Design and development of prosthetic arm using 3-d printing technology and control system

[1]Snehal B. Kalambe, [2]Ms.P.V.Gawande

[1]PG Student, [2]Assistant Professor
Department of Electronics and Communication,
Priyadarshini Bhagawati College of Engineering, Nagpur, India

***Abstract*: Prosthesis is an artificial device that replaces a missing body part. In medicine, prosthesis is an artificial device that replaces a missing body part, which may be lost through trauma, disease, or congenital conditions. Prosthetic amputee rehabilitation is primarily coordinated by a prosthetic and an inter-disciplinary team of health care professionals including psychiatrists, surgeons, physical therapists, and occupational therapists. A person's prosthetics should be designed and assembled according to the patient's appearance and functional needs.**

For instance, a patient may need transradial prosthesis, but need to choose between an aesthetic functional device, a myoelectric device, a body-powered device, and an activity specific device. The patient's future goals and economical capabilities may help them choose between one or more devices.

***Index Terms*: Prosthesis, Flex sensor, Data glove, Robotic arm, Raspberry pi.**

I. INTRODUCTION

Prosthesis is an artificial extension that replaces a missing body part. Prosthetic arm is typically used to replace parts lost by injury or missing from birth or to supplement defective body parts. One of the main requirements of artificial arm is that functionally, it should be as near to the natural hand as possible.The intended action of the arm is understood from the PWM signal parameters which are obtained by using defined circuit scheme. The pulses are generated by using raspberry pi and the respective motor is driven for movements of the hands and wrist, viz. hand open, hand close, wrist flexion, wrist extension etc. The ever increasing population trend of the new millennium expects new technical innovation to meet the new challenges being faced by human beings. The integration of medical science and engineering has made the task like complicated surgery by prosthetic arm simpler. The presented method offers great potential for the development of future hand prosthesis. To capture the motion of human limbs, sensors can be used. Sensor plays an important role in robotics. Sensors are used to determine the current state of the system. Robotic applications demand sensors with high degrees of repeatability, precision, and reliability. Flex sensor is such a device, which accomplish the above task with great degree of accuracy. The pick and place operation of the prosthetic arm can be efficiently controlled using raspberry programming. This designed work is an educational based concept as prosthesis control is an exciting and high challenge research work in recent year **.**

II. LITERATURE SURVEY

[1] fabrication of low cost prosthetic arm with foamed fingers vivek parasa1, dr. A gopichand2, n v s shankar3, k hanumantha rao4 international journal of engineering research & science (ijoer) issn: [2395-6992] [vol-2, issue-10, october- 2016] the current work is aimed at overcoming these difficulties by the use of epe foamed fingers which are driven actuated by a tendon by the gesture of palm while the foam provides the necessary anced science, engineering and technology. Issn 2319-5924vol 1, issue 1, 2012, proposed system implementation a one-dimensional virtual object to investigate differences in efferent control between the proximal and distal muscles of the upper limbs. Restricted movement was allowed while recording emg signals from elbow or wrist flexors/extensors during isometric contractions. The signals recorded by the surface electrodes are sufficient to control the movements of a virtual prosthesis. The presented method offers great potential for the development of future hand prostheses.

[2]control of hand prostheses using peripheral information silvestro micera, *senior member, ieee*, jacopo carpaneto, and stanisa raspopovic ieee reviews in biomedical engineering, vol. 3, 2010
Several efforts have been carried out to enhance dexterous hand prosthesis control by impaired individuals. Choosing which voluntary signal to use for control purposes is a critical element to achieve this goal. This review presents and discusses the recent results achieved by using electromyographic signals, recorded either with surface (semg) or intramuscular (iemg) electrodes, and electroneurographic (eng) signals. The potential benefits and shortcomings of the different approaches are described with a particular attention to the definition of all the steps required to achieve an effective hand prosthesis control in the different cases. Finally, a possible roadmap in the field is also presented.

