National Institute of Technology Rourkela

Defence Seminar

Seminar Title	: Development of Efficient Analytical Models for Investigation of Subsurface Media and Buried Objects by Ground Penetrating Radar
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Venue	: EC Seminar Hall
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Abstract :

Ground penetrating radar (GPR) is a geophysical sensor that is useful in subsurface exploration. Due to its capability of non-destructive testing and ability to detect both metallic and non-metallic objects, GPR has received significant attention among researchers and engineers. Bi-static GPR system is useful to investigate more depth due to its high signal to noise ratio compared to mono-static GPRs. Full wave models (FWMs) are very accurate to represent GPR scenarios as they make little assumptions on media, object, and transmitter and receivers antennas. However, their computational complexity is very high. The success of GPR investigation majorly depends on the accuracy of modelling GPR scenarios, clutter removal techniques, algorithm for signal processing, etc. GPR model must account for the effect due to antennas and non-homogeneous media on electromagnetic wave propagation. It must provide not only good accuracy but also computational efficiency to make it useful for real-time applications. Hence GPR models which are accurate and computationally efficient are in great demand.

GPR investigation has majorly two goals: one is quantitative characterization of subsurface media and the other is imaging of a finite target that buried inside subsurface media. In this work, several full wave models have been derived to represent layered media with antenna as point sources with different orientation. Subsequently an efficient FWM for bi-static GPR has been developed for quantitative characterization of subsurface media using bi-static off-ground GPR configuration. Here non-homogeneous ground is assumed as a planar multi-layered media where each layer is homogeneous and antenna effect is characterized by a suitable calibration technique. The integral equation of model has been reduced to a simplified algebraic formula by applying Sommerfeld identity and constant phase method. The proposed model has been tested for estimation of electrical properties of water layer and sand layer. Experimental analysis demonstrates that the proposed model is accurate in estimating property of subsurface and exhibits enormous computational efficiency.

Subsequently accurate and efficient forward model for layered media Green&rsquos function due to transmitted wave field has been developed for imaging applications. This solution has been derived based on FWM intended for layered medium. The proposed model has been validated with well-known FDTD based FWM available in literature. Then time reversal imaging (TRI) method has been implemented using the proposed model on gprMax and experimental data sets to perform buried object imaging in on-ground and off-ground configurations. The results demonstrate that the proposed model is very effective to image buried object in layered media and its computational efficiency is comparable with the existing standard imaging schemes for homogeneous media