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PRESS RELEASE

Source: Toyohashi University of Technology, Japan, Committee for Public Relations

Release Title: Enhancing virtual walking sensation for seated observer using walking avatars

Release Subtitle: Embodiment of a full-body or hands-and-feet avatar with rhythmic foot vibration induces illusory walking sensation without actual limb movement

Overview

Researchers at the Toyohashi University of Technology and the University of Tokyo have developed a virtual walking system for seated observers and have revealed that walking self-avatars improve the illusory walking sensation by integrating foot-vibration simulating footsteps. The walking-avatar is presented in the first-person and mirrored perspectives, to induce a sense of body ownership. This system provides a virtual walking experience to people with walking disabilities.

Details

Walking is a fundamental physical activity in humans. A research team at Toyohashi University of Technology, in collaboration with researchers at the University of Tokyo, has developed a virtual walking system for seated observers which allows them to experience walking without moving their limbs. A walking-avatar, in first-person and mirrored perspectives, enhanced illusory walking sensations by combining rhythmic foot vibrations to simulate footsteps. The “invisible” avatar, made of only hands and feet, also improved the illusion of walking. This system may provide virtual walking experience for people with walking disabilities. This study will be published in *Frontiers in Virtual Reality* on April 21st, 2021.

Various virtual reality (VR) walking systems have been developed. However, most of these require physical leg movements. Such systems are usually too large, heavy and complex to use at home, making it difficult for people with disabilities to operate them.

Researchers at Toyohashi University of Technology and the University of Tokyo have proposed a virtual walking system that does not require limb action for seated users. It comprises a head-mounted display (HMD) and four vibrators on which the observers position their feet.

A walking-avatar or virtual person was generated in the virtual environment, and the viewing direction of the virtual camera and the head of the avatar were linked to the real head motion of the user. The avatar was viewed from a first-person perspective and in mirrors placed in the virtual environment. When the avatar’s foot struck the ground, the foot vibrations were applied rhythmically to the heel and forefoot of



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the user's foot. The combination of the walking-avatar and foot vibrations was the most effective way to induce walking sensation and telepresence.

The "invisible" avatar, made of only hands and feet, also improved the virtual walking experience compared to the no-avatar state.

However, when the avatar was presented away from and in front of the user without mirrors from a third-person perspective, the avatar did not improve the illusory walking sensation.

Development Background

Project Assistant Professor Yusuke Matsuda said, "It may be abstruse that mirrors are placed at regular intervals in a virtual environment. However, it is important to make users feel as if the avatar is their own body. Walking people typically view a limited part of the avatar's body (such as their hands and insteps in the periphery) from a first-person perspective. Mirrors allow users to view the entire body from a first-person perspective." Junya Nakamura, a graduate student, said, "The hand-and-feet only avatar has been developed in the laboratory that I belong to, to induce illusory body ownership to an invisible body (Kondo et al., 2018). This method is easy to implement, requires low computing power, and can potentially minimize the conflict between the appearance of the physical and virtual body. Thus, in addition to the full-body avatars, I used hands-and-feet-only avatars in experiments."

Future Outlook

The research team believes that a virtual walking system without limb movement will provide an enjoyable experience for people with walking disabilities and improve their quality of life (QOL) in the future. If the portability of the system can be improved, it can be used at home.

Funding agency

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Publication

Matsuda, Y., Nakamura, J., Amemiya, T., Ikei, Y., Kitazaki, M., 2021. Enhancing virtual walking sensation using self-avatar in first-person perspective and foot vibrations, *Frontiers in Virtual Reality*, doi: 10.3389/frvir.2021.654088.



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Reference

Kondo, R., Sugimoto, M., Minamizawa, K., Hoshi, T., Inami, M., and Kitazaki, M. (2018). Illusory body ownership of an invisible body interpolated between virtual hands and feet via visual-motor synchronicity, *Scientific Reports*, 8:7541 doi:10.1038/s41598-018-25951-2.