III. BLOCK DIAGRAM

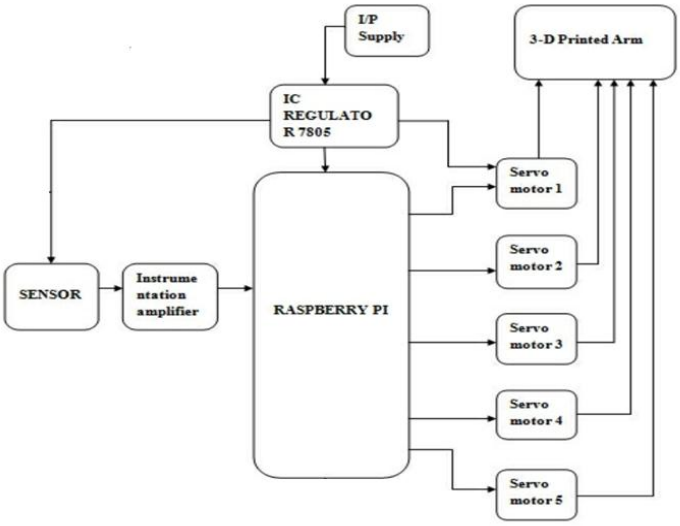


FIG3: BASIC BLOCK DIAGRAM

It is clear from the block diagram that the sensor attached with the raspberry pi will send the analog signal servo motor control where the 3D printed arm. IC regulator use for the maintain the voltage. Each servo motor are connected to the finger.

IV.METHEDOLOGY

In this design we are using flex sensor (bend sensors) to sense the motion of our fingers. We will be using 5 such sensors that will be arranged in a hand glove, which will make the sensors comfortable to wear. The Other part i.e. prosthetic arm will consist of 5 fingers that will be controlled using 5 servo motors i.e. one motor for each finger. All together it will be one hand consists of 5 flex sensor one in each finger. Bend of fingers is analysed using raspberry pi and this data will be send to another port via serial communication. The raspberry pi will generate appropriate PWM signals for controlling servo motors. The complexity of the project is reduced by properly categorising the whole project into sub design. It makes a better design and work effectively.
The readings of each fingers where measured in the form of voltage, while the movement of each fingers will be given with respect to angle. Thus to relate voltage with respect to angle we plot the graph of each finger and then we get a linear graph. By calculating equation of each line we can relate each other easily. Then by knowing only one of the value we can calculate another value very easily. This equation will be then feed to code of raspberry pi connected in sensor unit then it will generate appropriate angle for respective finger. Ones it is done all data will be formatted in particular packet so that it will be easily handled and send over serial port.

