Influence of Antenna Pattern on Synthetic Aperture Radar (SAR) Imaging and Complex Permittivity Extraction from Images of Multilayered Media

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**Abstract**:

Microwave and millimeter wave synthetic aperture radar (SAR) imaging technique has been widely used for nondestructive evaluation (NDE) applications. To evaluate the performance of a SAR imaging system, factors including image production time, image quality, and capability to get quantitative information from a produced SAR image are commonly investigated.

Implementation of SAR imaging usually requires two steps, namely; image data collection, and post processing of the collected data using a suitable algorithm that produces a high-resolution image. For a successful implementation and image production all aspects associated with these two steps must be fully considered during the image production process and when interpreting its content for useful information. To this end, it is found that the antenna pattern, and not just its beamwidth, affects SAR image resolution and image sidelobe level. Hence, a general approach is proposed that provides for a comprehensive analysis of the effect of antenna pattern on SAR image resolution and image sidelobe level. Pertinent to the scanning process, current approaches that aim at improving scanning time require involvement of an intelligent user with sufficient knowledge in SAR image production. However, such a user may not always be available. Therefore, an automated adaptive scanning approach is proposed to provide optimal cross-range resolution and image quality while reducing the scanning time to a minimum. Finally, it is also of great interest to deduce more information about target electrical (i.e., dielectric) properties from a produced SAR image. This is particularly of interest when imaging multilayered composite structures. However, the currently available approach is only applicable to an infinite half-space of a homogenous material. Consequently, a calibration methodology is proposed to extract the permittivity distribution for a multilayered composite medium from its produced SAR image.