Characterizing In-Building Scattering Primitives for Through-Wall Imaging.

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Abstract:

In recent years, various synthetic aperture radar (SAR) processing algorithms have been developed to form through-wall building images. In order to effectively develop baseline algorithms, simulations must provide in-building multipath contributions and scattering behaviors. In order to exploit information contained in through-wall images, and to define requirements for through-wall radar systems, it is necessary to understand the characteristics of in-building scattering phenomena. For example, it is readily evident that scattering sources inside a building, past a first wall, will be range-displaced (relative to free-space propagation) due to the delay imparted by passing through a single wall. Less apparent, but observable with suitable waveform design, is that a single wall results in a doublet image response, as both "front" and "back" surfaces of a wall provide a measurable return. Other impacts of in-building scattering phenomena include multipath-induced noise, and target defocusing.

An approach is to draw analogies with canonical perfectly conducting (PEC) scatterers from traditional SAR radar and determine the additional characteristics imparted by being observed in-building. For example, the interior structure of a building, to the first order, consists of walls, floors and doorways. Walls would be the equivalent of flat plate scatterers. Where walls and floors meet results in a dihedral corner primitive, and wall-wall-floor junctions comprise a trihedral corner primitive. These canonical equivalents are imaged after passing through at least one exterior wall. More interestingly, as apparent from the wall example, the image behavior of these in-building equivalent primitives will differ from the PEC scatterers, since the "front" of wall-floor junctions will allow energy to penetrate and transmit through and beyond the "back" of these junctions.

This paper will characterize the additional characteristics of the electromagnetic scattering phenomena present in through-wall image algorithms, focusing on understanding and simulating the responses for dielectric dihedrals and trihedrals. It will compare results from various simulation tools for these simple structural primitives, present through-wall images of these simple primitives using simulated data, and estimate parametrics to develop requirements for future radar and algorithm development.