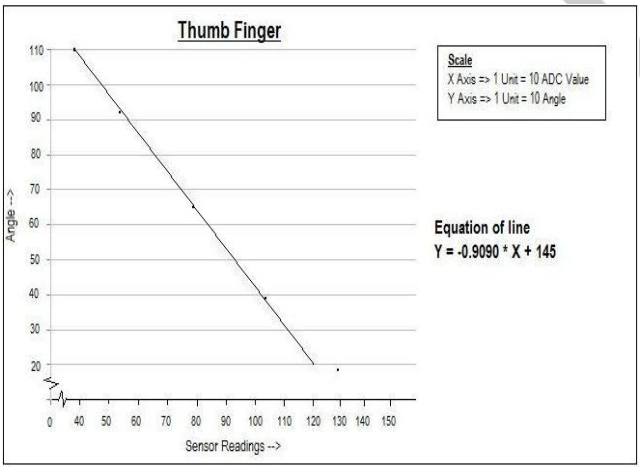


Fig4.1: Graph representation of thumb

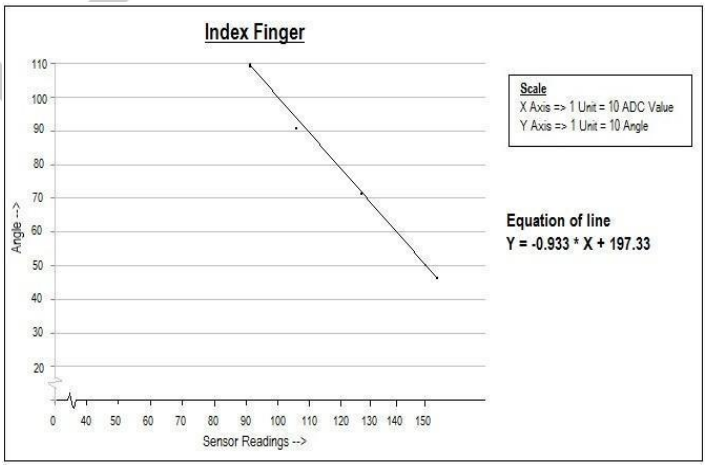


Fig.4.2: Graph representation of index

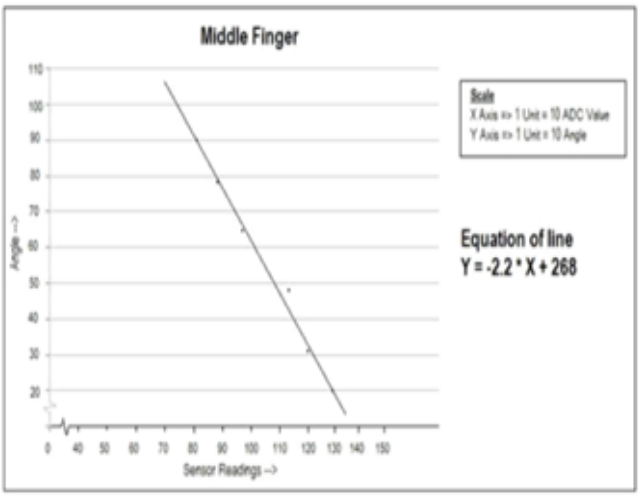


Fig.4.3: Graph representation of middle finger

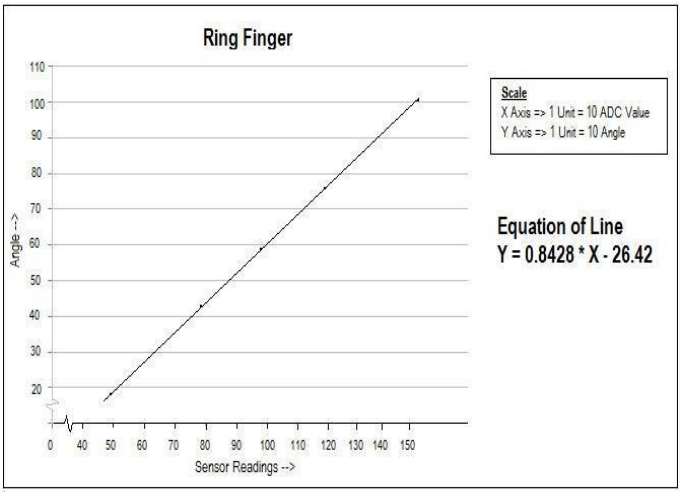


Fig4.4: Graph representation of ring finger

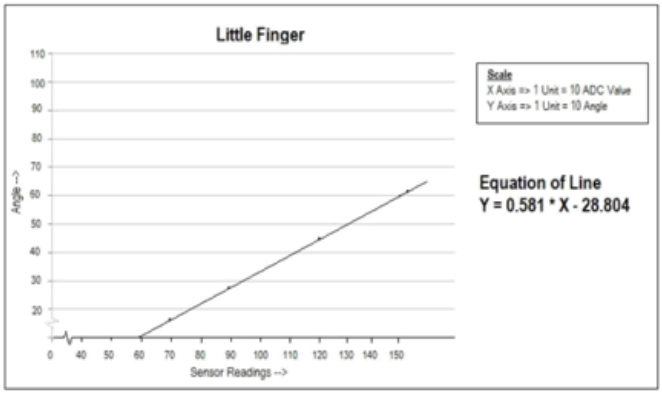


Fig4.5: Graph representation of little finger

V.COMPONENT USED

Flex Sensor: A flex sensor or bend sensor is a sensor that measures the amount of deflection or bending. Flex sensors are sensors that change in the resistance depending on the amount of bend on the sensor. They convert the change in bend to electrical resistance, the more the bend the more the resistance value. They are usually in the form of a thin strip from 1”-5”long that vary in resistance. They can be unidirectional or bidirectional. They work as variable analog voltage divider. Inside the flex sensor are carbon resistive elements within a thin flexible substrate. When the substrate is bent the sensor produces a resistance output relative to the bent radius.

