Exploring Embodied Experience of Flying in a Virtual Reality Game with Kinect

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ABSTRACT

Immersive Virtual Reality (VR) as a research tool provides numerous opportunities of what one can do and see in a virtual world which is not possible in real world. Being able to fly is an experience that humans have long dreamed of achieving. In this paper, we introduce a VR game where participants can use their body gestures as a Natural User Interface (NUI) to control flying movements via a Microsoft Kinect. The goal of this research is to explore the navigational experience of flying via body gestures: what people like to do, what they want to be, and most importantly, how they map their gestures to navigation control easily in a VR environment.

Keywords: Natural user interface; flying experience; virtual reality; body gestures; Kinect.

1 INTRODUCTION

VR environments are immersive worlds that allow participants to experience places that exist nowhere else, to use physics otherwise impossible in the real world, and to move their body and control their movements in innovative ways. Interactivity remains an important characteristic, and numerous input devices were developed for human-computer interaction and navigation in VR. The major requirements for VR interaction consist of: navigation speed, purposefulness and especially intuitive handling, which means ease of interaction with the system input.

Using suitable and ease of interaction operating metaphors, the actions and gestures translated to input devices are converted to movements and actions in the virtual world. The abstraction of the model character in the digital world to reality makes this necessary. The operating metaphor, therefore, is based on the logic of how human body movements can be used to control movement outside virtual reality. In other words, how do human movements translate into or support navigation in VR.

Being able to fly is an experience that humans have long dreamed of achieving. Humans have not only attempted to fly via various means in the reality, like fire balloon, hand gliding, airplane, and finally rockets, but also expressed the desire to fly in media like fiction movies and novels, and now virtual reality. However, the human body does not support the functionality nor affordance of flying like a bird, nor does anyone use their bare hands or arms to fly. Thus, mental effort and reasoning are required to map human gestures to the movements in a virtual world to achieve a sense of flying. Researchers have found that users associate and relate their body (as a human interface) to VR, which indicates that they use their body during spatial reasoning [3]. Associating and relating their bodies to VR have been argued to enhance spatial-perception. However, so far few researchers have examined natural user interfaces for flight in VR. A prominent example for a flying interface is the Birdly [8], where users lie face-down on an actuated platform with their hands attached to mechanical "wings" used to control the flight, thus providing a bird-like flying experience. For the current interface, however, we aimed for a distinct body gesture interface that creates a very specific experience of "floating as a ghost" rather than a bird to fit our overall theme.

The aim of this paper is to explore the navigational experiences of FLYING in a VR environment via body gestures. We conducted two rounds of playtesting focusing on participant's experience of gesture control and the mappings between their navigation in the real world and in VR. Thus, the specific research question is: how can people control flying movements easily in VR using their body gestures as the natural user interface? Results found leaning forward/backward to control forward/backward and moving arms up/down to go up/down gestures are easy for participants to control and map their physical gestures to the flying movements. Our results revealed that airplane mode (extending both arms and swing up and down) was perceived to be the easiest among all proposed rotation gesture designs.

The intention of our game is to fulfil human's effortless dream of flying and concurring the skies like ghosts. Our approach here is to combine available technology like Kinect with original design methods to create an exceptional full body experience. Our goal is to make an interactive immersive game and explore the freedom of gliding in the air and intuitively explore the skies. Instead of using mouse or joystick commonly used in flight simulators, the player commands the flight using his/her arms and hands, which directly control the wings (through flapping and navigating); as if he/she embodies a flying or gliding ghost.

2 RELATED WORK

Various types of NUI have been developed and implemented for navigating VR environments in research prototypes. Recently, LaViola et al. [3] explored how people could use wearable shoes to navigate an immersive VR environment, whereas Tollmar et al.'s research [7] analyzed the space of perceptual interface abstractions for full-body navigation in a screen specifically through pointing gestures. Although researchers [1] [2] [4] [6] [5] have explored the design space of body gestures, they primarily pre-defined and implemented the control gestures and navigation mapping in VR limited only to hands or arms. It is important to remember the importance of mapping physical-to-virtual movements rather than assume that what they perceive as "natural" and "intuitive" works for all others.

In a more recent study by Sikstrom et al. [5], researchers designed flying in a CAVE-like virtual environment where participants use only their arms to control flying movement. Nevertheless, it was still viewed by participants from a third-person view, and their input control was limited to shoulders instead of arms and/or hands. Similarly, in [2], participants could use their arms to control rotation while in [1] immersive experienced flying in the Oculus Rift HMD. However, it is important to note that both the VR content and gesture controls were defined by the researchers rather than emerging from participants.

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Therefore in this research, instead of using the game prototype as a means or apparatus to study further research matter, such as embodiment or immersion in VR, we focused on players' navigation experiences through their body gestures regarding the ease of use of the VR system. We believe that smooth and easy navigation and user interaction play a critical role in constructing an IMMERSIVE and effective virtual environment for the participants and ~~bad, difficult~~ unnatural gestures that cannot map well with navigation control will ruin the overall experience and bodily sensations.

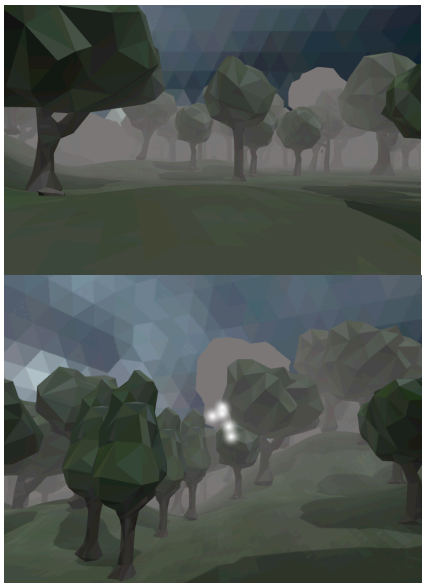

Figure 1: Screenshots from the Kinect VR game, Lost Spirit.

