THE EXPANSION OF DRIVING SAFETY SUPPORT SYSTEMS BY UTILIZING THE RADIO WAVES

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ABSTRACT

This paper introduces the service descriptions of DSSS, and discusses the advantage of utilizing the radio waves for some of those systems. The radio waves can broadcast information continuously while infrared beacon communicates once in a spot area. Right-turn Collision Prevention System is supposed to be one of more effective systems in case of using the radio waves and its functionality with the radio waves is verified. The basic characteristic tests are also conducted for DSRC of 5.8GHz band and New Radio systems of 700MHz band, which are the candidates of the radio waves for DSSS in Japan.

KEYWORDS

Cooperative vehicle infrastructure systems, Communication systems

CONCEPT OF DSSS (Driving Safety Support Systems)

DSSS is one of the vehicle infrastructure cooperation Systems, which is aiming at decrease of traffic accidents to support driving safety, delivering information from road side to vehicles, concerning "events outside the scope of drivers such as vehicles approaching or pedestrians around intersections" and "information of traffic controls such as traffic signals and road signs", all of which are difficult for vehicles to grasp by its autonomous systems alone.

The following eight systems are derived from analyzing accident factors and traffic violations at this point.

(1) Crossing Collision Prevention System
(2) Crossing Bicycle Collision Prevention System
(3) Right-turn Collision Prevention System
(4) Left-turn Collision Prevention System
(5) Crossing Pedestrian Recognition Enhancement System
(6) Rear-end Collision Prevention System
(7) Signal Recognition Enhancement System
(8) Stop Sign Recognition Enhancement System

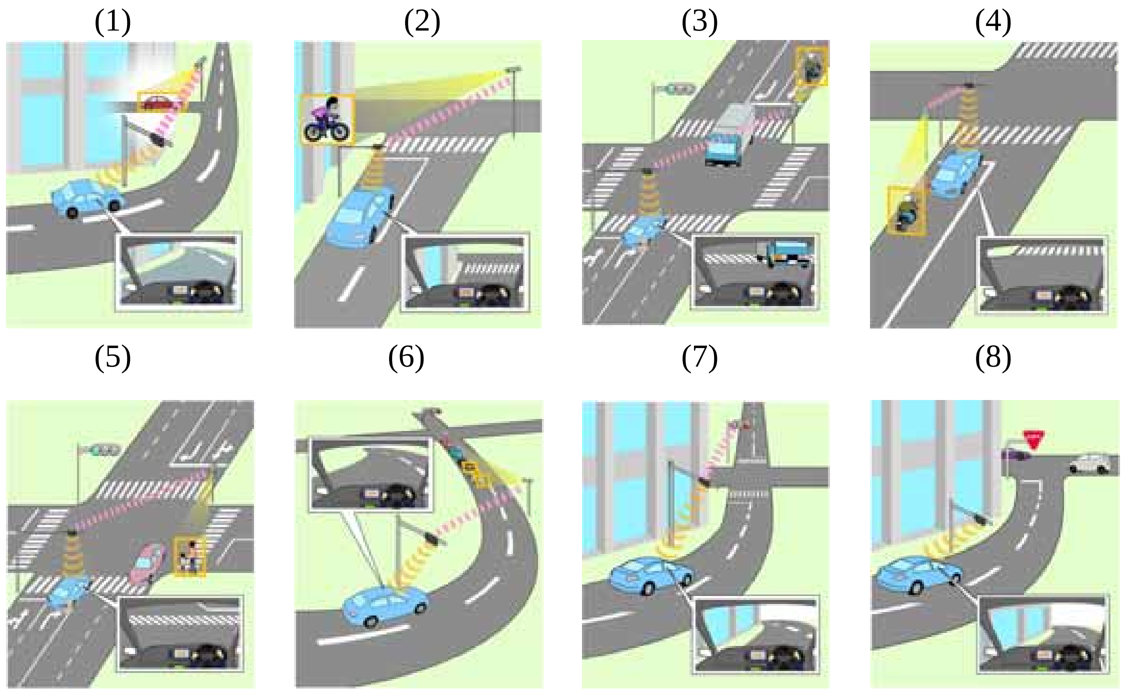

Figure.1 System Image of DSSS

THE STUDY OF UTILIZING THE RADIO WAVES FOR DSSS

The radio waves have a potential to be utilized as DSSS wireless communications in addition to infrared beacon as a key infrastructure of the vehicle infrastructure cooperation systems. Radio waves can broadcast information continuously and more widely while infrared beacon communicates once in a spot area. (Table.1)

