博士論文を要約したもの

博士論文題目

Effects of Visual and Somatosensory Stimuli for Locomotion in Virtual Reality

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（要約）

On a fundamental assumption, VR locomotion requires the users to feel that they are standing (the sense of standing: SoSt) and walking or running (the sense of self-motion: SoSm). These senses are specific senses of SoP with VR locomotion. Therefore, I can say that designing a locomotion technique that facilitates the creation of SoSt and SoSm is required regardless of scenarios of VR experiences.

In this study, I highlight on the visual and somatosensory stimuli with the consistency of posture and motion in VR locomotion that realizes travel by the movement of one's own lower limbs. The objective of this study is to provide three foundations for VR locomotion based on novel findings on the visual and somatosensory stimuli: posture, movement, and augmentation. I investigated the following five issues for the effects of the visual and somatosensory stimuli on SoSt and SoSm, and the kinesthetic illusion that can extend these effects.

Experiment 1

I shed light on how visual and somatosensory stimuli affect SoSt when a sitting posture is varied slightly. As expected, SoSt, which is a necessary element for the sense of walking, was enhanced in the sitting posture with a higher sitting height than in the reference sitting posture with a knee joint angle of 90 degrees. Furthermore, SoSt was related to postural perception, which is how strongly you were feeling of one's own posture.

Experiment 2

I shed light on how visual and somatosensory stimuli affect SoSm when a sitting posture is varied slightly. As expected, SoSm, which is the sense of walking and running, was enhanced in the proposed sitting posture with a higher sitting height than in the reference sitting posture. Furthermore, SoSm was

related to the perception of vection, which is SoSm derived from a visual sense of self-motion by optical flow. Further confirmation showed that metacognition was related to these changes, which is how strongly you were feeling of one's own posture.

Experiment 3

I shed light on the effects of the STS movement on SoSt and SoSm. As a result, the visual and somatosensory stimuli associated with the postural transition and contextual effect of the STS movement enhanced SoSt.

Experiment 4

I shed light on the effects of vibration stimulation during reaching movements of a Lower Limb on joint and positional sensation. On the one hand, the effects of vibration stimulation in an achilles tendon and a semimembranosus tendon on the joint and positional sensation tended to differ depending on the direction of the movements and the vibrating parts. On the other hand, the change in movements caused by the tendon vibration stimulation tended to change in one direction.

Experiment 5

I found that vibration stimulation of the hamstring changed a joint sensation during a reaching movement of a lower limb without vision. Furthermore, the effects were larger when stimulating with continuous vibration than when stimulating with intermittent vibration during the movements. The effects with continuous vibration were also larger than that induced by fatigue by the movements.

The findings of this study show the importance of choosing an appropriate sitting posture and contribute to choosing a convenient sitting posture through three foundations: posture, movement, and augmentation. First, the foundation for posture for locomotion is that you should design with as high a seating surface as possible in seated locomotion. Second, the foundation for movement for locomotion is that you should integrate a rising and falling seat function into seated locomotion so that you can perform a sit-to-stand movement. Third, the foundation for augmentation for locomotion is that you should integrate an augmented function of locomotion with vibration stimulation.