IARJSET

ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 7, July 2021

DOI: 10.17148/IARJSET.2021.8779

IMPLEMENTATION AND DEVELOPMENT OF PROSTHETIC HAND FOR THE DISABLED

Anoop Deekshith R[1], Jeevan R S[2], Gowtham B[3], Darshan T G[4], Sangeetha V[5]

Student, Dept. of Electronics and Communication, KS Institute of Technology, Bangalore, Karnataka. [1,2,3,4]

Assistant Professor, Dept. of Electronics and Communication, KS Institute of Technology, Bangalore, Karnataka. [5]

Abstract: " Prosthesis is an artificial approach, which is used to replace a disabled body part. Prostheses are typically used to replace and provide supplement to disabled/defective body parts. Disabled body parts can be of any reason like lost accidently, birth physical disability *etc.* The main requirement is that its function should be as natural as real arm. There are various designs of artificial arm that are available in the market, categorized as electrical, mechanical and Myo-electric arm. Mechanical prostheses use some motion of the body to provide the power necessary to control the prosthetic component. Electrical arms activate the hand by a motor which is driven by micro switches and relays. This paper effectively focuses on the ease of use, cost effective and simple to handle prosthetic arm for economically challenged

Keywords: Prosthetic hand, Disabled, Arduino, low cost,3D printing.

I. INTRODUCTION

A prosthetic limb is an artificial device or a replacement of missing body part. The arm is a fake arm for those who amputated their arm. Earlier, armories used prostheses mainly in battle to hold sword and shield. The history of prosthetics has always been intertwined with the history of warfare and the soldiers that fight. Examples from the middle-ages show how slow the field of prosthetics advanced. In the early sixteenth century, doctor Ambrose Pare made significant advances in both amputation surgery, and the development of prosthetic limbs. He was the first to introduce a hinged prosthetic hand, and a leg with a locking knee joint. These advancements, as well as his innovative techniques of attaching the limbs, are unfortunately still rather common in modern prosthetics. Earlier body powered prosthesis components have not much changed because most of the research has focused on externally powered prosthesis and high cost of manufacturing also a prime issue. The Adaptive Prosthesis utilized hydraulic controls, pneumatic controls and a microprocessor to provide control action.

In this busy world, a disabled person being dependent on somebody else is considered a burden in majority of the cases. Hence, being dependent on day to day tasks or even to do the slightest of actions can have an emotional imbalance and can cause ones self esteem to go low. Thanks to the advancement in robotic and electronics industry, this problem can be solved to a certain degree. Prosthetic limbs have been made earlier which is quite expensive.

For one, all electronics are contained within the prosthesis, which removes the need for external equipment, such as wires, electrodes, or batteries. The prosthetic hand is controlled using electrodes implanted in the muscles of the upper arm, to which nerves involved in opening and closing the hand have been rerouted. Second, force sensors embedded in the thumb of the hand provide sensory feedback while grasping objects. Those signals are relayed through wires connected to nerves in the upper arm, and then to the brain, where they are perceived as pressure against the Hand. But using the above technology requires a surgery and the cost goes up as the use of sophisticated technology comes into picture. Therefore, the risk of surgery is also high as well as the cost. High-tech customized prosthetics for amputees are now available in India at half the price of imported ones that cost upwards of Rs 1.5 lakh.

The makers use expensive 3-D printing technology to get the right shape and fit of the limb. Although, the accuracy and the dependability is high, the economically weaker section are deprived of such technology. While the science and technology have been evolving constantly over the years, we have been able to find a right alternative for such high techno-oriented hardware. Our project might not be able to achieve such a great deal of functions as already in the market but can be potentially used as an temporary solution until a right affordable technology can be procured. Considering the majority of patients who cannot cover those expense, our project aims to deliver a cheap alternative prosthetic arm for which can perform limited human actions without having to depend on anyone.

