IMPULSE CONTROLLED HUMAN ASSISTANT

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Abstract-

The paper aims at the development of the smart prosthetic hand based on electromyography for trans-radial amputees. This study aims at extracting the muscle commands from a surface electromyogram (EMG) for controlling the prosthetic hand connected to the amputation part. The proposed prosthetic hand is developed to realize 10 joints including 4 active joints driven by electrical motors. To note down the success rate and for the analysis of its practicality, the amputees having smart prosthetics are made to perform the individual finger control as well as peg-in-hole task according to the phantom-hand movement. Muscle activity signals are the basis of this technology as they are required to control the smart prosthetic. This paper presents a detailed circuit diagram and design of a smart prosthetic hand with a wearable Electromyogram (EMG sensor) and shows how this technology is being used to control powered prostheses by discussing all the important processes of this microsystem. The implantable system, consisting of EMG electrodes, a custom-designed circuit. The prototype microsystem is powered by a 9-volt battery. The electrical impulse will be detected and received by Electrodes then this detected impulse is fed to the amplifiers and filters to amplify it as well as make it free from noise signals. Based on the magnitude of these impulse signals the programmed microcontroller will take the required action.

1:- Introduction-

A lot of research is going on across the globe for the development of the smart and affordable prosthetic to aid an amputee who lost his or her any limb or wasn't born with any. There are many smart Prosthetics which are already available in the market no doubt they are very precise and were developed with a lot of research but at the same point they have a lot of drawbacks like they are very expensive and because of this a normal individual is not able to take benefit of this technology and the second drawback is they are very heavy. Soour main objective is todevelop an affordable lightweight and precise human prosthetic hand. In this hand we have used Electromyography, where electromyography is a technology that deals with the detection analysis and utilisation of electrical signals emanating from skeletal muscles. Myoelectric signals are generally generated during any muscle activity these signals are produced when exchange of ions takes place across the muscle membrane leading to the development of small electrical current. These signals are usually detected with the sensor. This sensor is coupled with a microcontroller unit and other electrical devices which are responsible for the control and operation of this prosthetic hand. Our basic aim is to copy the basic movement of natural human hand and cost-cutting.

To test this model we have used the following approaches

1:- First we developed an automated prosthetic hand which provide housing to all the electrical motors components and batteries.

2:- Then a suitable microcontroller unit is selected. Then this microcontroller is coupled with an EMG sensor (attached with surface electrodes) commonly known as Electromyogram. This EMG sensing unit is used to detect, analyse, amplify and filter the myoelectric signals (electric potential signals generated due to muscle activity).

3: Then these conditioned Myoelectric signals are fed tomicrocontroller, and on the basis of their magnitude microcontrolleroperate various servo motors.

The remainder of this paper is as follows: Section 2 provides the details about the technical components used. Section 3 presents the proposed model and working in detail, and Section 4 presents the conclusion of the proposed work.

2:- Technical components of the proposed system-

- **EMG Sensor (Electromyograph):**Electromyogram is an instrument that is used to perform electromyography, this instrument detects the muscle activity. An electromyograph detects the electric potential generated by muscle cells when these cells are electrically or neurologically activated. This sensor not only detects the signals but also amplify them.

- **Microcontroller Unit:** Here we have used Arduino Uno - The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 12 volts.

- **Li-Ion Battery:** A lithium-ion battery or Li-ion battery (abbreviated as LIB) is a type of rechargeable battery. Lithium-ion batteries are commonly used for portable electronics and electricvehicles and are growing in popularity for military and aerospace applications. In the batteries, lithiumions move from the negative electrode through an electrolyte to the positive electrode during discharge, and back when charging. Li-ion batteries use an intercalated lithium compound as the material at the positive electrode and typically graphite at the negative electrode.

