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PRESS RELEASE

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

Release Title: Virtual walking system for re-experience of another's travel

Release Subtitle: Illusory walking sensation by pre-recorded oscillating optic flow and synchronous foot vibration

Release Summary:

Researchers from Toyohashi University of Technology, The University of Tokyo and Tokyo Metropolitan University have developed a virtual-walking system that records a person's walking and re-plays it with vision and foot vibrations. Psychological experiments showed stronger sensations of walking and telepresence from the oscillating visual flow with foot vibrations than without vibrations. The system can present experiences of walking to persons who are at a distance or have a disability of walking in the future.

Full text of Release:

A research team consisting of Professor Michiteru Kitazaki at Toyohashi University of Technology, Associate Professor Tomohiro Amemiya at The University of Tokyo, and Professor Yasushi Ikei at Tokyo Metropolitan University have developed a virtual walking system that records a person's walking and re-plays it for another user with oscillating optic flow and synchronous foot vibration. Psychological experiments showed the stronger sensations of self-motion, walking, leg action, and telepresence from the oscillating visual flow with foot vibrations than with randomized-timing vibrations or without vibrations. These results suggest that the oscillating visual scenes and synchronous foot vibrations are effective for creating virtual walking sensations. The virtual walking system can present experiences of walking to persons who are at a distance or have a disability that prevents them from walking in the future. This research has been published in a British open access journal "i-Perception" in 2019.

Walking is a natural and frequent action performed by healthy adults in everyday life. It involves various sensations such as vision, touch, hearing and proprioception as well as motor commands and actions. Thus, it seems difficult to develop a virtual reality system for presenting walking sensation.

Recently, a research team from the Department of Computer Science and Engineering from Toyohashi University of Technology in corporation with Tokyo Metropolitan University, The University of Tokyo, and The University of Electro-Communications have developed a virtual walking system that records a person's walking and re-plays it for another user. The recording system captures walker's oscillating optic flow with



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a pair of stereo cameras and timings of feet's striking the ground with 4 microphones embedded in the shoes. The presenting system is comprised of a head-mounted display (HMD) and 4 vibrators attached to the heels and the forefeet.

Psychological experiments were performed to test the virtual walking system. The captured first-person-view scenes with image oscillations caused by the walker's head motion and the foot vibrations at synchronized timings significantly induced sensations of self-motion, walking, leg action, and telepresence. The synchronous presentation of visual oscillations and foot vibrations was critical for enhancing the virtual walking experience. These results suggest that the tactile stimulation on the feet for footsteps is effective for enhancing virtual walking sensations.

Professor Michiteru Kitazaki, a perceptual psychologist at Toyohashi University of Technology said, "We would like to further develop the virtual reality system that could enable people to walk on strange places such as the moon or the ocean floor, and improve the quality of life of people who have walking disabilities. This research is the first step for it. Thus, we aim to create a virtual sensation of walking using limited modalities, such as vision and tactile sensations."

Associate Professor Tomohiro Amemiya, a young virtual reality researcher whose research specializes in haptics at The University of Tokyo explained, "Tactile sensation on foot-sole can induce pseudo-walking sensation. The present research showed its psychological evidence. In addition, we have found that a similar rhythmic pattern consisting of walking vibrations applied to the soles of the feet facilitated tactile processing when looming sounds were located near the body in another our paper in "Psychological Science". The findings suggest that an extension of the peripersonal space representation can be triggered by stimulating the soles in the absence of body action, which may automatically drive a motor program for walking, leading to a change in spatial cognition around the body."

Professor Yasushi Ikei, a virtual reality expert researcher at Tokyo Metropolitan University said, "In line of these studies, we are developing a full-scale super-presence virtual re-experience system. For example, FiveStar VR (which won the best VR/AR technology award at ACM SIGGRAPH Asia 2018) presents vision, vestibular sense, smells, air flow, sounds, and touch to re-experience other's experience (<https://youtu.be/mOS5JBSZ3c>). The re-experience system expands our experiences and contributes to skill transfer and QOL of all persons".

The virtual waling system could expand our experience in the world and improve QOL of persons that have disabilities in walking in the future.



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Reference:

Kitazaki M., Hamada, T., Yoshiho, K., Kondo, R., Amemiya, T., Hirota, K., and Ikei, Y. (2019). Virtual walking sensation by pre-recorded oscillating optic flow and synchronous foot vibration. *I-Perception*

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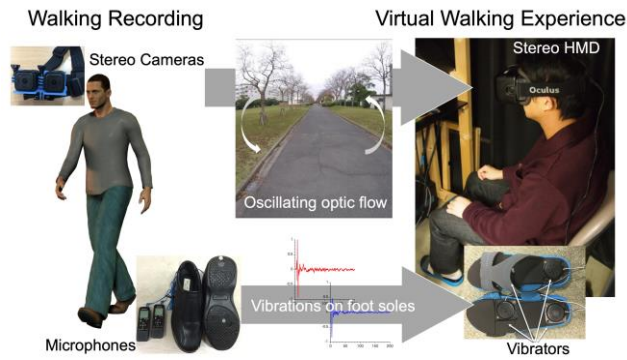
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Figure 1: Image of virtual walking



Figure 2: System overview



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