Powered Wheelchair Control through Electromyography Signals

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Figure 3. Prototype of EMG-Controlled Wheelchair

INTRODUCTION

There is a significant population of mobility-impaired individuals worldwide. These impairments can result from spinal cord injuries or neurological disorders such as muscular dystrophy. Manual and powered wheelchairs are the most common solutions, but these are not suitable for the more advanced cases of mobility impairments, e.g. quadriplegia, which impose high challenges on operating wheelchairs. Several novel solutions have been explored: sip and puff systems, chin and tongue controlled joysticks, visual eye-tracking systems, and bioelectricity-based solutions such as EMG (electricity generated from skeletal muscles), EOG (electricity generated from eye muscles), and EEG (electricity generated from brain activity). There are issues with many of these solutions. Sip and puff systems can be slow to respond and sensitive to moisture. Eye-tracking and EOG systems can be unreliable because eyes tend to twitch randomly. Chin and tongue joysticks can be uncomfortable and quickly cause fatigue. EEG and EMG are the two most attractive options as they can facilitate highly intuitive systems. EMG was chosen for this project because of the extreme difficulties in reliably processing and categorizing EEG signals. The EMG signals are captured by a commercial unit and sent to a laptop which runs a program that can convert the signals into commands to control a power wheelchair.

SUMMARY OF IMPACT

This system targets to provide the population with severe mobility disabilities an intuitive and comfortable mobility solution, particularly enabling people who normally have difficulties in operating wheelchairs to gain mobility and thus enhancing their independence in daily activities.

TECHNICAL DESCRIPTION

There are two main subsystems that make up the overall system. One is the EMG signal acquisition and processing system. The other is the power wheelchair control interface. Several commands (forward, stop, left, right, etc.) are assigned to various movements. Electrodes are used to acquire the EMG signals from the user. The placement of each electrode depends on the particular body movement needed for a certain command. Once the body movement is executed, an EMG signal on the order of 5-5000 microvolts is generated and sent to an 8-channel receiver. This receiver also collects the reference signal from an electrode attached to a bony area on the body. This reference voltage is subtracted from the EMG signal to eliminate the noise and DC offset associated with the skin-electrode contact. The receiver sends the signal to an amplification module which digitizes the signal and sends it to a laptop. The laptop runs a signal processing program that converts relevant portions of the signal to the commands. These commands are sent to the wheelchair by a DAQ module. The DAQ interfaces with the wheelchair through its joystick circuit. The overall joystick module has a sub circuit that records the position of the joystick through several inductive coils. This sub circuit has two wires that connect to the main joystick circuit. These wires were removed and replaced with wires connecting to analog outputs on the DAQ. Voltages corresponding to neutral, front, back, left, and right positions of the joystick are sent from the DAC (digital to analog converter) terminals of the DAQ when the appropriate movement patterns are recognized by the EMG acquisition program.

The cost of the parts and supplies for this project was about $1500, in addition to the EMG system, power wheelchair and laptop computer.

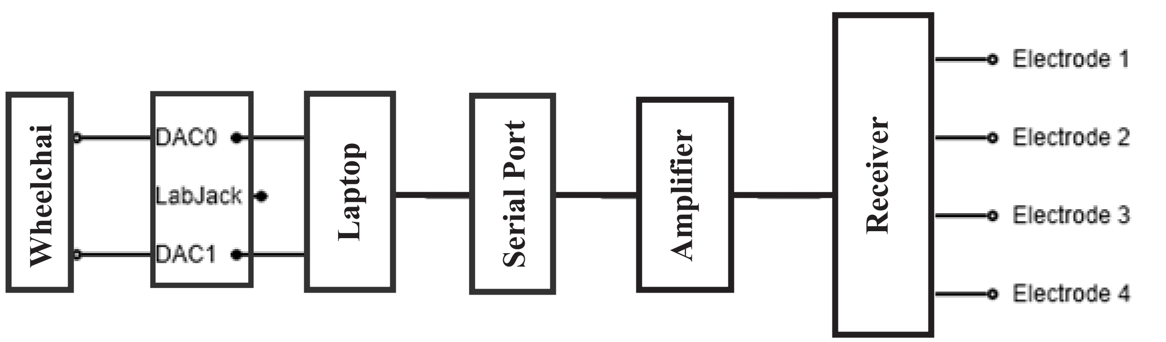

Figure 4. System Diagram of the EMG Wheelchair Control System