Statistical Backscatter RCS Model for Vehicles and Pedestrians at 77GHz

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Driving safety is always one of the most important issue for automotive industry considering the fact that more than one million lives are lost worldwide in traffic accidents every year. Automotive radar systems have played a significant role as an Advanced Driver Assistance Systems (ADAS) for some of today's vehicles. It aims at detecting stationary and moving object on the road around the vehicles and warn/avoid possible collisions. As different objects have different dimensions, shapes and materials, their radar cross section (RCS) can be quite different, and this provides the opportunity to identify different objects. The literature concerning modeling or measurements of RCS for vehicles or pedestrians at millimeter-wave frequencies are rather scarce. The limited data indicates, large RCS fluctuation as a function of incident angles and different target types but most data presented rather qualitatively with no process for systematic utilization. This is mainly due to the statistical nature of radar backscatter from targets with many scatter centers and the lack of sufficient samples. In this paper a methodical approach is used to capture the statistical models and the associated parameters of the radar backscatter from different targets running Monte-Carlo simulations. Due to large size of scatters compared to the wavelength and the fact that radii of curvature of such objects are also large compared to the wavelength physical optics (PO) method is used in calculation of RCS of objects with very fine angular resolution.

The average backscattering RCS for different types of vehicles including sedan, SUV, hatchback, truck, bus and bicycles are simulated and modeled as a function of incident angles and vehicle variations. The same has been done for pedestrians with different gender and size. To retrieve the distribution function, the data over ±10º angles around incident angles are used and considered having the same statistical features. For all these targets it is found that the RCS data follows the exponential distribution. The RCS for pedestrians is also categorized by motion (i.e. walking and jogging), and for each condition the backscattering RCS at all incident angles of more than 10 gestures are simulated and characterized. The average RCS is modeled as a function of incident angle, gender, human's height and weight. Their statistic distributions are studied as well.