

Progress of an ITS Field Operational Test for Traffic Safety and Congestion in Japan

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In order to reduce traffic accidents and ease traffic congestion utilizing ITS (Intelligent Transportation System), a large-scale FOT (Field Operational Test) involving 2,000 ordinary drivers was launched in October 2006 in the city of Yokohama in Kanagawa, Japan. The test is slated to continue through March 2009. Target applications include Intersection Collision Avoidance using V-I (Vehicle-to-Infrastructure) communication, ISA (Intelligent Speed Advisory) using digital maps in the vehicle navigation system, and the probe system, which provides detailed traffic information.

As new trials, Pedestrian Traffic Safety and Skid Incident Information Service have also started. In this paper, the progress of these FOTs will be introduced.

Keywords: *V2I, C2I, FOT, Safety, Intersection, Pedestrian, Congestion, Probe*

1. Introduction

In Japan, the fatality rate for traffic accidents has decreased over the last two decades. However, half of Japanese fatalities and serious injuries result from intersection collisions and pedestrian accidents. Due to limited visibility at intersections, it is very difficult to reduce these accidents using traditional technologies. Therefore, it is our hope that we can provide drivers with information that will increase their alertness in unsafe situations.

These accidents are fundamentally the same concerns in the US and Europe. To reduce intersection collisions is one of the purpose of VII (Vehicle Infrastructure Integration) in the US[1] and PReVENT in Europe[2]. These are activities to develop new safety systems by using vehicle-to-infrastructure communication (V2I) and vehicle-to-vehicle communication (V2V).

Global warming is also a major issue. In terms of transportation, traffic congestion is one of the biggest social problems in Japan, and it results in the waste of significant amounts of fuel. Our aim, therefore, is also to contribute to fuel and time savings by guiding drivers to the fastest route possible.

2. SKY Project

The SKY (Start ITS from Kanagawa, Yokohama) Project was launched in October 2004 in Yokohama in order to contribute to the local community by reducing traffic accidents and traffic congestion. SKY is a private sector collaboration between Nissan Motor Co., Ltd., NTT DoCoMo, Inc., Panasonic Corp., and Clarion Ltd. The aim is to develop systems that can be realized and deployed. Support has also been provided from the

public sector, namely the National Police Agency of Japan (NPA), the Kanagawa Prefectural Police and Universal Traffic Management Society of Japan (UTMS) regarding the intersection collision avoidance.

The objective of the SKY Project is to reduce traffic accidents and ease traffic congestion through the use of ITS systems that communicate with the infrastructure, in addition to in-vehicle technology, and utilize information on nearby vehicles and the surrounding traffic environment, further resulting in time and fuel savings.

Field Tests by ordinary drivers.

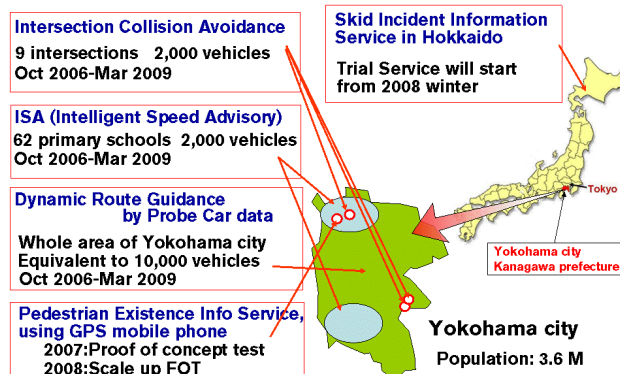


Figure 1 FOT Area

3. FOT Area and Applications

Target applications for SKY include Intersection Collision Avoidance using V-I communication, ISA using digital maps in the vehicle navigation system for elementary school zones, and the probe system, in which real-time traffic condition data is gathered from probe

cars. The FOT was launched in October 2006 and will continue through March 2009.