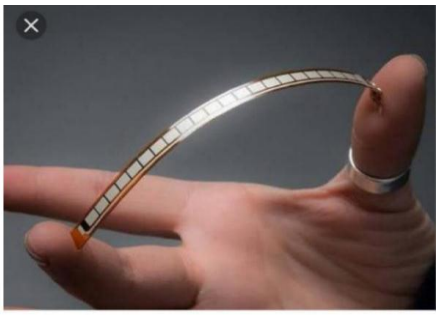


Fig 5.1: Flex sensor

Servo Motor: The servomotor is the automatic control of DC motor in term of rotation angle has played a vital role in the electromechanical engineering. Sensor plays an important role in robotics. Sensors are used to determine the current state of the

system. Robotic applications demand sensors with high degrees of repeatability, precision, and reliability. Flex sensor is such a device, which accomplish the above task with great degree of accuracy. The pick and place operation of the prosthetic arm can be efficiently controlled using microcontroller programming. This designed work is an educational based concept as robotic control is an exciting and high challenge research work in recent year.

Fig 5.2: Servo motor

IC7805 (LM7805): Voltage sources in a circuit may have fluctuations resulting in not giving fixed voltage outputs. Voltage regulator IC maintains the output voltage at a constant value. IC 7805, a voltage regulator integrated circuit (IC) is a member of 78xx series of fixed linear voltage regulator ICs used to maintain such fluctuations. The xx in 78xx indicates the fixed output voltage it provides. IC 7805 provides +5 volts regulated power supply with provisions to add heat sink as well. Let's look into some of the basic ratings to get an overview.

IC 7805 Rating

Input Voltage range 7V- 35V

Current rating IC=1A

Output voltage range $V_{Max=5.2V}$, $V_{Min=4.8V}$

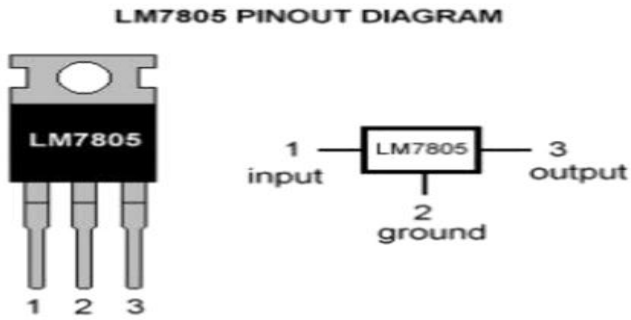
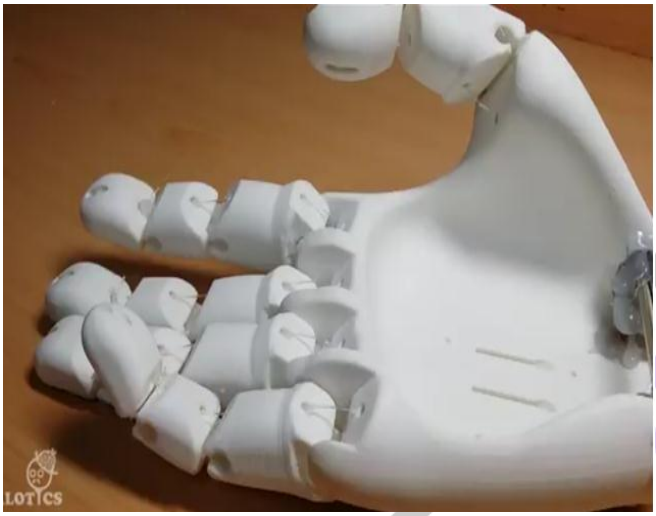


Fig 5.3: Pinout Diagram of LM7805

Raspberry pi: The **Raspberry Pi** is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries. The original model became far more popular than anticipated, selling outside its target market for uses such as robotics

Fig5.4: Raspberry pi

***3D printer module**:* 3D printing, also known as additive manufacturing (AM), refers to processes used to create a three-dimensional object in which successive layers of material are formed under computer control to create an object. Objects can be of almost any shape or geometry and are produced using digital model data from a 3D model or another electronic data source such as an Additive Manufacturing File (AMF) file.The futurologist Jeremy Rifkin claimed that 3D printing signals the beginning of a third industrial revolution, succeeding the production line assembly that dominated manufacturing starting in the late 19th century.The term "3D printing" originally referred to a process that deposits a binder material onto a powder bed with inkjet printer heads layer by layer. More recently, the term is being used in popular vernacular to encompass a wider variety of additive manufacturing techniques.



