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2-D Joint Structural Inversion of Cross-hole Electrical Resistance and Ground Penetrating Radar Data

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We present a joint structural inversion algorithm for cross-hole electrical resistance tomography (ERT) and cross-hole radar travel time tomography (RTT). The algorithm proceeds by combining the exchange of structural information and a regularization method that consists of imposing an L1-norm penalty in the wavelet domain. The minimization of the L1-norm penalty is carried out using an iterative soft-thresholding algorithm. The thresholds are estimated by maximizing a structural similarity criterion, which is a function of the two (ERT and RTT) inverted models. To solve this optimization subproblem, we used the simultaneous perturbation stochastic approach. Besides, the regularization in the wavelet basis allows for the possibility of sharp discontinuities superimposed on a smoothly varying background. Hence the structural information is extracted from each model using a Canny edge detector. The detected edge is used to construct a weighting matrix that is applied to alter the smoothness matrix constraint. To validate our methodology and its implementation, responses from two models were modelled. Experiments demonstrate that the proposed approach improves the spatial resolution and quantitative estimation of physical parameters. In addition, in comparison with joint structural inversion with only the exchange of structural information, our method avoids undesirable bias introduced by the exchange of structural information when the boundaries are near each other. Finally, the proposed algorithm will be applied to real data in the near future to evaluate its performance.