- Intersection Collision Avoidance & ISA:
By 2,000 Nissan customers.
- Probe: By equivalent to 10,000 Nissan customers and taxis.

Furthermore, two new trials have been launched. One is for a pedestrian safety application called the Pedestrian Existence Information Service, which utilizes the GPS in cell phones. Another is for Skid Incident Information Service at winter road in Hokkaido. (Northern area in Japan)

The test area is shown in Figure 1. Kanagawa Prefecture is located adjacent to the Tokyo metropolitan area. Its capital city, Yokohama, is the second largest city in Japan after Tokyo, and has a population of 3.6 million. The number of traffic accidents in Kanagawa is the third worst nationwide, and the rate of accidents per traveling distance that result in injury or death is the worst nationwide.

3.1 First-Stage Test Applications

The applications for Intersection Collision Avoidance are shown in Figure 2. All SKY test vehicles have a standard Nissan navigation system, purchased by the customer, as well as an Infrared Light Beacon Antenna (IR Beacon), which is widely sold in Japan. The vehicles obtain outside information through Infrared Light Beacon Roadside Units (IR Beacon RSU), of which there are now about 50,000 already in existence in Japan for controlling traffic. The intent is to apply these units, not only for traffic control, but also for traffic safety. Once outside information is obtained, the on-board system alerts the driver as needed. The system does not alert the driver when the vehicle is moving at low speed, decelerating, or braking.

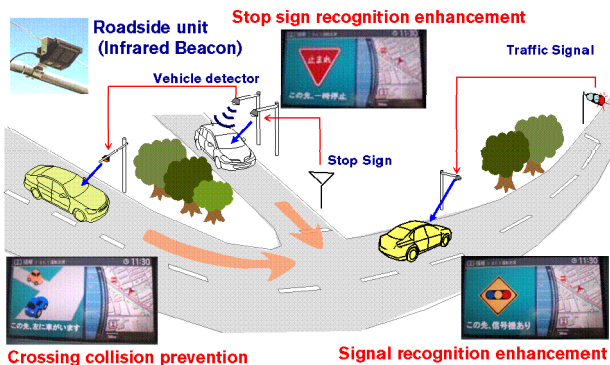


Figure 2 Intersection Collision Avoidance

Figure 3 illustrates the ISA (Intelligent Speed Advisory) system—intended for the safety of

pedestrians, especially small children. This system alerts drivers who are speeding near elementary schools.

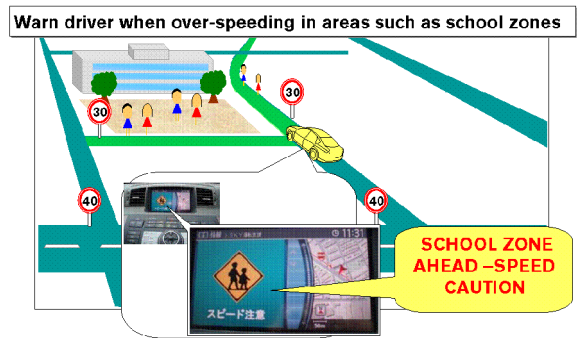


Figure 3 Intelligent Speed Advisory

The probe system is shown in Figure 4. This system makes use of the existing CARWINGS system—an advanced customer service system that utilizes the customer's cell phone. By using the call operator or the system itself, subscribers of CARWINGS can obtain fastest route information (Dynamic Route Guidance System) as well as convenience information (e.g. nearby fine restaurants and amusement park hours of operation). CARWINGS service summary is shown in Figure 5.

