Abstract

This thesis has studied two different target localization methods to identify human targets in the half-space investigation domain. One of them works in the time domain, and the remaining one works in the frequency domain. The signaling mechanism and the data processing techniques used by the Ground Penetrating Radar (GPR) have been used in the time-domain method.

In the time domain method, inhomogeneity in the investigation domain makes the target localization challenging. Analytical expression of GPR's signal in an inhomogeneous investigation domain has been developed. The inhomogeneity of the investigation domain has been considered in the direction of penetration and in the direction of scan simultaneously. By analyzing the GPR signal's behavior in the inhomogeneous investigation domain, a subspace projection-based clutter removal technique has been proposed to suppress the effect of clutters. The proposed clutter removal technique and the ones existing in the related literature have been applied on the synthetic and experimental data. It is observed that singular value decomposition, one of the subspace projection-based clutter suppression techniques, is suitable for removing the clutters in all kinds of inhomogeneous investigation domains when compared to the mean subtraction and time gating based clutter removal techniques. The performance of the MUSIC algorithm has also been tested for estimating the respiration rate when the human being was lying behind an inhomogeneous wall, and such kind of ultrawideband signaling is used.

The occurrence of the half-space geometry creates the scenario of a limited illuminating aperture. Traditional shape reconstruction inversion algorithms fail to extract the shape of the scatterer when they are applied in the limited illuminating aperture case. In this context, analytic expressions of scattered electric fields for different categories of cylindrical targets buried in the half-space have been developed. In all the cases, investigation domains have been considered two-dimensional and are infinitely long in the remaining dimension. The investigation domains have been excited by the fields generated by a z-directed line source of constant amplitude, operating in the microwave frequencies. The usefulness and validity of these scattering models have been examined by the full-wave solutions. By using the information retrieved from the reconstruction of current density by inversion and analytical expressions of the scattered electric field, information about the diameter and the type of the scatterer have been obtained. In addition, the performance of the linear sampling method for shape reconstruction of the scatterer in half-space is also explored.

Index Terms: Clutter, current density, full-wave solutions, GPR, half-space, inho-

mogeneity, inversion, investigation domain, scatterer, scattered electric fields, subspace projection