Interactive Instant Replay: Sharing Sports Experience using 360-degrees Spherical Images and Haptic Sensation based on the Coupled Body Motion

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ABSTRACT
We propose "Interactive Instant Replay" system that the user can experience previously recorded sports play with 360-degrees spherical images and haptic sensation. The user wears a HMD, holds a Haptic Racket and experience the first person sports play scene with his own coupled body motion. The system proposed in this paper could be integrated with existing television broadcasting data that can be used in large sports events such as 2020 Olympic, to experience the same sports play experience at home.

Author Keywords
Augmented Sports; Instant Replay; Haptic Interaction.

ACM Classification Keywords
H.5.1. Information interfaces and presentation (e.g., HCI): Multimedia Information Systems

INTRODUCTION
There have been many technologies that transmit the experience of haptic sensation up to date. Yamauchi et al. [1] allow transmitting haptic information (roughness, friction, and softness) over 300 km distance using Internet. These systems are possible to transmit tactile information in accordance with the motion of the user in real time by the master-slave system. However, it is not yet realize to relive recorded experience with haptic information and body movement. In contrast, Saga et al. [2] have proposed "HapticVideo" to record the work of a skilled person, to play it dynamically with kinesthetic sense presentation devices. In this case, the system converts the environmental information to the impedance information, visual information is synchronized with the user's work also can be presented, thereby realizing the record and replay of skilled work. From this research, it is believed that the recorded specific experience can be relive by presenting the recorded haptic and visual information is coupled to the movement of the user. So, in this research we propose a system named "Interactive Instant Replay" that the user can share sports experience using 360-degrees spherical images and haptic sensation based on the coupled body motion.

AH '15, Mar 09-11, 2015, Singapore, Singapore
ACM 978-1-4503-3349-8/15/03.
http://dx.doi.org/10.1145/2735711.2735778

Figure1. Interactive Instant Replay

INTERACTIVE INSTANT REPLAY
In television sports broadcast, instant replay video is used to show the fine details of the playing scene. The moment of motion of the players that cannot be seen in normal instant replay can be seen during slow-motion. Thus it is more appealing to find out the fine details about the game play. In the Interactive Instant Replay, the regenerated combined video playing of a sports athlete to the movement of the user, it is possible to vary the playback speed interactively based on the user tracked motion. Furthermore haptic information is also presented in a slow motion manner. Hashimoto et al. [3] has proposed haptic slow motion presentation method that generating a slow motion tactile

by stretching in the tactile information acquired by the time axis direction. In this system also we use a similar method to achieve the slow motion haptic. In our previous study, "Haptic Broadcasting [4]", use player's third-person view video as presenting visual information. In this study, have used player's first-person 360-degrees view video more so that the user can feel as its own experience.

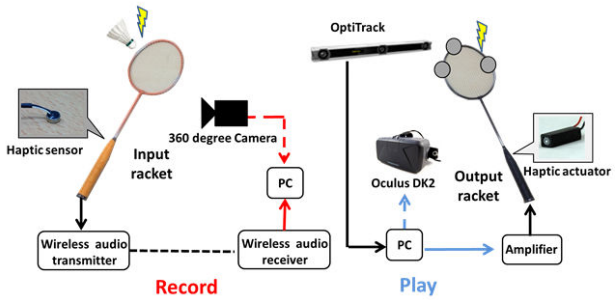

Figure 2. Interactive Instant Replay system

IMPLEMENTATION

In this research we constructed a system to target the badminton game. The user is able to relive the experience to hit the badminton shuttle in player's point of view. In "TECHTILE toolkit [5]", it is proposed to deal with haptics easily than conventional by treating haptic information as audio signals. As shown in Figure 1, A tactile microphone (Primo: MX-E4758) is used as the haptic sensor that can capture low frequencies up to 100 Hz or less vibration generated during shuttle impact. A wearable wireless audio transmitter (SHURE: SVX14/PGA31) is attached to the player to transmit haptic content between the input racket and a computer. A Haptic actuator (Tactile Labs: Haptuator Mark II) and an amplifier is used as the display. In addition, to achieve a haptic slow motion effect proposed by Hashimoto and Kajimoto [4] into interactive gameplay, racket is tracked using an motion tracking system "Opti Track". The motion data from the racket is used to change the playback speed of the recorded haptic content. Thus, audience can feel entire game play experience as they would be playing at a slow motion manner by swinging the racket slowly. Thus, by swinging the racket several times it is also at possible to feel the difference of hitting the sweet spot. We used eight GoPro cameras in a helmet configuration to take first-person view 360-degrees spherical images of badminton player. To capture the video in high frame rate, the video was captured at maximum of 240fps. The 8 GoPro cameras footage were stitched and 360-degrees spherical images were processed in Unity Game Engine and presented using Oculus DK2.

By making one-to-one correspondence to the frame number of the video and the racket of the position, and allowed to video presentation, body movement and the coupling. The moment of racket speed and tactile collision obtained from the motion data from the ratio of the racket speed in the video when recorded, was calculated the rate of tactile presentation.

Figure 3. 360-degrees Spherical Video

DEMOSTRATION

In Augmented Human 2015, we demonstrate our system in 2 configurations. The Audience is able to 1) experience the game play as an audience standing in the middle of the court; 2) experience interactive haptic slow motion (Figure. 1) as the players first-person view with 360-degrees spherical images. Furthermore, the audience can not only feel the interactivity, but also the impact of the shuttle as they were playing at a slow motion manner by swinging the racket slowly at their own speed.

ACKNOWLEDGMENTS

This work was supported by JST-CREST Haptic Media Project and Kanto Bureau of Economy, Trade and Industry. The 360 degrees camera used in this work was developed by NHK Enterprises, Inc. in corporation with Dverse Inc., and 360 degrees camera design, video shooting and editing was conducted by HOME360 Inc.

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