

Mutual Natural Tangible Interactions with Virtual Characters in Virtual Reality Research Overview

Research Description: In this project, we explored real-virtual objects that spanned the virtual and physical boundary in world-fixed VR. The objects were manipulated by a human user and a virtual human. We designed and developed world-fixed VR systems that afforded the mentioned novel interaction in two primitive forms: rotation and translation. The shared real-virtual objects had two complementary parts: real and virtual. These two parts were electromechanically linked, so that they were always in synchrony. When the human user manipulated a shared object, the effect was observed in the virtual world. Similarly, when the virtual human manipulated a shared object, the effect was observed in the real world in real time. To compare the effects of the developed novel interaction on user experience, we also developed a control version where the objects were separated as completely real and virtual. In this version, the two sides did not affect each other's world (i.e., real or virtual). We designed and implemented tasks that centered around the developed interaction. The human user and the virtual human worked on sorting boxes using the shared objects as controllers. We carried out controlled user studies to investigate the effects of the developed novel interaction on user experience. Overall, user studies showed improved user experience with the developed interaction as compared to the control version, specifically increased sense of presence and co-presence, affective attraction to the virtual human, and enjoyment of interaction.

User Study Procedure: The research staff prepared the system before the participant entered (turning on the infrared lighthouses, plugging the cables, resetting the orientation of the objects etc.). They switched the software to standby mode, in which a gray solid color was projected to the curtain instead of the actual virtual world (to avoid breaking presence while the participant wore the hard hat as the virtual world would move around based on the orientation of the hard hat). When the participant arrived, they were asked to read and sign the consent form and fill out a simple demographics questionnaire in the outer room of the laboratory. They were asked to go to the inner room where the system was set up. They were helped to wear the hard hat with the motion tracker mounted on. They were shown where they should stand while interacting with their first-assigned object (positions were marked in front of the objects for consistency). The research staff exited the inner room, closed the curtain between the outer and the inner rooms, started the experiment, and the tutorial of the participant's first-assigned object began. After the participant completed the tutorial, they proceeded with the three levels of that object. Then, the software instructed them to fill out a questionnaire on a tablet computer placed on the left side of the room on a tall table. Then, a written instruction was displayed on the projection curtain that asked the participant to stand in front of their next object (wheel or block) after they are finished with the questionnaire, and when they are ready verbally say "Ready to Proceed". After that, the tutorial of the second object began. After the tutorial, the experiment proceeded with the three levels of the second object. Then, the participant filled out a second questionnaire on the tablet computer on their experience with this object and the overall system. The research staff helped the participant take off the hard hat, they were given a gift card, and the experiment ended.