Electromagnetic Modeling for Interpretation of Airborne SAR Imagery

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The theory that governs the formation of Synthetic Aperture Radar (SAR) imagery generally assumes that the radar return is due to stationary, isolated, and uncorrelated point scatterers distributed on a flat plane. For most naturally occurring scenes (such as those arising in remote sensing applications) this assumption does not apply. This lack of consideration for the electromagnetic scattering phenomenology limits the useful interpretation of the SAR imagery, and places the burden of recognizing image features on the expertise of the image analyst. In this work, an end-to-end electromagnetic and radar simulation model has been developed to understand and evaluate the appearance of complicated scene features in spotlight SAR images as a function of scene parameters, sensor characteristics, and radar processing approaches. Furthermore, the model can be employed to investigate the potential of advanced physics-based processing techniques that can be used to produce more appropriately-formed image output.

The model uses as input Digital Terrain Elevation Data (DTED) with accompanying information on land cover and/or building structures. The scattering from the terrain is computed using a modified Kirchoff scattering approximation, where the modification takes into account local terrain slopes. The surface roughness is assumed to have a Gaussian distribution with the RMS height and correlation length chosen as appropriate for the specified class of land cover. The scattering model has been developed to emulate the performance of the Lincoln Multi-Mission ISR Testbed (LiMIT). LiMIT is an airborne SAR sensor that was developed and deployed by MIT Lincoln Laboratory, with a recent collection campaign over San Clemente Island as part of the Navy's Silent Hammer Sea Trial experiment. In this talk, an initial comparison of the output imagery of the SAR synthesis model is compared to images acquired by LiMIT during Silent Hammer. Further extensions to the model and concepts for physics-based SAR processing will be presented and discussed.