EMG Signal Controlled Wheelchair

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ABSTRACT
EMG Signal Controlled Wheelchair is one possible way to help amputees, quadriplegics and people with limb impairment in day-to-day locomotion. The design described in this paper aims to enable movement by simple hand twitches. The paper describes the project from conceptualization toimplementation. The EMG signals detected through electrodesundergo Signal Acquisition System and provide digital output to the microcontroller which in turn drives the respective motor. The Control Code is designed as when the persontwitches its left or right hand the wheelchair turns left or right respectively and when both twitched simultaneously the wheelchair moves forward.

General Terms
Electromyography (EMG), wheelchair, Pulse Width Modulation (PWM)

Keywords
Signal Acquisition System, Surface Electrodes

1. INTRODUCTION
Millions of people around the world suffer with mobility impairment and hundreds of thousands of them rely on powered wheelchairs for activities of daily living [5]. These users can control movement of the wheelchair by input devices such as joystick control or mouse or keyboard. But one of the surveys suggests that nearly half of the people using these kinds of wheelchairs cannot control or move their wheelchairs by using controller interfaces. Thus, there is a need to develop control methods of wheelchairs for elderly and people with restrained mobility in their lower limbs. And here, EMG signals are used to control these movements. This model is basically to find a way to alleviate the constraints faced by the disabled people in their day-to-day movement. Sometimes, involving a joystick can also require extra effort, which can be otherwise reduced by using EMG Signal Controlled Wheelchairs. EMG pertains to Electromyography, which involves converting the potential difference derived from muscle movement into electrical pulses. EMG signal-controlled wheelchair is being proposed upon referencing various surveys. The road to the product becoming fathomable has been a long one. First, the introduction of EMG signals, then the gradual transition from manual wheelchair to joystick-based wheelchair to now an EMG signal-controlled wheelchair. Instead of persisting with joystick-controlled wheelchair which still needed some arm or leg activity, EMG signal-controlled wheelchair which can convert minimal muscle movement into electrical signal using electromyography. It can be used for locomotion which is a huge help for the physically impaired orneurologically affected patients.

2. METHODOLOGY
2.1 Electromyography
The study of electromyography is important, as it will help in recognizing various parameters for controlling the wheelchair. EMG signal is an electrical signal generated by contraction and relaxation of muscle [1]. It generally lies in the range of 50-150 Hz.

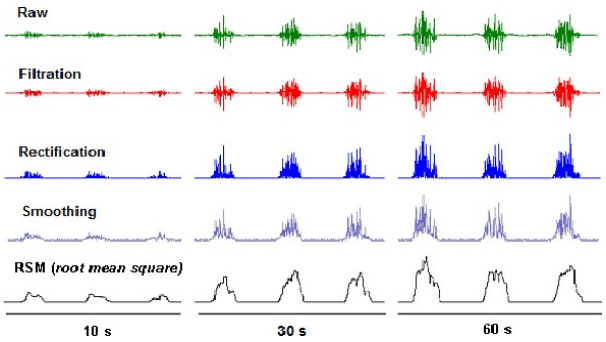

Figure 1: EMG Signals [7]

Invasive and non-invasive are two methods in which an EMG signal can be captured. Surface EMG Electrodes is a non-invasive method, where the electrodes are positioned on hand. The reference electrode is placed on the bony area of the elbow and other two electrodes on the forearm, which takes the differential signal and then compares it with the reference signal.

2.2 Signal Acquisition System
Myoelectric signals are generated by residual muscles of the person's body. When a muscle contracts, ions flow in and out of the muscle cells. This muscle contraction is converted into electric current using Surface Electrodes [6]. At different muscle groups different muscle responses are obtained.

According to an individual's response, a testing circuit is designed. The signal acquisition system takes input signals from Surface Electrodes and amplifies them using Myoware Muscle Sensors v3.0. Generally, noise components are in the frequency range of 0-10 Hz and 500 Hz. Filtering circuits (High Pass Filter and Low Pass Filter) are used to filter out the noise. This circuit is designed on the general-purpose board for a prototype which transmits digital output of muscle flexion to a microcontroller.

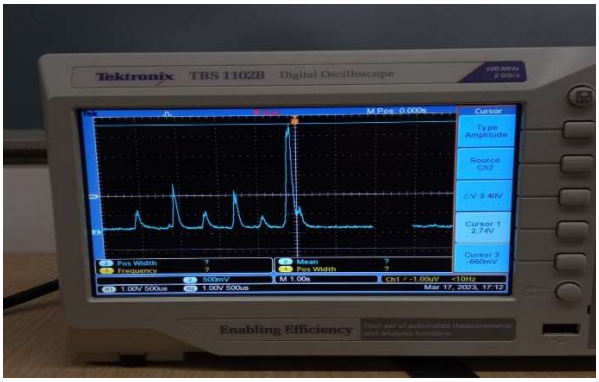

Figure 2: Digital Output of Muscle Flexion

2.3 Microcontroller Unit and Driver Integration

To develop a Control Code for wheelchair operation, it is important to decide the Threshold levels of received signals.For different operations, threshold levels are decided on an aggregating basis of different individual responses.

