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On the Analysis Methods for the Time Domain and Frequency Domain Response of a Buried Objects*

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There has been a continuous interest in the analysis of ground-penetrating radar systems and related applications in civil engineering [1]. Consequently, a deeper insight of scattering phenomena occurring in a lossy half-space, as well as the development of sophisticated numerical methods based on Finite Difference Time Domain (FDTD) method, Finite Element Method (FEM), Boundary Element Method (BEM), Method of Moments (MoM) and various hybrid methods, is required, e.g. [2], [3]. The present paper deals with certain techniques for time and frequency domain analysis, respectively, of buried conducting and dielectric objects.

Time domain analysis is related to the assessment of a transient response of a horizontal straight thin wire buried in a lossy half-space using a rigorous antenna theory (AT) approach. The AT approach is based on the space-time integral equation of the Pocklington type (time domain electric field integral equation for thin wires). The influence of the earth-air interface is taken into account via the simplified reflection coefficient arising from the Modified Image Theory (MIT). The obtained results for the transient current induced along the electrode due to the transmitted plane wave excitation are compared to the numerical results calculated via an approximate transmission line (TL) approach and the AT approach based on the space-frequency variant of the Pocklington integro-differential approach, respectively. It is worth noting that the space-frequency Pocklington equation is numerically solved via the Galerkin-Bubnov variant of the Indirect Boundary Element Method (GB-IBEM) and the corresponding transient response is obtained by the aid of inverse fast Fourier transform (IFFT). The results calculated by means of different approaches agree satisfactorily.

Frequency domain analysis is related to the assessment of frequency domain response of dielectric sphere using the full wave model based on the set of coupled electric field integral equations for surfaces. The numerical solution is carried out by means of the improved variant of the Method of Moments (MoM) providing numerically stable and an efficient procedure for the extraction of singularities arising in integral expressions. The proposed analysis method is compared to the results obtained by using some commercial software packages. A satisfactory agreement has been achieved.

Both approaches discussed throughout this work and demonstrated on canonical geometries could be also useful for benchmark purpose.

References

[1] L. Pajewski et al., Applications of Ground Penetrating Radar in Civil Engineering – COST Action TU1208, 2013.

[2] U. Oguz, L. Gurel, Frequency Responses of Ground-Penetrating Radars Operating Over Highly Lossy Grounds, IEEE Trans. Geosci. and Remote sensing, Vol. 40, No 6, 2002.

[3] D.Poljak, Advanced Modeling in Computational electromagnetic Compatibility, John Wiley and Sons, New York 2007.

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