

A Geosynchronous Orbit Synthetic Aperture Radar Simulator for Moving Ship Targets

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Abstract : Ship detection is of great significance for both military and civilian applications. Synthetic aperture radar (SAR) with all-day, all-weather, ultra-long-range characteristics, has been used widely. In view of the low time resolution of low orbit SAR and the needs for high time resolution SAR data, GEO (Geosynchronous orbit) SAR is getting more and more attention. Since GEO SAR has short revisiting period and large coverage area, it is expected to be well utilized in marine ship targets monitoring. However, the height of the orbit increases the time of integration by almost two orders of magnitude. For moving marine vessels, the utility and efficacy of GEO SAR are still not sure. This paper attempts to find the feasibility of GEO SAR by giving a GEO SAR simulator of moving ships. This presented GEO SAR simulator is a kind of geometrical-based radar imaging simulator, which focus on geometrical quality rather than high radiometric. Inputs of this simulator are 3D ship model (.obj format, produced by most 3D design software, such as 3D Max), ship's velocity, and the parameters of satellite orbit and SAR platform. Its outputs are simulated GEO SAR raw signal data and SAR image. This simulating process is accomplished by the following four steps. (1) Reading 3D model, including the ship rotations (pitch, yaw, and roll) and velocity (speed and direction) parameters, extract information of those little primitives (triangles) which is visible from the SAR platform. (2) Computing the radar scattering from the ship with physical optics (PO) method. In this step, the vessel is sliced into many little rectangles primitives along the azimuth. The radiometric calculation of each primitive is carried out separately. Since this simulator only focuses on the complex structure of ships, only single-bounce reflection and double-bounce reflection are considered. (3) Generating the raw data with GEO SAR signal modeling. Since the normal 'stop and go' model is not available for GEO SAR, the range model should be reconsidered. (4) At last, generating GEO SAR image with improved Range Doppler method. Numerical simulation of fishing boat and cargo ship will be given. GEO SAR images of different posture, velocity, satellite orbit, and SAR platform will be simulated. By analyzing these simulated results, the effectiveness of GEO SAR for the detection of marine moving vessels is evaluated.

Keywords : GEO SAR, radar, simulation, ship

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