BodyPoweredSenSE RTD 2013

nano-tera.ch swiss scientific initiative in health / security / environment systems

Evaluation of Source Functional Connectivity in Low-Density EEG

Elham Barzegaran, Maria Knyazeva

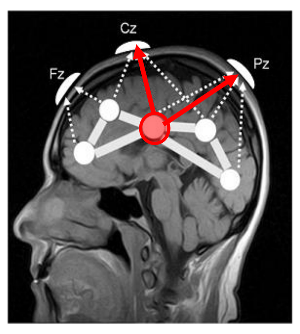
Centre Hospitalier Universitaire Vaudois and University of Lausanne

http://BodyPoweredSenSE.ch

Introduction

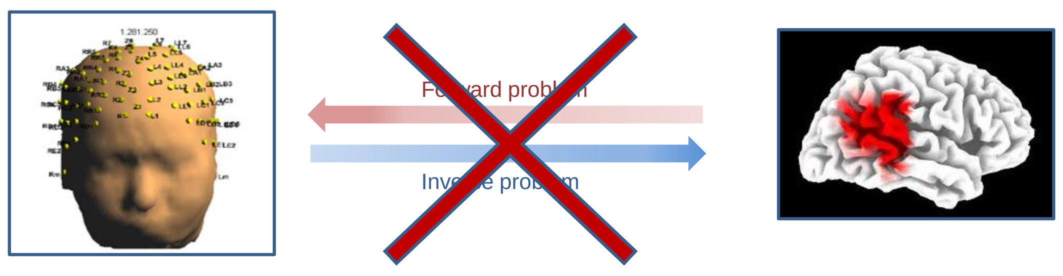
• Wearable ICT allows only **low-density EEG** for monitoring of patients. However, while low-density EEG has technical advantages, it suffers from **limitations** for quantitative assessment.

• These **limitation** are as follows



➢ **Due to volume conductance, FC estimation is not reliable in electrode space.**

➢ **Due to inadequate surface sampling, source estimation of low-density EEG is not accurate.**



• The **goal** of this project is to use a method of analysis, which would overcome these limitations.

• In our approach, we estimated functional connectivity (FC) in low-density EEG. FC corresponds to the interactions of different brain regions and has been shown to change in a number of psychiatric and neurodegenerative diseases [1-3].

• We evaluated the performance of this method by means of simulated EEG data with varying parameters.

Method

A Method that estimates cortico-cortical connectivity from scalp EEG recordings was proposed by **Pascual- Marqui [4].** The method

- works with low-density EEG,
- eliminates the effect of mixed sources,
- is computationally simple and efficient.

The steps we followed:

$$S^{-r}_{source}(f) = K^T S^{-1}_{electrode}(f) K$$

•Estimation of electrode partial spectral covariance

•Estimation of lead-field matrix (K)