1

2

Fig5.5: 1) 3D printed arm 2) 3D printing module

VI.HARDWARE REQUIREMENT

1) Raspberry pi
2) Servo motor
3) Voltage regulator
4) 3 d printing module
5) Mechanical accessories
6) Dc battery

VII. RESULT:

Hardware part

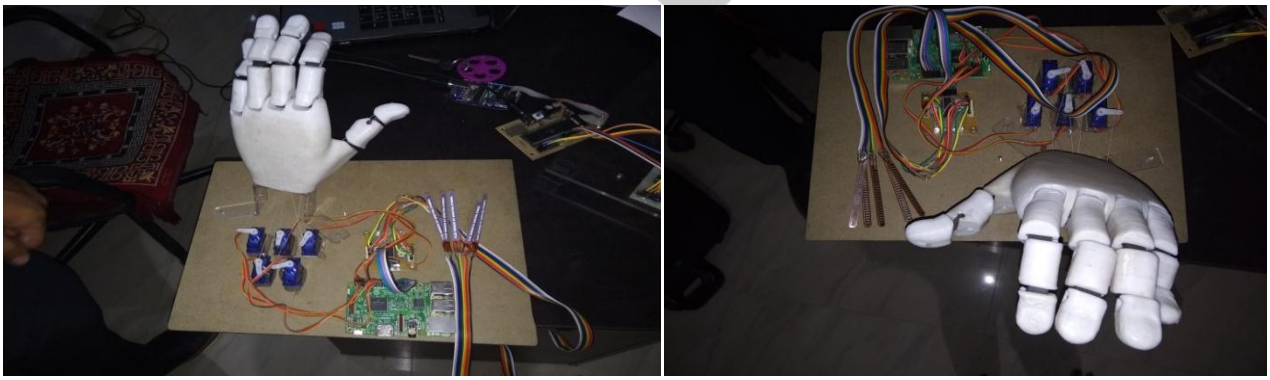


Fig7.1: Hardware part of project

Movement of fingers

Fig7.2: Movement of fingers

Thus we have successfully design and development of prosthetic arm using 3D printing technology and control system. Prosthetic arm can be used in various application and domain. It can be used in place where actual human hand is required but it is dangerous to use them. It has also raised the reach of our presence. fig7.1 shows the hardware part of the project, here arm is totally depend on sensor. Fig7.2 shows the movement of fingers. Sensors are connected to the raspberry pi that are connected to the amplifier to amplify the input. Each Servo motor are connected to the each finger with the strings. Movement of finger depend on the muscular activities.

VIII. CONCLUSION:

In conclusion, the goal of this project was to redesign a prosthetic arm to meet the needs of amputees. Following a multi-step design process, the team was able to 1) research and study the prosthetic arm so that we could base our design off of it. 2) In order to identify problems with current prosthetic arms, we did more research on the customer needs; furthermore, 3) we analyse different prosthetic arms to identify each part in terms of its particular function then 4) we redesign the product to the specifications of the costumers. We identified most of the problems with the current prosthetic arms. According to our customer needs, most consumers were complaining about product's low performance and quality. In addition, they were not satisfied with the price of their prosthetic. As a result of the redesign process, the team was able to produce an ideal prosthetic arm that has a high reliability and efficiency.Additionally, we lower the cost of the product so consumer could easily afford it.For that reason, we also lower maintenance cost and the cost of parts replacement. Lastly, we wanted to improve the cosmetics of the prosthetic arm. Therefore, we hide visible mechanics and strings so it would look more appealing. Also, we have this product in variety of sizes and colours. Overall, for this project our team was successfully able to improve and redesign a unique prosthetic arm.

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