INCORPORATING BIOLOGICAL SIGNALS FOR UNDERSTANDING USER INTENTIONS FOR INTELLIGENT WHEELCHAIR

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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgment 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

Over the years Intelligent wheelchairs which can gather information from the environment to make decisions for itself have been developed to fulfil the needs of the wheelchair users. To improve the human robot interaction between the wheelchairs and the users, wheelchairs come with several types of controllers which are designed to meet the customer satisfaction. Use of biological/ electrophysiological signals for improved user satisfaction has an increasing demand all over the world.

In order to incorporate user intentions for the navigation purposes and object manipulation purposes of an intelligent wheelchair electrophysiological signals can be used. Due to the high signal to noise ratio and the fact that it does not require invasive surgical procedures to extract the electrophysiological signal, electromyography is used for above mentioned purposes. Since, electromyography is generated due to the motion intention of the user, it can accurately represent the intention of the user. Furthermore, the number of working muscles required to build a controller for above mentioned purposes is high. Hence, it can be seen that most of the existing electromyography based controllers use muscles associated with hand movements as they can generate several number of combinations of muscle activations depending on the hand movement/ grasping pattern. However, these are invalidated if the wheelchair user is suffering from physical conditions like trans-radial amputation where the upper limb is amputated between wrist and the elbow, trans-humeral amputation where the upper limb is amputated between shoulder and elbow and the partial/complete paralysis of the upper limb. This thesis proposes an Electromygraphy based controller for navigation and intelligent object manipulation of the wheelchair, which can be used even by the wheelchair users with trans-radial amputation, trans-humeral amputation and partial limb function. Any wheelchair user who has partial/complete function of biceps brachii of both of the arms, triceps brachii of the dominant arm and the right and left sternocleidomastoid of the neck, can use the proposed electromyography based controller. Moreover, the controller is enhanced with vision sensor and a proximity sensor for the intelligent object manipulation task. By using the common user preferences and his previous experience in arranging objects on a wheelchair tray controller was designed to be user friendly.

Experiments were carried out to monitor the adaptability and usability of the proposed Electromyography based controller among different users. Results confirmed that it can be used by any user after calibrating it for few trials. A human study was performed for different subjects to monitor whether patterns emerge in placing objects in different situations. After implementing a clustering algorithm, common locations and arrangements for object placements were identified. Furthermore, experiments were performed after building the whole system inside the CoppeliaSim simulation environment, to monitor the capability of the proposed system in manipulating and arranging objects according to the user preferences in different situations. Simulation results proved that the proposed system can place the objects in accordance with the results of the human study.

Keywords- **cHRI, Electromyography, Reach to grasp, Navigation, Intelligent object manipulation, Intelligent Wheelchair**

DEDICATION

To my loving wife

who has been the bed of roses in this road of prickles.....

and

to my dearest family

who keeps lifting me up unconditionally

every time I fall down.....

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

IW	Intelligent Wheelchair
EMG	Electromyography
EEG	Electroencephalography
ECoG	Electrocorticography
EOG	Electrooculography
PWM	Pulse Width Modulus
PC	Personal Computer
Tab	Tablet
URDF	Universal Robot Description Format
HITL	Human in the Loop