Topics

Three-Dimensional High Resolution Measurement of Radar Cross Section for Car in 76 GHz Band

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1. Introduction

It is important when designing and/or developing automotive radar for detecting the distance and velocity of the preceding vehicle using reflected radiowaves to know how it is reflected by the vehicle body. Radiowaves used for automotive radar are usually millimeter waves having the very short wavelength of approx. 4 mm (frequency: 76 GHz).

Therefore, spatial distribution is generated based on the reflection intensity of radiowave depends on the difference in the contour or material of respective sections of a vehicle. Accordingly, it is necessary to understand the distribution characteristics of such reflective intensities when designing or developing a millimeter wave automotive radar.

This paper describes a measuring system developed to measure the reflective intensity distribution in detail and the measurement results using this measuring system.

2. Measuring system

We built a measuring system that can measure the distribution of a Radar Cross Section (RCS) with high resolution in 3-dimensions. As shown in Fig.1, the antenna 2-dimensionally scanning the plane xz transmits radio waves and receives reflected waves from an object. Using the received signal, the present measuring system produces a 2-dimensional synthetic aperture radar on the xz plane and the space Fourier transform in the y-axis direction to determine the of RCS distribution.

Table 1 shows a summary of the measuring system specifications. For the measurement, we used a 76 GHz band radiowave. Here, the parameters were selected to provide a resolution of about 0.1m. At this time, we set the measuring distance at 7m and the scanning range for the x and z axes to 0.24m. In addition, the ground clearance for the center of the scanning range of the xz plane was set to 0.4m, which is approximately equal to the bumper height of a sedan-type car.

3. Measurement result

Fig. 2 shows the variation in the RCS distribution with the angle of direction θ for a sedan-type vehicle. The distribution of the measured RCS is indicated with the minimum set to -6dBsm with different colors for every 3dB. The preceding vehicle running on a straight course has a θ of 0°, which changes to about 20° on a comparatively steep curve with a 300m radius. When θ is 0°, the RCS becomes maximum of +5.6dBsm in the vicinity of the center of the bumper reading. Moreover, the license plate and the muffler areas also indicated comparatively high RCS of approx. +2dBsm. No portions elevated higher than the trunk hood such as the side view mirror and corners indicated RCS of -6dBsm or over. As θ increases, the maximum value of RCS decreases, and the maximum value area simultaneously shifts to the ends of an the vehicle. From these results, it is understood that the radiowave reflective characteristics of automobile sharply change

Table 1 Specifications of RCS measurement system.

Center Frequency	76GHz
Band Width	6GHz
Antenna Gain	20dBi
Measurement Range	7m
Sweep Range (x-axis)	0.24m
Sweep Range (z-axis)	0.24m
Resolution (x-axis)	58mm
Resolution (y-axis)	25mm
Resolution (z-axis)	58mm

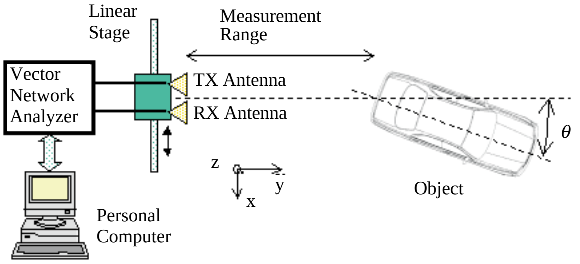

Fig. 1 Configuration of RCS measurement system.

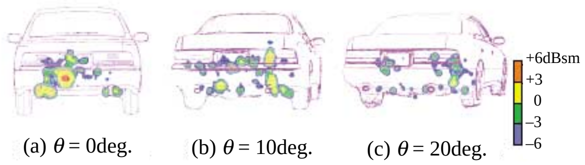

Fig. 2 Three dimensional high resolution measurement results of RCS for a sedan type car.

according to direction of a vehicle.

4. Summary

We have built a measuring system to acquire the RCS distribution in three-dimensions with high resolution and measured the RCS distribution for a sedan-type car in the 76GHz band. In the future, we intend to measure the RCS for various types of vehicles.

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