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Diagnosis of multiple sclerosis from EEG signal analysis using Empirical Mode Decomposition and Support Vector Machine

Rodrigo Villalba Barrientos[1]
Christian Schaerer[2]
National University of Asuncion, Paraguay.
Miguel García-Torres[3]
Division of Computer Science, Universidad Pablo de Olavide, ES-41013 Seville, Spain.
Manuel Vázquez-Marrufo[4]
Universidad de Sevilla, Spain.

1 Problem definition

Multiple Sclerosis (MS) is a chronic disease of the central nervous system that produces several degrees of persistent neurological damage. In many cases, patients lose their capacity for body control, vision and balance. The most common diagnostic methods for MS are based on neuroimaging (magnetic resonance imaging), although analysis of cerebrospinal fluid and electroencephalogram (EEG) signals have also been shown to be effective [1]. This work presents a model to classify people into healthy or sick according to the EEG signal analysis. The procedure for the analysis and classification of the signal is illustrated in Figure 1. To construct the model, samples were taken from 35 healthy people and 33 people with MS using 9 electrodes (C5, C6, Cz, F5, F6, Fpz , P5, P6, Pz) placed on the scalp. A problem that arises when obtaining the EEG signals using non-invasive methods

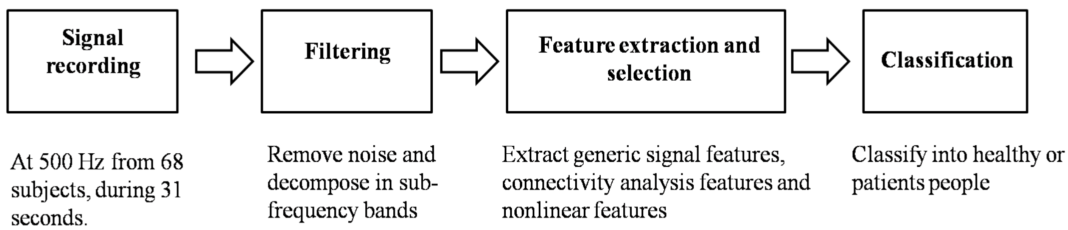

Figure 1: The classification procedure of EEG signals.

consists in the contamination with noise of the original signals. In order to minimize the

[1]rodrigovb@yahoo.com
[2]cschaer@pol.una.py
[3]mgarciat@upo.es
[4]marrufo@us.es

impact of noise, the data are usually filtered using band-bass filters. Normally, the EEG signals are filtered in a range of 0.5 - 45 Hz. However, while the band-pass filters improve the signal-to-noise ratio (SNR), they significantly alter the original signal and when a lot of noise is removed it is also likely that some signal will be removed. These results have motivated the researchers to fully analyze EEG data without any filtering methods, but resorting to signal analysis methods [2].

In this work, an adaptive Empirical Mode Decomposition (EMD) for analyzing EEG signals is explored. EMD algorithm decomposes the EEG signal into several modes called Intrinsic Mode Functions (IMFs). After the decomposition, IMFs with frequencies above 45 Hz are eliminated.

To extract features from the data, three types of measurements are used: generic features of time series (amplitude, standard deviation, percent beyond 1 std, maximum, maximum slope, median, median absolute deviation, percent close to median, minimum, skew, weighted average), connectivity analysis measures (coherence) and nonlinear measures for dynamical systems (sample entropy, Hurst exponent and parameter H of the Detrended Fluctuation Analysis). Data are classified applying Support Vector Machine (SVM) with hyperparameter optimization, setting the parameters with 10-fold cross validation.

2 Results

This is a part of an ongoing work. Our first experiments using the Empirical Mode Decomposition on a portion of the dataset for the preprocessing shows encouraging results comparing with other techniques. Using the original data, 51% of precision are obtained by the SVM classifier (hyperparameters: c = 30 and gamma = 0.0001) with 55% of positive predictive value (PPV) and 48% of negative predictive value (NPV). Preprocessing the data with Loess smoothing, the performance obtained was 44% (c = 100 and gamma = 0.0001) with 47% of PPV and 41% of NPV. The EMD had better performance, obtaining 59% (c = 3 and gamma = 0.001) with 67% of PPV and 50% of NPV.

References

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