Frequency and Time Domain Error in Buried Target Radar Signature Extraction

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The ground-penetrating radar (GPR) model developed by van den Bosch et al., [1] allows for the extraction of the target radar signature, in theory free from the antenna signal artifacts (internal re ections, emission and reception equivalent currents amplitudes and the multiple re ections) and from the soil response. For this, the radar system has to be characterized for determining the antenna operational parameters H_i (antenna internal re ections), H_t^2 (antenna transmission and reception) and H_f (antenna scattering), and a measurement above the soil without the target has to be performed in order to extract its radar signature R_S. With this in hand, one is able to recover the target signature R_T by using the method developed in [1], where comparisons between extracted and computed target signatures have been made, and excellent agreement has been found.

However, real world conditions are far from the laboratory settings in which the experiments were performed. The operational parameters of the antenna can be wrongly estimated. In our experience, these parameters are strongly dependent upon the strength with which the waveguide is attached to the VNA. On another hand, the soil EM parameters, namely the dielectric permittivity and magnetic permeability, can—and do—vary greatly from point to point, therefore an estimation of those parameters or of R_S may not correspond to the reality of the ground surrounding the buried target.

In this work, the relative error on the target signature is decomposed into a weighted sum of the relative errors on the terms that participate to the total radar signal. It is shown how the frequency domain magnitudes of these weights are inversely proportional to the magnitude of the target signature. Special attention is devoted to the error due to wrong soil radar response estimation. Its consequences are thoroughly examined in the time domain, which allows for an intuitive yet rigorous interpretation of the resulting degradation of target discrimination against the background.

REFERENCES

1. Van den Bosch, I., P. Druyts, S. Lambot, I. Huynen, and M. Acheroy, "Accurate and efficient modeling of monostatic GPR signal of dielectric targets embedded in stratified media," *Proceedings of the Progress in Electromagnetics Research Symposium (PIERS)*, 251–255, Hangzhou, Zhejiang, China, August 2005.