- **Surface Electrodes:** Surface EMG electrodes provide a non-invasive technique for measurement and detection of EMG signal. The theory behind these electrodes is that they form a chemical equilibrium between the detecting surface and the skin of the body through electrolytic conduction, so that current can flow into the electrode. These electrodes are simple and very easy to implement. Application of needle and fine wire electrodes require strict medical supervision and certification. Surface EMG electrodes require no such formalities. Surface EMG electrodes have found their use in motor behaviour studies, neuromuscular recordings, sports medical evaluations and for subjects who object to needle insertions such as children. Apart from all this, surface EMG is being increasingly used to detect muscle activity in order to control device extensions to achieve prosthesis for physically disabled and amputated population. Surface EMG has some limitations as well. Since these electrodes are applied on the skin, hence, they are generally used for superficial muscles only. Crosstalk from other muscles is a major problem. Their position must be kept stable with the skin; otherwise, the signal is distorted.

- **Servo Motors:** A servo motoris an electrical device which can push or rotate an object with great precision. If you want to rotate and object at some specific angles or distance, then you use servo motor. It is just made up of simple motor which run through servo mechanism. If motor is used is DC powered then it is called DC servo motor, and if it is AC powered motor then it is called AC servo motor. We can get a very high torque servo motor in a small and light weight packages. Due to these features they are being used in many applications like toy car, RC helicopters and planes, Robotics, Machine etc.

3:- Proposed Model-

Purpose of illustration we have taken a prosthetic hand having 5 servo motors program to move only 120 degrees at a time. This prosthetic hand contains a microcontroller unit, sensing unit and a sensing cable attached to the surface electrodes. The sensing unit used in this model is based on EMG technology, it is a technique used for evaluating and recording the electrical activity produced by skeletal muscles. Electromyography is performed by using an instrument called an electromyograph basically it produced a record known as electromyogram. When any muscle is in the state of rest it does not show any recordable electrical potential but when an activity is performed the amplitude of the generated electrical potential increases and

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then these electrical signals are detected by an EMG sensor known as electromyograph.

The block diagram of the proposed model is illustrated below:-

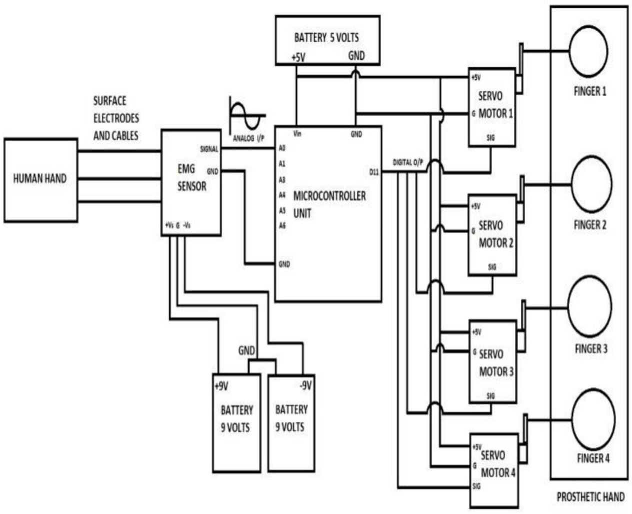

Figure 1: Block diagram of proposed model

The human body is a very complex phenomenon and it is only possible when the muscular system coordinate with the human brain. When there's a need of muscles to perform a particular activity the brain sends excitation signals through the central nervous system to activate a particular muscle set. Muscles are innervated in groups called motor units whenever any activity performed the motor unit gets activated and produce MUAP(MOTOR UNIT ACTION POTENTIAL). The magnitude of these signals depends upon the number of muscles activated in a particular activity, means the more is the number of muscles activated in a particular activity higher is the magnitude of the signals generated. The surface electrodes are placed on the amputee’s body.The main work of these electrodes is to detect the myoelectric signals and fed them to the electromyograph. This electromyograph filter, amplify and invert that received signal. Then this conditioned signal is fed to the microcontroller unit, where its magnitude is compared with a predefined threshold value. This predefined threshold value vary according to the body structure of an amputee. If the magnitude of conditioned signal is more than the threshold value, the microcontroller unit operates servo motor coupled with a particular finger by sending a digital control signal, if the amplitude of the myoelectric signal is less than a threshold value microcontroller unit will not take any action.

Depending upon the magnitude of generated signals three possible conditions occurs.