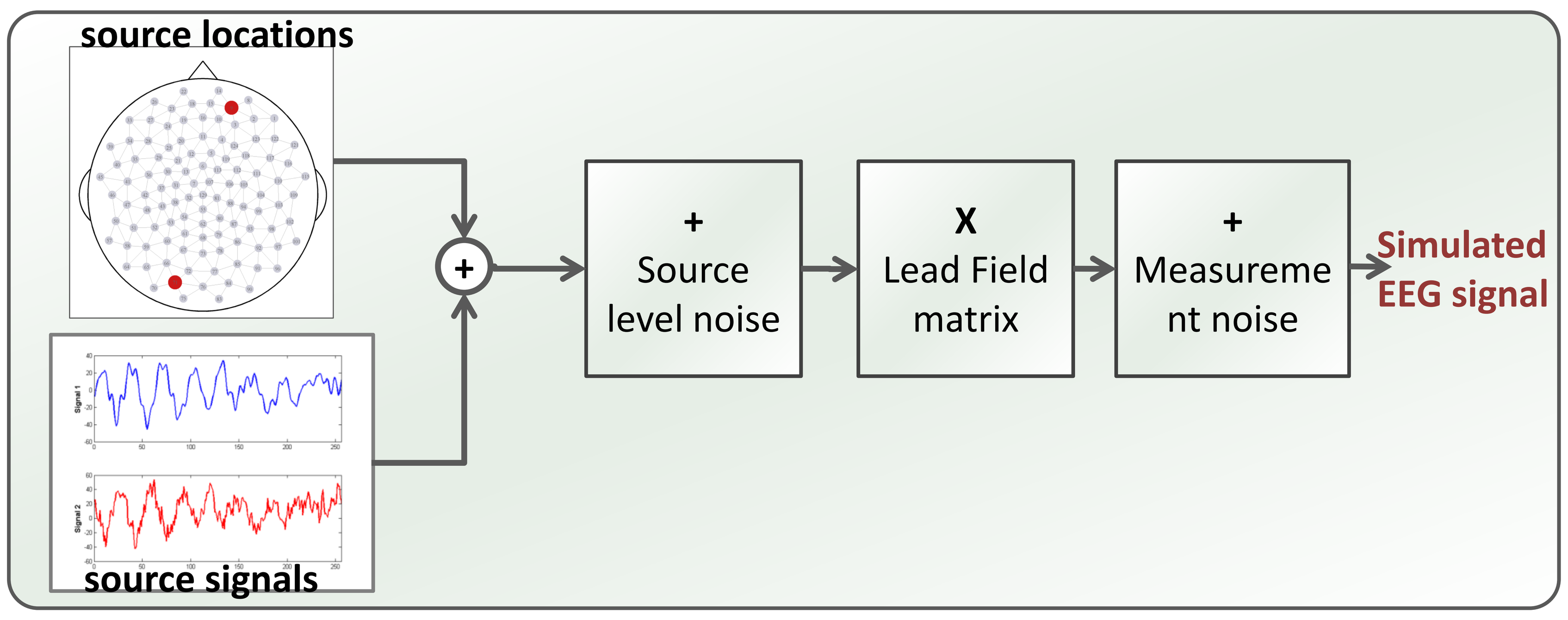
•Estimation of functional connectivity in source space

Simulation

- We simulated Two paired time series.

