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Research on Driving Assistance System using Real-Time Road Information Monitor during Nighttime

Kazuna Tokimi [1)]　Satoshi Shimizu [1)]　Yuto Nishisako [1)]　Yoshiyuki Tanaka [1)]

1) Nagasaki University, Graduate School of Engineering
1-14 Bunkyomachi, Nagasaki city, Nagasaki, 852-8521, Japan

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In this study, driving experiments using the simulator developed laboratory were conducted to analyze the effects of an auxiliary monitor on driving behavior during nighttime. The experiments were conducted on a 3.5 m-wide, single-lane, straight course with two unsignalized intersections and buildings placed around the intersections to limit visibility. The experiments were performed at night as well as during the day. The auxiliary monitor was centered on the vehicle and monitored from 60 m above the ground, allowing the driver to observe the traffic situation up to 30 m ahead. It was placed to the left of the steering wheel to avoid obstructing the driver's field of vision. The acquired data, such as the position and speed of the vehicle and the subject's line-of-sight information, were recorded every 0.01 s in an Excel file. The flow of the experiments was as follows.

Exp. 1 (With auxiliary monitor): The subject drove through the experimental course with the auxiliary monitor. Measurements were taken until the vehicle passed through the intersection, after which the participant responded to a questionnaire regarding the driving.

Exp. 2 (Without auxiliary monitor): The participants were asked to drive the experimental course in the same manner as above without the auxiliary monitor. Next, the same procedure was conducted during the day and once complete, the subjects were asked to respond to a questionnaire regarding the entire experiment.

A total of ten subjects (five pairs) were asked to participate in this experiment, and the nighttime and daytime courses were conducted on different days.

The time to collision (TTC) was used as a parameter to evaluate the risk of collision between two vehicles, indicating the number of seconds elapsed, at their current relative speeds, until collision without any avoidance action. The maximum and minimum values of TTC are infinity and 0 s, respectively. TTC can be expressed by the following equation:

$$TTC = \frac{x_1 - x_2}{v_1 - v_2}$$

The experimental results are shown in Figure 1, and the following were noted:

1) Stopping time at intersections decreased in Exp.1.

2) Eye movement near intersections decreased in Exp.1.

3) The risk of collision between two vehicles (one ahead and one behind) decreased in Exp.1.

The auxiliary monitor significantly reduced eye movement and stopping times at intersections, during the night. This is because the auxiliary monitor enables better perception of the surrounding at night. In the subjective evaluation questionnaire, respondents tended to indicate that they felt more at risk while driving at night and that they needed to be presented with an auxiliary monitor. In this experiment, the collision risk between subjects was evaluated; however, the risk between the subjects and the autonomous vehicle was not examined. In addition, the position, display range, and timing of the auxiliary monitor are still under consideration, and we believe that it is necessary to optimize the display according to the driving scene.

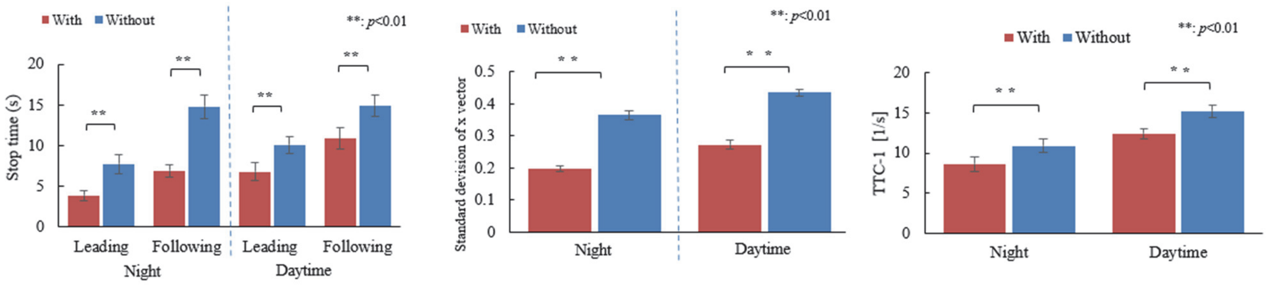

Fig. 1　Mean data of the stop time and eye movements and TTC index values for all subjects.

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