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Adaptation of a Joystick-type Control Interface on Narrow Tilting Vehicles for Improving Controllability

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Narrow tilting vehicle (NTV) is being researched as a novel solution to transportation problems such as road congestion and lack of parking space. Due to its characteristic behavior of tilting into a turn, it gives a unique driving sensation different from traditional automobiles or motorcycles. This study aims to improve the controllability and receptivity of the operation interface of the NTV. At first, we focused on the feature that the vehicle body tilts inward and proposed a joystick-type operation interface that is thought to be easy to match the behavior of the vehicle body with the sense of operation. Next, the experiment was conducted to compare the operability of the handle-type and the proposed joystick-type operation interface. A view of the NTV and the joystick-type control interface is shown in Fig. 1 and Fig. 2, respectively.

The experiment was conducted for 4 participants with informed consent on two different courses as shown in Fig. 3. Course 1 was a simple ellipse, while Course 2 was a more complex course that included turns of different radii and left-turn-to-right-turn transitions. Participants drove four laps per trial at fixed speeds on these courses, for a total of four conditions for each interface and course combination. The speed settings were 21 km/h for Course 1 and 15 km/h for Course 2. For each trial, the operating input angle was recorded. A questionnaire was also performed after each trial to evaluate the subjective evaluation of the operability of the vehicle. The questionnaire consisted of four items on a seven-point scale: ease of driving, enjoyment, tension during driving, and arm fatigue.

As a result, no abnormal operation was observed in both the handle-type and the proposed joystick-type operation interface as shown in Fig.4, and the vehicle was able to run without any problem while keeping the course. The Root Mean Square (RMS) for the angular velocity of the joystick was smaller than that of the steering wheel. On the other hand, the results of the questionnaire showed that the fatigue level of the joystick tended to be higher than that of the steering wheel. The results suggest that the joystick achieved a smoother control compared to the steering wheel with proper force feedback but caused more fatigue in drivers. In future works, it is necessary to consider a reaction force presentation method that reduces driver arm fatigue while achieving smooth operation.

Fig.1 A view of NTV

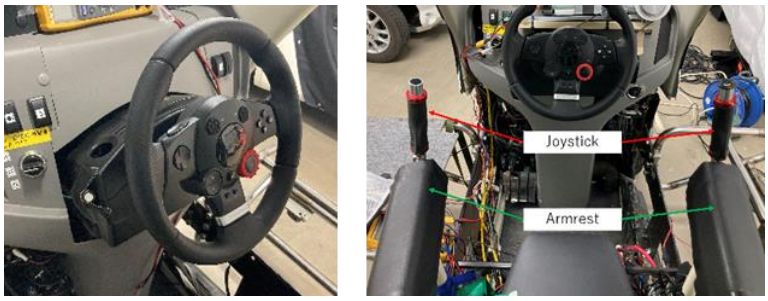

Fig. 2 A view of 2 interfaces: Steering Wheel (left) and Joystick (right)

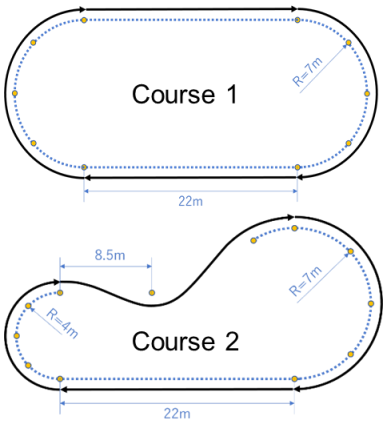

Fig. 3 Diagram of driving courses

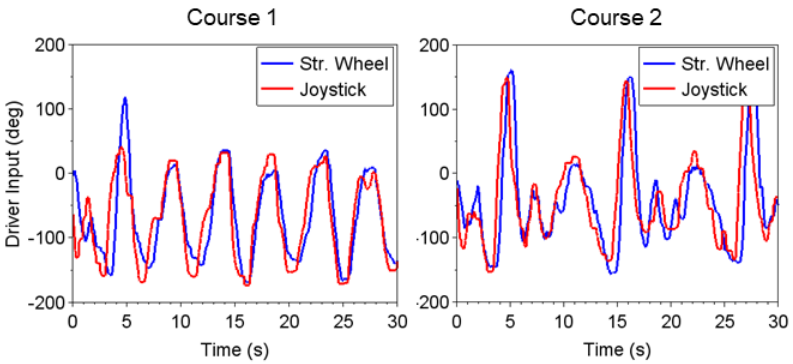

Fig. 4 Input angle of each interface (Participant 1)