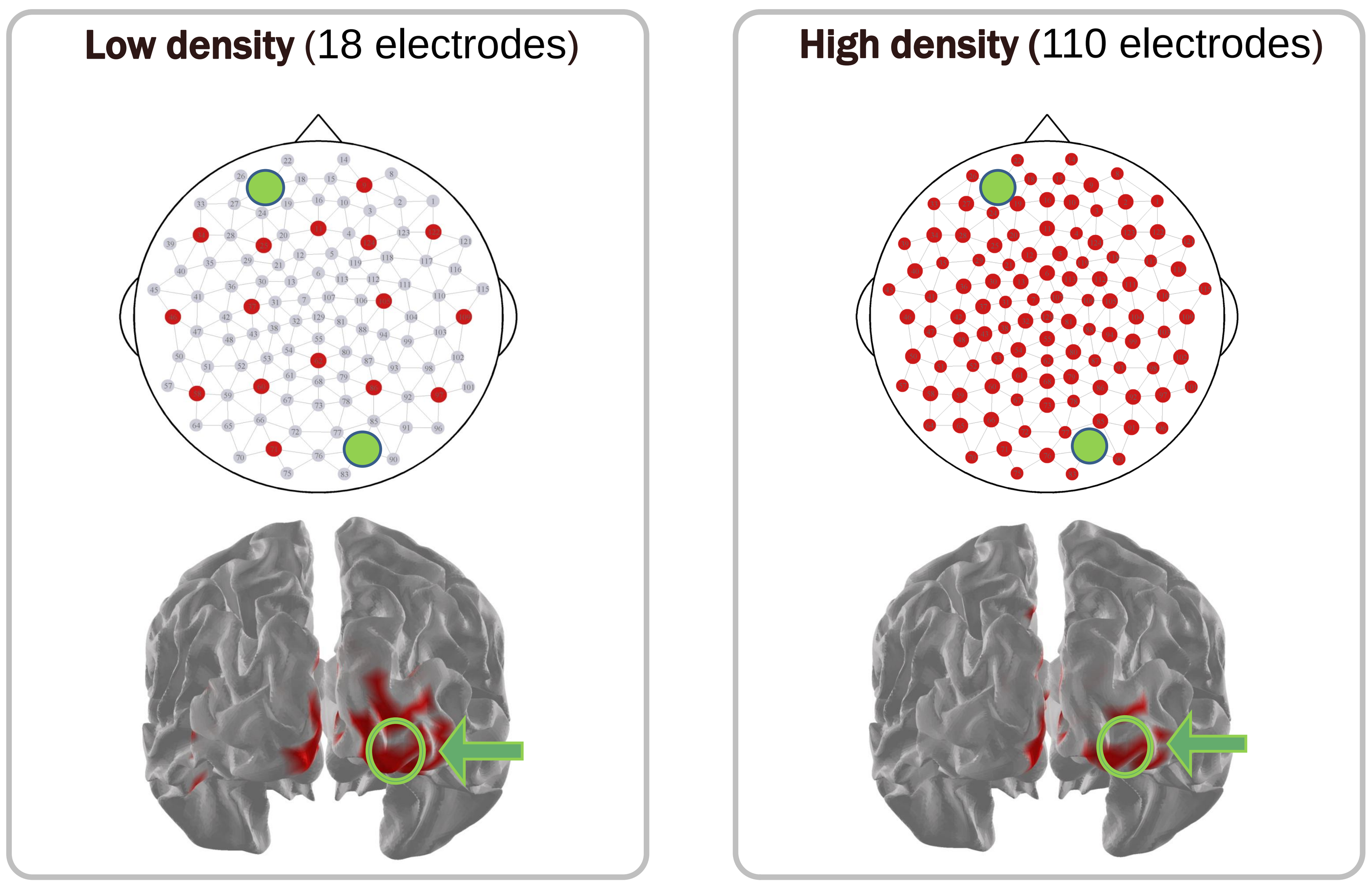
$$\begin{cases} X_t = S_t + e_t \\ Y_t = S_{t-t'} + \delta_t \end{cases}$$

