

# Abstract

**Mohamed Hossam El-Din Zaky**

## **A Stable Model for a Motor Imagery Based Brain-Computer Interface**

Brain-computer interface (BCI) has been known as a cutting-edge technology in the current research. It is able to measure the brain activity directly instead of using the natural peripheral nerves and muscles and translates the user's intent brain activity into useful control signals. Electroencephalography (EEG) is the chosen BCI technology because it is noninvasive, portable and inexpensive. Currently, BCI using EEG can be divided into two strategies Selective attention and spontaneous mental signal. For the Selective attention strategy, BCI relies on external stimuli which might be uncomfortable for individuals who need to focus on external stimuli and the environment simultaneously. This is not the case for BCIs which rely on spontaneous mental signals initiated by the users themselves. BCI that uses Sensorimotor Rhythm (SMR) is one of the examples of the spontaneous mental strategy. This thesis presents a stable model for classifying multi-motor imagery tasks through offline analysis, first a model for individual BCI where the subject performed a daily session for a complete week, second a model for universal BCI where two subjects performed the same tasks. Finally, a model to check the effect of extensive training on the classification accuracy for three successive sessions, and a stable model for classification was reached in that case also. Based on the results, first for the individual model, according to the evaluation parameters, using Linear Discriminant Analysis (LDA) as a classifier with Common Spatial Pattern (CSP) feature gives the highest performance compared to the other classifiers achieving an average classification accuracy of 88.46%. For a universal BCI, when statistical features taken from the signal in time-domain are combined with CSP as a feature, the LDA classifier reaches an average classification accuracy of 95.22%, which is the highest accuracy that can be obtained by any classifier. Finally, for the extensive training test on the subject, using LDA with CSP feature combined with Band Power (BP) feature gives the highest performance compared to the other classifiers achieving an average classification accuracy of 90%. It was realized in the three models also that LDA outperforms all classifiers with the majority of features, but when the feature vector length is increased, Support Vector Machine (SVM) is better.