EGU22-6251, updated on 14 Aug 2022
https://doi.org/10.5194/egusphere-egu22-6251
EGU General Assembly 2022

Algorithms fusion for near-surface geophysical survey

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The near-surface geophysical methods have been widely applied to investigations of shallow targets for scientific and engineering research. Various data processing algorithms are available to help visualize targets, data interpretation, and finally, achieve research goals.

Most of the available algorithms are Fourier-based with linear stationary assumptions. However, the real data are rarely the case and should be treated as nonlinear and non-stationary. In recent decades, a few newer algorithms are proposed for processing non-stationary, or nonlinear and non-stationary data, for instance, wavelet transform, curvelet transform, full-waveform inversion, Hilbert-Huang transform, etc. This progress is encouraging, but conventional algorithms still have many advantages, like strong theoretical bases, fast, and easy to apply, which the newer algorithms are short of.

In this study, we try to fuse both conventional and contemporary algorithms in near-surface geophysical methods. A cost-effective ground-penetrating radar (GPR) data processing scheme is introduced in shallow depth structure mapping as an example. The method integrates a nonlinear filtering technique, natural logarithmic transformed ensemble empirical mode decomposition (NLT EEMD), with the conventional pseudo-3D GPR data processing methods including background removal and migration to map the subsurface targets in 2D profile. The finalized pseudo-3D data volume is constructed by conventional linear interpolation. This study shows that the proposed technique could be successfully employed to locate the buried targets with minimal survey effort and affordable computation cost. Furthermore, the application of the proposed method is not limited to GPR data processing, any geophysical/engineering data with the similar data structure are applicable.