National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: Enhancing GPR Signal Processing Methods for Clutter Reduction and Velocity Estimation
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Venue	: EC Seminar Hall
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Abstract	: Ground penetrating radar (GPR) is a popular tool for non-destructive subsurface investigations. It is widely used in various sectors like archeological survey, civil applications like infrastructure mapping and structure assessment of tunnels and bridges, utility mapping and some defence applications like identification of landmines and unexploded ordances etc. The GPR data often contains unwanted re ections, noise, and artifacts caused by various sources such as surface roughness, electromagnetic interference, and heterogeneous subsurface media properties. These unwanted re ections are known as clutter which hinders the detection of subsurface detail. Hence, the interpretation of subsurface details from raw GPR data is challenging due to its complex nature and the complexity varies with dierent subsurface propertiles. Therefore, its removal in GPR data is crucial for enhancing the quality and accuracy of subsurface imaging and interpretation. Moreover, clutter removal facilitates the extraction of reliable information about the subsurface velocity, which is a fundamental step in GPR data processing for precise localization and detection of the buried target. Therefore, sophisticated signal processing techniques are needed for eective clutter removal and accurate subsurface velocity estimation, both of which are crucial for maximizing the utility and reliability of GPR in subsurface exploration. This work presents a detailed analysis of subsurface velocity estimation methods to assess their applicability across various subsurface proples The eectiveness of a few approaches are validated on laboratory measured data by employing traditional clutter removal technique. GPR imaging serves as a valuable tool for verifying the accuracy of these subsurface estimations by focusing the re ections to the true locations. Furthermore, the concept GPR imaging (i.e. migration and reverse time migration) is leveraged to indirectly estimate the subsurface velocity from a range of trial velocities. There are certain drawbacks of traditional clutter removal approaches. They may leave residual clutter or they are not eective in complex GPR scenarios like roughness enabled subsurface. Additionally, some approaches are dependent upon certain factors (like regularization parameter) which cannot be generalized across diverse profiles. In order to overcome these limitations of traditional clutter removal approaches, a deep learning based Attention U-Net is proposed for the eective suppression of clutter in real world GPR images. The proposed architecture integrates a channel attention modules (CAM) and spatial attention module (SAM) into the base U-Net model to eectively learn the clutter distribution in the data and successfully remove the clutter. Additionally, a deep learning based lower complexity network known as Laplacian enabled U-Net is proposed for clutter removal with reduced computational requirements. The proposed approach integrate a mean followed by Laplacian filtering along the skip connections of a base U-Net model. The ecacy of these proposed methods are compared with several state-of-the-art approaches on both simulated and laboratory measured data, through qualitative and quantitative evaluation.