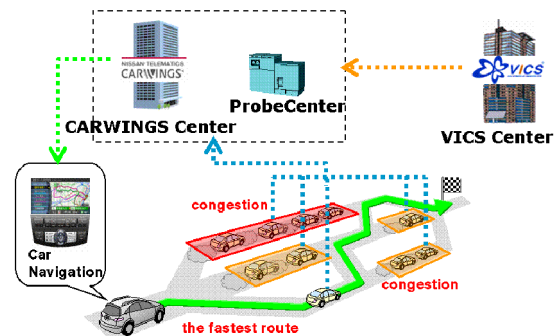


Figure 4 Traffic Information Probe System

CARWINGS®

Provides the customers with useful information

Operator Service
Provide fine restaurant locations
Set destination & fastest route guidance
Emergency call, etc.

Information Channel

Dynamic Route Guidance

Town Guide

Figure 5 CARWINGS Services

Each of the 2,000 SKY test vehicles and 700 taxis send data on driving conditions to the CARWINGS center every five minutes, where traffic conditions are calculated using VICS (Vehicle Information Communication System)—a public traffic information service in Japan—and the SKY probe data. The center then provides the fastest route information in accordance with the customer's request.

We are focusing to use existing hardware such as car navigation system, beacon antenna, cell phone that is owned by a customer, and IR beacon RSU. Only by a car navigation software re-programming, customer vehicles can have such a function very easily. It takes only 15 minutes for the car navigation software to re-program.

3.2 Additional Proof of Concept Tests

3.2.1 Pedestrian Existence Info Service. Pedestrian and bicyclist fatalities account for one-third of all fatalities in Japan. And most pedestrian deaths that result from a traffic accident occur within a 500 meter radius of their residence. In light of this, the SKY Project has started an additional proof of concept test for pedestrian safety. In Japan, as of April 2007, GPS technology is mandatory in cell phones. Our intention is to apply this GPS functionality for pedestrian traffic safety.

Figure 6 shows the pedestrian information system. Each cell phone sends its position data to the CARWINGS center at a given interval. The vehicle navigation system also has its position data sent at a given interval. The center eliminates position data from cell phones used by pedestrians outside of the residential area or by persons riding in cars or on the train. Then the system calculates the position and movement of each pedestrian and each vehicle. If a pedestrian is positioned in the path of a vehicle, this information will be transmitted to the vehicle, which will then be provided to the driver through the on-board unit, giving the driver time to respond. This proof of concept test has been conducted using fifty cell phones and five cars.

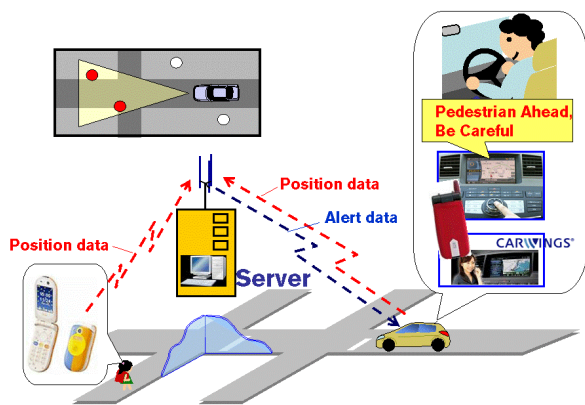


Figure 6 Pedestrian Existence Information Service

Now, the scale-up field operational test has started from Nov 1st, 2008. We chose one small town near Nissan's development sites. In that town, there are many blind intersections resulting from elevations, residential block walls, and other obstacles. Furthermore, since these intersections are located near parks or playgrounds, there is a high potential risk of accidents involving children. We distributed 500 cell phones that have a testing function to 500 residents in the town, and also recruited 200 ordinary drivers as driver monitors. We prepared several test vehicles for 200 volunteer drivers. Those vehicles are equipped with a driving recorder which records each driver's driving behavior and the system operational logs.

The purpose of the test is to grasp the ..

- Driver's behavior change with information.
- User's acceptability of HMI (Human Machine Interface)
- Real world movement of GPS mobile phones

Using the test result data, we are planning to analyze the real world effectiveness of this system.

