DESIGN AND FABRICATION OF PROSTHETIC ARM USING EMG SENSOR

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Abstract: This paper presents an overview of the design and fabrication of a prosthetic arm based on EMG signal. The EMG control is the foremost used approach in today's prosthetic devices since it is a non-invasive compared with other strategies. There exists a demand for such systems as current implementations are complex to utilize, high in cost and inaccessible. We are planning forward to design such kind of EMG signal recorder which is used in prosthetic arm control. Electronic devices and PC/Laptop have been integrated together to achieve the overall goal.
Keywords: EMG; prosthetic arm; non- invasive;

INTRODUCTION

Prosthetic arms are artificial devices designed for people with upper extremity amputations to provide them some functions of natural arms. The number of amputations loss cases in the developing countries are significantly higher than in western countries due to lack of medical knowledge and the prevalence of illness that have been defeated in the developed world. For an amputee, upper limbs loss has many different consequences not only in terms of physically but also socially, economically and psychologically. In order to minimize these consequences and assist the amputee to adapt to normal life, artificial hands and wrists are used to perform daily activities such as dressing, writing and grabbing different objects. Nowadays, several commercial prosthetics devices are available. These devices' range varies from passive cosmetic hands to body harness power split-hooks, myo electric hooks and hands. Despite all the different in their mechanical designs, control signal types and power sources, most of them are extremely expensive at hundreds or thousands of euros. Even cosmeses, prosthetics made only for aesthetics, although less expensive, are still hundreds of euros. Therefore, in the developing countries only 5% of the amputees own prosthesis not only because there are pricey, but also due to distribution and maintenance problems. One of the main purposes of this project is to develop a low-cost prosthetic arm for patients in developing countries

II. COMPONENTS USED SERVO MOTORS

For finger actuation, a SG90 servo motor was chosen. This small and simple motor was chosen since it can provide the necessary features such as small size, light weight, integrated gearbox and cheap price. Despite all the advantages, this servo motor also has some limitations that were necessary to modify. SG90 are originally designed for a specific degree rotation, in this case it is 180 degrees and 90 degrees in each direction. This feature was caused by the hardware limit in gearbox and feedback potentiometer. . In this project, the servo motors need to have continuous rotation and continuous rotation feedback loop.

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To achieve the continuous rotation, the servo motor was completely disassemble and some modifications were performed with the gearbox such as removing the physical stop wedge from the gear and potentiometer

Fig: Servo Motor

. The gear has half shaft hole that is attached to potentiometer to provide a feedback signal.

EMG SENSOR:
Electrodes can be positioned onto the skin owing to the electrical activity adjacent to the skin surface results from muscle shrinkage. The contact area of the electrode is called the detection surface and the physiological data logged by a surface electrode is termed as surface EMG (SEMG). Figure.22 shows the design & construction of an EMG system. The EMG detection scheme takes input from three electrodes: two adjacent electrodes located on the biceps of the upper arm and one reference electrode positioned on the elbow.

The formal structure for acquisition& analysis of the EMG signal to control

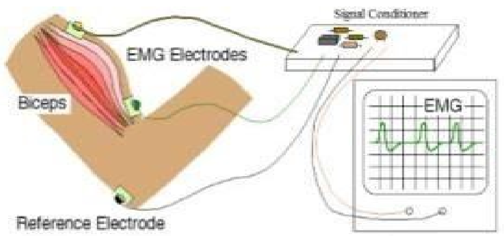

Fig: Method of detecting EMG signals

prosthetic arm is shown in Fig.23. The important parts are:

- Signal conditioning
- Feature extraction.
- Envelope detection the data monitoring and acquisition devices may cause interference to the captured EMG signal. To avoid this problem all the monitoring and acquisition devices need to be optically isolated to the data processing system. When EMG is captured by electrodes which are directly connected to the skin, the captured EMG signal is a mixture of all muscle fibre action potentials found in the muscles. These action potentials arise at arbitrary intermissions. Hence, the EMG signal can fluctuate as any positive (+ve) or negative (- ve) voltage. Motor unit action potential (MUAP) denotes the summation of the muscle fibre action potentials of a single motor unit. MUAP can be collected by a surface electrode injected into the muscle.

ARDUINO:
An Arduino Uno microprocessor was the basis of the materials for this design. The Uno is relatively small and quite functional. Attached to the Arduino is an Adafruit Motor Shield (v2). The motor shield is able to drive DC and stepper motors much more efficiently than using Arduino alone.

