ULTRA-WIDEBAND EMI SPECTROSCOPY FOR DETECTION OF UXO: A METHOD OF INVERSION FOR ESTIMATION OF PHYSICAL DIMENSIONS AND PROPERTIES OF METALLIC OBJECTS FROM WIDE-BAND ELECTROMAGNETIC INDUCTION MEASUREMENTS

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The UXO objects are highly conducting and permeable and therefore, almost indistinguishable form non-UXO metallic litters at ground penetrating radar frequency range since metallic objects in general behave as PEC. It is therefore highly desirable to develop UXO detection method that uses highly sophisticated discrimination criteria so that underground unexploded explosive cleanup to be cost effective. In this presentation it is shown that ultra-wide band (1Hz to 300kHz) EMI spectroscopic measurement data obtained from the buried metallic objects representing UXO's can be inverted to estimate physical dimensions and certain material properties of the object. There are two specific advantages using low frequency excitation. First, the ground is almost transparent to both the incident primary and scattered secondary fields at this low frequency range. Second, low frequency fields are capable of penetrating highly conducting magnetic or non-magnetic objects giving rise to in-phase and quadrature components of secondary fields; this is known as the EMI response of the object. In phase component is due to induced surface currents where as Gaussian shaped quadrature component is due to induced volume currents. Measured EMI response data contain wealth of information waiting to be extracted. Extensively studying the EMI responses due to canonical objects both solid and shell structures under axial and transverse excitation several characteristics parametric features have been identified: peak value, peak frequency, peak width, zero-crossing frequency etc. etc. These crucial parameters contain all the information about the physical dimension of and material properties the object. First step is to extract these parameter values from the measured spectroscopic EMI response data. In order to match each of these measured parameter values using analytical expressions for canonical objects we can generate for example all possible outer diameters and shell thicknesses that correspond to a specific parameter value. Next, each of these parameter values graphically plotted as a function of all possible diameters and shell thicknesses. The intersection of various parameter curves revel the estimated diameter and thickness of the object. A number of inversion (estimated diameter and thickness) examples are presented using experimentally measured EMI response data and compared with actual dimensions. Inverted diameters and thicknesses are realistically accurate.

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