Investigating Control of Virtual Reality Snowboarding Simulator Using a Wii FiT Board

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Abstract. This work presents a virtual reality snowboarding application which uses a Nintendo Wii balance board for richer interaction modalities. We present the application and test the prototype with 7 participants to investigate immersion, enjoyability and to an extent performance. The outcomes from the study will be used to start forming research directions and questions to indicate likely research and development directions for future research.

Keywords: Virtual reality · Snowboarding · HMD · Wii FiT board

1 Introduction and Motivation

Modern gaming is a competitive and continuously evolving area with companies constantly looking for innovations. With technology in the gaming industry moving more and more towards multimodal interaction, it is unsurprising that virtual reality head mounted displays are being revisited despite previous failings in the gaming industry during the 1980s and 1990s (for example one of the earliest virtual reality headsets in the domestic gaming market was the Virtual Boy, released by Nintendo in 1995). Technology advancements allow for both simulations and more interactive and immersive games to be created in a virtual reality setting, with better graphics and realism. Furthermore, the advancement of multimodal interaction techniques becoming more ubiquitous permits the integration of novel interaction within the experience.

With this principle and momentum in mind, we developed and present the initial stages of a prototype snowboarding system using virtual reality. By extending control to more than a standard game controller, we begin to experiment with improving the realism within a game. In order to make an environment to be experienced as 'real' two conditions must be met: immersion and presence [1]. Witmer and Singer [2] describe presence as the feeling of being in a particular environment or location when you're physically in another. Essentially, higher levels of presence means the player feel more a part of the game they're playing; something game developers continue to strive for as

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they develop games. Many factors can affect presence, such as human and technological. A talk about virtual reality at Steam Dev Days [3] highlighted several standards that virtual reality headsets need to meet in order to achieve a high level of presence. The first is field of view, a high field of view is necessary for headsets to be able to mimic a real scene with a high level of presence. The second is high resolution. This is where head mounted displays face some issues. Due to having a wider field of view the pixels are magnified, the per-degree pixel density of a device like the Oculus Rift is serious set-back. Technological progress has been rapidly developing and so work advocating for the slow improvement in this area may not be as accurate as previously though [4].

To simulate a snowboarding task and enhance the user experience we developed a prototype that allows the user to control input via a Wii Fit board. Beyond presenting the prototype, we present findings from a pilot test involving 7 participants which give insights into different experience factors and supply us with material to reflect on from the first test in a user centered design approach. We also recognize other limitations when interacting in virtual reality; namely, that users also experience side effects such as nausea and headaches, overall making for a very poor experience, both as a virtual reality device and in general [5]. We are sensitive to the fact that adding another dimension such as the balance board to control the interaction may also add to these effects.

2 Prototype

The developed prototype is a simple snowboarding game where the player snowboards downhill toward a goal and repeats this process over three laps with their performance being timed in the top right corner. We implemented control by a Nintendo Wii Balance Board as a controller in an attempt to mimic a snowboard. The player is constantly being propelled forward both by gravity and extra momentum being programmed into the game. By transferring their weight the player can move themselves left and right in the game and jumping on the board will also jump in the game.

The user's virtual self materializes on the top of a snowy slope and is propelled forward, having obstacles such as rocks and trees to overcome by sliding left and right. Movement is also encouraged by curves in the track. A pitfall jump is also present in the level which makes the user have to produce a jump action successfully to overcome (See Fig. 1).

3 User Testing

A pilot test was carried out to progress the prototype as per our user-centred design methodology. The experiment was run on an Oculus Rift DK2 headset. The DK2 has an OLED display which contains 3 different sensors, a magnetometer, gyroscope and accelerometer. The native resolution is 1920 × 1080 or 960 × 1080 for each eye. The display has an overall field of vision of 100° and a max refresh rate of 75 Hz. The HMD weighs 0.95 lb. The test involved 12 individuals that use the prototype and HMD in one condition as well as a screen and keyboard for a second condition. None of the participants had experience using an HMD. To reduce bias, 6 participants were

