Adaptive CLEAN with Target Refocusing for Through-Wall Image Improvement

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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 interior features may be lost below the sidelobes of the wall scattering signature. In addition, signal distortion after propagation through one or more wall becomes an issue as most conventional SAR imaging techniques assume free space propagation. As a result, the object's detectability decreases and the target scattered signals may be displaced and defocused. In this paper, we introduce signal processing techniques to improve building interior images. Specifically, an adaptive CLEAN algorithm is introduced in conjunction with target refocusing techniques to de-emphasize undesired signal effects from external walls, and thus more accurately image the lesser contrast objects. Instead of using the point spread function as in the conventional CLEAN algorithm, adaptive CLEAN incorporates a delay spread model found more appropriate for subtracting sidelobes that could obscure interior objects. To extract parameters of the unknown wall, a minimum mean squared error (MMSE) estimator can be built to examine the likeliness between the collected data and our pre-computed spread models. Target refocusing also allows for correcting target distortion and displacement due to through-wall propagation. It is shown that by combining adaptive CLEAN with target refocusing techniques, we are able to reconstruct interior targets (with minimal exterior wall distortion). The introduced processing techniques are demonstrated via simulations generated with a well validated high frequency code with ray tracing.