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Non-destructive sub-surface prospection technique based on scattered electromagnetic data processing

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Remote sensing diagnostic techniques for sub-surface analysis are nowadays playing an important role in a variety of application fields, ranging from infrastructure assessment and geophysical monitoring to cultural heritage preservation. As can be easily seen, for most of them, the non-invasive aspect becomes even fundamental.

The aim of this work is therefore to provide an affordable methodology for the extraction of geophysical features from electromagnetic data. For the analysis, a ground penetrating radar (GPR) is employed, which is a probing system designed primarily for the detection of objects and/or interfaces below the Earth's surface [1]. Its typical architecture is made of two separated antennas, a transmitter (TX), for the generation shortwave pulses, and a receiver (RX), which measures the radiation scattered by targets. It is straightforward that its non-destructive nature makes it one of the more suitable tools for those sub-surface surveys where a basic requirement is to keep the test domain unaltered.

The solution of the problem is here addressed from a very general point of view, such as by modelling the sub-surface scenario as a multi-layered medium composed of a number of strata with different characteristics, i.e. relative dielectric permittivities (ϵ_r) and thicknesses (x_r). More in detail, exploiting the conceptual framework presented by the same authors in [2], a set of suitable features related to the geophysical properties of each layer is extracted from the e.m. signal sensed at RX, which basically consists in the superimposition of all the backscattering radiations generated nearby discontinuities (e.g. layer interfaces, buried objects): where possible, each contribution can be isolated and analyzed to determine the characteristics of the corresponding layer (object).
Besides the appropriate choice of the above-mentioned features, one of the algorithm's keypoints resides in the inversion process that allows to reconstruct the actual values of ϵ_r and x_r: it is not performed in an analytical way, but exploiting the potentialities of a Multi-Layer Perceptron (MLP) [3]. Even if, from the one hand, it needs a preliminary phase for the training of the network, on the other hand it simplifies the solution, speeding-up performances and enabling a more flexible implementation.

References

[1] Daniels, D.J., Gunton, D. J., and Scott, H. F., "Introduction to subsurface radar", Proc. IEE, part F, Vol. 135, 278-320, Aug. 1988.

[2] Caorsi, S. and Stasolla, M., "ANN-based sub-surface monitoring technique exploiting electromagnetic features extracted by GPR signals", Adv. Geosci., vol. 19, pp. 3-9, 2008.

[3] S. Haykin, *Neural Networks, A comprehensive foundation*, McMillan, New York, 1994.