- We calculated Lead field matrix using SPM, for 5124 distributed source points.



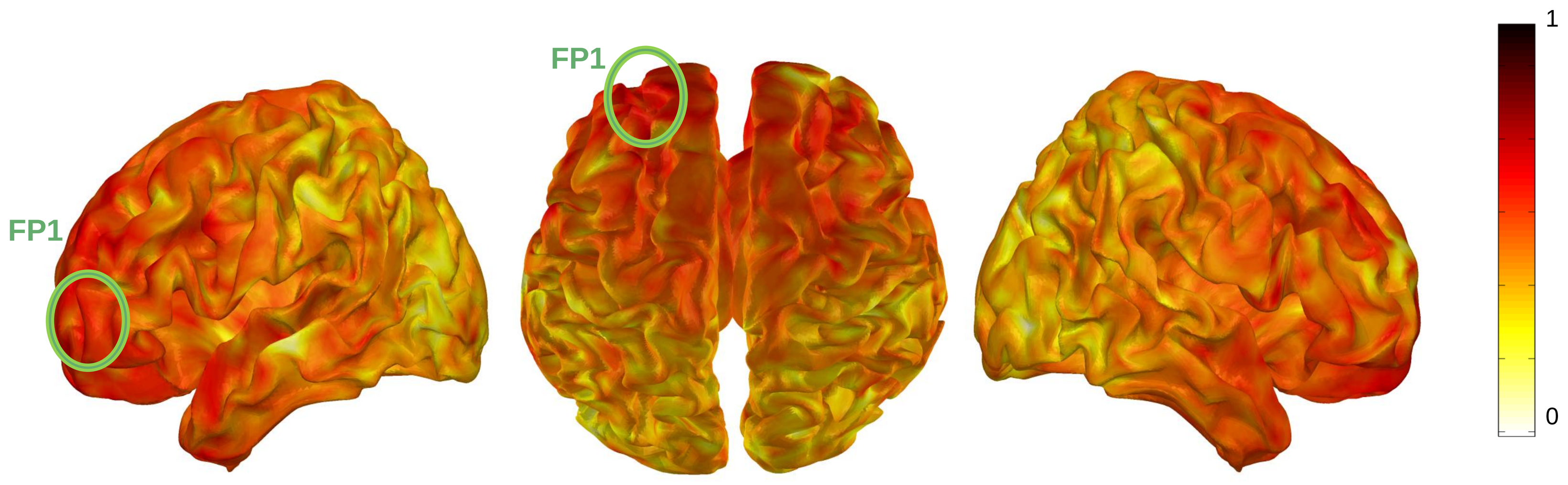
Results

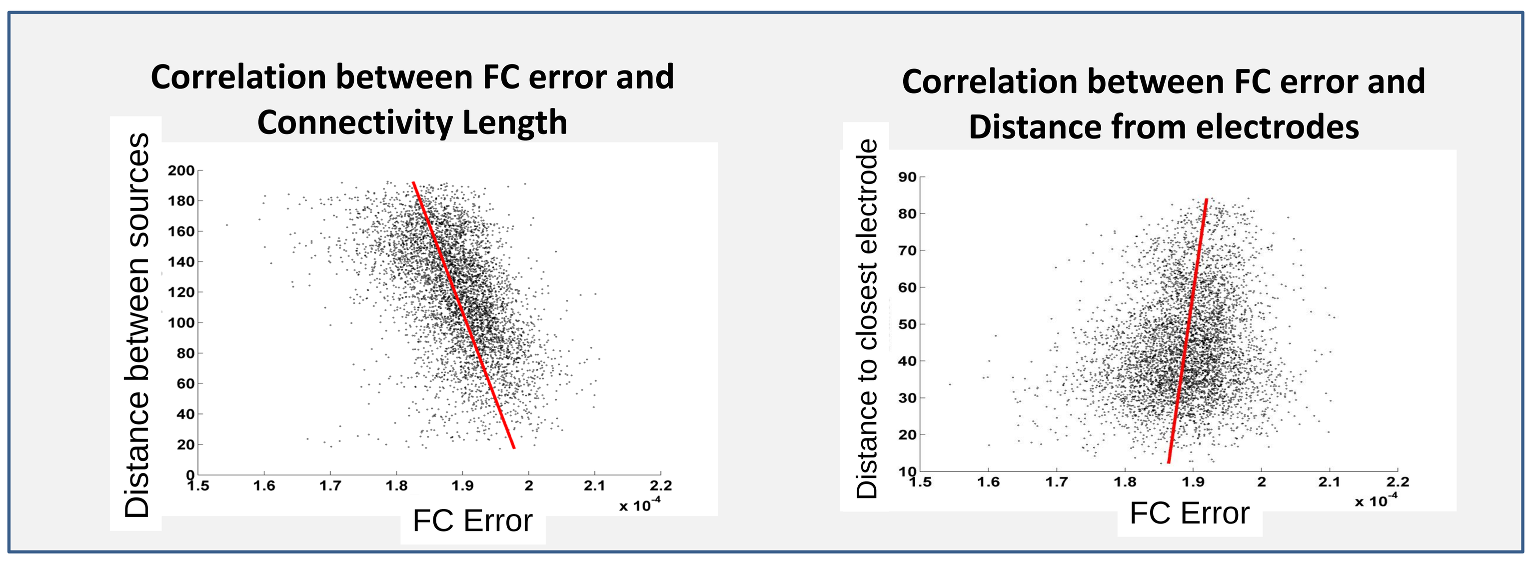
Effect of Electrode Density on FC



• Two simulated signals were located under the electrodes
  • FP1 (Left Frontal),
  • O2 (Right Occipital).
• we simulated signals for low- and high-density EEGs.
• we calculated FC from sources under FP1 to the rest of the brain.

Effect of Source Location on FC





• We used two simulated signals, where
  • The first source was fixed under FP1 (Left Frontal).
  • The second source had varying location between 5123 source points in each simulation.

• We calculated FC from sources under FP1 to the rest of the brain in each simulation.

•We calculated The **FC error** of each simulation as follows

$$\frac{\sum_{n=1}^{p} |\hat{D}(n)| . d(n)}{d(n)},$$

where $d(n)$ is the distance of a source n from real source and $|\hat{D}(n)|$ is the estimated power of the source n.

Conclusion

• The performance of the method for estimation of cortical partial coherence depends on the ***location*** and **distance** between EEG sources.

• The method accurately estimates synchronized sources located under the electrodes.

• The method fails to accurately estimate synchronized sources located between the electrodes.

• In experimental or clinical situations, when the exact location of EEG sources are unknown, the application of the method is limited.

References

[1] Barzegaran, Elham, et al. *Journal of Neurology, Neurosurgery & Psychiatry* (2015): jnnp-2014.

[2] Barzegaran, Elham, et al. *Frontiers in human neuroscience* 6 (2012).

[3] Knyazeva, Maria G., et al. *Neurobiology of aging* 34.3 (2013): 694-705.

[4] Pascual-Marqui et al. arXiv preprint arXiv:1108.0251 (2011).

Elham.barzegaran@chuv.ch