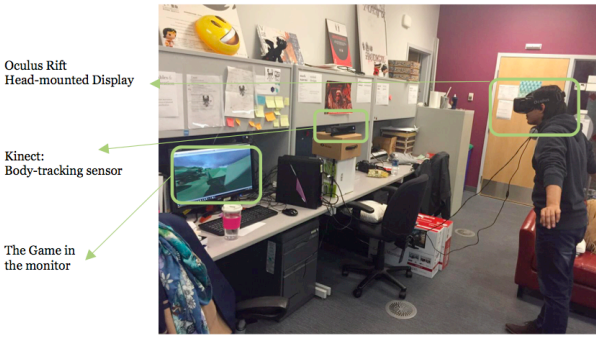

Figure 2: One participant trying the VR System: including Kinect and Oculus Rift Head-mounted Display.

3 The Kinect VR Game: Lost Spirit

We developed a VR game called Lost Spirit to test the most natural interaction in a flying-as-navigation experience. The player can fly above a forest, as well as complete tasks such as (1) finding and collecting five hidden items in the dark forest; and (2) handing them over to the final Gate Tree to finish (figure 1). In the game, the player wears an Oculus Rift DK2 HMD with headphones, and controls his/her flying movement using pre-defined body gestures via a Kinect tracking sensor (figure 2).

4 Outcomes

We conducted a pilot study to explore the ease of use of the flying gestures as well as participants' subjective experience of flying in VR and their preferred natural interactions. In general, participants were engaged with the experience and liked the overall feeling of flying in a VR environment. We received positive feedback from most participants for the creativity and novelty of this game design, flying control and fundamental game concepts. For instance, P01 reported "I can fully immerse in the game, and manipulate freely", P02 said "the concept is great and the feeling is very close to flying. I like the aesthetics too", and P07 commented, "the beautiful scene combining with the flying feeling makes me relax." Moreover, P08 said "It's totally a new kind of video game. It helped me experience the feeling of flying using an immersive way, which I have never had before. I like it!" However, a few participants reported that they felt tired when keep holding hands or leaning forward without moving the body without changing gestures. Some other participants also pointed out that the speed of moving forward or backward was not associated with velocity and they preferred to have faster speed if leaning angle increases.

5 Conclusions

In this paper, we studied participants' experience in a VR game where participants could use their body gestures as a Natural User Interface (NUI) to control flying movement via Microsoft Kinect: lean forward/backward to control forward/backward and move arms up/down to go up/down gestures are intuitive and easy to control for people to map their physical gestures to the flying movements. The findings of this research provide inspirations and insights for future VR-human interface design to construct an easy approach for body-gesture controlled movement in navigating-as-flying scenario. Although the application of Kinect offers novel interface in human-computer interaction through NUI, limitations also restrict the way people can interact with the VR system. From an ergonomic aspect, human beings are not made for moving a long time with outstretched arms, because they become heavy and start hurting. This especially happens during longer navigation and application sessions. However, for the **short** VR sessions, this problem is not a limitation so far. Further, Kinect does not supply haptic feedback to the users. Those should also be concerns addressed in future research regarding this topic.

References

[1] Rita Francese, Ignazio Passero, and Genoveffa Tortora. 2012. Wiimote and Kinect: Gestural User Interfaces Add a Natural Third Dimension to HCI. Proceedings of the International Working Conference on Advanced Visual Interfaces, ACM, 116–123.

[2] Kohki Ikeuchi, Tomoaki Otsuka, Akihito Yoshii, Mizuki Sakamoto, and Tatsuo Nakajima. 2014. KinecDrone: enhancing somatic sensation to fly in the sky with Kinect and AR.Drone. DeepDyve.

[3] Joseph J. LaViola Jr., Daniel Acevedo Feliz, Daniel F. Keefe, and Robert C. Zeleznik. 2001. Hands-free Multi-scale Navigation in Virtual Environments. Proceedings of the 2001 Symposium on Interactive 3D Graphics, ACM, 9–15.

[4] M.F. Shiratuddin and Kok Wai Wong. 2011. Non-contact multi-hand gestures interaction techniques for architectural design in a virtual environment. 2011 International Conference on Information Technology and Multimedia (ICIM), 1–6.

[5] E. Sikstrom, A. de Gotzen, and S. Serafin. 2015. Wings and flying in immersive VR #x2014; Controller type, sound effects and experienced ownership and agency. 2015 IEEE Virtual Reality (VR), 281–282.

[6] William Steptoe, Anthony Steed, and Mel Slater. 2013. Human tails: ownership and control of extended humanoid avatars. IEEE transactions on visualization and computer graphics 19, 4: 583–590.

[7] K. Tollmar, D. Demirdjian, and T. Darrell. 2003. Gesture + Play Exploring Full-Body Navigation for Virtual Environments. Conference on Computer Vision and Pattern Recognition Workshop, 2003. CVPRW '03, 47–47.

[8] Rheiner, M. 2014. Birdly an Attempt to Fly. *ACM SIGGRAPH 2014 Emerging Technologies*, ACM, 3:1–3:1.