Prosthetic Arm

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Harsita Bhowmik
School of Electronics Engineering)
KIIT UNIVERSITY)
Bhubaneswar,India
2104077@kiit.ac.in

Shreyan Pal
School of Electronics Engineering)
KIIT UNIVERSITY)
Bhubaneswar,India
2104102@kiit.ac.in

Soumadyuti Chakraborty
School of Electronics Engineering)
KIIT UNIVERSITY)
Bhubaneswar,India
2104103@kiit.ac.in

Tannistha Sikdar
School of Electronics Engineering
KIIT UNIVERSITY
Bhubaneswar,India
2104107@kiit.ac.in

***Abstract*—Myoelectric Prosthetic Arm. There has been a significant increase in the amputation of upper limbs making the lives of people difficult leading to the increasing use of artificial limbs as a substitute but they come with a high cost and lesser efficiency. So we came up with our work on the project to provide a cost-effective, affordable, and highly efficient model of a myoelectric prosthetic arm. The basic ideation of this project was a noble cause: to bring revolution in this field with our innovative technology. The main challenge we faced in making this project was mimicking human-like movement accurately on which we are still working to make it better. We present better technology in our low-budget prosthetic arm.**

***Index Terms*—EMG, Myoelectric Prosthetic Arm, Prosthesis, Human Anatomy**

I. Introduction

About 23,500 new upper limb amputees are produced in India with a backlog of about 4,00,000 amputees without any aids. The number of helpless amputees all over the world is unthinkable. Amongst the 23,500 upper limb amputees, eighty-five percent of them are men and the remaining fifteen percent consists of women and children. The major causes of their loss are accidents and lack of treatment for diseases like leprosy[1]. Not everyone can afford high prostheses to substitute for their amputated upper limb. The increasing number of backlog cases suggests that about fifty percent of them could not help themselves financially to get a prosthesis. Observing the immense need for revolution and innovation in this field, we came up with our cost-effective, highly efficient, and affordable Myoelectric Prosthetic Arm. The basic idea was to help people in need without effective technology. Emg Sensor reads the electric signal from the muscle and sends it to the Microcontroller(Arduino-Uno) which in turn sends it to the Analog-Digital Converter and sends it to the Servo motor which rotates, leading to movement of the prosthetic arm accordingly.

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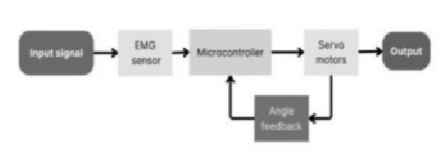

Fig. 1. Flow Diagram showing working of the Prototype

II. Methodology

A. Design and Construction

Our device consists of basically three components : (1) an Emg Sensor,(2) an Arduino-controlled servo motor network, and (3) a Prosthetic Arm. The construction has been designed in such a way that the three-channeled emg data is read by the Arduino using Arduino communication protocol which in turn is sent to the servo motor network. The perfectly tuned MG996 Servo motors are strategically placed to mimic the precise and accurate movement of actual fingers. Each joint of the finger is perfectly attached and connected to the Servo motors by fishing lines resembling the ligaments in humans. Much care has been taken in maintaining perfect tension of the fishing lines. The Arduino is coded with the perfect algorithm for flawless operation[6].

B. Work done and Progress

The work on this project has been divided into three phases for in-depth research and development of which this is the outcome. ***We have tried our best to mimic the joint movements. We are still in PHASE- II of our project but we have a clear plan ahead which is PHASE - III .***

