DESIGN AND FABRICATION OF PROSTHETIC HUMAN HAND USING EEG AND FORCE SENSOR WITH ARDUINO MICRO CONTROLLER

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Abstract--This project deals with the design and development of a five fingered prosthetic hand for amputated persons. The design of the system is based on a simple, flexible and optimal control strategy that enables the person to use the device as normal arm. The hand system has independent commands to move the limb up and down and position the fingers precisely. Implementation of the mechanical hardware design of the human hand is based on connected double revolute joint mechanism. The tendon system of the double revolute joint mechanism and feedback network provides the hand with the ability to confirm to object topology and therefore providing the advantage of using a simple control algorithm. The model is should be fabricated with Servo motors and force sensors for fingers actuation. The entire setup is mounted on to the shoulder of the amputated person. Inputs for the motors can be generated through EEG signals generated from brain, which enables the user to grasp the objects with the way they think accordingly.

Keywords: EEG (Electroencephalography), Electrodes, BCI-Brain computer interface.

I. INTRODUCTION

In biomechanics, they are difference between an orthotics and a prosthetics. Prosthetics is an artificial device that replaces a missing body part, which may be lost through trauma, disease, (or) congenital conditions. When a person becomes a limb amputee, he or she is faced with staggering emotional and financial lifestyle changes. The amputee requires a prosthetic devices and services which become a life-long event. Prosthesis is an artificial extension that replaces a missing body part such as an upper or lower body extremity. It is part of the field of biomechatronics, the science of fusing mechanical devices with human muscle, Brain, skeleton, and nervous systems to assist or enhance motor control lost by trauma, disease, or defect. An artificial limb is a type of prosthesis that replaces a missing extremity, such as arms or legs. The type of artificial limb used is determined largely by the extent of an amputation or loss and location of the missing extremity. Artificial limbs may be needed for a variety of many

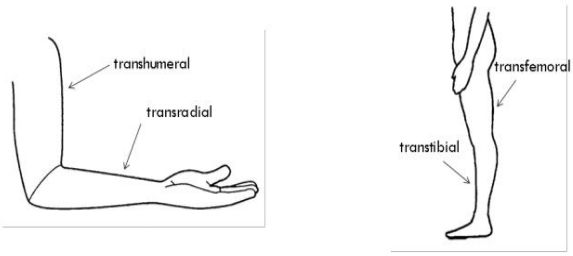

Fig 1 Types of Prosthesis

Reasons, including disease, accidents, and congenital defects. There are four main types of artificial limbs. These include the transtibial, transfemoral, transradial, and transhumeral prostheses. Here we are planning to fabricate transradial prosthesis, and then we need to choose a mind controlling device to operate the prosthesis with more flexible ways.

From many papers on biomedical and mechatronics we study and analyze the grip force distribution for different prosthetic hands designs and the human hand fulfilling a functional task is taken and From[1] design approach of the prosthetic hand and it's mainly focused on increasing the functionality, cosmetic and controllability of the prosthetic hand. From[2] Many times even experienced electromyographers fail to provide enough information and detail on the protocols, recording equipment and procedures used to allow other researchers to consistently replicate their studies.

The values from the above papers are taken into consideration.

II. PROPOSED METHODOLOGY

Arduino is open-source computer hardware and software company, project and user community that designs and manufactures microcontroller-based kits for building digital devices and interactive objects that can sense and control objects in the physical world.

The project is based on microcontroller board designs, manufactured by several vendors,

using various microcontrollers. These systems provide sets of digital and analog I/O pins that can be interfaced to various expansion boards and other circuits. The boards feature serial communications interfaces, including USB on some models, for loading programs from personal computers.

For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) based on the Processing project, which includes support for the C and C++ programming languages.Arduino programs may be written in any programming language with a compiler that produces binary machine code. Atmel provides a development environment for their microcontrollers, AVR Studio and the newer Atmel Studio.

Electro Encephalography is the study of the electrical activity of the brain. The biological name of brain is Encephalon. In EEG measurement, electrical activity of brain is measured from electrodes which are placed on the scalp. It is possible to take the deeper potential from EEG sensor. Before studying about EEG measurement, we have to know about the source of EEG signals. This source is nothing but brain. Brain is divided in too many parts, that every part is used to control the human body parts. In EEG recording, here single electrode systems are used. These signals from surface electrodes are amplified using preamplifier and filtered with a band reject filter. Our signals processed and get to run the motors for prosthetic hand movements according the way we think and grasp the objects.

