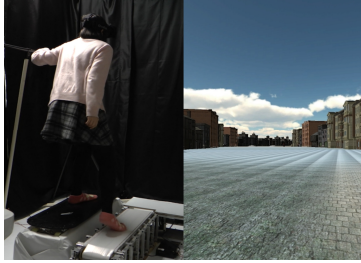
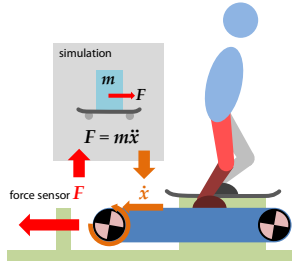


VibroSkate: A Locomotion Interface with the Exact Haptics and Kinesthesia

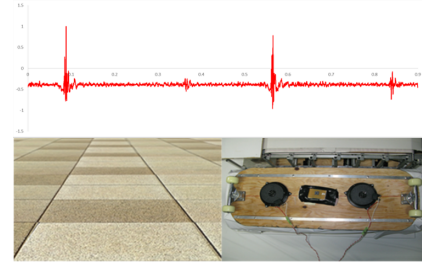
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(a) Overview



(b) Treadmill Control



(c) Vibration Display

Keywords: locomotion interface, locomotion input, locomotion feedback, force input/output, skateboard

1 Introduction

Latest development of VR technology enabled people to enjoy varieties of immersive VR environment in small spaces. Locomotion interfaces are essential to explore extensive virtual worlds with more sense of immersion.

VibroSkate is a small and low-cost locomotion interface which reproduces the exact haptics and kinesthesia of feet. The device simulates skateboarding, and enable the players to feel the ground and the acceleration, with realistic vibrations of a skateboard.

VibroSkate gives players strong sensation as if their physical body exist in the virtual world, by exploring the world with exact force to thrust the body.

2 Technology

There are two technical innovations in our proposal. One is a exact reproduction of relation between feet kinesthesia and haptic sensation, and the other is the vibration synchronized with locomotion.

While skateboarder kicks the ground, they feel the kinesthesia and force feedback on their feet according to mass and physics of the body. VibroSkate reproduce this relation by detecting players' kicking force and simulating the dynamics. The speed of treadmill is controlled along the velocity of simulated skateboard (Figure (b)). This method achieves the exact reproduction of kicking foot's kinesthesia and feedback force as real skateboarding.

Nowadays, conventional small and low-cost devices for home entertainment do not calculate the exact force[Cakmak and Hager

2014]. On the other hand, VR devices in labs are huge and/or require multiple motors because they try to reproduce the vestibular senses, making difficult to adapt for home entertainment purposes. Christensen and Hollerbach [Christensen et al. 1998] show that kinesthesia and feedback force gives a strong moving sensation. Our design follows this path but omitting feedbacks for the vestibular sensation.

While skateboarding, vibrations caused by wheel friction are transmitted to the feet, so the skateboarder can perceive the different textures of ground and speed. VibroSkate reproduce those vibrations using two large transducers (Figure (c)). Vibrations are presented according to the user's input and ground conditions. These vibrations are sampled using a real skateboard rolling over different surfaces, so the device can make user like if they are skating over the real surface.

[Farkhatdinov et al. 2013] shows that vibration can present velocity perception. VibroSkate utilized this to create exciting skateboarding.

3 Future

VibroSkate can change VR game experiences. This force input locomotion interface allows players intuitive and dexterous control of moving speed. Players will be able to experiment a real sense of distance of attractive game worlds.

Skateboarding through scenic virtual worlds is exciting itself, and it can become a new form of entertainment. VibroSkate enables people to dive into and explore attractive worlds they have never been to, or even a fantastic world that never exist in the real world.

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