1) Phase 1: The first phase begins with learning about all the components and functions of Arduino Uno, Servo motors, and Potentiometers, and deep research in the field of Human Wrist Biomechanics, history, and development of

ig. 2. Phase-I Work progress

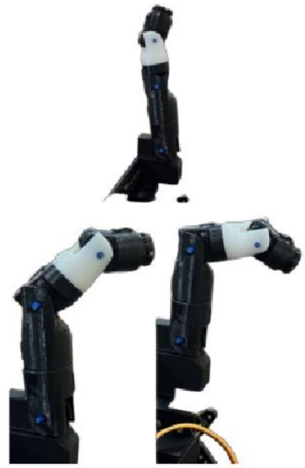

Fig. 3. Phase-II Work progress

Prosthetic arms. Angle Measurements of all joints(MCP, DIP, PIP) present in each of the fingers have been taken and studied for better insight. A DIY(Do-It-Yourself) Model of Body-Powered Prosthetic Wrist was brought and connected to gain knowledge on the connection of various components. After attaching all the parts, developments have been done on it, connecting the joints to servo motors and potentiometers with fishing lines leading the fingers to fold and unfold themselves according to the changing resistance of potentiometers and the pre-programmed algorithm of Arduino Uno

2) Phase 2: After gaining all the insights on human biomechanics and careful observation of the working of DIY model and sensors along with angle measurements of finger joints. Our work entered PHASE - II of our project. In this phase,3D printing of the prototype model as prepared on Fusion 360 is done. After printing all the parts, the connection has been done using Super Glue to bring it to the shape of the Human arm. Using fishing lines as the ligaments and bolts as required for the joints. After this, Flex Sensors have been implemented on the prototype. Flex Sensors change the resistance which in turn measures the amount of bending or deflection of the strip. Flex Sensors have been used to mimic the human finger movement. The Flex Sensors have been attached to all the fingers of the hand glove which is worn by one of the team members and as she moves her finger the finger of our prototype also moves accordingly. The flex sensor is connected to the Arduino Microcontroller to which Servo motors are connected which in turn is responsible for the movement of fingers. The flex sensors have been perfectly tuned and calibrated so that the prototype fingers mimic human finger movement with the highest accuracy.

3) Phase 3: In this phase, EMG Sensors are implemented which detect electrical nerve signals from muscles and send them to the Arduino Microcontroller which in turn is responsible for the movement of Servo Motors connected to the fingers of our prototype on placing the conductive pads are placed on certain positions of volunteer's forearm and accordingly it reads the nerve signal and works. Calibration of the sensor has been done on proper understanding of the working and mechanism of the EMG Sensor leading to precise and controlled movement of the prototype.

C. *Understanding of Components used*

1) Servo motors: Servo motors are electromechanical devices used for controlled and precise rotational movement according to changes in supplied current and voltages. In other words, they are rotary actuators used for angular positioning of connected parts. The Servo Motor consists of a DC Motor, Gearbox, Potentiometer, and Control Circuit.

2) Flex Sensors: Flex Sensors change resistance according to the amount of bending or shape. It is a thin strip of conductive material wrapped in plastic which measures the change in resistance. With the bending of the strip, the conductive layer stretches and contracts which leads to a change in resistance. In our work, we have implemented a flex sensor to effectively move the prototype in accordance with the movement of the flex sensor placed on the fingers of the volunteer's hand.

3) EMG Sensors: The EMG Sensor detects the electrical signals from the muscles on placing the conductive pads on certain positions of the volunteer's hand. The EMG Sensor consists of mainly three components: Surface Electrodes, Instruction Amplifiers, and Active Low pass filters. Surface Electrodes obtain the electric signals[5], the instrumentation filter removes the electromagnetic noises from the electric signals and the active low pass filter allows only the high-frequency signals to pass through[4] with a cutoff frequency of 482Hz, *4) Arduino UNO:* The Arduino Uno is an affordable, easy-to-use, and efficient programmable open-source product with a built-in ATmega 328 Microcontroller which can be programmed easily using Arduino IDE. The Microcontroller gives Arduino Uno the possibility to connect with other sensors, microcontrollers, and other Arduinos.

D. Applications

This prototype has multiple applications with its strong built quality and high efficiency with much lesser delay and latency as compared to other prostheses available in the market at the price point at which we have completed our project.

