Study on Propagation Loss Characteristics Considering Car Antenna Position for Inter-vehicle Communications Using 700MHz Band at Intersection

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***Abstract*—In the development of the inter-vehicle communication systems for the prevention of car crashes, it is important to know radio propagation characteristics at blind intersections. In field experiments and numerical simulations to investigate radio propagations, a half wavelength dipole antenna is assumed to be the wave source in many cases. However, the directivity of car antenna is changed by effects of car body and antenna positions on car body. Therefore, it is necessary to investigate effects of car antenna positions on radio propagation characteristics at blind intersections. In this paper, propagation loss characteristics considering car antenna position for inter-vehicle communications using 700 MHz band at a blind intersection is investigated. Here, the hybrid method using both the FDTD and ray-tracing methods is used for the electromagnetic analysis.**

I. Introduction

Recently, the inter-vehicle communication systems have been proposed for the prevention of car crashes [1], [2]. It is expected that car accidents at blind intersections in urban area are prevented by sending and receiving the information such as the location, direction and speed of vehicle by these systems. 700MHz band is used for the inter-vehicle communication systems in Japan. In the development of these systems, it is important to know radio propagation characteristics at blind intersections [3]. In field experiments and numerical simulations to investigate radio propagations, a half wavelength dipole antenna is assumed to be the wave source in many cases. However, the directivity of car antenna is changed by effects of car body and antenna positions on car body. Therefore, it is necessary to investigate effects of car antenna positions on radio propagation characteristics at blind intersections. Conventionally, we have investigated the effect of car body and antenna positions on car antenna directivity [4].

In this paper, propagation loss characteristics considering car antenna position for inter-vehicle communications using 700 MHz band at a blind intersection is investigated. Here, the hybrid method using both the FDTD and ray-tracing methods is used for the electromagnetic analysis [5].

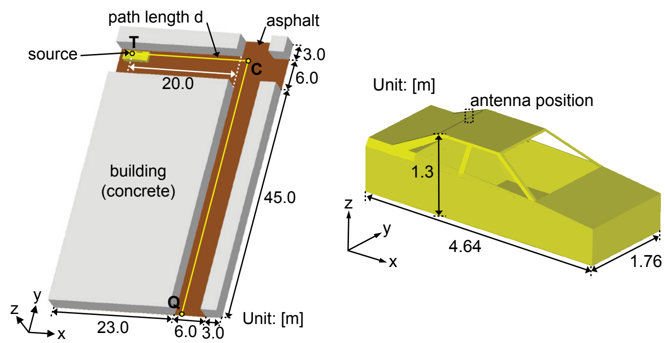

Fig. 1. Blind intersection in urban area and car model.

TABLE I. Electric Constant Used In This Simulation.

road (dry asphalt)	ε_r	4.9
	σ	0.00761 S/m
building (concrete)	ε_r	7.0
	σ	0.0473 S/m

II. Blind Intersection in Urban Area

Fig. 1 shows a blind intersection in urban area and a car model used in this simulation. In this work, a width of road is set to 6 m as an example, and height of building is approximated by infinity. It is assumed that the road and buildings consist of asphalt and concrete, respectively. These electric constant are shown in Table I [6], [7]. In this work, two types of wave source are investigated: 1) λ/2 vertical dipole antenna without car body, 2) λ/4 vertical monopole antenna on car rooftop as shown in Fig. 1. Here, a transmit frequency is 760MHz. The propagation loss on TCQ path is calculated in this simulation.

III. Analysis Mehotd

Fig. 2 shows a procedure of hybrid method using both the FDTD and ray-tracing methods for the electromagnetic

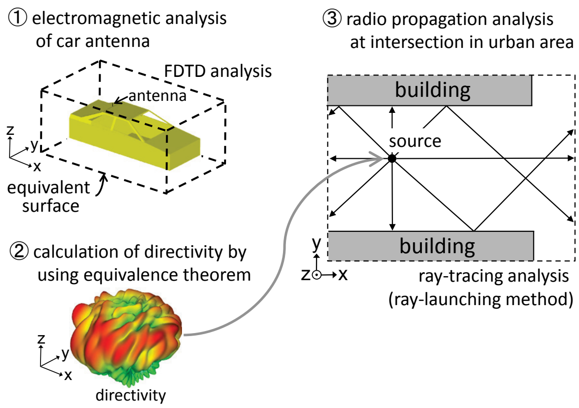

Fig. 2. Procedure of hybrid method using both FDTD and ray-tracing methods for electromagnetic analysis.

TABLE II. SIMULATION CONDITIONS USED IN THIS WORK.

FDTD method	spatial increment	1.0 cm
ray-tracing method	maximum number of reflection	10
	maximum number of diffraction	1
	diffraction coefficient	UTD method

analysis. In this method, 1) the electromagnetic analysis for car antenna mounted on a car is performed by using the FDTD method, 2) the directivity is calculated by using the FDTD results and the equivalence theorem, 3) the propagation loss on TCQ path is calculated by using the ray-tracing method with the directivity obtained by 2). Table II shows simulation conditions used in this work. Here, transmitted waves are not considered in the ray-tracing analysis.

IV. NUMERICAL RESULTS

Fig. 3 shows propagation losses at a blind intersection in urban area. In this figure, simulation results indicate the median value within interval of 4 meters along the TCQ path [8]. For reference, a propagation loss model of ITU-R P.1411-7 [9] is shown in this figure. This model takes into account transmitting and receiving heights, distance from intersection to transmitting and receiving points, road width, and so on.

As shown in this figure, it seems that the propagation losses for both cases of λ/2 dipole antenna and rooftop antenna indicate the same tendency as the case of ITU-R P.1411-7. In the line-of-sight region, it is seen that the propagation loss for the case of rooftop antenna increases quantitatively compared with the case of λ/2 dipole antenna. On the other hand, in the non-line-of-sight region, it seems that the propagation loss for the case of rooftop antenna denotes quantitatively the same tendency as the case of λ/2 dipole antenna.

V. CONCLUSION

In this paper, propagation loss characteristics considering car antenna position for inter-vehicle communications using

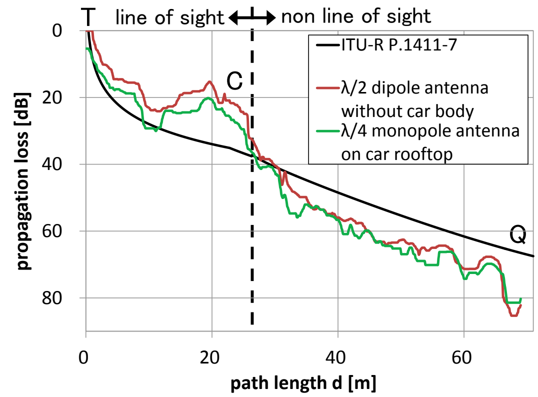

Fig. 3. Propagation losses at blind intersection in urban area.

700 MHz band at a blind intersection was investigated. As a result, it was seen that the propagation loss for the case of rooftop antenna denotes the same tendency as the case of λ/2 dipole antenna in the non-line-of-sight region in this simulation.

In the near future, the case of different antenna position will be investigated in detail.

ACKNOWLEDGEMENT

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