SAN 2020

WORKSHOP: PREPROCESSING TECHNIQUES ON COMBINED EEG AND MEG DATA OF A DRUG-RESISTANT EPILEPSY CASE

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Introduction

In recent years non-invasive brain temporal imaging modalities such as combined EEG (Electroencephalography) and MEG (Magnetoencephalography) referred to as EMEG have gained attention in epilepsy research. This study aims to investigate preprocessing techniques applied on EMEG epilepsy data to restrict biological and non-biological artefacts. Specifically, preprocessing consists of Wavelet Independent Component Analysis (wICA) and thresholding techniques that are applied on the EMEG data of a 49-year-old female patient with focal epilepsy as it was presented in the study of (Aydin, 2017). The raw EEG/MEG signals are first bandpass filtered from 0.5 to 500 Hz and then, a Notch filter is applied on 50 Hz and its harmonics to remove Power Line Noise. The filtered signals are visually inspected to discard channels that could not be preprocessed due to high noise. Subsequently, wICA (Castellanos, 2006) is used to reveal independent component (IC) spectral information and use it for identification and distinction of artefactual from brain activity sources. The extended Infomax algorithm is used for the application of ICA on preprocessed EEG and MEG data separately. An important parameter before ICA is the dimensionality reduction that (1) reduce the white noise of the original data and (2) speed up the application of ICA. We apply such a parameter through the metric Percentage of Useful Information, i.e. the number of principal components that could statistically explain best the original data (Antonakakis, 2013).

Afterwards, each IC is partitioned into segments and Stationary Wavelet Transform (SWT) is applied. To identify only artefactual segments, the correlation coefficient was calculated between the segments' SWT and the reference channels. The final algorithmic step is to reject the artefactual segments and reconstruct the rest to retain only cerebral activity. Two methods are examined for signal decomposition: (1) Empirical Mode Decomposition (EMD) and (2) Wavelet Transform (WT). EMD decomposes the signal into basic functions called Intrinsic Mode Functions (IMFs), some of which represent non-cerebral activity. An IMF is classified as non-cerebral activity and discarded if its standard deviation exceeds the standard deviation of the first IMF (Lindsen, 2010). Contrarily, the WT algorithm estimates the wavelet coefficients of the artefactual segment. All wavelet coefficients that exceed the scaled standard deviation of the segment are considered artefactual and downscaled (Donoho, 1995). After the coefficient shrinkage, Inverse Wavelet Transform is applied. The results from the application of both different artefact detection and correction approaches on the EMEG epilepsy data are presented and discussed.

Keywords

EEG, MEG, Preprocessing, EMD, Wavelet-Independent Component Analysis