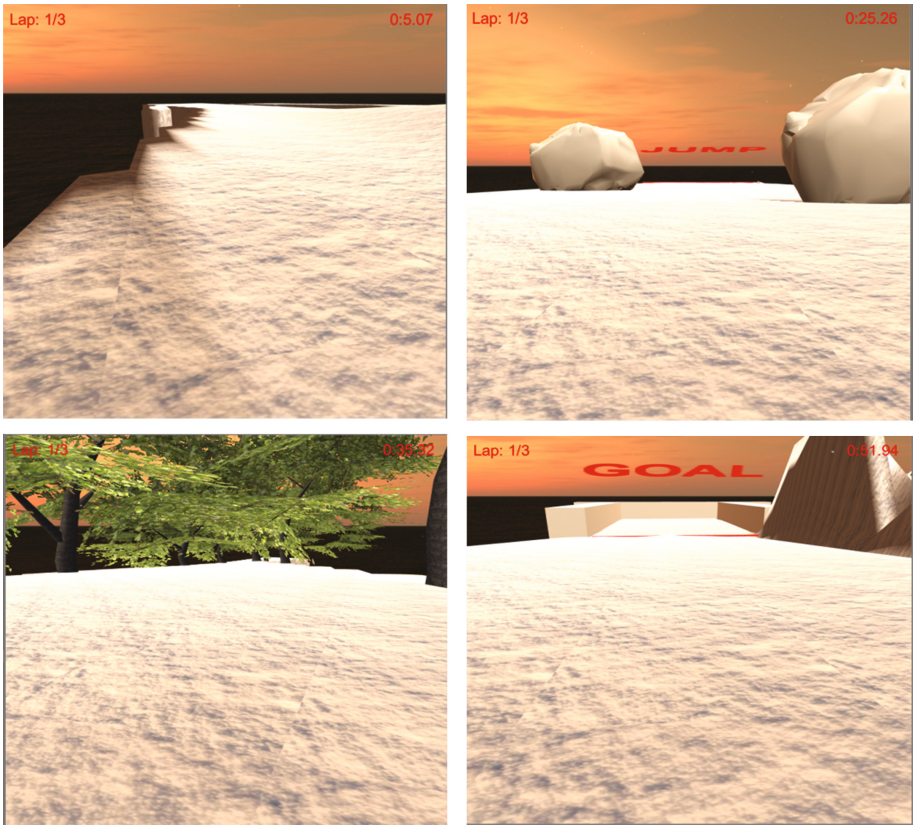

Fig. 1. Different scenes from the snowboarding experience

introduced to the HMD version first while the other 6 participants the screen and keyboard version. We then interviewed for qualitative feedback while recording some qualitative measures, not to make a statistical relevance calculation but to receive preliminary information to guide further research and development direction.

Time Performance. The times for each play through were recorded and the results indicated towards player performance to be improved with the HMD. The average time with the HMD was 6:07 min and the average time without the HMD is 7:50 min there is a notable difference.

The participants commented on increased **enjoyability and 'fun'** using the HMD as opposed to the screen and keyboard. The HMD scored an average of 8.2/10 while 6.8 without. One note is there's the possibility of the higher rate of enjoyment with the HMD to be due to the novelty of using a virtual reality headset. The balance board was also given mention and appeared to be fairly popular with people stating they enjoyed how it controls similar to a real snowboard.

In terms of **perceived difficulty** in control there did not seem to be a noticeable difference between the comments received between the HMD condition and the

keyboard scenario. We direct the reader to Lugrin et al. [6] whose research found that even in the situations where players performed worse with the HMD due to difficulty, they still enjoyed it more. The main comments from the interviews which related to difficulty in the HMD condition was the Wii Fit board, with participants reporting difficulty balancing on the board. There was also mention of the HMD making the balance problems worse due to participants being unable to see their feet.

Immersion was rated higher on the HMD, both in the comments as well as scoring, 6.4/10 for the HMD scenario and 4.4/10 for the screen and keyboard. Positive HMD comments included being "able to look around the scene", "having the screen covering the eyes" and "blocking external distractions".

Lastly, players were asked about any **negative side effects** they experienced from the HMD and balance board combination. Whilst there were no issues with most participants, one player experienced disorientation, balance issues and slight nausea.

Feedback for improvements was limited, with the only suggestion made to be able to adjust your speed, (i.e. going faster or slower) at will rather than a constant speed.

4 Conclusions and Future Work

The work presents the initial stages of research into creating an affordable virtual reality snowboarding simulation using feet control. A prototype level was created and tested with 12 participants which produced positive qualitative feedback to progress the development. Future work is aiming to create a much larger scope of levels and challenges, improve the realistic tracks of the environment and also allow for body tracking using a Kinect sensor to produce a within simulation body movement for the user, thus increasing the feel of immersion.

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