Multiple Levels of Detail Environment Modeling for Radio Propagation Simulation and Prediction

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Digital elevation models (DEM) or digital terrain elevation models (DTED) are widely used in radio propagation simulation and prediction. The resolution of DEM's is getting higher and higher with the latest resolution of centimeters generated by LIDAR (light detection and ranging). These high resolution DEM's provide more realistic representation of the environments and will enhance the accuracy of propagation modeling results. But they also have some drawbacks. First, the storage of high resolution DEM's will cost large computer disk space and slowdown the I/O process. Second, not all propagation scenarios need high resolution DEM's depending on the frequency and range. Third, the DEM's do not explicitly have the three dimensional (3D) information about topographic structures, such as ridges, which is physically important in diffracted field calculations. For example, 3D ridges are key contributors of diffracted field in certain mountainous regions. But many widely used and DEM-based methods (e.g., knife-edge models) ignore the 3D features. Our previous work has shown that the orientation and interior angle of a ridge can cause 3dB difference in path loss prediction for a single ridge. For two ridges, the difference is almost doubled.

In this paper we propose a propagation modeling framework to exploit the advantages of high resolution DEM's and limit some of their drawbacks. The main objective is to develop an environment model that has multiple levels of detail (LOD) of the terrain and has 3D topographic structures (important to propagation modeling) explicitly represented as vectors. Whenever a propagation simulation request is received, the framework will automatically select a terrain model with appropriate LOD and carry out the simulation.

The high resolution DEM's will be used for the extraction of realistic 3D structures with different levels of importance to propagation modeling. These 3D structures will be stored as vectors (against the raster form of DEM's) and will save significant disc space. For example, in a DEM tile with resolution of 3 arc-seconds (about 90 m), there are 1201×1201 data points in NASA's SRTM database. If we use 3D ridge structures to represent the same terrain, the number of data points can be reduced by hundreds of times. Also, the CPU time for diffraction calculation is in general less than the methods based on raster form elevation data (DEM's).

We expect great potential use of the framework such as real time and progressive propagation modeling with moving transmitters and receivers.