Table.1 Comparison between Infrared beacon and Radio waves

Media	Communication Frequency	Communication Area	Other features
Infrared beacon	Once	A few meters	Vehicle positioning and lane identification available by using spot type communication area
Radio waves	Continuously	Dozen - hundred meters	Information update available

The expansion and the diversification of the DSSS services are expected by using the radio waves. For instance, the update of information becomes available even if the traffic signal schedule is changed by the actuated controls. The systems with radio waves could achieve the improvement of the service availability and could increase the number of locations in service. Moreover, the update of the information on approaching vehicles and pedestrians becomes possible, so that Right-turn Collision Prevention System, Crossing Pedestrian Recognition Enhancement System could be more effective.

FUNCTIONAL VERIFICATION TEST OF SAFETY SUPPORT SYSTEMS WITH RADIO WAVES

Right-turn Collision Prevention System and Crossing Pedestrian Recognition Enhancement System are picked up among the effective systems by using radio waves. The system function is verified with the information continuously acquired from the roadside sensors. The experiment is conducted with radio wave of 700MHz band. Figure 2 shows the configuration of the experiment systems.

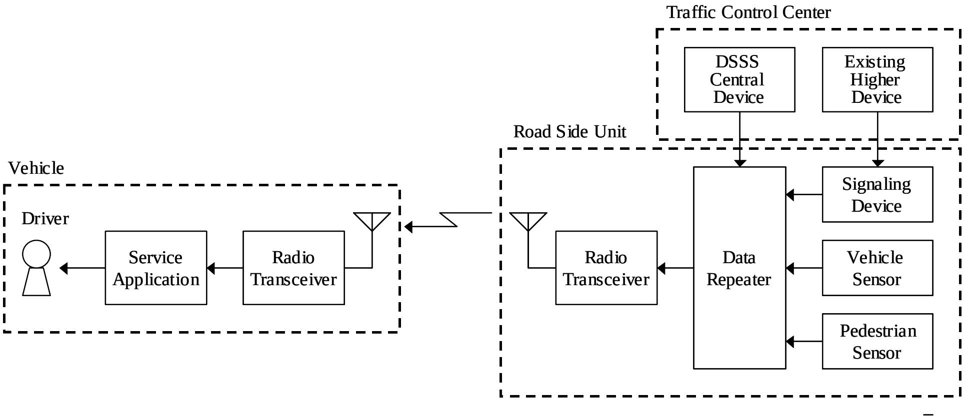

Figure.2 System configuration

Figure 3 and 4 show the image and the system configuration of infrastructures of the intersection where the experiment was executed.

Figure.3 Image of the intersection

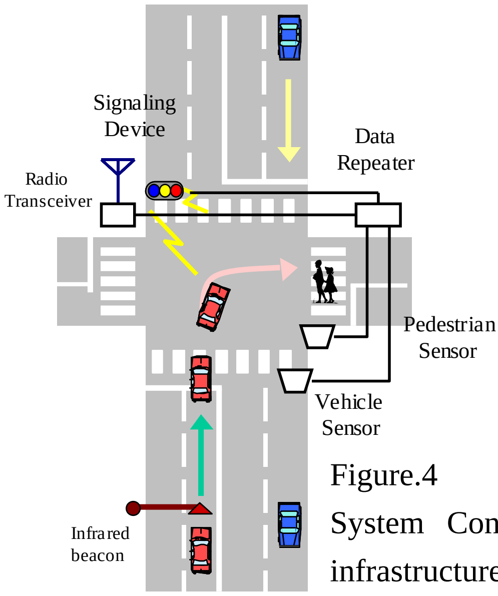

Figure.4 System Configuration of infrastructures

It is confirmed that the right turn vehicles continuously acquire the latest sensor information within the range from the approaching area to the end of the intersection as a result of the experiment and that the systems support the drivers appropriately according to the change in the situation.

