

LP/Don/30/2017

DEVELOPING MUSCLE MEMORY USING HUMAN TO HUMAN INTERFACE



LIBRARY
UNIVERSITY OF MORATUWA, SRI LANKA
MORATUWA

Harsha Niroshana Yapa
149161C



519.6 "IT"
004.8 (043)

Department of Computational Mathematics
University of Moratuwa
Sri Lanka
February 2017

TH3299
+ CD-ROM

TH 3299

DEVELOPING MUSCLE MEMORY USING HUMAN TO HUMAN INTERFACE

Harsha Niroshana Yapa
149161C

Thesis submitted in partial fulfilment of the requirements of the
Degree of MSc in Artificial Intelligence.

Department of Computational Mathematics,
University of Moratuwa,
Sri Lanka.

February 2017

Declaration

I declare that this dissertation does not incorporate, without acknowledgment, any material previously submitted for a Degree or a Diploma in any University and to the best of my knowledge and belief, it does not contain any material previously published or written by another person or myself except where due reference is made in the text. I also hereby give consent for my dissertation, if accepted, to be made available for photocopying and for interlibrary loans, and for the title and summary to be made available to outside organization.

UOM Verified Signature

Name of Student

Harsha Niroshana Yapa

Signature of Student

Date: 09/02/2018

Supervised by

Prof. Asoka S. Karunananda

Name of Supervisor(s)

Signature of Supervisor(s)

Date:

Acknowledgement

I would like to thank Professor Asoka S. Karunananda for all his input, advice, and encouragement throughout the course and always being on hand to provide helpful comments. In fact, when I met Prof. Asoka for the first time, he planted this research idea in my mind, which eventually came out in this project.

I am grateful to my wife, Dulanga Kodithuwakku & lovely baby girl Dulanya for kind support rendered to me when I need it the most. Thanks for being so patience with me during the stressful times.

My parents, they always wanted me study whatever and whenever i get an opportunity. Thanks for pushing me and encouraging me to successfully complete another milestone in my education.

Thanks must also go to Dr. Sisitha Ukwatta, for providing me with information on Human nerve system and related medical terms & procedures. Last, but certainly not least, I am grateful to my batch mates, who supported me in numerous ways.

Abstract

The Learning is something very crucial for the development of the human race. Humans are not a species that bring their intellect hard coded to their DNA, instead they learn things by observation and repeating the activity until it develop muscle memory. In this research, an attempt was made to minimize the time associated with the learning and memorizing of these repetitive tasks by using a Human to Human Interface, where it will capture neural impulses from one human and feed to second human, allowing the second human to develop same type of muscle memory.

As humans, we learn different things by observing how others perform it. If we take an example, children learn to write letters by observing the how their parents write them, or parents may actually hold their kids' hand and guide them on writing letters. When parent hold his/her child's hand and guide them, muscles on Child's hand send sensory signals to brain claiming the way to perform this particular action. However imagine action like learning to play piano, this is complex activity which needs insane amount of time of practicing. A research has been conducted to identify neural impulses generated when piano player is playing a song. Special EEG capturing device is constructed to capture neural impulses from Median, Ulnar, and Radial nerves of the Piano Player's Hands. The EEG signals were captured using the non-invasive methods. The captured signal is then processed through filter, where it will remove all the noises and unwanted EEG signals/muscle Contractions generated due to Blood Flow, etc. These processed signals then feed to TENS device, where it generate artificial stimulation as form of electric current. This new feed of current then applied to trainee's nerves using the passive techniques. Also this stage, there is a noise added to the signal, due to method used in administering the stimulation to trainee's hand. Once the signal applied to respective nerves on the second human (trainee), his hands are moved according to the trainers hand movements.

This solution has been tested using three test subjects (2 men and 1 women), with an average age of 28 years, and results show rapid increase in the effectiveness of the learning when this interface is used. The Error rate while playing piano using Human-to-Human interface was 1.4167 where conventional method showed rate of 2.1666. In conclusion, Human to Human interface assisted learning was 32.69% error free than the conventional method of learning.

