EGU22-1544
https://doi.org/10.5194/egusphere-egu22-1544
EGU General Assembly 2022

Dielectric Constant Estimation through Alpha Angle with a Polarimetric GPR System

Lilong Zou, Fabio Tosti, and Amir M. Alani
School of Computing and Engineering, University of West London (UWL), London, United Kingdom of Great Britain – England, Scotland, Wales (Lilong.Zou@uwl.ac.uk; Fabio.Tosti@uwl.ac.uk; Amir.Alani@uwl.ac.uk)

As a recognised non-destructive testing (NDT) tool, Ground Penetrating Radar (GPR) is becoming increasingly common in the field of environmental engineering [1]-[3]. GPR uses electromagnetic (EM) waves which travel at specific velocity determined by the permittivity of the material. With the development of new GPR signal processing methodologies, finding information on the physical properties of hidden targets has become a key target. Currently, only three types of approach could be applied for the quantitative estimation of permittivity from GPR data, i.e., hyperbola curve fitting, common middle point (CMP) velocity analysis and full-waveform inversion. However, the main challenges for the estimation of permittivity from GPR backscattered signals are to provide effective and accurate strategy for prediction.

In this research, we used a dual-polarimetric GPR system to estimate the dielectric constant of targets. The system is equipped with two 2GHz antennas polarised perpendicularly each to one another (HH and VV). The dual polarisation enables deeper surveying, providing images of both shallow and deeper subsurface features. Polarimetry is a property of EM waves that generally refers to the orientation of the electric field vector, which plays here an important role as it allows either direct or parameterisation permittivity effects within the scattering problem in the remote sensing [4].

The aim of this research is to provide a novel and more robust approach for dielectric constant prediction using a dual-polarimetric GPR system. To this extent, the relationship between the relative permittivity and the polarimetric alpha angle have been investigated based on data collected by a GPR system with dual-polarised antennas. The approach was then assessed by laboratory experiments where different moisture sand targets (simulating the effect of different relative permittivity targets) were measured. After signal processing, a clear relationship between the alpha angle and the relative permittivity was obtained, proving the viability of the proposed method.

Acknowledgements

The authors would like to express their sincere thanks and gratitude to the following trusts,

charities, organisations and individuals for their generosity in supporting this project: Lord Faringdon Charitable Trust, The Schroder Foundation, Cazenove Charitable Trust, Ernest Cook Trust, Sir Henry Keswick, Ian Bond, P. F. Charitable Trust, Prospect Investment Management Limited, The Adrian Swire Charitable Trust, The John Swire 1989 Charitable Trust, The Sackler Trust, The Tanlaw Foundation, and The Wyfold Charitable Trust.

References

[1] Zou, L. et al., 2020. Mapping and Assessment of Tree Roots using Ground Penetrating Radar with Low-Cost GPS. Remote Sensing, vol.12, no.8, pp:1300.

[2] Zou, L. et al., 2020. On the Use of Lateral Wave for the Interlayer Debonding Detecting in an Asphalt Airport Pavement Using a Multistatic GPR System. IEEE Transactions on Geoscience and Remote Sensing, vol. 58, no. 6, pp. 4215-4224.

[3] Zou, L. et al., 2021. Study on Wavelet Entropy for Airport Pavement Debonded Layer Inspection by using a Multi-Static GPR System. Geophysics, vol. 86, no. 3, pp. WB69-WB78.

[4] J. Lee and E. Pottier, Polarimetric Imaging: From Basics to Applications, FL, Boca Raton: CRC Press, 2009.