Further on the paper explains the method and introduces simple control with limited actions using user friendly, easy to use hardware

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II. LITRATURE SURVEY

L. McLean, et al[1]discovered the designing of myo-electric control of prosthetic arms from its conception in post-war Germany thro ugh its popular acclaim in "bionic arms" toward its undertaking as a procedure and correct option for many arm amputees. the United Kingdom, the USSR, the USA and Canada are followed with particular at tension to the gradual achievement of collaborative ties research and the even slower evolution of commercial products for natural applications

Z. Escudero, et al[2] demonstrated handicapped people that amputees are one of the most necessary groups in the nature. The aspiration of developing prostheses is mainly to improve their circumstances of life and to help them recover freedom and dignity. Replacing an amputated limb is a complex assignment, as it is desired to replace the osseous structure, to collocate a locomotive system and to give to the prosthesis a command operation

M. H. Asyali, *et al*[3]says that electromyography (EMG) signal and existing assessment have validate that multichannel EMG signal controls are not appropriate due to early fatigue problems and high effort essential to perform even simple movements. Therefore, new voice-controlled active hand prosthesis to execute several basic functions was presented. The prosthetic hand engaged 3 DC motors and gears to transmit motion to the fingers. The second part of the study incorporated the use of speech recognition to control the prosthetic hand

A Vijayaraj *et al*[4]demonstrated mobile robot is controlled by using speech signal. The input speech signal is given through micro phone. Speech extractor is used to convert the given speech signal to word signal. The word signal produces the command. According to the given commands the various operations were demonstrated in the mobile robot like move forward, backward, left and right, clockwise rotate, anticlockwise rotate, open, close, up, down, and stop

D. S. Koliousis *et al*[5]presented the hardware designing of a theoretical Isolated Word Recognition (IWR) system introduced in an earlier study. The recognizer uses a short- term energy and zero-crossing based detection arrangement, and a discrete Hidden Markov model recognizer implemented to recognize seven different words. The hardware system implemented uses economic off-the-shelf (COTS) electronic components, in-ear microphone, importable and economic. The microprocessor processes the identified speech input signal in real-time

III. SYSTEM DESIGN AND ARCHITECTURE

The block diagram and the flow chart is mentioned as follows. The project uses two major parts

1. The physical Prosthetic limb
2. All sensors and microcontroller fitted in a synthetic glove

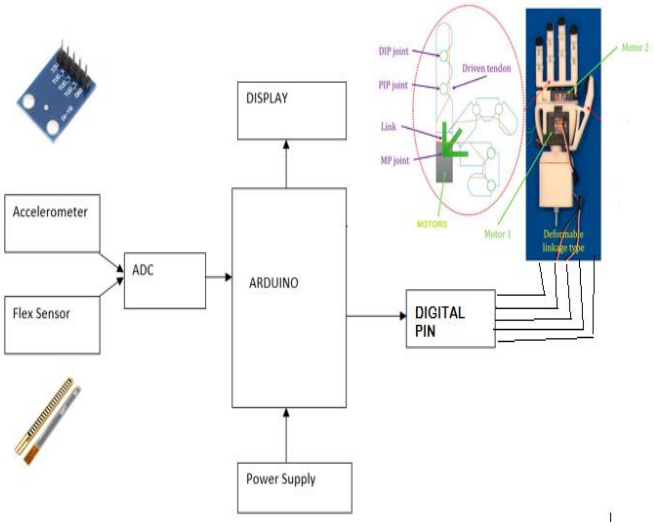

FIG 1. BLOCK DIAGRAM

IARJSET
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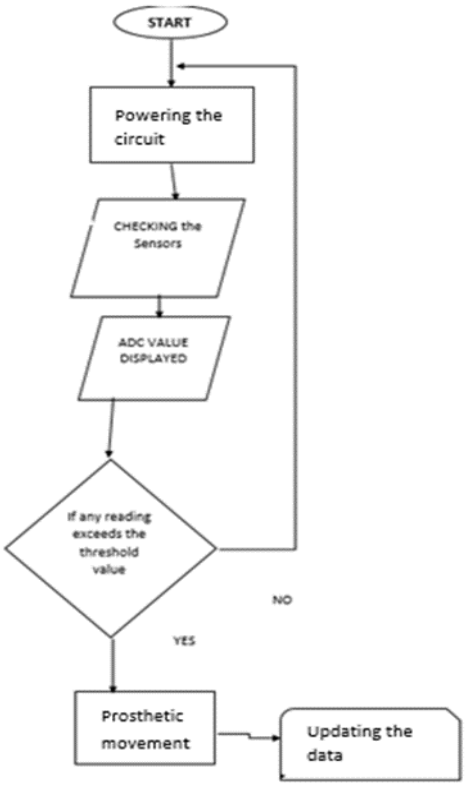

