Subsurface Estimation of the Geometry and Electromagnetic Properties of Buried Anomaly and Half-space Background with Unknown Rough Boundary

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A new inverse method is developed to recover the geometric structure and electromagnetic contrast of an anomaly buried in a half-space defined by a rough, unknown boundary. Spline curves are used to model both the shape of the object as well as the profile of the boundary. The problem is then cast as one of determining a relatively small number of control points for these curves along with the complex permittivities of the anomaly and the background medium. The direct relationship between the control points and the boundary points and nonlinear relationship between the geometry and resulting scattered field defined by Maxwell's equations enable us to restore these parameters with a high degree of accuracy even when the data are corrupted by noise.

The physical forward model employed in the inversion algorithm is the Semi-Analytic Mode Matching method (SAMM) which is a fast and efficient method to calculate the scattered near-fields from a buried lossy homogenous object in the lossy homogenous background and is defined in terms of the modal expansions enforcing the boundary conditions at the boundaries of different media. SAMM is of low computational complexity compared to other methods and highly accurate in the region of interest.

The Levenberg-Marquardt method is used as a nonlinear least-squares minimization algorithm to optimize the unknown parameters including the control points and complex permittivities. In the talk accompanying this abstract we provide details concerning the manner in which the SAMM model allows us to compute closed form expressions for the sensitivity of the scattered fields with respect to both the geometric and contrast parameters. Numerical results will be provided to verify the capability of the proposed algorithm.

REFERENCES

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