A REWORKED SECOND ORDER BLIND IDENTIFICATION ALGORITHM IN EEG PROCESSING TECHNIQUE FOR FAST RECOGNITION OF MOTOR IMAGERY MOVEMENTS

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Introduction

In this paper we propose an *improvement* in the processing technique which is applied to Electroencephalography (EEG) signals with the purpose to recognize motor imagery movements and use this finding in performing *brain-based control of rehabilitation devices* This technique identifies in the patient signal the occurrence of desynchronization and synchronization (ERD/ERS) events related with motor imagery. However, to do this, the received patient signal is first subjected to the removal of environmental and system noise as well as interference noise which correspond to normal human activities such as eye-blinking and cardiac motion (artifacts). This kind of processing has to take place within time limits imposed by the on-line control requirements of the rehabilitation devices.

Second Order Blind Identification (SOBI) independent component analysis (ICA) algorithm is a widely used algorithm in removing artifacts. This algorithm, however, presents *long processing time* making the overall time for motor imagery movement identification not suitable for brain-based control of rehabilitation devices. A *rework* of this algorithm based on SCHUR decomposition, results to an *accelerated determination* of the imagery movement.

Methods

During imagery motor movements tasks, the so called mu and beta ERD and ERS are taking place, allowing us to determine human patient imagery movement [1]. These imagery tasks, which can be recognized as *power suppression and spikes* (Figure 1), indicate that the ERD/ERS events of imagery motor movements are taking place. However, original recordings of EEG data contain environmental and system noise and interference that corresponds to normal human activity such as eye-blinking and cardiac motion which need to be removed in order to isolate the ERS/ERD events from the rest of the signal.

In order to remove noise that is correlated with eye-movement (EOG) and heart motion (ECG), the Second Order Blind Indedification (SOBI) source separation algorithm [2] can be used. The algorithm works with the use of *joint diagonalisation* on a set of partial covariance matrices. The SOBI modification addressed in this study concerns the way that covariance matrices are diagonalized.

In order to determine the imagery movement, power and energy features of the signal obtained after the removal of artifacts are compared with the same features of classified signals from an available database and the class to which the processed signal belongs, is identified. The database classification is done off-line by using the SVM algorithm.

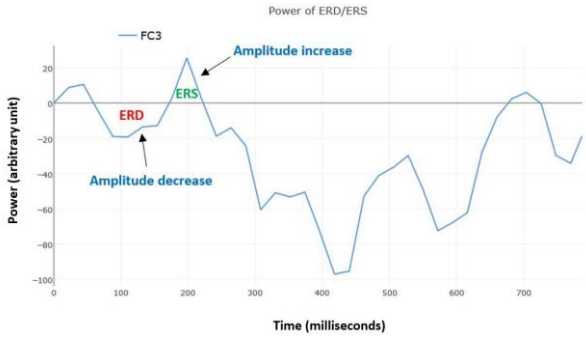

Figure 1. ERD/ERS of motor imagery tasks during EEG recording over premotor cortex signal.

Results

The evaluation of the EEG processing with the purpose of identifying motor imagery movement based on SOBI and modified SOBI algorithms are shown in Table 1. It becomes evident that a reduction of *almost 80%* in the execution time is achieved.

Table 1: EEG process technique execution in seconds

Data set	Execution time of EEG processing algorithms in seconds	
	based on typical SOBI	based on modified SOBI
1	9.845235	1.567458
2	10.379097	1.845277
3	11.514513	1.814460
4	9.800095	1.739605
5	9.799495	1.600469

References

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2. K. Knuth, “Difficulties applying recent blind source separation techniques to eeg and meg,” Maximum Entropy and Bayesian Methods pp. 209-222, 1997.

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