

DORT METHOD FOR UWB ELECTROMAGNETIC FIELDS IN INHOMOGENEOUS AND DISPERSIVE MEDIA

Yavuz, M. E. , Teixeira, F. L.

ElectroScience Laboratory, The Ohio State University, 1320 Kinnear Rd, Columbus, OH, USA

The *decomposition of the time-reversal operator* method (DORT under its French acronym) provides a simple and robust algorithm for detection and localization of point-like, well-resolved scatterers in disordered media by exploiting the invariance of the Maxwell's equations under time-reversal (TR) [C. Prada and M. Fink (1994), *Wave Motion*, 20, 151-163]. However, in lossy and dispersive media, this invariance is broken and additional attenuation and phase shift occur on the signals propagating in such media. Therefore, a compensation has to be applied to obtain a performance similar to the lossless (nondispersive) case. In this work, we first study the effects of frequency dispersion on the eigenvalue and eigenvectors of the time-reversal operator (TRO) and on the subsequent selective focusing using the associated eigenvectors. Having a better understanding of the TRO behavior under these conditions, we apply the full time-domain DORT method to ultrawideband (UWB) electromagnetic (EM) signals in both dispersive and inhomogeneous media under limited aspect antenna configurations. The frequency dispersion is modeled using an *inhomogeneous N-species Lorentzian media* (which can be reduced to a Debye media as a particular case) where UWB signals undergo frequency dependent attenuation. To compensate for the losses, a time-dependent filtering approach previously employed for homogeneous media [M. E. Yavuz and F. L. Teixeira (2005), *IEEE Geosci. Remote Sensing Lett.*, 2(2), 233-237] is extended to inhomogeneous random media. Since attenuation undergone depends on each particular realization (of a random medium with known statistical properties), filters adapted for random media are obtained using the ensemble averages. Although exact compensation can not be achieved, the overall performance is close to that of the non-dispersive case for weak background fluctuations where Born approximation holds. Finally, a previously proposed alternative numerical compensation algorithm based on a synthetic modification of the medium dispersive characteristics [P. Kosmas and C. M. Rappaport (2005), *IEEE Trans. Microwave Theory Tech.*, 53, 2317-2323] is assessed and compared against the time-dependent filtering approach. The TRO is explicitly obtained via finite-difference time-domain simulations (FDTD). Random medium models are based on inhomogeneous soil models with spatially fluctuating random permittivities with Gaussian distribution. Impenetrable point-like targets are considered as primary scatterers.

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1. (a) Mehmet Emre Yavuz
ElectroScience Laboratory
The Ohio State University
1320 Kinnear Rd
Columbus, OH
43212 USA
yavuz.5@osu.edu
(b) 614-292-6191
(c) 614-292-7297
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