Abstract:

The study of neurophysiological conditions of the brain is important to diagnose the health of the brain. For this, EEG is utilized by medical professionals as a valuable tool. EEG captures brain activity with high time resolution. EEG source imaging is important in understanding the physiological aspects of the brain. In an experimental setting, the sources in the brain are considered sparse in space and time. Additionally, the inverse problem of estimating source locations from EEG measurements turns out to be greatly ill-posed. The number of sources outnumbers the number of measurements. Due to this, it is a challenge for any advanced solver to explain the measurements.

The technique we developed deals with the issue of ill-posedness. Certainty based reduced sparse solution (abbr. as CARSS) estimates the possible source candidates that might be active. Thereby CARSS reduces the ill-posedness in the problem. Due to the sparse nature, the peak and the shape around the peak are evident on the scalp at the same location. The two principles in the context of EEG source localization on which the method is developed are:

1. When a dipole is active, its extremum and the 'shape' around the extremum, are prominently evident in the measurement vector.
2. The region of evidence of the extremum in the measurement vector is as it is for the dipole.

It is a two-stage process with a preliminary stage at the beginning. Stage-0 deals with finding the peak locations of the lead fields. The second stage involves estimating the local peaks observed in the measurements. The last stage involves solving the inverse problem. The method is examined in detail.

Possible extensions of CARSS are proposed. Three real data studies are examined. They are (i) Binaural beat therapy (32 channel-EEG), (ii) Disgust emotion elicitation (256 channel-EEG), and (iii) Total sleep deprivation (32 channel-EEG). Detailed observation and interpretation of the results are investigated.