Augmented Winter Ski with AR HMD

Kevin Fan[1], Jean-Marc Seigneur[2], Jonathan Guislain[2], Suranga Nanayakkara[3], Masahiko Inami[4]

[1] Keio Media Design, 4-1-1 Hiyoshi, Kohoku, Yokohama, 223-8526 Japan

[2]University of Geneva, 24 rue Général Dufour, Geneva, 1204 Switzerland

[3]Singapore University of Technology and Design, 8 Somapah Rd, 487372 Singapore

[4] University of Tokyo, 7-3-1 Hongo, Bunkyo, Tokyo, 113-8654 Japan

kevinfan@kmd.keio.ac.jp, {seigneuj | j.guislain}@gmail.com, suranga@sutd.edu.sg, inami@inami.info

ABSTRACT

At time of writing, several affordable Head-Mounted Displays (HMD) are going to be released to the mass market, most of them for Virtual Reality (VR with Oculus Rift, Samsung Gear…) but also for indoor Augmented Reality (AR) with Hololens. We have investigated how to adapt such HMD as Oculus Rift for an outdoor AR ski slope. Rather than setting physical obstacles such as poles, our system employs AR to render dynamic obstacles by different means. During the demo, skiers will wear a video-see-through HMD while trying to ski on a real ski slope where AR obstacles are rendered.

Categories and Subject Descriptors

H.5.1 [**Multimedia Information Systems**]: Artificial, augmented, and virtual realities. I.4.8 [**Scene Analysis**]: Object recognition.

Keywords

Augmented Winter Sports, Augmented Reality (AR), Visual Augmentation, Wearable Augmentation, Head-Mounted Display (HMD)

1. INTRODUCTION

In 2016, several Head-Mounted Displays (HMD) will be released to the mass market. Amongst them is a branch of optical HMDs, for example, Microsoft Hololens, which are ideal for Augmented Reality (AR) applications since users can see through them. However, the majority of HMDs to be released, e.g. Oculus Rift, HTC Vive, Samsung Gear VR, are tailored towards completely immersive Virtual Reality (VR) environments. We have taken the opportunity to extend these VR HMDs with external cameras to create video-see-through HMDs in order to explore their AR potential by applying them closely related to our everyday lives, to create Augmented Sports.

Amongst the HMDs to be released to the mass market, Hololens is the closest to being able to augment the human vision without having to use a camera to see the outside world. Unfortunately it seems more fitted to indoor scenarios: "… unlikely that you'll be able to walk down to the shops Google Glass-style with HoloLens. That's based on the lack of outdoor use … Microsoft claimed that scenarios at work and home will get most value for the innovative technology" [5].

Figure 1. Augmented Winter Ski

A branch of AR researches has studied using HMDs to enhance our outdoors entertainment with computer-generated graphics. ARQuake is an outdoor FPS game via optical-see-through method [4], while outdoor strategy games using video-see-through HMDs are also discussed [3]. These works use dedicated hardware that was not available to the mass market, and suggest new outdoor games rather than integrating with existing outdoor entertainment such as sports

Integrating HMDs with sports present challenges due to sports' fast-paced nature and the disturbance of HMDs to our inherent ergonomic coordination towards familiar sports. Our objective is to explore the potential of using commercially available HMDs as the main apparatus for enhancing sports with AR. We choose ski as the evaluation sport as being fast-paced and require full body coordination. Although skiing with HMDs has been discussed [1], their focus was on correcting posture by looking at self while skiing. We built an AR ski setup with video-see-through HMD (Figure 1) and constructed an AR

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Figure 2. Stereoscopic video-see-through HMD.

obstacle ski slope to be demonstrated at AH 2016 Augmented Winter Sports session.

2. DESIGN AND IMPLEMENTATION

Obstacle courses are common in ski trainings and competitions. They usually consist of physical poles/gates that define what a skier should follow. However, these static obstacles imply fixed course for every skier. With AR technology, we can generate obstacles dynamically, which could also be moving instead of fixed, and ski course could vary among different level of skiers, to provide a much richer ski entertainment.

Our Augmented Winter Ski system consists of a video-see-through HMD, and a ski slope of approximately 20 meters. As skiers wear the HMD and ski across the slope, they are able to see the environment in real-time augmented with objects. Their head orientation and relative position in ski slope is tracked so that we may render the AR objects accordingly as the skiers move.

HMD: We employed a video-see-through HMD rather than optical since the mainstream of consumer HMDs to be released are VR headsets, and we want to study their potential for building consumer AR sports. Moreover, optical-see-through HMDs have a drawback in that the augmented view is limited to a certain area of foveal view, while peripheral view cannot be augmented. Video-see-through HMDs do not have this limitation as the whole user view can be augmented.

Our system consists of a HMD (Oculus Rift Development Kit), two cameras (Microsoft Lifecam Studio), and two wide-angle lenses. The HMD has a field of view (FOV) of 100 degrees. To induce the least amount of motion sickness while viewing the real world through HMD, the FOV of cameras should match that of HMD. Therefore we modify the cameras, which have 75 degrees FOV, with wide-angle lenses to match 100 degrees. The two cameras are installed (Figure 2) to provide stereoscopic see-through vision.

AR Ski Slope: The ski slope for the demonstration will be approximately 20 meters of open ground with no need of physical obstacles. A representation of the slope will be generated in the backend so that initial positions of the obstacles to be dynamically generated can be set. The obstacles will be rendered in the skier's view in the HMD when the skier approaches. Tracking system is necessary to render the obstacles at correct place as skier moves, so that their position in the real world can be properly reflected. Skier's head orientation is tracked through HMD's sensors. To track the skier's position across the ski slope, we use a fingerprinting method of Wi-Fi signals similar to [2].

As depicted in Figure 1 taken during our trials in the Alps in October 2015 at 3400m of altitude in real snow conditions, we tested an initial prototype built from Oculus Rift HMD extended with Genius F100 Widecams (FOV 120) and an adapted Mac Book Air stored in a backpack.

3. DEMONSTRATION

Our demonstration will take place during the Augmented Winter Sports session. Demonstration will cover about 20 meters of gentle slope. Participants will wear stereoscopic video-see-through HMD, and be able to explore augmented skiing. Poles and coins will be rendered in the skier's view which they have to avoid or collect. We imagine participants to enjoy both wearable and augmented sport.

4. CONCLUSION

We have presented our augmented winter ski prototype that we will demonstrate during the AH 2016 Augmented Winter Sports session. We extend consumer ready VR HMDs to create stereoscopic video-see-through HMDs as apparatus of augmented sport. Seeing as how AR offers much potential for sports, many future work directions are promising. For example, providing environmental context-aware information to the skier such as coloring quality of snow. Furthermore, with increasing number of drones in sports events, showing drones hidden from skier's FOV with AR is essential for avoidance.

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