Contents

	Page
List of Figures	vii
List of Tables	viii
Chapter 1 Introduction	1
1.1 Prolegomena	1
1.2 Aims & Objectives.....	2
1.3 Background and Motivation	3
1.4 Problem in Brief.....	3
1.5 Novel Approach to reduce time associated with the Learning	4
1.6 Structure of the Thesis	4
1.7 Summary	4
Chapter 2 Emergence of Human Computer Interfacing	5
2.1 Introduction.....	5
2.2 Brain Computer Interface (BCI)	5
2.2.1 Invasive Brain Computer Interface	6
2.2.2 Partially - Invasive Brain Computer Interface	7
2.2.3 Non - Invasive Brain Computer Interface.....	7
2.3 Functional Electrical Stimulation	8
2.3.1 Electrical Activation of Human Muscle	10
2.4 Transcutaneous Electrical Nerve Stimulation.....	11
2.5 Summary	12
Chapter 3 Electroencephalography and Artificial Muscle Stimulations	13
3.1 Introduction.....	13
3.2 Electroencephalography.....	13
3.3 EEG Tests	16
3.4 Transcranial direct current stimulation (tDCS).....	17
3.5 Arduino	18
3.6 Summary	19

Chapter 4 Approach to Develop Muscle Memory using Human to Human Interface	20
4.1 Introduction.....	20
4.2 Hypothesis.....	20
4.3 Inputs.....	20
4.4 Output	20
4.5 Process	21
4.5.1 Neural Impulse Capturing System	21
4.5.2 Signal Processing unit.....	22
4.5.3 TENS device	22
4.5.4 Neural Impulse Feeding System	22
4.6 Suggested Application	22
4.7 Functional Requirements	22
4.8 Users	23
4.9 Summary	23
Chapter 5 Analysis & Design of H2H Interface Program.....	24
5.1 Introduction.....	24
5.2 Human Nerves	24
5.3 EEG Input/output.....	25
5.4 Data Processing.....	27
5.6 Summary	28
Chapter 6 - Implementation of H2H Interface Program	29
6.1 Introduction.....	29
6.2 Detect the EEG Signal	29
6.3 Interpretation of EEG Signal	32
6.4 Generation of new EEG Signal.....	33
6.5 Summary	34
Chapter 7 Evaluation.....	35
7.1 Introduction.....	35
7.2 Experimental Design.....	35
7.3 Experimental Result.....	37
7.4 Conclusion	39

7.5 Summary	40
Chapter 8 Conclusion & Further Work	41
8.1 Introduction	41
8.2 Conclusion	41
8.3 Further Work	42
8.4 Summary	43
Reference	44
Appendix A	46
EEG Capturing using Arduino Shield	46
A.1 Introduction	46
A.2 Arduino Source Code	46
Appendix B	49
EEG Analogue to Digital Conversion using Arduino Shield	49
A.1 Introduction	49
A.2 Arduino Source Code	49

List of Figures

	Page
Figure 1.1 - Brain Activity of Monkey moves a Robot Arm	2
Figure 2.1 - Brain Computer Interface to Control Cursor	6
Figure 2.2 - FES on Foot Drop Syndrome	9
Figure 2.3 – A four-lead TENS unit	11
Figure 3.1 – EEG Signals	14
Figure 3.2 – Arduino UNO board	18
Figure 4.1 – Proposed System	21
Figure 4.2 – Proposed Neural Impulse Capturing System	21
Figure 5.1 – Nerves on the Human Arm	25
Figure 5.2 – EEG I/O System	25
Figure 5.3 – Arduino EEG Shield	26
Figure 5.4 – TENS Device	27
Figure 6.1 – EEG Arduino Shield	30
Figure 6.2 – EEG Capturing Configuration	31
Figure 6.3 – EEG Capture/View Application	32
Figure 6.4 – TENS Device Setup	33
Figure 6.5 – TENS Device Configuration	34

List of Tables

	Page
Table 7.1 – Experiment Design	35
Table 7.2 – Experiment Results	37