Imaging through obscuring random media based on interference gating of the mutual coherence function

E. Bleszynski*, M. Bleszynski, and T. Jaroszewicz
Monopole Research, Thousand Oaks, CA 91360, USA

We describe selected aspects of the develepment of an approach to imaging with short pulses or chirped signals propagating through particulate random media in which attenuation is not dominated by absorption (i.e., energy dissipation), but contains a sizable scattering-induced contribution. The goal of the proposed method is to exploit the signal energy which has been removed by scattering from the coherent component of the wave, but is still present in the wave intensity or its mutual coherence function (MCF).

The approach described here is designed to extract the image bearing component of the MCF which could be used in *range* measurements. In order to reduce the detrimental effects of the medium-induced diffusion (which results in pulse elongation and loss of range resolution), we propose processing of the received two-frequency MCF by means of the "interference gating" method. This procedure involves high-pass filtering of the MCF in its the relative frequency variable; the filter suppresses the dominant contributions to the MCF diffusion (due to small relative frequencies) and enhances the wave-type behavior of the MCF propagation due to interference of significantly different frequencies.

We analyze and discuss the MCF propagation in two different regimes: of medium particles small or large relative to the relevant wavelengths. The evolution of the MCF, and in particular the mechanism of diffusion, is different in these scenarios and requires choosing appropriate signal and gating parameters. Based on analytic models and on simulations, we provide estimates of the parameters and of the attainable range resolution. Depending on the waveform and the medium, we also suggest various possible measurement procedures, including measurements of field correlations at different spatial points.

We also describe an extension of the proposed approach to synthetic-aperture-type imaging, involving interference of the MCFs measured at different points of the aperture and requiring appropriate signal processing techniques. Possible applications of the method in the area of imaging through atmospheric clouds, fog, and aerosols are also discussed.

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