Time-domain analysis of multiple scattering effects on the radar cross section (RCS) of objects in a random medium

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The effects of the random media on radar cross section (RCS) have been studied using the stochastic Green's function and phase functions [Ishimaru al el, 2004]. It was shown that the analytical model can predict the enhanced backscattering due to multiple scattering and the increased RCS if a random medium is closer to the transmitter. The general formulation includes the 4th-order moments including the correlation between the forward and the backward waves. The fourth moments are reduced to the second-order moments by using the circular complex Gaussian assumption. The stochastic Green's functions are expressed in parabolic approximation, and the objects are assumed to be large in terms of wavelength; therefore, Kirchhoff approximations are applicable. This theory includes the backscattering enhancement and the shower curtain effects, which are not normally considered in conventional theory. However, the previous studies were limited to the continuous wave (CW) case.

In this paper we will extend the formulation to the time-main and show the time-domain response of RCS in several cases. First the analytical formula was obtained using the two frequency correlation function of the scattered field. Then the Fourier transform was applied to obtain the time-domain responses. Instead of using the conventional FFT, the chirp-Z transform was applied for smoothing out the time-domain responses. Numerical examples of a conducting object in a random medium characterized by the Gaussian and Henyey–Greenstein phase functions are shown to highlight the difference between the multiple scattering RCS and the conventional RCS in terms of optical depth, medium location and angular dependence.

[1] A. Ishimaru, S. Jaruwatanadilok and Y. Kuga, "Multiple scattering effects on the radar cross section (RCS) of objects in a random medium including backscattering enhancement and shower curtain effects", Waves in Random Media, 14 (2004) 499-511