Effect of Emotional Stimulation and Spatial Awareness on the Perceived Realism of Virtual Art

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（バーチャルアートの臨場感に及ぼす感情刺激と空間認識の影響）

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Abstract of Dissertation

Enhancing the realism in virtual reality (VR) presents several technical, economic, and functional challenges. In particular, designers have to solve several cognitive and technical challenges related to immersion and perception when it comes to the virtual representation of the artwork. The objective of this thesis was to provide innovative and unified methods that can be utilized to improve realism in the virtual portrayal of artworks.

To this end, two novel approaches, namely emotional hacking enabled VR (EHVR) and smooth transition and hybrid reality (STHR), were developed, experimentally verified, and ultimately demonstrated in a real-world setting.

Emotional hacking is based on the interaction of physiological condition and emotional stimulation and on the notion that emotional involvement during a virtual experience significantly impacts the degree of immersion. In the EHVR, vibrotactile biofeedback was provided through the footrest, simulating the feeling of a heartbeat. Syncing the vibrotactile feedback at the start of the experience and then introducing a fake faster heartbeat to produce fear in the middle of the experience. A total of 103 individuals participated in the EHVR experiment. The use of subjective questionnaires showed that most of the participants found the VR experience extremely realistic and frightening. Heart rates were found to increase to 118% of the resting value at the end of the experience, implying that the physiological state of the participants was influenced by exposure to the system.

During the EHVR study, users were observed to remember the real world during VR and overlay it on VR content in their minds. So, to further enhance the realism in the virtual representation of artwork, the concept of STHR was implemented by deliberately blocking out the real space to prevent creating a memory of the real space so that it does not conflict with the VR content. At the start, the users were exposed to a 3D-printed real object that was a replica of one of the virtual items they would encounter during VR. This step was intended to give haptic input consistent with both the real world and the virtual environment. It was designed to have a minimum mismatch between VR and real-world setup. By introducing minimal haptic feedback by felicitating physical matching interactions, users' perception of the VR environment could be

altered to think everything they see in VR exists in reality. Feedback from visitors to a virtual art gallery created using the STHR concept confirmed that including STHR improves the immersion and believability of VR.

Overall, the findings of this thesis will play a critical role in sparking future research into emotional stimulation and haptic feedback to improve VR realism.