A Time Domain Point Source Method for Inverse Scattering by Rough Surfaces

C.D. Lines — Department of Mathematical Sciences, Brunel University, Uxbridge, Middlesex, UB8 3PH, U.K.

S.N. Chandler-Wilde — Department of Mathematics, University of Reading, Whiteknights, PO Box 220, Berkshire RG6 6AX, U.K.

Abstract

In this paper we propose a new method to determine the location and shape of an unbounded rough surface from measurements of scattered electromagnetic waves. The proposed method is based on the point source method of Potthast (IMA J.Appl.Math., 61:119-140, 1998) for inverse scattering by bounded obstacles. We propose a two-dimensional version for inverse rough surface scattering which can reconstruct the total field when the incident field is not necessarily time harmonic. A single time harmonic point source transmitter of an electromagnetic field is positioned above the unbounded surface to be located and the total field produced is measured on a finite horizontal line, also above the unbounded scattering surface. Our version of the point source method is a procedure for approximating the total field at all points above the scattering surface from these few measurements, via solution of an (ill-posed) linear Fredholm integral equation of the first kind. We briefly explain the justification for this method (for more detail see the PhD thesis of Lines). We then propose a *time domain point source method* to reconstruct the total electric field when the incident wave is not necessarily time harmonic. In particular, in the numerical experiments we carry out, we have chosen an incident pulse that is similar to those arising in ground penetrating radar applications. We show numerical examples for the simplest case, when the boundary is perfectly conducting and the incident field is in TE polarization, so that a homogenous Dirichlet condition applies on the boundary. We reconstruct the total field above the surface and also locate the position of the boundary as the curve along which the reconstructed total field is minimal. The results show great accuracy of reconstruction of the total field and of the prediction of the surface location.