Further information

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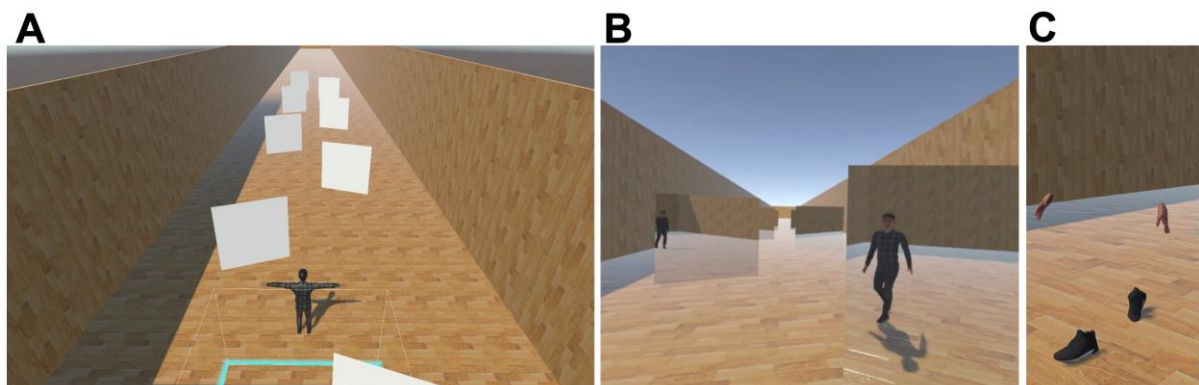
Movie:

<https://youtu.be/SyEY7C2RC7o>

Title: Sample movie demonstrating virtual walking

Caption: While the full-body avatar or the hands-and-feet-only avatar was walking, foot vibrations (represented as sounds in the movie) were applied to the heels and forefeet of users.

Figure1:

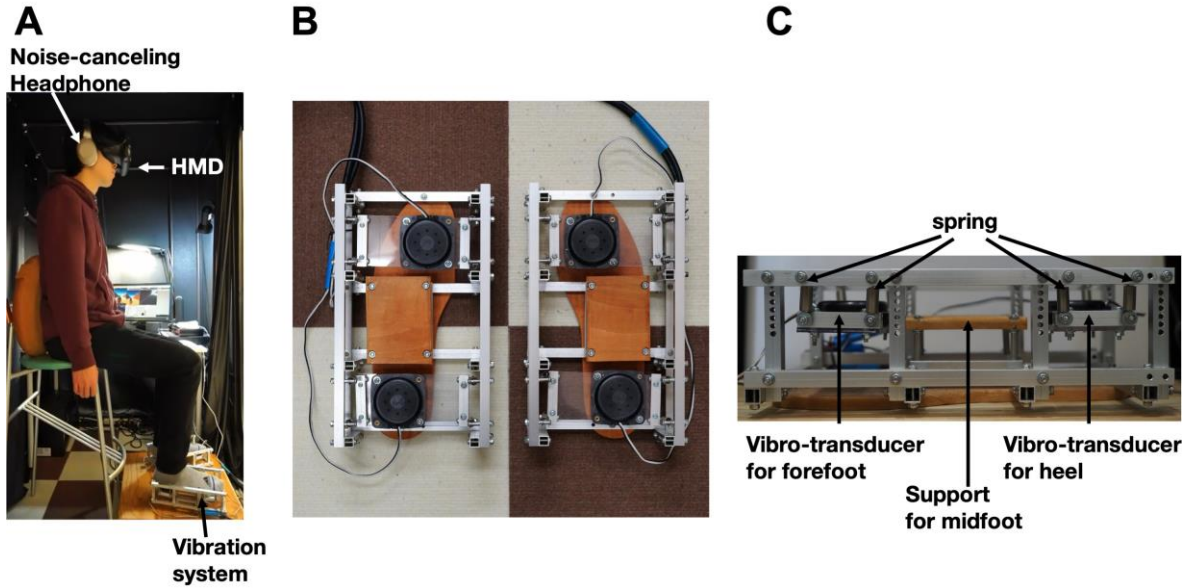


Title: Virtual scenes in experiments

Caption: (A) Top view of the virtual environment in the mirror experiment. (B) Representation of a scene in the mirror experiment with a full-body avatar. (C) Hands-and-feet-only avatars.



Figure2:



Title: Apparatus of virtual walking system.

Caption: (A) System overview. (B) Top view of the vibration system consisting of four vibro-transducers. (C) Side view of the vibration system. Vibro-transducers were connected to an aluminum frame with springs to prevent the transmission of vibrations.

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