Terrain Clutter Simulation Using Rough Surface Scattering Models with Digital Elevation Data and National Land Cover Data

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Clutter suppression is critical to the performance of Ground Moving Target Identification (GMTI) and other radar applications. To develop effective clutter mitigation algorithms, it is necessary to understand the characteristics of terrain clutter. Of particular interest to a radar systems designer are the mean reflectivity values of the terrain environments over which the radar system is designed to operate. It is customary to collect clutter data on each terrain type of interest and develop an empirical model specific to the terrain. This tried-and-true empirical approach can be costly and the resulting models have a limited range of validity. In addition, there has been a growing interest in the properties of the clutter produced by heterogeneous composite terrain. The traditional empirical approach to inhomogeneous clutter characterization requires additional data collections and modeling.

With the increasing availability of digital terrain data, researchers have been interested in developing site-specific clutter models that can predict the mean terrain reflectivity of an arbitrary geographic location. In this presentation we introduce a physics-based approach to inhomogeneous clutter modeling that uses the information available from the National Elevation Dataset (NED) and the Land Cover Data (LCD) as an input to electromagnetic rough-surface scattering models. The physical characteristics of the terrain of interest are determined from the NED with a 1/9 arc-second spatial resolution and the LCD with a 1 arc-second resolution. First, we map both data sets to a common latitude and longitude coordinate system and determine the region that is common to both data sets. Then, we apply the linear and nearest-neighbor interpolations to the NED and LCD, respectively. Next, we generate surface facets using the 3-D Delaunary triangulation algorithm, and differentiate the shadowed and illuminated facets using a line-of-sight algorithm. The surface of each illuminated facet can be described by an appropriate surface spectrum, such as the Gaussian, Exponential, or Band-limited exponential correlation function, consistent with the information available from LCD. In addition, we will examine the impact of ε_r, which is closely related to soil moisture content, on terrain reflectivity. The roughness parameters, such as rms height and correlation length, can be extracted from the data sets to determine the small-scale local terrain features. The scattered field from each illuminated facet is then computed using either the small-slope approximation (SSA) or small-perturbation method (SPM), depending on its roughness. The total scattered field from the resolution cell can be computed by summing up the contribution from each illuminated cell.