Journal of My Journey: Seamless Interaction in Virtuality and Reality with Digital Fabrication and Sensory Feedback

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ABSTRACT

Whether in virtuality or reality, the decisions or actions pursue the goal we acquire in the virtual or real world. Besides, the decision or action that the users make in virtuality or reality only affects one physical or virtual environment. Previous works have revealed the concept of substitutional reality that utilizes the physical environment to enhance the immersive experience. However, there was no trace that the event in virtuality has parallel happened in the physical space. We present Journal of My Journey, an extended reality system with digital fabrication and sensory feedback for seamless interaction in virtuality and reality. The user's behavior in the virtuality does affect reality. To show the ideal, we developed an immersive game to explore the possibilities of bringing sensory feedback from the real world to help with puzzle-solving in the game and exporting the output of the decisions made by the players perform in the virtual world into reality by using digital fabrication.

CCS CONCEPTS

• **Human-centered computing** → *Interaction devices*; • **Software and its engineering** → **Interactive games**.

KEYWORDS

Seamless Interaction, Digital Fabrication, Sensory Feedback, Substitutional Reality

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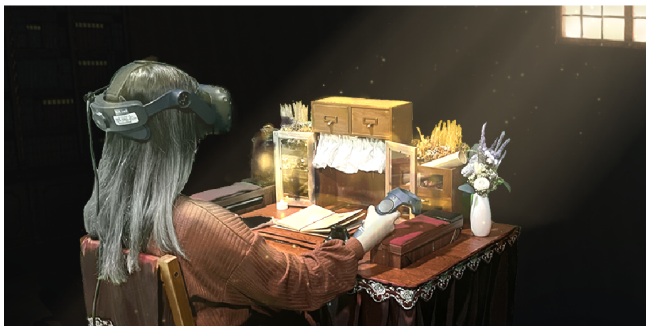

Figure 1: Seamless Interaction in Virtuality and Reality

1 INTRODUCTION

In digital games, we always perceive lots of visual and audio feedback, but there is rarely any stimulation to other senses such as touch and smell. The players only need to use a keyboard, mouse or joystick to control the playable character, therefore the hints and interactions can only be designed in the virtual world, and this is not appealing to the other senses of the players. Besides that, the choices made by the players in the game rarely affect the real world, which makes the virtual world and the real world always exist as two parallel lines. To break the barrier between the two worlds, sensory feedback and digital fabrication techniques would be the possible solution to achieve this goal.

As previous works suggest, sensory feedback would enhance the immersive experiences of the users in the virtual world. From the work Lotus [Chen et al. 2018], odors and wet air feedback were being provided to the users and it can simulate smell from different places to enhance the sensory stimulation of the users in the virtual environment. Haptic Around [Han et al. 2018] has implemented multiple tactile sensations such as wind and mist and it significantly increases the sense of realism of users in the virtual world. Substitutional Reality [Simeone et al. 2015] mapped physical objects to virtual objects to design the VR experience. This research has shown that the mismatch between the physical objects enables a wider range of virtual environments to be substituted. Haptic retargeting [Azmandian et al. 2016] and Sparse Haptic Proxy

[Cheng et al. 2017] both mapped a proxy to the virtual environment to provide passive haptic feedback and this can help to provide a rich set of interactions that could be used in VR games. iTurk [Cheng et al. 2018] makes users animate passive props to provide haptic feedback to the users. Haptic revolver [Whitmire et al. 2018] uses different customizable tactile wheels to provide haptic feedback according to the virtual environment. Previous works only provide haptic feedback and enhance the immersive experience of the users in the virtual world, but these feedbacks do not affect reality.

In this work, we present an extended reality system that provides sensory feedback with a reconfigurable passive haptic proxy(the journal), allowing the players to have an immersive gaming experience and output their choices from the game to the real world.

2 DESIGN AND IMPLEMENTATION

Journal of My Journey is an extended reality system that consists of a passive haptic proxy, mist module, ink coloring module and a pico laser cutter. The passive haptic proxy (Figure 2ab) is a customized notebook with symbols engraved on it, which is being mapped to the journal in the VR game. Mist module (Figure 2c) provides coldness and olfactory feedback to the players to enhance the immersion of the VR games. The ink colouring module (Figure 2d) and the pico laser cutter (Figure 2e) work as our digital fabrication method that enables the choices that the player made in the VR game to be output to reality, mainly on the proxy(notebook). The layout of our works is also being partially mapped to the virtual game to enhance the VR experience of our users. The ink colouring module and pico laser cutter are being placed in a small cabinet to avoid mishandling of the users during the VR experience. The users can customize their notebook by tearing the paper and also pushing the notebook along the rail into the cabinet for digital fabrication purposes. The water tanks of the mist module are being half lifted above the table to enable the flow of mist, supported by the metal structures that were being screwed into the table.We also added an acrylic plane on the device to ensure the safety of the users during the laser engraving session.

3 APPLICATION: IMMERSIVE GAME

In order to achieve seamless interaction for the users, we developed a VR game with Unreal Engine 4. The game has been split into a day and night cycle. During the day, the users need to talk to NPC and search for the clues in the virtual world and have to feel the passive haptic proxy(notebook) in reality because clues will be engraved on it, after that they have to tear the respective paper off. While reaching certain places or experiencing foggy weather in the VR game, the mist-based olfactory modules will provide sensory feedback to the users in reality such as coldness and humidity. During the night, the users will have a series of puzzles to solve in the game and that will incur the laser cutting process on the physical notebook. It will engrave symbols from the game on the physical notebook depending on the choices that the users made in the VR Game. During the VR gaming process, the users will also trigger events such as mixing liquid or breaking vases, and these actions will reflect on the real world by spraying different colors of ink on the physical notebook. As an easter egg, after spraying the ink, words and pictures related to the games will appear on the blank notebook. This will customize the notebook and be a memento for the users to take away after the VR experience ends.

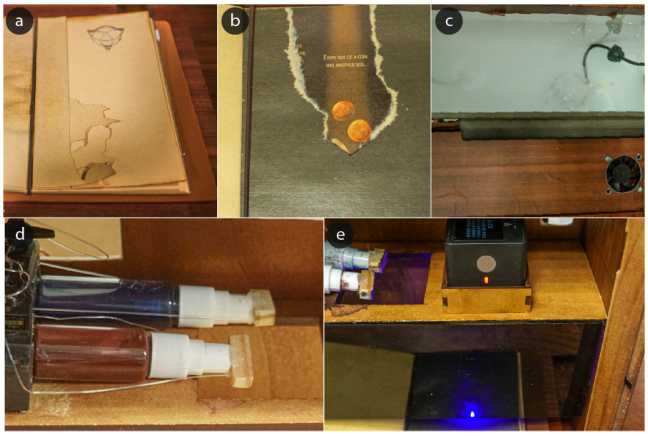

Figure 2: Hardware design of (a)(b) passive haptic proxy, (c) mist module, (d) ink coloring module and (e) pico laser cutter

4 DISCUSSION AND FUTURE WORK

This work explores the possibilities of integrating digital fabrication techniques and sensory feedback in VR games , thus creating a seamless interaction experience for the users. By finishing the experience, we hope that the users will also realize that the choices that they make in the virtual experience do affect the reality. In the future, we will carry out user studies to investigate how seamless interaction will affect the players during the VR gaming experience.

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