3.2.2 Skid Incident Information Service Hokkaido is in the northern area of Japan. There, about 50 people are killed in a skid accident every year. Therefore, we have started a trial by 100 ordinary drivers who lives in this area. The vehicle which experienced a skid incident sends data such as skid flag, position, speed, time, so on to the CARWINGS server. CARWINGS server gathers such information and delivers the skid incident information to all other Nissan CARWINGS users. During their drive, they can get the information of either skid incidents happened in the morning up until 30 minutes ago, the recorded skid points or the points where accidents have happened in the past.

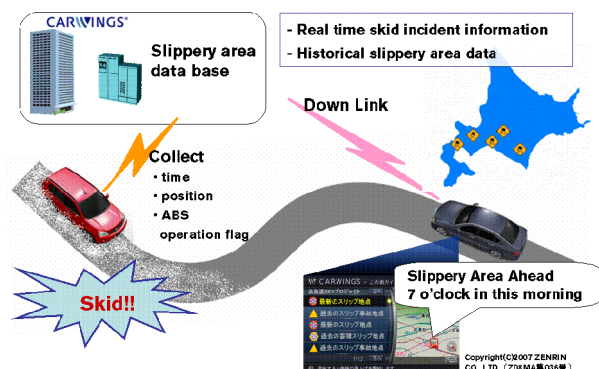


Figure 7 Skid incident Information Service

CARWINGS system already has functioned to gather such kind of probe data. Therefore we can easily actualize such service. Trial Service has started from 2008 winter

4. Verification of Effectiveness

It is very difficult to grasp the effectiveness of such kind system quantitatively. An example of verification of effectiveness (Intersection Collision Avoidance) is shown as follows. Figure 8 illustrates the log system that uses an up-link of vehicle real-time running data of 2,000 participants to avoid stop sign/red signal violations and crossing collisions. A road side data logger stores the up-linked data for points A and B. We did not ask participants to come the test sites once a day, so on. Participants use their cars in their every day car life without being conscious of the test. We only monitor and log the participants data who pass through the test sites. The participants number, 2,000, was decided on premise that some participants never came to the test sites (9 intersections in Yokohama city). In addition, traffic flow and speed change data from vehicles without SKY functionality are also measured. Using the stored data, statistical analysis will show whether there is any difference between the data gathered from vehicles with or without safety support systems/information.

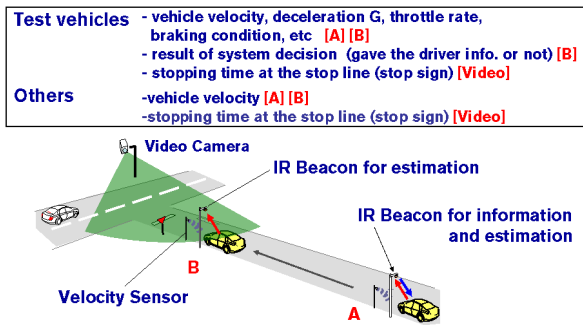


Figure 8: Data log system for verifying effectiveness

We have already collected over 20,000 data logs during the last 2 years. In order to avoid negative impact of ITS (i.e. over-trust, misunderstanding, and system distrust), the driver support level was kept at a minimum. However, we are receiving good quantitative results that drivers change their driving behavior (drive more safely) as a result of the support information.

Figure 9 (Stop sign recognition enhancement result) shows that 41% of vehicles exceed the speed limit at 20m before the stop sign. System can help reduce that rate to 23%, especially in high speed vehicles. Vehicles with the system show a 35% increase in the complete stop rate at the stop line.