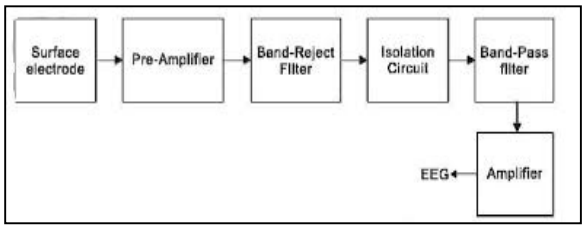

Fig 2 EEG process

III. WORKING PRINCIPLE

Human brain consists of millions of interconnected nerve cells. This nerve cell produces tiny electrical signals that forms pattern called brain waves. In order to analyze human brain activity we process this pattern using EEG Electrodes. EEG Electrode pickup the Bio-electrical signal from human brain. This signal contains different set of frequencies. This signal is given to band rejection filter to remove unwanted portion. Afterwards the signal energy is amplified and given to band pass filter which has a frequency set of 4-7 Hz. This signal pattern is called as theta wave.ADC converts this signal into digital data. Bluetooth slave Module Hc-06 transfer the digital data over the air. The above task has been done in head band.

Bluetooth module in robotic arm is paired with the Bluetooth module which is in head band. Whenever the headband gets correct data from EEG it starts transmission process. In robotic arm side the manual inputs are controlling the arm independently. Indication leds give the status of communication between headband and robotic arm. Blue led start glowing when headband Bluetooth module paired with arm Bluetooth module.

Green led start glowing when the data transmission is stared. When the manual inputs are false the Bluetooth module start receiving the data from headband. This data is compared to predefined activity data (attention and meditation).If the data is matched with predefined data, controller govern the arm movement respectively

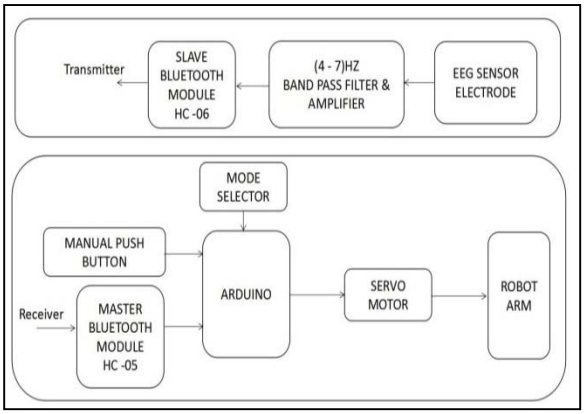

Fig 3 Proposed Block Diagram

A. Proteus

Proteus is a simulation software for various circuit designs with microcontroller. It is mainly used design and simulate the circuit with perfect connection and all the components can be able connected and the program can be upload using this simulation software and arduino software. The prosthetic hand can be controlled using to mode of operation they are manual mode and sensor mode. Here we are using the touch sensor instant of force sensor. It will give the measurements of touch when object is detected using to control the servo motor. Bluetooth module is used to transmit the EEG signal from head to arm. We are using two servo motor for thumb finger and rest of fingers.

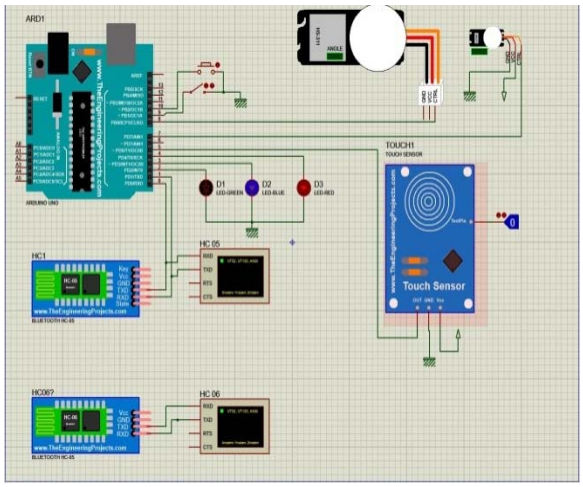

Fig 4 Simulation using Proteus

B. Electrodes Placing

In order to make patient's records comparable over time and to other patient's records, a specific system of electrode placement called International 10-20 system is used. The system is for 1 electrode. We can place the electrodes on FP1 position with the help of neuro sky brainwave sensor.

