Raw data simulation of large scale environments including complex targets for synthetic SAR image generation

Nicolas Douchin, Paul Pitot

OKTAL Synthetic Environment, 11 avenue du Lac, 31 320 Vigoulet-Auzil, France
nicolas.douchin@oktal-se.fr

Abstract

Synthetic Aperture Radars (SAR) are considered for their all-weather capacities to achieve target detection, recognition and even identification, in the frame of surveillance, targeting and guidance systems. This type of sophisticated radar can produce high quality images with very complex features such as dihedral and corner reflector high scattering contributors, shadows and lay over effects. Besides, image quality is very dependent on the carrier velocity and trajectory. The mechanisms that govern such sensor systems are so complex that simulation ins needed to assess their performance in a large variety of operational conditions. And the synthetic environment, which means physical target and its background (terrains, buildings, vegetation and other entities) rather than just the target itself, is very import for such sensors system simulation.

This paper presents a solution, called SE-Workbench-SAR, dedicated to the simulation of raw data of large scale environments including complex targets for synthetic SAR image generation. It is based on a combination of Shooting and Bouncing Rays (SBR) technique, that has been optimized to calculate efficiently the intersections between rays launched from a transmitter and a complex 3D database, and EM models for computing propagation, reflection and diffraction. These models are the asymptotic formulations of Geometrical Optics (GO), Physical Optics (PO) and Equivalent Current Method (ECM). Since it relies on asymptotic methods SE-RAY-EM is well suited for computing the EM interactions of an incident wave with complex 3D models of large scale environments and objects at high frequencies, typically in the 1 – 100 GHz range.

SE-Workbench-SAR tool is presented along with its validation process and typical examples of results are shown as synthetic SAR images.

Besides several technical topics are discussed concerning the implementation (CPU vs. GP-GPU) and the tradeoff between physical accuracy and performance of computation.

Finally, the presentation focuses on the major issue of the 3D modelling that concerns both the environment and the target, in order to illustrate the impact of the geometrical level of details of the 3D mock-ups on the fidelity of the synthetic SAR images.

Keywords: Target and background 3D modeling, radar simulation, SAR, ray-tracing, SBR, GP-GPU, CUDA