michael Backes, Markus Dürmuth, and Dominique Unruh. Compromising reflections-or-how to read lcd monitors around the corner. In *2008 IEEE Symposium on Security and Privacy (sp 2008)*, pages 158–169, 2008.

[2] Evren Bozgeyikli, Andrew Raij, Srinivas Katkoori, and Rajiv Dubey. Locomotion in virtual reality for room scale tracked areas. *International Journal of Human-Computer Studies*, 122:38–49, 2019.

[3] Katrien Jacobs and Céline Loscos. Classification of illumination methods for mixed reality. *Computer Graphics Forum*, 25(1):29–51, 2006.

[4] Joel Kronander, Francesco Banterle, Andrew Gardner, Ehsan Miandji, and Jonas Unger. Photorealistic rendering of mixed reality scenes. *Computer Graphics Forum*, 34(2):643–665, 2015.

[5] Rafał Krupiński. Virtual reality system and scientific visualisation for smart designing and evaluating of lighting. *Energies*, 13(20), 2020.