77 GHz Radar Traffic Scene Simulator Based on Physical Optics Method

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Traffic safety is one of the main concerns of automotive industry and the society at large considering the fact that there are more than a million people losing their lives in traffic accidents each year according to World Health Organization. Many new vehicular technologies such as advanced driver-assistance systems (ADAS) and autonomous vehicle technology aim to alleviate such problem. One such technology makes use of millimeter-wave radar systems for standoff sensing and detection. If used in imaging mode, radars can provide a unique perspective of the scene complementary to optical and infrared images. Because of the complex nature of electromagnetic scattering, the radar response is far less comprehensible compared to other sensor's response such as camera or Lidar system. Thus it is quite useful but also challenging to simulate the radar response in realistic environment with arbitrary radar parameters such as antenna's pattern, polarization, the radar's range or angular resolution. The dimension of a real traffic scene can be hundreds of meters, which is about tens of thousands of wavelength at the typical automotive radar operating band. Therefore it is impossible to apply any full-wave simulation method and since the radii of curvatures of most targets in traffic scene such as vehicles, pedestrians, buildings and traffic signs are much larger than the wavelength, asymptotic methods such as physical optics (PO) or geometric optics (GO) methods can be used with good accuracy.

In this presentation, we will a fast and yet accurate radar simulation tool. This tool is the applied to present the simulation of radar responses in various traffic scenes, including straight and curved street and crossroads with the presence of vehicles, pedestrians, traffic signs and buildings. Assuming the radar is operating in imaging mode with beam steering in horizontal direction radar images of dynamic scenes (radar and other vehicles are in motion) are created. In these simulations the noise level, different antenna's properties and the radar's range resolution can be varied and detection different hazardous conditions are examined. In order to reduce the complexity of simulation, only the lit areas of the targets by the main beam and few side lobes near the main lobe are considered in the calculations. The effect of different side lobes level on the final radar response are studied. More than 50 statistic scene simulations are performed at each scene to simulate many different dynamic traffic environments.