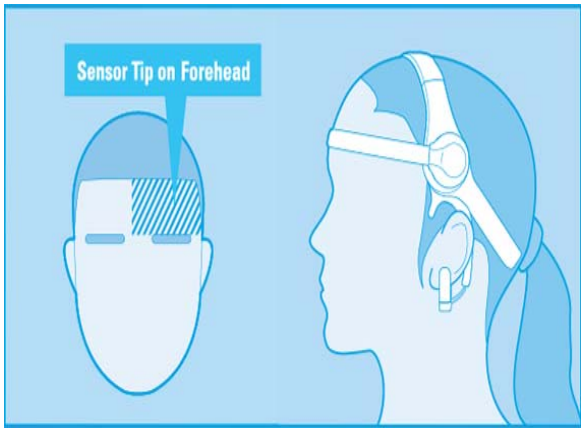

Fig 5 Position for Placing Electrodes

C. Servomotor

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system. Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

III. DESIGN OF PROSTHETIC ARM

A. Creo

CREO is modeling software used in mechanical Industries.3D CAD parametric feature solid modeling, 3D direct modeling, 2D orthographic views, Finite Element Analysis and simulation, schematic Design, technical illustrations, and viewing and visualization can be done using this software.

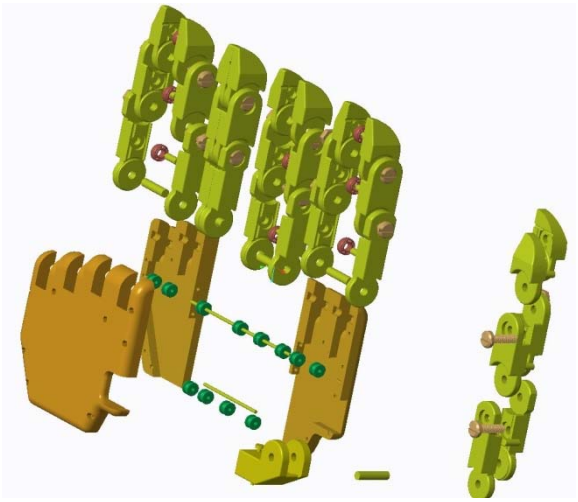

Fig 6 Hand Assembly Exploded Left View

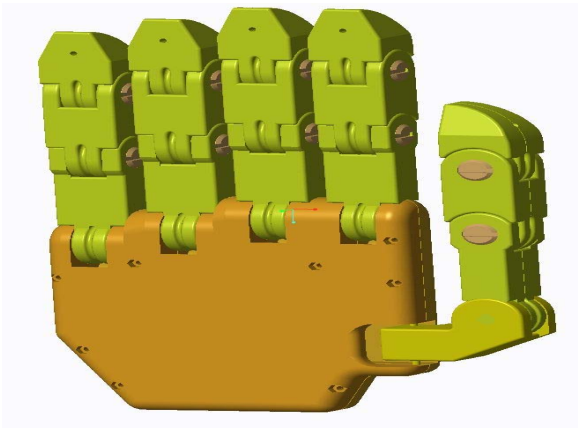

Fig 7 Design Hand Assembled Front View

In the Creo modeling software we have designed the model of the prosthetic Arm with the measurements in dimensions. According to our requirements fingers, thumb joint, bottom palm, and top palm. These results are taken into consideration for designing and fabricating the prosthetic hand. These values are applied in the design and the output is taken in to consideration for designing as well as fabricating the prosthetic hand.

IV. TESTING AND VALIDATION

Fig 8 Front and Back View of Prosthetic Arm

Fig 9 Physically Challenged Human Calibration

V. CONCLUSION & FUTURE SCOPE

From the different types of prosthetics arms used nowadays, the method I proposed is more over easy to be constructed and user friendly. Thus implementing this idea many people could use the prosthetic arm in an effective way. The design and simulation for the prosthetic hand was completed in this paper, and the further development of the prosthetic hand had been developed from the analysis of the result which has been obtained from this paper. In future EEG sensors can replaced with the EMG needle electrode by surgery. It will give more flexibility to the Prosthetics hand system.

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