1:-Resting muscle or no muscle activity:-

In this case muscles are at rest means in this condition our nervous system is not sending any excitation signal to the motor unit therefore our electrodes will not detect any myoelectric signal and because of this microcontroller unit will not take any action as the magnitude of myoelectric signal is almost zero

2:- Unintentional muscle activities

It include activities like sleeping, uneven sitting or any other biological posture in which our nervous system sends excitation signal by default.In this case number of muscles involved is very less therefore the magnitude of myoelectric signal is less than the current threshold value. Therefore in this case also microcontroller unit will not operate any servo motor.

3:- Intentional muscle activities:-

This case deals with the activities like lifting weights, holding a bottle etc.In this case the number of muscles involved is far more than the number of muscles involved in other two cases. Therefore this leads to the generation of myoelectric signal whose magnitude is equal to or more than the predefined threshold value. Therefore in this case microcontroller unit will operate servo motors.

The sensitivity of the prosthetic hand can be increased or decreased by varying the threshold value of the sensing unit stored in microcontroller unit. If the value increases sensitivity decreases and if the value decreases sensitivity of sensing unit increases. But at the same time amputee's body plays a vital role while deciding the threshold value as in some bodies it is easier to detect myoelectric signals and in some it is not. So for every new model we have to decide the threshold value according to the person for which it is designed.

Figure 2:- Front view of the model

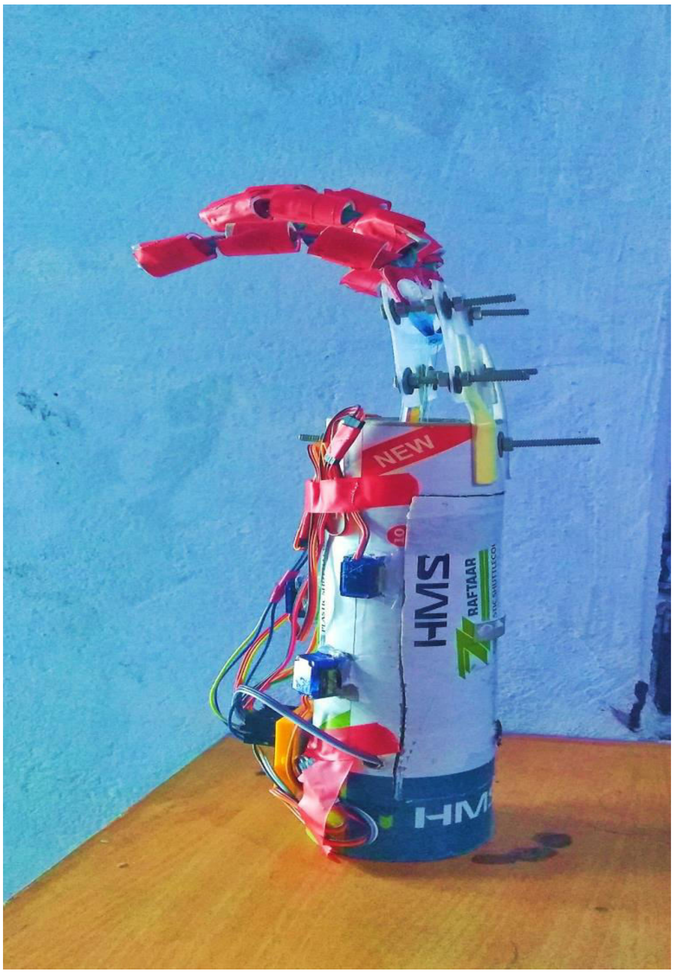

Figure 2:- Side view of the model

4:- Conclusion-

Here we have designed a model of an affordable smart and automated model of a prosthetic hand, for the people who lost their arm in an accident (like army veterans) or wasn't born with any. A life without arm is very difficult to live, people can't even do or perform basic activities like drinking water from a bottle or hold a burger. The current prostheses which are available in the market are very expensive, and this is the major drawback that creates hindrance for an averagely earning human to get benefit of this technology.So we tried to eliminate this problem by designing our own affordable prosthetic hand, and for this we have used

EMG technology. Now anyone can take benefit of this technology at a very low price.

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