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Introduction

MEG and EEG are important tools for non-invasive functional brain imaging because of their exquisite temporal resolution. However, since the MEG/EEG inverse problem is ill-posed, priors have to be set to obtain a unique source estimate. While spatio-temporal priors have been frequently used, the time-frequency (TF) characteristics of the signals are rarely taken into account. In this contribution, we present an inverse solver, which is based on structured sparsity in the TF domain.

Methods

We employ a convex composite prior combining l_{21} and l_1 norms for regularizing the inverse problem. The prior is imposed on the Gabor-transformed source activations and promotes a block row structure with intra-row sparsity. This structure promotes spatial sparsity and temporal smoothness on the solution by thresholding the TF coefficients. The implementation is based on FISTA, a fast first-order iterative scheme using proximal operators.

We evaluate the proposed solver using non-stationary EEG simulations with isolated current dipoles and dipole patches and compare the results to other convex sparse prior based solvers.

Results

In the isolated dipole simulations, the composite prior led to the smallest root mean square error and provided the spatially sparsest and temporally smoothest solution of all employed solvers. Thanks to the TF coefficient thresholding, noise was significantly reduced in the reconstruction, which is advantageous particularly with low SNR.

The dipole patch simulation showed that the proposed method is able to recover the source locations and TF characteristics correctly even if the model assumption, *i.e.*, sparse dipolar sources, is violated.

Conclusion

The presented inverse solver was designed to recover the spatial sparsity, temporal smoothness, and non-stationarity of neural activations. The results indicate benefits of our method over alternative solvers particularly for low SNR and evidence that priors promoting structured sparsity in the TF domain lead to a promising approach for analyzing MEG/EEG data.