FIELD TRIAL TEST FOR RADIO WAVES

Aims

The field trial test of the radio waves is conducted and the basic characteristic data is acquired regarding DSRC systems using 5.8GHz band, which has already been allocated for ITS, and New Radio (NR) systems using UHF band, which is to be allocated after 2012, as the candidates of the radio waves to achieve the service extension.

Parameters of field evaluation

Table.2 shows parameters of field evaluation. And the measurement is performed for the downlink. Figure.5 shows the overview of the verification systems of DSRC and NR.

Table.2 Parameters of Field Evaluation

	DSRC	NR
RF frequency	5790MHz (Downlink)	792.5MHz (Downlink)
Transmit power	100mW	70mW
Modulation scheme	π/4-QPSK	QPSK/OFDM
Packet size	100Byte/Packet	100Byte/Packet
Antenna height (Road-Side : RS)	8m	5.5m
Antenna height (Vehicle : V)	1.935m	
Antenna gain (RS)	13dBi	2.2dBi (omni-directional)
Cable loss (RS)	3.52dB	1.6dB
Antenna gain (V)	2.0dBi (omni-directional)	2.0dBi (omni-directional)
Cable loss (V)	6.3dB	1.3dB
Vehicle Speed	0km/h ～ 50km/h	

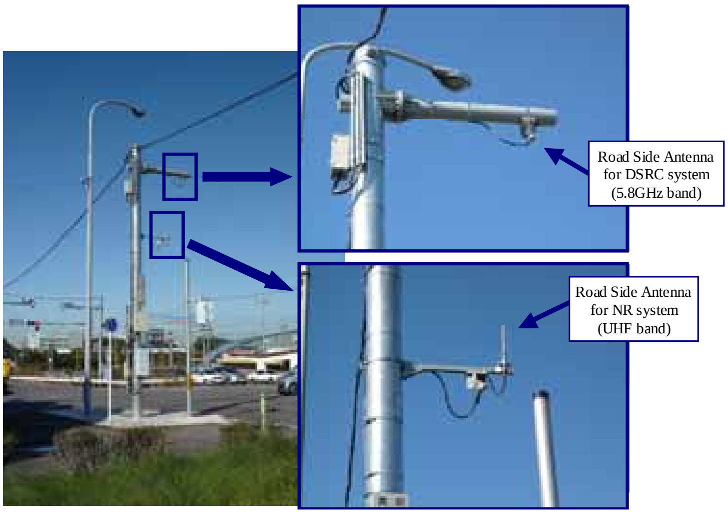

Figure.5 Antenna installation

Figure.6 Test surroundings (suburban area)

Field evaluation results

The field evaluation is performed at a suburban area, which is comparatively open without high structures (see Figure.6). The measurements of the characteristics for each system are performed several times with running along the actual normal traffic flow. Figure.7 and 8 show the characteristics of the Packet Arrival Rate (PAR) versus the distance from roadside unit on each system of DSRC and NR. The horizontal axis in the figures shows the moving distance from the roadside unit.

