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Introduction

Real-Time source localization from single trial electroencephalography (EEG) / magnetoencephalography (MEG) has recently been brought into focus of neuroscience to clarify brain functionality, identify mental states and to improve online applications such as brain-computer interface systems. To succeed with real-time single trial localization two major challenges have to be solved: first, handling the low signal-to-noise ratio (SNR) and second, managing the computational effort. We aim to address both by reducing the lead field through clustering the lead field dipoles.

Methods

With low SNR the possible source localization resolution of single trial measurements is much lower compared to averaged signals, meaning, it is not possible to distinguish as many sources. Due to that circumstance we are clustering similar lead field dipoles, which we are likely not able to differentiate by a localization algorithm. In order to maintain the position information of the resulting clusters, the clustering is done region of interest (ROI) wise. The ROIs are defined by the Destrieux atlas. To keep a high variance we cluster the lead field dipoles of each sensor separately. The clustering is accomplished using a k-means approach, which encapsulates a ROI in n clusters depending on their size. To localize correlated activated ROIs we are using the RAP-MUSIC scanning approach.

Results

The localization shows a high accuracy up to a SNR of -20dB in simulations, e.g. the correct or neighbored ROI is localized. We use cluster sizes depending on the given SNR, which results in lead field reductions of 40 to 80 times. This leads to a large amount of calculation steps saved, e.g. a lead field reduction from 8195 to 174 dipoles provides savings by 2206 times.

Conclusion

This new method allows real-time ROI localization with a computationally intensive scanning approach. In a second processing step a high-resolution localization based on selected ROIs can be applied.