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Student No.	Last name, First name
M2220170	Nakayama, Yusuke

(Title)

Study on Display System of Vection Synchronized with User's Movement

Vection is a phenomenon in which, when watching the movement of a train on an adjacent track through the window of a stationary train, one feels as if the train on which one is riding has started moving. It is an optical illusion in which one feels as if one is moving in the opposite direction to the progress of the visual stimulus.

In many previous studies on vection displays methods, the user is generally instructed not to move. The display of vection while the user is moving has not been adequately studied, and further research is needed. It has been confirmed that the intensity of vection is strongly influenced by the display of visual stimuli in the peripheral vision area. Several systems that can display visual stimuli in the peripheral vision area have been proposed, but they all require a large configuration, are expensive to construct and require permanent installation.

In this study, a system was proposed to increase the intensity of vection during movement by displaying visual stimuli that change synchronously with the user's movements. The proposed system is portable and easy to construct.

In the proposed system, an object containing deodorant beads in a transparent case and a mesh-patterned sheet is placed outside the LED array. The LED chips installed inside the object emit light, and the shadow of the object is projected on the wall. The user's swimming motion were detected by Kinect V2 and controlled by Arduino Due so that the position of light-emitting LED chip would change according to the magnitude of the motion. By synchronizing the user's motion with the changes in the light-emitting position, the user's motion and the movement of the shadow are synchronized, and vection is displayed.

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Preliminary experiments showed that the constructed system was able to display vection to 10 subjects. The system is simple to construct, as it only uses LED chips to project shadows. The system itself is portable and can display vection as long as there is a dark space of a certain size.

In the next evaluation experiment, the intensity of vection from the display of visual stimuli synchronized with the subject's motion was tested on 23 subjects; four visual stimuli display patterns (Patterns I~IV) were compared for three items: latency, duration and magnitude of vection. In Pattern I, a shading moving at a constant speed was displayed as a visual stimulus to the stationary subject. In Pattern II, the subject is instructed to perform a hand motion as if swimming, but the shading displayed as a visual stimulus moved at a constant speed. In Pattern III, the subject was instructed to make swimming motion as in Pattern II. The visual stimulus was synchronized with the motion of the subject's palm, and the shading moved only when the subject moved the palm from the front to back. In Pattern IV, as in Pattern III, the visual stimuli were synchronized with the amount of palm motion, and the visual stimulus was set to be presented with inertial force in order to create the reality of swimming.

Experimental results showed that the magnitude of vection was greater when the display of visual stimuli was synchronized with their swimming motion than when they were not. It is found that when the shading were set to act on physical forces in the water, reality increased and the magnitude of vection was greater. Since the latency and duration of vection were not equally distributed, a one-way ANOVA could not be performed. Therefore, the experimental method and setup are necessary to be revised.

On the other hand, the number of subjects for whom both latency and duration could not be measured for each pattern of visual stimulus display was 4 for Pattern I, 3 for Pattern II, 1 for Pattern III and 0 for Pattern IV. Since there were fewer subjects in patterns III and IV than patterns I and II, these results suggest that vection is more likely to occur in subjects when their motion are synchronized with the visual stimuli.

These results suggest that the system proposed in this study can be used to display vection to a moving person, and that the magnitude of vection can be increased by synchronizing the subject’s motion and the display of visual stimuli.

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