ABSTRACT

The "Driving Safety Support System" (DSSS) coordinates the advanced functions of traffic control infrastructure and the intelligent functions on vehicles themselves in order to improve safety for vehicle traffic and decrease traffic accidents. We think that a signal information provision system in DSSS is effective to avoid a head-on collision in a signal intersection. By this system, the infrared beacon which has enough actual results provides vehicles with information such as signaling information or road alignment information. Vehicles judge dangerous situations from this information and self-vehicle position, velocity or brake information, and risk aversion works by notifying the driver of care information.

In this judgment, self-vehicle position which is distanced from an intersection (stop line) is important information.

We adopted a method to sense the precise location of vehicles from communication establishment timing of an infrared beacon and an in-vehicle unit and planned the demonstration test which collected foundation data of the detection accuracy. By this report, we describe the demonstration test aimed for verification of the positioning accuracy.

KEYWORDS

Vehicle safety, Communication, Signal control, Intersection service
SUMMARY OF SIGNAL INFORMATION PROVISION SYSTEM

Figure 1 shows conceptual diagram of signal information provision system.

A signal controller sends the signal schedule information to an infrared beacon. We use an infrared beacon in road-vehicle-communication and provide a test in-vehicle unit with signaling information and road alignment information from an infrared beacon. A test in-vehicle unit judges enforcement of an information supplement from signaling information, road alignment information and situations (position, velocity, brake) of self-vehicles and gives information to a driver. In addition, a test in-vehicle unit records car behavior of the case.

Road-vehicle-communication between an infrared beacon and test in-vehicle units is carried out in the procedure in Figure 2.

A test in-vehicle unit grasps the precise location of self-vehicle from position information included in road alignment information in the timing which road-vehicle-communication is established.
DEMONSTRATION TEST

TEST DATE AND LOCATION
We extracted intersections with traffic signal of Toyotashi, Aichi where head-on collisions and right-turn collisions occurred frequently.
Test date: From November, 2006 to March, 2007
Test location: Three intersections, Toyotashi, Aichi, Japan
  • 1, Tsuchihashi-cho  • Yamanote-sho southeast  • 3, Miyukihonmachi

VERIFICATION OF POSITIONING POINT ACCURACY
We placed the running position of vehicle of the time point when an infrared beacon received an uplink from an in-vehicle unit as a positioning point. The video camera photographs the running position of vehicle of the time point and calculates the positioning point by analyzing the image. Figure 3 shows a summary of the experimental system. Here, we will inspect stability of positioning.

Figure 3  A summary of experimental system
A ROAD-VEHICLE-COMMUNICATION AREA BY AN INFRARED BEACON

The communication area of an infrared beacon consists of the area where we can receive UL information from a car surely and the area where reception probability becomes under 100%.

An uncertain reception area:
The probability that can receive UL information does not reach 100%

A reception possible area:
The area that can receive UL information by establishment of 100%

The assumed positioning error range is as follows
(1) Just after that an in-vehicle unit came in the uncertain reception area, the in-vehicle unit transmits UL information, and the infrared beacon can receive the UL information normally. In this case, road-vehicle-communication is concluded in the most upper reaches.

(2) An in-vehicle unit comes in the reception possible area, and the infrared beacon can't receive UL information of the beginning, and can receive UL information of the next. In this case, the infrared beacon receives UL information in the most lower reaches.
TEST RESULT OF THE DEMONSTRATION TEST

Experiment result by the experimental vehicle

The examination running was done with the experiment vehicle. We compared the positional detection accuracy that had been obtained with two kinds of infrared beacons. We showed the result in Figure 5, Figure 6, and Table 1.

In the normal infrared beacon, standard deviation was 0.27m and the dispersion range was 0.95m.

In the infrared beacon which squeezes the UL communication area, standard deviation was 0.10m and the dispersion range was 0.37m.

It is thought that from this, it is indispensable to the improvement of positioning accuracy to squeeze the UL reception area.

<table>
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<th>a infrared beacon</th>
<th>distance from the infrared beacon</th>
<th>number</th>
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Table 1  Relative result of positioning of experimental vehicle
Experiment result by general vehicles

The examination running was done with general vehicles. We compared the positional detection accuracy that had been obtained with two kinds of infrared beacons. We showed the result in Figure 7, Figure 8, and Table 2.

In the normal infrared beacon, standard deviation was 0.61m and the dispersion range was 5.8m.
In the infrared beacon which squeezes the UL communication area, standard deviation was 0.40m and the dispersion range was 2.9m.

On the one hand, there are some vehicles whose UL information reception position approaches to lower reaches extremely. We suppose that the cause of this delay is bad communication quality between an infrared beacon and vehicle. In order to improve this delay, we improve the performance of an infrared beacon.

Table 2 Relative result of positioning of general vehicle

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CONCLUSION

We devised the system which detects the absolute position of the vehicle from establishment timing of communication between the infrared beacon and the in-vehicle unit, and the verification test which collects the fundamental data of the positioning did.
As a result, we verified that squeezing the communication area of an infrared beacon can improve accuracy of self-vehicle position detection.
The position detection system which uses an infrared beacon is a feature in which the influence of weather and road environment is not received easily, and it is advantageous in the system which judges the execution of information provision from self-vehicle position.
We plan the demonstration experiment of the service of DSSS at 5 cities in 2008.