Building Structure Modeling and Reconstruction from Through-Wall Radar Data

Eric R. Keydel[1], Nikola S. Subotic[2], Joseph W Burns[2], Andrew M. Morgan[1], Wayne D. Williams[1], Duane Setterdahl[3], Peter Shargo[3]

[1] SAIC, 3600 Green Court, Suite 650, Ann Arbor, MI 48105
[2]Michigan Tech Research Institute, 3600 Green Court, Suite 100, Ann Arbor, MI 48105
[3] SAIC, 1901 South 1st Street, Suite D-1, Champaign, Il 61820

Abstract

The ability of low frequency radar to propagate through exterior grade building walls and provide backscatter information about interior structures has been established on a number of government-sponsored research programs. Recent research supported by the Defense Advanced Research Projects Agency Special Projects Office focused on the problem of reconstructing 3-D building interior information from through-wall radar measurement data.

The objective of building structure reconstruction from radar data is to infer the composition and physical configuration of building interior structures and present this information in a manner that is readily interpretable by someone with little or no training in radar physics. The complexity of the phenomenology and interactions between building structures renders linear direct inversion techniques intractable because of the high dimensionality of the parameter space that must be estimated. Alternate model-based techniques that employ forward models of the through-wall phenomenology and iteratively recover interior information are required.

This paper presents the results of recent research in the application of iterative model-based reconstruction techniques that interpret and recover information about building interiors from through-wall radar data. These techniques couple phenomenological models to exploit low-level structure responses and interactions with higher-level reasoning to assemble the low-level exploitation results into an understanding of the building interior structure. The phenomenological models and the measurements supporting these models will be described, the reasoning structure will be illustrated, and preliminary building reconstruction results based on synthetic data will be presented.