Backscattering Assessment of Small Targets in the Radiative Near-Field for Automotive Collision Avoidance Radar

Wen-Jiao Liao* (1), Yuan-Chang Hou(1), Tai-Heng Hsieh(1), and Hao-Ju Hsieh(1)
(1) National Taiwan University of Science and Technology, Taipei, Taiwan

The automatic emergency braking system is expected to be a standard automotive safety measure in the next decade. The microwave radar, along with other ranging systems, such as LIDAR, camera and ultrasound sensors, is one of the essential components. In particular, the collision avoidance radar (CAR) operates in the millimeter wave band is aimed for short- and mid-range target detection. Since scattering properties of typical motorway and road side targets may vary greatly, radar cross section (RCS) assessment of potential targets is necessary for development of detection and characterization algorithms. Both strong scatters, such as cars and trucks, as well as weak ones should be evaluated. In [1], backscattering from the bicycle and the rider is measured in a compact range for the 77 GHz band. Note, because potential target sizes are in the order of tens of inches to several yards, they are likely located in the near-field of millimeter wave radars. For example, based on the $2D^2/\lambda$ criteria, the far zone boundary is 14.4 m for a circular disk with a 30 cm diameter at 24 GHz. Hence, the planar wave incidence assumption is not valid and the amount of backscattering becomes a function of the radar-to-target. The interference from different scattering centers may result in a suddenly dropped backscattering level, which can lead to a miss detection for the worst case scenario.

In this work, we explore this phenome via full wavelength simulation. A circular metal disk of 22.5 cm in diameter serves as the target. For normal incidence, as the antenna-to-target distance increases from 30 to 70 cm, a minimum of 7 dBV/m is observed in the reflected E-field at 50 cm while reflection levels are greater than 20 dBV/m at other distances. Simulations also reveal that for short ranges, reflected E-fields of normal incidence are 10 dB smaller than the ones with small oblique incident angles. Measurements are conducted in a millimeter antenna range where the maximum antenna-to-target distance is 80 cm. Results validate that phase cancellation from small targets can take place in short ranges for automotive radars operated in the millimeter wave band. As a consequence, cautions should be taken for the development of target characterization algorithms.

[1] D. Belgiovane, and C.-C. Chen, "Bicycles and human riders backscattering at 77 GHz for automotive radar," *10th European Conference on Antennas and Propagation*, pp. 1-4, Apr. 2016.

Acknowledgement: This work is supported by the Ministry of Science and Technology, Taiwan (R.O.C.), under Grants MOST105-2221-E-011-020-MY2