FIG 2. FLOW CHART

Many embedded systems have substantially different designs according to their functions and requirements. The microcontroller which is located at the center of the block diagram forms the control unit of the entire project. Embedded within the microcontroller is a program that helps the microcontroller to take action based on the inputs provided by the output of the sensors. This project consists of microcontroller, Accelerometer, flex sensor, LCD display and a power supply.
Coming to the working, we use Arduino IDE suite for the programming part. All the sensors will be checked and code will be developed. The light weight fiber based prosthetic hand will be procured from a workshop. All the sensors are tested against the prosthetic model and threshold values are noted down. In this paper we are considering only the wrist and the finger movement. These movements are synchronized with the functioning working arm.

HARDWARE:
For the hardware part, the Arduino microcontroller, flex sensor and the accelerometer is fused into a wearable glove. This glove is made to wear on the fully functional arm for the disabled patent. On the other hand, the prosthetic arm is fitted on the amputee part. Inside the prosthetic arm, we use 5 servo motors for each finger. All those motors are connected to a microcontroller using hard strings. Whatever function is done within the sensors range in the functional arm is replicated on the prosthetic arm. For example, if the patent insists to pick up an object, the action is performed in the arm which has the sensors and the same will be replicated in the prosthetic arm thus making the function successful.

SOFTWARE:
For the software part, as we mentioned earlier, we will be using Arduino IDE and all the sensors are coded in the same software. An additional LCD sensor is used for the assistance of the developers and to make sure the values are intact

CONTROLLING USING VOICE COMMANDS:

While this actions can be performed using sensors, it can also be controlled using voice commands. First we use the help of Bluetooth module and develop a code for it in the Arduino board.
Thus by using the Bluetooth module and syncing it with the Arduino IDE, we can provide the commands such as “open” and “close” for opening and closing of the palm. We also gave a command for moving the elbow up and down providing commands such as “forward” for moving the arm forward and “backward” moving the arm backward etc.
For showing the count, we developed the code for showing each and every finger individually. Such as giving the

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command as “count” and it counts the finger one by one

FIG 3. Application used to control voice command

IV. ADVANTAGES

- It is used for assisting the disabled
- It is used to pick up and drop the objects
- Comparing to the previous technology, a cost effective and simple prototype can be used
- It can be used as an immediate alternative and temporary solution
- Using voice commands we can control the arm

V. RESULTS

5.1 THE OVERALL SETUP:

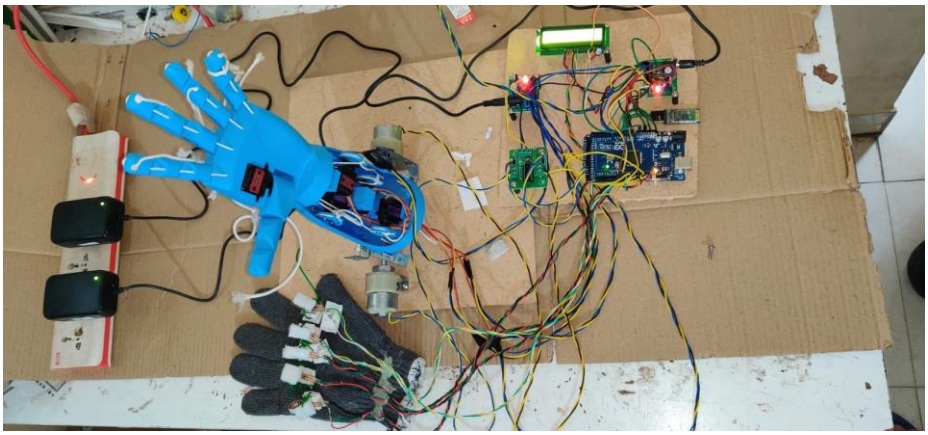

FIG 4 Overview of the setup

As we can see from the figure 4, the physical setup of the project is done. We have a 3D printed prosthetic arm which is controlled by 5 geared 180 degree angle servo motors connected to each other by the strings. All those servo motors are connected to flux sensors which is present in the glove. Those sensors are connected to a arduino uno board. An lcd display is present to read the instructions whatever we provide. For voice command control, we use bluetooth module which is in turn connected to the arduino. A motor driver IC is present which helps in the control of DC motor. Accelerometer is also present for the movement of elbow position.

