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Abstract for an Invited Paper
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Through-wall microwave imaging: some applications of physics to urban reconnaissance[1]

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I will review some recent physics-based modeling approaches in support of microwave through-wall building tomography. Building layout estimation is a nonlinear inverse problem with a large number of degrees of freedom (geometry, location, and scattering properties of major building elements, such as walls, floors, and ceilings, plus many other smaller elements such as windows, doorways, and stairways). The physics of microwave propagation in such environments is very complex, involving multiple reflection, transmission, and diffraction events. Careful control of measurement protocol, using well-focused and directed transmitter and receiver arrays, can mitigate this to some degree. However, even under the most optimistic scenarios, the number of interactions increases exponentially as the signal penetrates more deeply into the building. Multiple overlapping returns from different building elements quickly overwhelm one's ability to disambiguate their sources. To explore the fundamental limitations on solutions to the inverse problem, efforts to create physics-based models that capture the signal complexity as accurately as possible will be described. These models remain an approximate description of reality, but nevertheless enable one to understand the effects of the explosion of multiple scattering events on the inversion, and quantify the limits of the inversion quality under even the most optimistic scenarios for data diversity and precision.

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