

Cultural Electric Noise as Controlled Source in Electric Prospecting

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SUMMARY

Stray voltage and current are often considered as noise for electric and electromagnetic (EM) surveys. This study presents an approach that uses cultural noise as an active source for electric prospecting, eliminating the necessity of deploying controlled sources. Our approach capitalizes on the increased ability of simultaneously acquiring large amount of electric field data using a distributed dense array, which provides critical information about the stray current source.

Our model assumes that there are one or multiple grounded current electrodes in or near the survey area, but their locations and intensities are unknown. The first stage of our approach is the source inversion that solves for the locations and intensities of the equivalent sources. For a robust source estimation, we use a 1D layered model for the subsurface conductivity, combined with the A-B electrode locations and current intensity as the source parameters. The simplification of subsurface model and minimization of the number of sources avoids over-fitting the electric field data at receivers and stabilizes the recovery of source parameters. In our implementation, we use the random forest algorithm to simultaneously predict the thickness and conductivity of the subsurface model and the electrode locations and source current, with the E_x and E_y data at all the receivers as the input.

The second stage inverts for the subsurface conductivity by using the recovered current source coordinates, intensities, and the E_x and E_y data at receivers as the input for a subsequent 3D inversion like in the regular procedure. The first and second steps can be repeated in iterations, so the source parameters and the conductivity parameters are updated alternately.

We carried out field experiment with a controlled grounded source as the stray current source. Assuming a five-layer subsurface conductivity model, our algorithms successfully recovered the current electrodes with an average positioning error less than 100 m near a 1000 m scale survey area. The subsequent 3D inversion using the source parameters and the five-layer model as the initial model reveals a detailed image of conductivity distribution, which completely fits the observed electric field data from a dense acquisition array. Our results demonstrate the feasibility of converting undesired cultural noise to useful and free sources for exploration purposes.

Keywords: Cultural noise; Controlled source; Source inversion; Electric resistivity
