Full Polarimetric Synthetic Aperture Radar (SAR) Image Simulation based on Shooting and Bouncing Rays/Physical Optics (SBR/PO) Method

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This study delves into Full Polarimetric Synthetic Aperture Radar (SAR) image simulation, leveraging a hybrid computational model that employs the Shooting and Bouncing Rays (SBR) and Physical Optics (PO) methods. This innovative approach seeks to enhance the understanding and interpretation of SAR images, bringing into play more intricate and sophisticated representations of complex geospatial features. The core of the simulation process incorporates the SBR method for tracing the electromagnetic waves' interactions with the scene's geometry, taking into account multiple reflection events. The PO method is engaged to calculate the fields scattered by the objects in the scene, based on their physical attributes. The simulation process is a multistage endeavor, beginning with the creation of a detailed 3D scene geometry. The electromagnetic modeling is subsequently carried out using the SBR and PO methods. Comprehensive modeling covers all aspects of the radar signal's journey, from initial propagation and interaction with the scene, to its eventual reception by the radar system. Various parameters such as antenna pattern, polarization, frequency, and physical attributes are also considered in the simulation. The application of this hybrid method has demonstrated a high degree of efficacy in simulating PolSAR images, as seen in the examples provided. The produced images mirror the actual PolSAR images remarkably well across multiple scenarios, underscoring the real-world applicability of this method. The novel SBR/PO-based approach to Full Polarimetric SAR image simulation amalgamates the best of both techniques to generate high-fidelity images. The refined understanding of the full polarization matrix of SAR images achieved through this simulation method is expected to significantly improve the accuracy and utility of such images in real-world applications.

Keywords: Synthetic Aperture Radar (SAR), Full Polarimetric SAR, Shooting and Bouncing Rays (SBR), Physical Optics (PO), SAR simulation