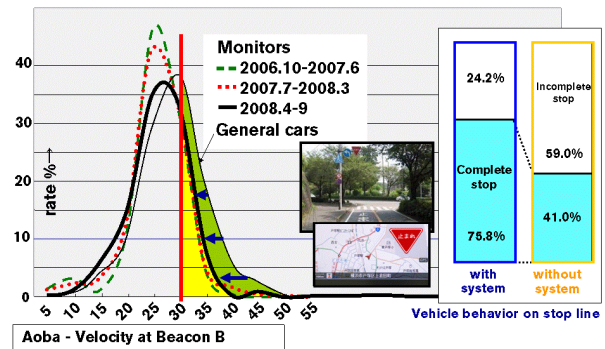


Figure 9: Example of the test result (Stop Sign case)

Signal recognition enhancement result also shows that 70% of vehicles exceed the speed limit at 30m before the red signal. System can help reduce that rate to 56%, especially in high speed vehicles. Crossing collision prevention result shows that, at the 40m before the intersection, 38% of vehicles exceed the speed at which drivers can avoid a crash if a vehicle appears from the side road. System can help reduce rate to 22%, especially in high speed vehicles. By the long term test, we also grasp that the experience with the system did not affect the user, and over-trust was not seen when the drivers, who have once experienced the system, do not receive information anymore at the test sites. On the contrary, long term test data shows that the driver is learning potential dangers.

Questionnaire survey shows a majority of consumers responded favorably. (1,200 answered)

With regard to the probes, 3 test vehicles that have different route guidance level of car navigation system were prepared.

- Level 1: Map database only
- Level 2: Using traffic information by batch processing probe data and VICS (already commercialized level)
- Level 3: Level 2 + real-time probe (SKY probe)

3 vehicles start at the same time and drove to the destination, about 40km ahead from the start point, following their car navigation route guidance on the congested road in Yokohama city.

The test results of 10 times test average indicate that the availability of real time traffic information data (Level 3) may help reduce travel time by 8% and CO2 emissions by 4% comparing with Level 2, travel time by 20% and CO2 emissions by over 10% comparing with Level 1. (Figure 10).

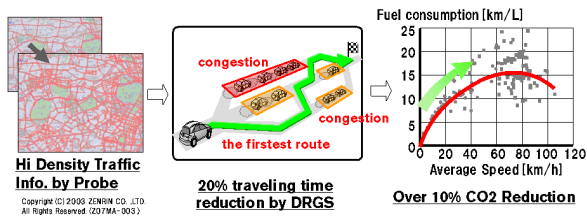


Figure 10: Test results (probe)



Masao FUKUSHIMA Responsible for the entire technological management of autonomous ITS advanced driver assistance system and cooperative safety support system such as Vehicle to Vehicle communication and Vehicle to Infrastructure communication.

The project leader of SKY (Start ITS from Kanagawa, Yokohama).

-The 2008 SAE Delco Electronics Intelligent Transportation Systems Award.

-2009 U.S. Government Award for Special Appreciation by U.S. DOT NHTSA

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5. Actualization of an ITS system

The Japanese government has initiated “ITS-Safety 2010”, a national project involving both public and private sectors that aims to realize an ITS safety support system using V-I from 2010. Our hope is that the success of SKY will contribute to the formation of a government-initiated V-I and V-V (Vehicle-to-Vehicle) safety support system from 2010.

6. Conclusion

The SKY Project challenges, through a whole new field of technology, to reduce traffic accidents and traffic congestion, which could not be solved by current technology.

Our system concept is “use existing hardware” and “better than nothing”. Even under such a concept, we are receiving good quantitative results such as safer driving behavior, user acceptability by a large majority, and shorter traveling time. Our hope is that the success of the SKY Project will contribute to a more safer and environmental-friendly society.

7. References

1. Vehicle Infrastructure Integration (VII)
National System Requirements
Research and Innovative Technology Administration
Feb 2008 Version 1.3
2. PReVENT
IP_D15 Final Report Amendments
6 May 2008
3. Fukushima, Masao, and Masatada Seto, “Field Operational Test Plan of Vehicle Infrastructure Cooperative System for Intersection Collision Avoidance in Kanagawa, Japan,” 14th World Congress on Intelligent Transport Systems, Beijing, October 2007.