



AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Computer and Systems Engineering

A Brain-Computer Interface Speller for Smart Devices

A Thesis submitted in partial fulfilment of the requirements of the degree of

Master of Science in Electrical Engineering

Computer and Systems Engineering

by

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Bachelor of Science in Electrical Engineering

(Computer and Systems Engineering)

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Statement

This thesis is submitted as a partial fulfilment of Master of Science in Electrical Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Thesis Summary

Brain–computer interfaces (BCIs) have attracted much attention recently, triggered by new scientific progress in understanding brain function and by its impressive applications. BCIs have the potential to enable severely disabled individuals to communicate with other people and to control their environment.

Motor imagery is currently one of the main applications of Brain-Computer Interface (BCI) which aims at providing the disabled with means to execute motor commands. One of the major stages of motor imagery systems is reducing the dimensions of the input data and enhancing the features prior to applying a classification stage to recognize the intended movement. We utilize autoencoders as a powerful tool to enhance the input features of the band power filtered electroencephalography (EEG) data. We compare the performance of the autoencoder-based approach to using Principal Component Analysis (PCA). Our results demonstrate that using autoencoders with non-linear activation function achieves better performance compared to using PCA. We demonstrate the effects of varying the number of hidden nodes of the autoencoder as well as the activation function on the performance. We finally examine the characteristics of the trained autoencoders to identify the features that are most relevant for the motor imagery classification task.

One of the main applications of BCIs is virtual keyboards (spellers). Hex-O-Spell is considered one of well known spellers based on motor imagery. Developing Hex-O-Spell for smart devices (smart phones, tablets, ...) can improve the quality of life of disabled individuals allowing them to be more independent. As part of this thesis, a Hex-O-Spell application was developed and examined on three different subjects.

Keywords: Brain-Computer Interface, BCI, Hex-O-Spell, Spellers, Autoencoder, Motor Imagery, EEG, Mobile Application

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Table of Contents

List of Figures	i
List of Tables	iii
List of Abbreviations	iv
List of Symbols	v
Chapter 1 Introduction	1
1.1 Research Scope	1
1.2 Research Objectives	2
1.3 Research Contributions	2
1.3.1 Developing Methods for Motor Imagery.....	2
1.3.2 Introduce Autoencoder as a Dimensionality Reduction Method....	3
1.3.3 Developing a Hex-O-Spell for Smart Devices	3
1.4 Thesis Organization.....	3
Chapter 2 Background	5
2.1 Human Brain Anatomy	5
2.2 Bain-Computer Interface.....	7
2.3 10-20 EEG Standard.....	8
2.4 Electroencephalography (EEG).....	10
2.4.1 P300	10
2.4.2 SSVEP	11
2.4.3 ERD	13
2.5 Neural Oscillation Types.....	15
2.6 BCI Motor Imagery Model	17
2.7 Other Motor Imagery Methods	18
2.7.1 Common Spatial Patterns	18
2.7.2 Support Vector Machines	19
2.8 Cross-validation	19

2.9 BCI Applications	20
2.9.1 Spellers	20
2.9.2 Web Browsing	21
2.9.3 Wheelchair Control.....	22
2.9.4 Entertainment.....	23
2.10 BCI Applications for Mobile Devices.....	24
2.10.1 NeuroPhone System	24
2.10.2 BCI Messenger	25
2.10.3 RunApp and ImgView.....	26
2.11 Tools.....	28
2.11.1 GNU Octave	28
2.11.2 Android Studio	29
Chapter 3 Motor Imagery Recognition Techniques.....	30
3.1 Introduction	30
3.2 Pre-processing	30
3.3 Feature Extraction	32
3.4 Classification.....	32
3.4.1 Linear Discriminant Analysis.....	32
3.4.2 Naive Bayes Classifier.....	33
3.5 Results	34
3.5.1 Dataset	34
3.5.2 Evaluation.....	37
3.5.3 Frequency Bands	39
3.5.4 Classification	41
Chapter 4 Using Autoencoders for Dimensionality Reduction in Motor Imagery	43
4.1 Introduction	43
4.2 Motor Imagery Workflow	43

4.3 Autoencoder	44
4.4 Principal Component Analysis	47
4.5 Dimensionality Reduction Results	48
4.5.1 Autoencoder versus PCA using Optimal Parameters	48
4.5.2 AutoEncoder Results versus Results of the BCI Competition	49
4.5.3 Performance for Different Number of Dimensions	50
4.5.4 Performance of Linear versus Sigmoid Activation Functions.....	51
4.5.5 Analysis of AE Weights	52
Chapter 5 Developing a Motor Imagery Hex-O-Spell Application.....	54
5.1 Introduction	54
5.2 Hex-O-Spell Algorithm.....	54
5.3 Emotiv Headset	57
5.4 Hex-O-Spell Mobile Application	58
5.4.1 Application user manual	58
5.4.2 Application Structure Code	61
5.4.3 Motor Imagery Methods Implemented for Smart Devices.....	63
5.5 Experiment	64
5.5.1 Experiment Prerequisites	65
Chapter 6 Conclusions and Future Work.....	66
6.1 Conclusion.....	66
6.2 Future Work	67
Publications.....	69
References	70

List of Figures

Figure 2-1: Human Brain Structure [2].....	5
Figure 2-2: brain lobes position in human brain[3]	6
Figure 2-3 : 10-20 System Electrode Positions[9].....	9
Figure 2-4: EEG Signal of one channel for one stimulus[12]	10
Figure 2-5 : P300 Speller GUI[14]	11
Figure 2-6: EEG signal (Oz-Cz) acquired during visual stimulation with a frequency of 15 Hz and its frequency spectrum[16].....	12
Figure 2-7 : Bremen-BCI (SSVEP) speller[17].....	13
Figure 2-8 : ERD / ERS phenomena in channels C3 and C4 for left and right imagery in band power (11-13) Hz	14
Figure 2-9 : Raw signal for C3 and C4 for right hand and left hand motor imagery	14
Figure 2-10 : AIRLab Speller based on Motor Imagery BCI[19]	15
Figure 2-11 : Overview of the BCI Motor Imagery approach	18
Figure 2-12 : Cross-validation process	20
Figure 2-13 : Nessi a web browser based on BCI[28]	22
Figure 2-14 : Wheelchair controlled by BCIs[30]	23
Figure 2-15 : Subject playing World of WarCraft PC game using BCI[33]	24
Figure 2-16: Calling Tim using NeuroPhone Application[34]	25
Figure 2-17: (a) BCI Messenger in Chinese mode. (b) BCI messenger in English mode[35].....	26
Figure 2-18: (a) RunApp interface. (b) ImgView interface[36]	28
Figure 3-1 : EEG Signal before and after pre-processing phase.....	31
Figure 3-2 : Figure demonstrate sample signal for 4 classes (right hand, left hand, both feet, and tongue).....	35
Figure 3-3 : Time frame for each subject trial[45].	36
Figure 3-4 : Validation results when using LDA and NBC classifiers (mean \pm std).....	42
Figure 4-1 : Proposed dimensionality reduction and classification approach	44
Figure 4-2 : Simple AE Neural Network architecture	45
Figure 4-3 : Autoencoder-based Dimensionality Reduction.	47