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Infrastructure Alert System Based on Intersection Monitoring Using Measurement Sensor and Infrared Camera

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The number of traffic accidents in Japan is decreasing year by year, but it is still high, with about 381 thousands accidents occurring in 2019. The percentage of people killed or seriously injured in traffic accidents is highest at night, and about 40% of accidents occur at intersections. Against this background, the authors propose an infrastructure-type system to prevent accidents at intersections.

Figure 1 indicates the proposed system, it is divided into two parts: an assist driver cognition and a monitoring system configuration for the entire intersection. Sensors installed at the intersection monitor the entire intersection and determine whether the pedestrian crossing should flash red based on comprehensive situation about pedestrians and vehicles. Drivers entering an intersection obtain an lighting alert of impending danger, enabling them to drive safely.

This system approaches the driver's cognition by flashing lights. It is reported that 90% of the cognitive information during driving comes from visual information. Therefore, this system utilizes the characteristics related to vision among human cognitive characteristics. In order to direct drivers' attention to the crosswalk, the authors focused on the characteristics of "Attention capture" and "Affordance". "Attention capture" is a characteristic that people unconsciously pay attention to dynamic objects. "Affordance" is a term often used in the field of cognitive psychology and is defined as an environmental factor that causes a particular perception. In particular, the color red can remind people of prohibition or danger just by looking at it. By combining the characteristics of "Attention capture" and "Affordance," we believe that it is possible to prevent traffic accidents at intersections caused by "Visual attention". Specifically, the system guides the driver's line of sight to the pedestrian crossing by placing a flashing red light at the pedestrian crossing, and make the driver immediately take action to avoid danger, such as braking.

Figure 2 shows the configuration of the monitoring system. The sensors used in the monitoring system are LiDAR (Light Detection and Ranging) and an infrared camera. A Raspberry pi is used to acquire sensor data, and the acquired data is sent to the server PC via the cloud. The server PC determines whether the entire intersection is dangerous based on the sensor data it receives. The results of the decision are sent back to Raspberry pi, and Arduino controls the flashing lights of the pedestrian crossing based on the results of the decision.

Figure 3 shows the results of detection and determination of dangerous scenes by the monitering system. The upper left of the image shows the result of projecting LiDAR point cloud data onto the image, the lower left of the image shows the result of detecting an object using deep learning and indicating the center of gravity of the object rectangle with a red point, and the green point on the right side of the image shows a detected vehicle and the red point shows a detected pedestrian. The green area indicates the vehicle's danger zone, and the red area indicates the pedestrian's danger zone. The system determines if the vehicle and pedestrian are in a dangerous area for each other, and if so, the mark at the top of the image indicates WARN. The display is OK for non-hazardous scenes. Figure 3 shows that the detection results indicate that the system is able to determine dangerous scenes. Similar results were obtained for both day and night.

To verify the usefulness of the proposed system as a whole, an experiment was conducted on test subjects using actual vehicles. In the experiment, a simulated intersection was constructed on the university campus, and the amount of eye movement and braking by the driver when turning right were acquired. It was also confirmed in advance that the monitoring system would work at this simulated intersection. Two experiments were conducted with and without the alert system. In the experiment, the drivers were asked to turn right at a simulated intersection to verify what difference the presence or absence of the system makes to the drivers.

With proposed system at intersections made subjects check the area around intersections more carefully and safely, as seven out of nine subjects moved more during the eye movement. In addition, a t-test was performed on the braking amount of 11 subjects, and a significant difference at the 5% level was confirmed between the presence and absence of the proposed system. This indicates that the proposed system made the subjects drive more carefully through the intersection. Therefore, the proposed system makes drivers safer in intersections.

These results show that drivers tend to drive more safely with the proposed system. Therefore, the proposed system is expected to prevent traffic accidents at intersections.

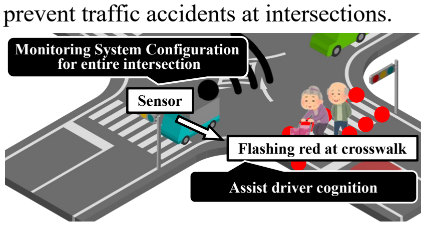

Fig.1 Model of the proposed system

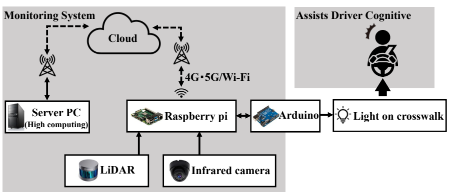

Fig.2 Monitoring System Configuration

Fig.3 Results of monitoring system operation at real intersection in dangerous scene

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