Model-Based CLEAN Algorithm for Through-Wall Radar Image Enhancement

Paul C. Chang, Robert J. Burkholder*, John L. Volakis and Ronald J. Marhefka
The Ohio State University Dept. of Electrical and Computer Engineering
ElectroScience Lab, Columbus, OH 43212, http://esl.eng.ohio-state.edu

Through-wall radar images obtained by near-field scanning along the sides of a building may be heavily dominated by the scattering from the exterior walls, thereby obscuring the interior details which are of primary interest. The exterior wall also attenuates and distorts the radar signal as it penetrates the building, so the scattering from the interior features may be lost below the sidelobes of the wall scattering signature. One approach to reducing the sidelobe obscuration of the interior is with the CLEAN algorithm (J. Tsao and B. D. Steinberg, *IEEE Trans. Antennas and Propagation*, 36, 543-556, 1988). The CLEAN algorithm assumes a point scattering model and sequentially subtracts the scattering signatures of the brightest points from the data. However, the scattering signature of a wall is much different than a point scatterer, so the subtraction is not as effective and may in fact remove some of the features of interest. In this paper a model-based CLEAN approach is presented which is specifically adapted to remove the strongest wall scattering signatures from the image without affecting the weaker scattering features inside the building. The approach uses the analytic solution for the radar scattering from a multi-layered wall structure. The algorithm searches the individual downrange profiles (from each sensor position) for the strongest wall scattering signatures, and then subtracts them from the radar data. *A priori* information on the exterior wall location and composition helps with the extraction, but is not absolutely necessary.

The model-based CLEAN algorithm is tested with simulated radar scattering data from a building model generated using the NEC-Basic Scattering Code (NEC-BSC). The NEC-BSC is based on the uniform geometrical theory of diffraction (UTD) and efficiently computes all the significant wall transmission, reflection and multi-bounce effects, as well as edge and vertex diffraction. Numerical results will be presented to compare images generated without CLEAN, with the conventional CLEAN, and with the model-based CLEAN. It will also be demonstrated how the analytic wall transmission model can be used to improve the fidelity of the interior image.