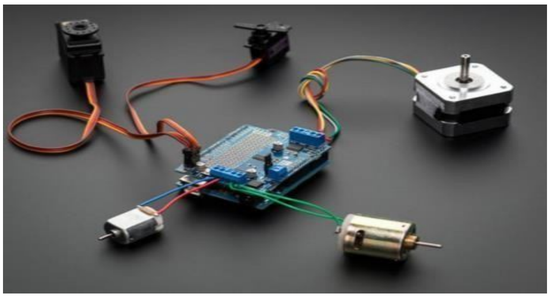
Fig: Arduino Uno Motor Party Pack (v2)

The shield has the ability to drive up to 4 DC motors or 2 stepper motors at one time, along with an ability to stack if multiple motors are required. If you were looking for a more functional prosthetic with more motors, the Adafruit Motor Shield would be able to provide this. One downside with the stepper motor is the fact that it does not detect if the object does not move; it just keeps going until the Arduino program tells it to stop moving. However, this type of motor seemed reasonable for purposes of the project. The metals used in the construction of the arm are a 1-inch and ½- inch diameter aluminum rod. I went with aluminum since it is extremely malleable, flexible, and lightweight.

FLEX SENSOR

A flex sensor or bend sensor is a sensor that measures the amount of deflection or bending since the resistance is directly proportional to the amount of bend.

Fig: flex sensor

WORKING:

The device will be attached to patient's forearm to replace the lost hand.

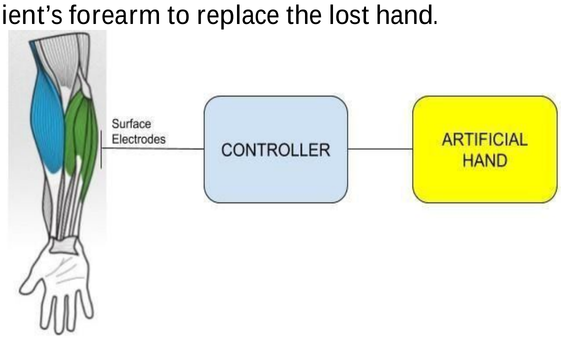

Fig: Prosthetic ARM

Three electrodes reading the EMG signal will be attached in for arm to control the hand. The EMG signal is detected from the subject and collected signals are processed and then employed to control the prosthetic arm and the recorded EMG signals are amplified and filtered. The Arduino receives the signal and passes it on to the pc/laptop for signal processing. And the Arduino helps us to control neutral prosthetic hand in real time. The first and main task to be solved by conducting this research was to build a device in the form of a prosthetic arm which can be controlled by the patient. This aims at helping the patient perform simple daily tasks like grabbing and releasing objects. Since the device will be attached in the patient's forearm, the design needs to be light and the size needed to be suitable for this application. The second purpose of this project was to develop a low-cost prosthetic arm for patients in developing countries

In this paper, the prosthetic arm controlling technique for a trans-humeral amputation patient is studied with the help of single channel EMG signal capturing. To develop a prosthetic arm control mechanism and apply it to an amputee patient is the key purpose of this research. The basic anatomy and physiology of the human hand is extremely necessary. Anatomy is the study of structure, and physiology is study of function. Through the study and understanding of the structure and function of the human hand, a better prosthesis model can be created. The natural hand is in many ways a perfect instrument. It embodies multiple degrees of freedom and is capable of integrated function. With the current technology, it is unrealistic to think that all the criteria and performance specification of the normal hand could be reproduced in a man-made hand device. and is capable of integrated function. With the current technology, it is unrealistic to think that all the criteria and performance specification of the normal hand could be reproduced in a man-made hand device.

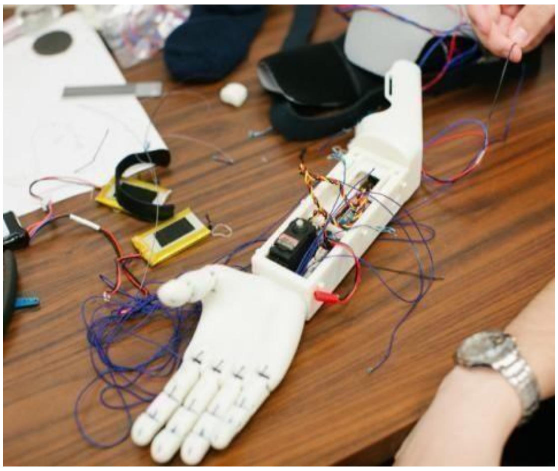

Figure : Limbitless Arm

CONCLUSION AND FUTURE IMPROVEMENT

For an amputee, upper limbs loss has many different consequences. Due to the hand loss, the number of work and life opportunities is greatly reduced for them. Hence, research into creating a prosthetic arm which can be conveniently controlled by EMG signal from arm is of great value. Therefore, the goal of this project was to create a low-cost prosthetic arm by using Electromyography data collected from the forearm.

The EMG recording and prosthetic system we develop will be very cheap and can be affordable for people in developing countries like India. We expect to obtain 5 Degrees of Freedom with 2 fingers. The two fingers helps for easy grasping of objects.

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