Accordingly, the Control Code is developed for operation. Three threshold levels are required. Twitching of Left and Right Hand individually to move in respective direction and twitching both hands simultaneously to move in forward direction. Motor drivers are tested using dummy PWM signals. The control code is then integrated with Motor Drivers. For complete functionality, the signal acquisition system is integrated with the Microcontroller Unit and motordrivers.

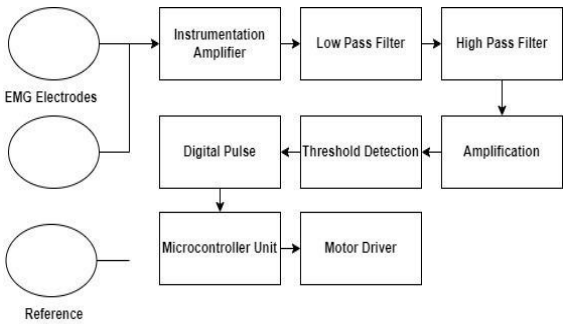

Figure 3: System Block Diagram

Table 1: Actuation Logic

Left Hand Response	Right Hand Response	Action	Motors
Peak	Peak	Move Forward	Both Motors move
Peak	Flat	Turn Left	Right motor moves, hence Left turn
Flat	Peak	Turn Right	Left motor moves, hence Right turn
Flat	Flat	No motion	Wheelchair stays still

3. RESULTS

The prototype of the wheelchair is shown in the Figure 3. The signal acquisition system is tested on different individuals. This helped to acquire more accurate threshold values. This threshold values acts as reference. Once reference is obtained signal acquisition system converts this electrical signal into digital pulse which drives the motor through Microcontroller. Two digital pins are used on microcontroller for direction identification. Whichever pin gets the high pulse drives the respective motor and if both high drives both the motor and the wheelchair move in forward direction.

Figure 4: Prototype of the proposed wheelchair

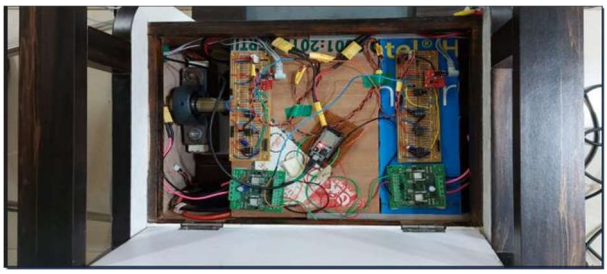

Figure 5: The electronic circuitry loaded within the wheelchair

4. CONCLUSION AND FUTURE SCOPE

The Signal Acquisition System helps in maneuverability of Wheelchairs. The Control Code was implemented with respect to the physical circuit for accurate movements. Thiswheelchair aims to alleviate problems of movement for physically challenged people.

EMG Signal Controlled Wheelchair can also be equipped with certain IoT features. Features like Live Location Tracking and User Dashboard for wheelchair monitoring on the cloud will help the individual and his family as well. Dashboards indicating battery power and life cycle of wheelchairs will help the manufacturing company and individual for maintenance.

5. REFERENCES

[1] C. J. D. Luca, “Electromyography. Encyclopedia of medical devices and instrumentation,” (John G. Webster, Ed.) John Wiley Publisher, 98-109, 2006.

[2] Leslie Cromwell, Fred J. Weibel and Erich A. Pfeiffer, Biomedical instrumentations and measurement 2nd edition(1980), Prentice-Hall, Inc., Englewood cliffs, N.J. 07632. ISBN 0-13-076448-5

[3] Guyton and Hall., Textbook of Medical Physiology11th edition(2006), Elsevier Inc., Philadelphia, Pennsylvania 19103-2899. ISBN 0-8089-2317-X

[4] Hossein Ghapanchizadeh, Siti A. Ahmed and Asnor Juraiza Ishak, Recommended surface electrode position for wrist extension and Flexion, 2015 IEEE Student Symposium, DOI: 10.1109/ISSBES.2015.7435877

[5] T. Carlson, J. del R Millan, “Brain-controlled wheelchairs: a robotic architecture”, IEEE Robotics & Automation Magazine, vol. 20, no. 1, 2013, pp. 65–73. 2013.

[6] S.Sathish, K.Nithyakalyani, S.Vinurajkumar, C. Vijayalakshmi and J. Sivaraman,"Control of Robotic Wheel Chair using EMG Signals for Paralysed Persons", Indian Journal of Science andTechnology, Vol 9(1), DOI: 10.17485/ijst/2016/v9i1/85726.

[7] Altimari, Leandro & Dantas, José Luiz & Bigliassi, Marcelo & Kanthack, Thiago & Moraes, Antonio & Abrao, Taufik. (2012). Influence of Different Strategies of Treatment Muscle Contraction and Relaxation Phases on EMG Signal Processing and Analysis During Cyclic Exercise. 10.5772/50599.