E. Results and Discussions

Sl no.	Name of Joint	Index Finger	Middle Finger	Ring Finger	Little Finger
1	MCP	100	97	115	104
	PIP	110	112	118	102
	DIP	80	74	75	76
2	MCP	65	52.3	85	80
	PIP	90	99	84.5	50
	DIP	80	76	68	82.4
3	MCP	85	100	86	82
	PIP	106	112	108	92
	DIP	65	88	74	95
4	MCP	95	90	80	115
	PIP	102	112	102	95
	DIP	84	86	92	92
5	MCP	75	70	55	65
	PIP	85	74	65	80
	DIP	75	66	54	55
6	MCP	90	100	98	88
	PIP	100	105	110	100
	DIP	90	80	98	102

Objective and Motivation: The main motive of building this project is to provide people in need with highly efficient and affordable prosthetic arms to give them freedom from lifetime difficulties. Our prototype allows the user to perform all their activities, from daily household chores to hard laboring work.

Advantages of the Prototype

1) Strong built Quality
2) Portable and lightweight
3) Does not affect the human body
4) Easy to control

F. Problems with the Prototype

1) Lesser number of degree of freedoms than a human hand.
2) Not suitable for heavy weights. The weight bearing capacity needs to be studied in the future works. .
3) The material is not adjustable or easily modifiable to design changes

G. Conclusion

This work depicts the potential of EMG signals on how it can improve prosthesis technology. This work is completely done with the motivation of bringing a change in the lives of thousands of amputated people all over India and over the globe and also a small step in bringing a revolution in the prostheses industry. This paper provides a brief insight into the working and development of a Myoelectric Prosthetic Arm. Our future work would include further tuning and calibration of the EMG Sensors for better performance and accuracy along with research on how to attach this prototype to the body of upper limb amputees.

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REFERENCES

[1] Dinesh Mohan."A Report on Amputees in India" In The American Orthotic and Prosthetic Association,1986

[2] A. Low-Cost, AR Application to Control Arm Prosthesis — Virtual Reality. Available at: springer.com.

[3] Seo, Minsang, Dukchan Yoon, Junghoon Kim. "EMG-based prosthetic hand control system inspired by missing-hand movement" In Ubiquitous Robots and Ambient Intelligence (URAI), 2015 12th International Conference on, pp. 290-291. IEEE, 2015.

[4] D. Zhang, X. Chen, S. Li, P. Hu, and X. Zhu. "Emg controlled multifunctional prosthetic hand: Preliminary clinical study and experimental demonstration" In Robotics and Automation (ICRA), 2011 IEEE International Conference on. IEEE, 2011, pp. 4670–4675.

[5] F. Ortes, D. Karabulut, and Y. Z. Arslan. "General Perspectives on Electromyography Signal Features and Classifiers Used for Control of Human Arm Prosthetics" In Encyclopedia of Information Science and Technology, Fourth Edition, pp. 492-504. IGI Global, 2018

[6] Ahamed, Md Asif, Md Asraf-Ul Ahad, Md Hanif Ali Sohag, and Mohiuddin Ahmad. "Development of low cost wireless biosignal acquisition system for ECG EMG and EOG" In Electrical Information and Communication Technology (EICT), 2015 2nd International Conference on, pp. 195-199. IEEE, 2015.

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2	Deep Mukherjee, Kshitij Rastogi. "A performance analysis between IOPID and FOPID controller on a coupled tank", 2017 International Conference on Inventive Systems and Control (ICISC), 2017 Publication	1
3	Xiaolong Wang, Yuchen Feng, Xinjie Gu, Yuzhu Long, Mithun Mukherjee, Kaneez Fizza, Qi Zhang, Mian Guo. "Edge Intelligence for Synchronized Human-Robotic Arm Interactions over Unreliable Wireless Channels", GLOBECOM 2022 - 2022 IEEE Global Communications Conference, 2022 Publication	1

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