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Parametric Study of the Scattered Electromagnetic Field by Differently-Shaped Buried Objects in Various Scenarios

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In this study the electromagnetic field scattered by a buried object is obtained by use of a commercial full-wave frequency-domain solver which implements the Finite Element Method (FEM). The buried object is supposed to have different simple shapes and material composition such as a cylinder or cylindrical shell modelling for example a void in concrete or a poly-vinyl chloride (PVC) pipeline, respectively. Material properties available in literature are correctly modelled by data interpolation. The model is excited by a linearly-polarized plane wave impinging normally on the interface between air and soil/cement half-space. Comparison with simulation data provided by another simulator implementing the finite-difference time domain (FDTD) technique in the case of a simple buried perfect electric cylinder allows for FEM data validation. We further study the properties and the spatial variation of the scattered fields in different contexts by varying the geometrical and material properties of the model relative to the impinging wave characteristics. The aim is to clearly determine the conditions under which detection is possible. Moreover, by application of signal processing techniques to scattered field data, the position, shape, and object orientation recognition problems are considered. Results from different DSP algorithms are compared with the goal to find the best performing one relative to the context. Performance is evaluated in terms of detection success and resolving ability. The use of ground penetrating radar (GPR) techniques in the field of Civil Engineering offers inspection capabilities in the structure with no destructive intervention.

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