Development of an EEG signal based Brain Machine Interface for a Meal Assistance Robot

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Degree of Master of Science

Department of Mechanical Engineering

University of Moratuwa
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Thesis submitted in partial fulfillment of the requirements for the degree Master of Science in Biomedical Engineering

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DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

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Abstract

Most of the countries in the world are facing the problems of aging population and disabilities among the population. Among different problems faced by these individuals, self feeding can be identified as an important aspect that should get more attention from the research community. In addition, self feeding reflects the interdependency of an individual and thus relate to their mental health. Taking care of these individuals using care takers is becoming more and more difficult due to diminishing workforce for such tasks. Therefore assistive robotic technologies play a major role in providing feeding solutions to these individuals with disabilities. Meal assistance robot is a device designed to assist the individuals in need with self feeding.

The research work of this thesis is focused on developing an EEG signal based Brain Machine Interface for a meal assistance robot. Meal assistance robot is capable of handling solid food items using the spoon mounted on the end effector. Identifying user's food selection is carried out using a Steady State Visually Evoked Potential based Brain Machine Interface where 3 LED matrices flicking at 6Hz, 7Hz and 8Hz are used to generate the stimulations in the brain. User has to gaze at a LED panel to activate the motion path of the robot which will feed the solid food from the container associated with the gazed LED panel. System is incorporated with a visual servoing algorithm to identify the user's mouth position and adapt the food feeding location according the mouth location. Further, Mouth open/close status detection system is developed to measure the user's willingness to intake the food. The developed meal assistance robot is experimentally validated using 15 subjects in different experiments.

After detailing the research methods carried out, discussion of the results obtain are presented at the end of the thesis with limitations of the research and possible future improvements.

***Keywords*-Meal Assistance Robot, SSVEP, visual servoing, EEG**

DEDICATION

This dissertation is dedicated to my parents, to whom i can trace my every success to.

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LIST OF ABBREVIATIONS

FFT Fast Fourior Transformation

CCA Canonical Correlation Analysis

ADL Activities of Daily Living

SSVEP Steady State Visually Evoked Potential

EEG Electroencephalography

FMRI Functional Magnetic Resonance Imaging

MRI Magnetic Resonance Imaging

DOF Degree of Freedom

SCI Spinal Cord Injury

TMR Targeted Muscle Reinnervation

ECoG Electrocorticography

EMG Electromyography

EOG Electrooculography

BMI Brain Machine Interface

fNIRS Functional Near-Infrared Spectroscopy

SSVEP Steady State Auditory Evoked Potential

ERP Event Related Potential