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5.2 PERFORMING SIMPLE HOLD AND DROP OPERATION:

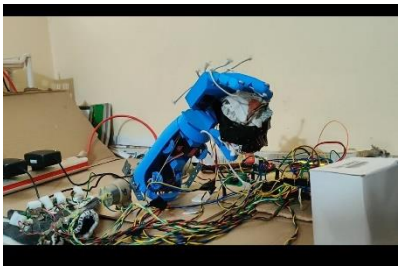

FIG 5 Hold operation

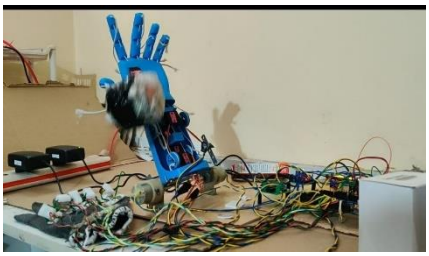

FIG 6 Drop operation

For performing the hold operation, the flux sensor which is connected to the glove is pressed altogether at once , and thus an object is held. The same operation if we want to do it using voice command, then we first activate the Bluetooth mode, and then we provide an instruction as “close” the fingers closes and the object is held as shown in fig 5. Similarly if we want to perform the drop operation, the we release all the pressed flux sensor And thus the object is dropped. The same operation if we want to do it using voice command, then we first activate the Bluetooth mode, and then we provide an instruction as “open” the fingers closes and the object is dropped as shown in fig 6

5.3 REPLICATION OF ELBOW MOVEMENT:

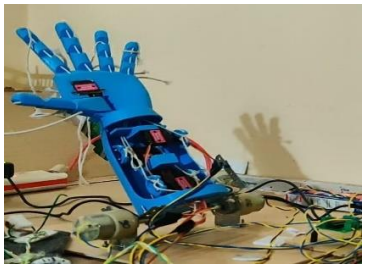

FIG 7 Elbow backward movement

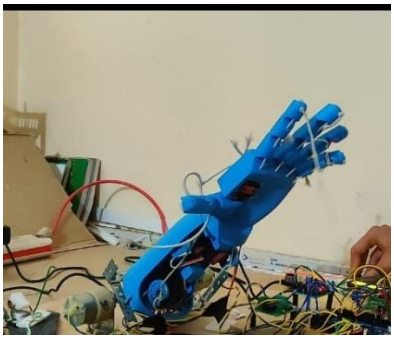

FIG 8 Elbow forward movement

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As we have shown in the diagram, to replicate the elbow movement, we have used accelerometer. We have taken a certain threshold value and have set a limit for the same. So, whenever the accelerometer crosses the threshold value, then the elbow moves frontward or backward as shown in the fig 7 and 8

The same operation if we want to do it using voice command, then we first activate the Bluetooth mode, and then we provide an instruction as "forward" for moving the elbow forward and use command "backward" for moving it backwards.

5.4 USING COUNT OPERATON:

Another simple operation that can be performed is counting the numbers. For example, if we want the hand to count from 1 to 5 then we can use the command "count" from the Bluetooth module and then the fingers start to count the same

5.5 FURTHER WORK AND SCOPE:

With 3D printing advancing and becoming more affordable, the possibility of anyone being able to easily design and print a prosthetic arm or limb could soon become a reality. New 3D scanning and body modelling technology could also enable people to 3D scan their arm or limbs and have prosthetics modelled after them, making for more natural fitting and appearance. New state-of-the-art prosthetics that take in data on how the wearers walk or move their hand and build algorithms to anticipate their intentions are being built. These developments are intended to help those using prosthetic devices to move in the most natural manner possible. Even more impressive, researchers are developing versions of bionic arm and limbs, controlled by thought. They attach to an implant inserted directly into the bone, and nerve reassignment surgery then allows brain signals to directly control movement.

VI. CONCLUSION

The controller was trained for different commands. The commands were trained from different values from accelerometer and flex Sensor(palm and Elbow Connected Sensor). According to these commands the movement of arm takes place. The commands were differentiable so that any kind of overlapping between the commands would not create the confusion to microcontroller. Different kind of arm movements such as Palm opening, Palm closing, Elbow up and Elbow down were demonstrated The testing was done using the different motors and the respective response time was calculated. This response time associated with the specific motor and specific weight will help to built prosthetic hand with specific application

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