VibroTracker: a Vibrotactile Sensor Tracking Objects

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Abstract

Although vibrotactile feedback enlivens virtual interaction, it is difficult to measure actual vibrations of moving objects. Our VibroTracker system achieves this with an optical gaze controller and a laser Doppler vibrometer, enabling users to relive the vibrotactile sensations experienced by others.

Keywords: tactile sensor, vibrotactile sensation, laser Doppler vibrometer, haptic media

1 Introduction

It is exciting merely to watch sports events, but simulating the haptic sensations experienced by a player would make spectating even more enjoyable. This is not peculiar to sports events. In addition to video and audio, the ability to relive the sensations experienced by others would also offer great entertainment value at temporal and spatial distances (Fig. 1). One example of such a device is the TECHTILE toolkit [Minamizawa et al. 2012], which is user-friendly and has expressive power, but existing systems have some problems in measuring vibrations. A contact-type vibrometer deforms the original vibrations and is a burden to wear or carry. Even with a non-contact sensor like a microphone, it is difficult to measure slight vibrations of a fast-moving target against the surrounding noise. Our VibroTracker system solved these issues by using a laser Doppler vibrometer (LDV) and a high-speed optical gaze controller (Saccade Mirror), enabling users to relive the vibrotactile sensations experienced by others.

2 Vibrometer and Tracking System

VibroTracker consists of two parts, an LDV and a Saccade Mirror. The LDV is an optical transducer used for determining the vibration velocity and displacement at an irradiated point [Günther et al. 2009]. The LDV enables vibration measurement with high accuracy, in real time, without any influence from surrounding noise or physical contact. The Saccade Mirror adjusts a camera's pan and tilt angles and can keep an object always at the center of the viewing field by means of visual feedback [Okumura et al. 2011]. When the LDV is coaxially mounted on the Saccade Mirror, non-contact vibration measurement of a fast-moving target becomes possible. The object vibrations are reproduced by a vibrator attached to a similar object held by the user, allowing the user to share the vibrotactile sensations.

3 Experiments

In an experiment, the VibroTracker measured the vibrations of three targets at a distance of 3 m using an eye-safe (Class 2) laser: a vibrating speaker radiating a 55 dB, 1 kHz sine wave, a ping-pong paddle smashing a ball, and a ping-pong ball on the rebound. Fig. 2 (a) shows that vibration measurement and object tracking worked well when the vibrating speaker was moved manually. The sine wave and motion of the object are shown respectively in the high-frequency component and the low-frequency component of the vibration velocity. Figure 2 (b), (c) shows that the VibroTracker could also measure the vibration of the paddle and ball in motion. This system enables spectators to pretend to be a player and enjoy the games, and even allows them to experience the simulated sensation of touching the ball in motion.

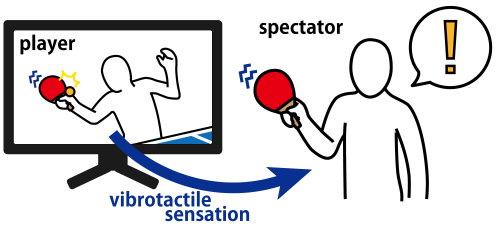
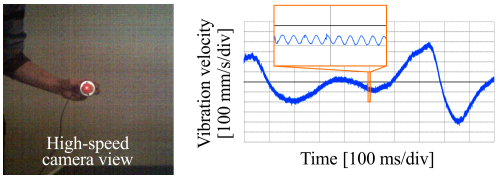
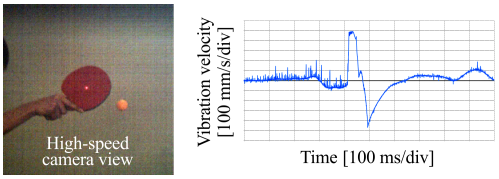


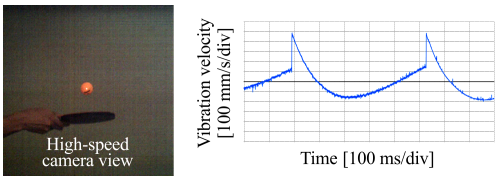
Figure 1: *Reliving another's vibrotactile sensations.*



(a) Vibration speaker



(b) Ping-pong paddle smashing a ball.



(c) Ping-pong ball on the rebound.

Figure 2: *The vibrations of three targets.*

References

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