Detection and Characterization of Targets Buried Below a Rough Surface

K. Belkebir, **O. Cmielewski**, **A. Litman**, **M. Saillard**, **and H. Tortel**
CNRS, France

The problem of detection and characterization of an object buried at very low depth beneath a rough surface is addressed. At least two approaches have been proposed to solve such an inverse problem. One of them consists in reconstructing simultaneously both the scatterer and the surface profile. One can also proceed in two steps: first, the surface profile is reconstructed from the early-time response to ultra-wide band signals, and the corresponding Green's function is built numerically. The second step deals with the reconstruction of a scatterer embedded in a (rough) stratified medium. However, both methods assume that the buried object has been previously detected and localized, since only a small area around the scatterer is considered. Here, the whole signal processing scheme is described, from detection to inversion, assuming that a multi-static and multi-frequency data set is available, from measurements of the scattered field along a piece of line.

The problem of detecting the target is tackled by analyzing the frequency averaged Wigner-Ville function as applied to the data and does not require any assumption about the signature of the target. We will present two ways of characterizing the target.

The first one is performed using the iterative solution derived from the Newton-Kantorovitch algorithm as applied to the Wigner-Ville function instead of the scattered field as it is usually done. Indeed, if this built-in function is well adapted to the detection of the object and performs a good clutter rejection, our hope is that an inversion procedure based on its optimization allows us to use a forward model involving a flat interface instead of rough surface, the contribution of the latter being considered as noise. Such an approach permits us to save a lot of time since it involves the standard half-space Green's function.

In the second approach we have first used a new type of correlation of the scattered fields in order to obtain an estimation of the surface profile. A direct solver based on a finite element method has been built in order to take into account the reconstruted surface profile. A "level-set" type method coupled with this solver has been used in an iterative process in order to recover the shape of the buried scatterer.

The efficiency of both approaches will be illustrated via numerical experiments and comparisons will be reported.