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Experimental Validation for ROI prior Contrast Source Inversion Algorithm for Microwave NDT Model

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There is an emergent task for detecting an air crack or metallic rust for aging bridge, tunnel or highway roads, which rapidly increase in recent years in Japan or other developed countries. Due to a high demand for a large-scale and speedy monitoring for the above transportation infrastructure, microwave non-destructive testing (NDT) techniques come under spotlight because it achieves deep penetration depth in concrete media by non-contact measurement, being an advantage from sound or ultrasonic diagnosis.

Several investigations demonstrated that there are significant differences among various types of rusts, *e.g.*, black, salt or red rusts, in dielectric property [1], and then, the quantitative imaging for complex permittivity is much promising to identify an air crack, type of rusts or other materials. This paper, then, focuses on one of the inverse scattering algorithm as contrast source inversion (CSI) [2]. The CSI has some advantages from other inverse scattering approaches such as distorted Born iterative method (DBIM)[3] or others that it can reconstruct a dielectric profile without using forward solvers, which often require an expensive computational cost. However, the CSI still suffers from inaccuracy in dealing with a large-scale problem due to a lack of measurement data, compared with the number of unknowns.

To retain accurate dielectric profile in the above challenging situations, this paper introduces the RPM based radar image as prior information for the ROI in the the CSI framework. In the experimental validations, we introduce a simple but effective calibration method for converting the experimental data to the simulation data using calibration targets. Then, the reconstruction result for concrete materials including four air cavities with 10 mm diameter as shown in Fig. 1, demonstrated that the restricted ROI based CSI achieves high accuracy for dielectric profile reconstruction even in using the experimental data.

Figure 1. Calibration and unknown target in the experiment (left). Comparison of original and reconstructed permittivity using ROI restricted CSI.

References

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