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Verification of speed control support effectiveness for electric scooters using the metaverse

Makito Toki [1)] **Keisuke Suzuki** [1)] **Shusaku Toda** [2)]

1) Kagawa University
2217-20 Hayashi-cho, Takamatsu-shi, Kagawa, 761-0396, Japan
2) Aioi Nissay Dowa Insurance
1-28-1 Ebisu, Shibuya-ku, Tokyo, 150-8488, Japan

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With the enforcement of the revised road traffic act, the use of electric scooters on public roads was officially authorized in Japan as of 2023. Meanwhile, in countries where electric scooters have already become widespread, challenges include a rise in fatal accidents involving these devices. In Japan as well, the number of accidents has been on the rise since the launch of these services, and concerns about safety are growing. The purpose of this study was to analyze the effects of speed-limiting assistance on driving behavior and accident risk; to this end, we conducted a participant experiment using a VR electric scooter simulator that we developed in-house.

Two experiments were conducted using a VR electric scooter simulator: Analysis of the effect of speed limit settings on reducing traffic accidents. The participants in the experiment were 20 young adults (mean age: 24.0 years, standard deviation: 1.9 years) who held a standard driver's license. We set three speed limits (6 km/h, 10 km/h, and 20 km/h) and verified whether they could safely avoid a pedestrian who suddenly darted into its path, based on the minimum distance between the electric scooter and the pedestrian. Figure 1 shows the minimum approach distance to pedestrians by risk detection distance. At a speed of 20 km/h, collisions with pedestrians occurred in all test runs, whereas at speeds of 10 km/h and 6 km/h, collisions were rare. Based on the experimental results, we set two maximum speeds (20 km/h and 10 km/h) for determining the maximum speed according to the risk onset distance and performed a binary logistic regression analysis. The results confirmed that the risk onset distance is a significant explanatory variable for maximum speed selection ($p < 0.05$). Based on the above, the derived regression equation is expressed as Equation (1). Note that p represents the selection probability (%) and x represents the risk detection distance (m).

$$p = (1 + e^{-0.514x+5.445})^{-1} \quad (1)$$

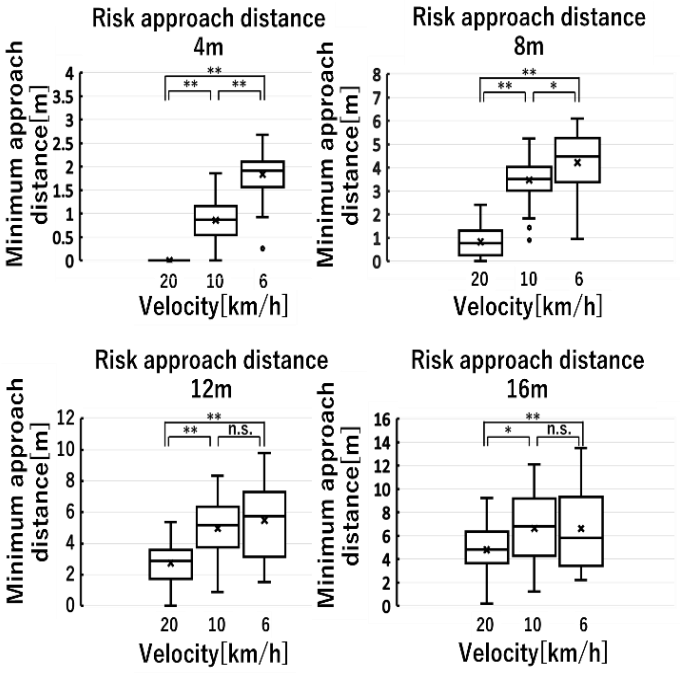

Fig.1 Minimum approach distance for each driving speed and risk appearance distance

Next, we analyzed the extent to which speed-reduction support through information prompts is effective in promoting preventive behavioral changes among electric scooter users. The participants in the experiment were 21 adults (mean age: 22.6 years, standard deviation: 4.6 years) who held a standard driver's license. The conditions for displaying the information were set to "No support", "Visual", and "Auditory". Based on the results in Figure 1, the recommended speed was set to 10 km/h, and the system was configured to display the information when the speed exceeded this limit. Figure 2 shows the results for walking speed under each condition. We confirmed that walking speed was reduced when auditory were presented, compared to the other information presentation conditions.

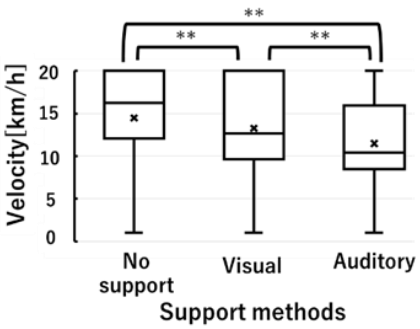

Fig.2 Changes in driving speed due to speed limit information