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Proposal of an Active Safety System for Motorcycle Riders Based on Structural Equation Modeling

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The fatality rate of motorcycle riders in traffic accidents is much higher than that of four-wheel vehicle drivers. To reduce the number of motorcycle accidents, the author's research team first constructed the model shown in Fig.1, which estimates the risk of collision at an intersection based on the amount of vehicle state under normal driving when risk events have not yet manifested, using structural equation modeling as a previous study. As a result, we confirmed that the amount of lateral wobble has a strong causal relationship with the risk of collision at an intersection. Therefore, we proposed a preventive safety system as shown in Fig.2, which presents information about the "Average of Distance from the Center of lane (DC_{avg})," a vehicle state quantity that has a particularly strong causal relationship with collision risk among lateral wobble quantities, to the motorcycle rider in real time.

We also verified the effectiveness of the system in reducing accidents by conducting experiments on subjects with and without information presentation using the Riding Simulator. The subjects were 10 males with a regular motorcycle license (Mean age: 21.5 years, SD: 0.88). Subjects drove at a speed of 60 km/h on a 20 km long, one-lane driving course with intersections every 1 km and curves of R=50 m every 5 km. The risk event was set to occur three times per condition, assuming an encounter with a four-four-wheeled vehicle at an intersection. According to the experimental results, we confirmed that TTC_{min} increased due to the use of the system as shown in Fig.3 (F (28) = -2.077, p = 0.047). This is considered to be a result of the fact that presenting information on the amount of lateral wobble kept the motorcycle rider's driving concentration high and prevented the rider from entering a potentially collision-prone state.

We then analyzed the effect of driving style on the accident reduction effect of information presentation. As a result, as shown in Fig.4, we confirmed that TTC_{min} may increase with the presentation of information in Group A (n=6), which tends to be impatient, but we did not confirm an increase in TTC_{min} with the presentation of information in Group B (n=4), which tends to be more methodical and anxious riders. The reason for this result could be that group B had a higher mental and visual workload to pay attention to the information presentation and consequently paid less attention to the traffic environment ahead. Therefore, as a future study, we plan to optimize the information presentation method so that the motorcycle rider can pay sufficient attention to both the traffic environment ahead and the presented information.

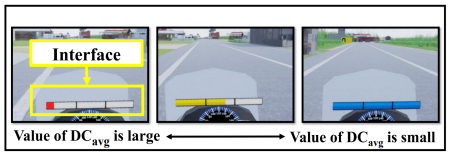

Fig.2 Display of the information presentation system proposed in a VR simulator

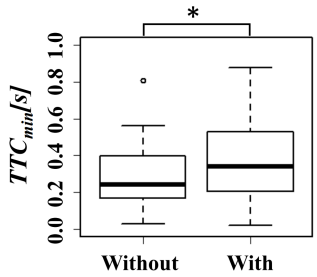

Fig.3 Results of TTC_{min} with and without information presentation system

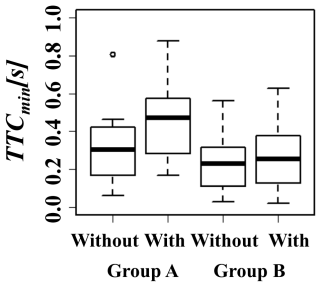

Fig.4 Effectiveness of information presentation by driver group

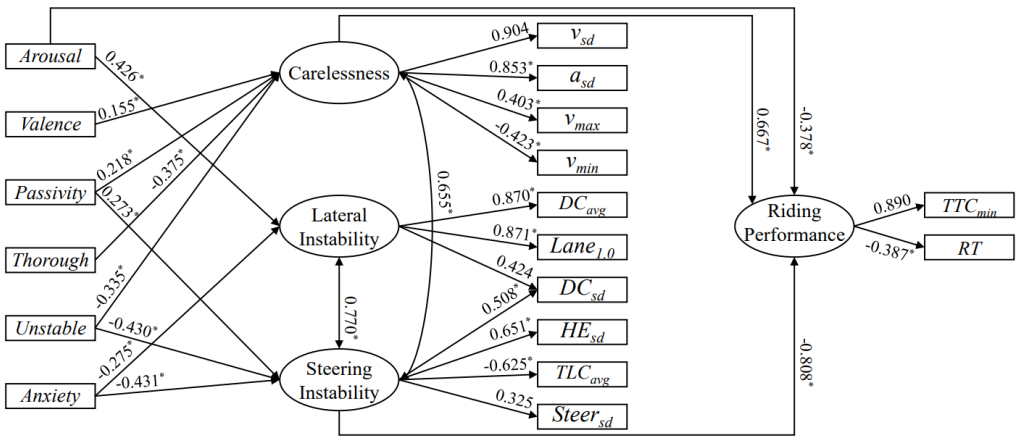

Fig.1 A model for estimating the collision avoidance ability of motorcycle riders constructed using structural equation modeling