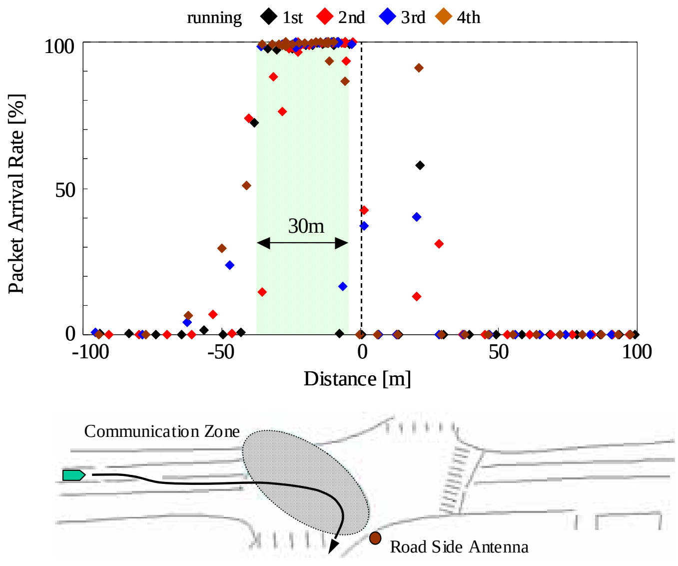

Figure.7 PAR of the DSRC

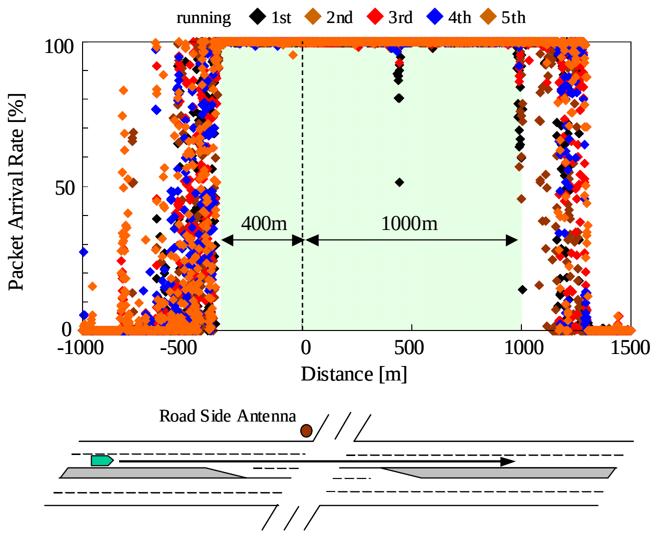

Figure.8 PAR of the NR

It is confirmed that PAR of DSRC is more than 95 percent within the zone of approx. -30 meters from roadside unit, while PAR of NR is more than 95 percent within the zone from -400 meters to 1000 meters. The reason why the transmissible distance of NR is asymmetry from the roadside unit is that the distances of the line of sight from the roadside unit to each side are asymmetric each other in terms of physiognomy.

From the results above, it is confirmed that the transmissible distance is longer than DSRC, however, NR could be more influenced by surroundings with high structures because of the long range of its communication area. The field evaluation test, thereupon, is performed likewise under the circumstances with a lot of high structures in the urban area. The roadside unit is set up above the pavement near the intersection. The distance of the buildings on each side of the street is 28 meters (see Figure.9).

Figure.9 Test surroundings (Urban area)

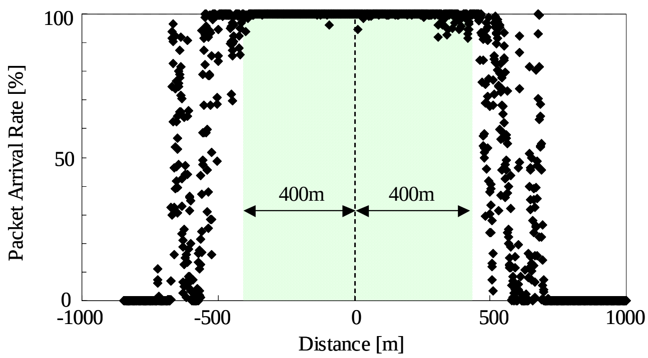

Figure.10 PAR of the NR

Figure.10 shows the characteristic of PAR of NR versus the distance from the roadside unit. It is confirmed that PAR is more than 95 percent within the zone of approx. 400 meters in this situation. This shows that NR might have some potential to secure a-few-hundred-meter range of communication area even in urban areas surrounded with high structures.

When the radio wave systems is adopted and the introduced into DSSS in the future, it is required that the system requirements of DSSS for the radio wave systems should be clarified, and the specifications of the radio wave systems should be defined based on the system requirements.

CONCLUSIONS

(1) The expansion of the DSSS services are expected by utilizing the radio waves, since the update of information on the status of approaching vehicles and pedestrians becomes available.
(2) It is confirmed that the DSSS with radio waves work functionally and support the drivers appropriately based on the latest information according to the change in the situation.
(3) The partial characteristics of DSRC systems using 5.8GHz band and New Radio systems using UHF band are confirmed in some field trial tests.
(4) When the radio wave systems is adopted to DSSS in the future, the specifications of the radio waves should be defined based on the requirements of DSSS.