Project Reference Number: 46S_BE_3091

Synopsis
on

"DEVELOPMENT OF ERGONOMIC AFFORDABLE PROSTHETIC ARM FOR TRANSRADIAL AMPUTEES"

Bachelor of Engineering
in
Electrical and Electronics Engineering

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1. KEYWORDS

Arduino, EMG Signal Processing, Myoelectric, Myosignals, Prosthesis, Prosthetic hand, Prosthetic Limb, Transradial amputees.

2. INTRODUCTION

Prosthesis is a wearable device that intends to provide the functionality and/or appearance of a missing body part. The hand is a powerful tool and its loss causes a severe psychological and physical drawback. In the case of trans-radial prostheses, the wearer or the trans-radial amputee is fitted with an artificial wrist and a hand that is either mechanically or electro-mechanically operated. Transradial amputation is the partial amputation of the arm below the elbow, at some point along the radial bone.

A bionic/prosthetic limb gives the user much more control and movement through the use of sensors and actuators that respond to both thoughts and muscle movement. This functionality takes much of the workload off of the user's body and acts more like a real limb. Many transradial prostheses have been developed in the past, nonetheless most of them would be inappropriate if/when a large bandwidth human-machine interface for control and perception would be available, due to either their limited dexterity.

The prosthetic hand is an artificial device which is designed for the people with upper limb amputations to come up with some functions of the natural hands. The number of amputees in the developing countries is significantly greater than in developed countries due to minimum medical facilities and the popularity of illnesses that have been cured in the developed world. Loss of upper limbs has many circumstances not only in the sense of physically but also in social and psychological department. Artificial hands and wrists are used to conduct everyday tasks such as washing, writing and picking various items to mitigate these effects and enable the amputee to return to normal life.

The main aim of our Team is to examine the natural hand's functional capacity and evaluate the most common grasping patterns of the hand from an unlimited range of patterns.

3. OBJECTIVES

Objective-1: To develop a 3D printed prototype prosthetic arm that mimics the functionality for transradial prosthesis (Gesture based).

Objective-2: To design Myosensor (EMG Sensor) based prosthetic arm control and test for different object grasp control.

4. METHODOLOGY

4.1. Hardware Materials used in Objective 1 are as follows:

4.1.1. Microcontroller (Arduino UNO): 01 Quantity

Fig.1: Arduino UNO

Specifications: **ATmega328, Operation Voltage:** 5V, Current: 20-50mA, Pins: Analog Input Pins (6), PWM Digital I/O Pins (6), SRAM: 2 KB.

4.1.2. Servo Motor: 05 Quality

Fig.2: Servo Motor

Specifications: **Tower Pro MG90S Micro Servo,** Operation Voltage: 4.5-6V, Dead Band Width: 5μs, Weight: 13.4g.

4.1.3. 7805 Regulator Board: 01 Quality

Fig.3: 7805 Regulator Board

Specifications: **7805 Regulator Breakout Board**, Operation Voltage: 5V, Input Voltage: 14V, Current: 1A.

4.1.4. 3D Printed Prosthetic Arm

Fig.4: Prosthetic Arm

Specifications: **Prosthetic Arm,** Weight: 320 gm, Height: 30 cm, Diameter: 9 cm, Material Type: PLA (Poly Lactic Acid)

4.1.5. Flex Sensor: 05 Quality

Fig.5: Flex Sensor

Specifications: **Flex Sensor,** Operation Voltage: 5V, Power Rating: 0.5W, Operating Temperature: -45ºC to +80ºC, Bend Resistance Range: 45k to 125k.

4.1.6. Li-ion Rechargeable Battery (1200 mAh): 02 Quality

Fig.6: Li-ion Rechargeable Battery

Specifications: **Li-ion Rechargeable Battery,** Normal Voltage: 3.7V, Battery Capacity: 1200mAh, Charge Voltage Range: 4.2V to 5.5V.

4.1.7. Block Diagram of gesture based Prosthetic Arm

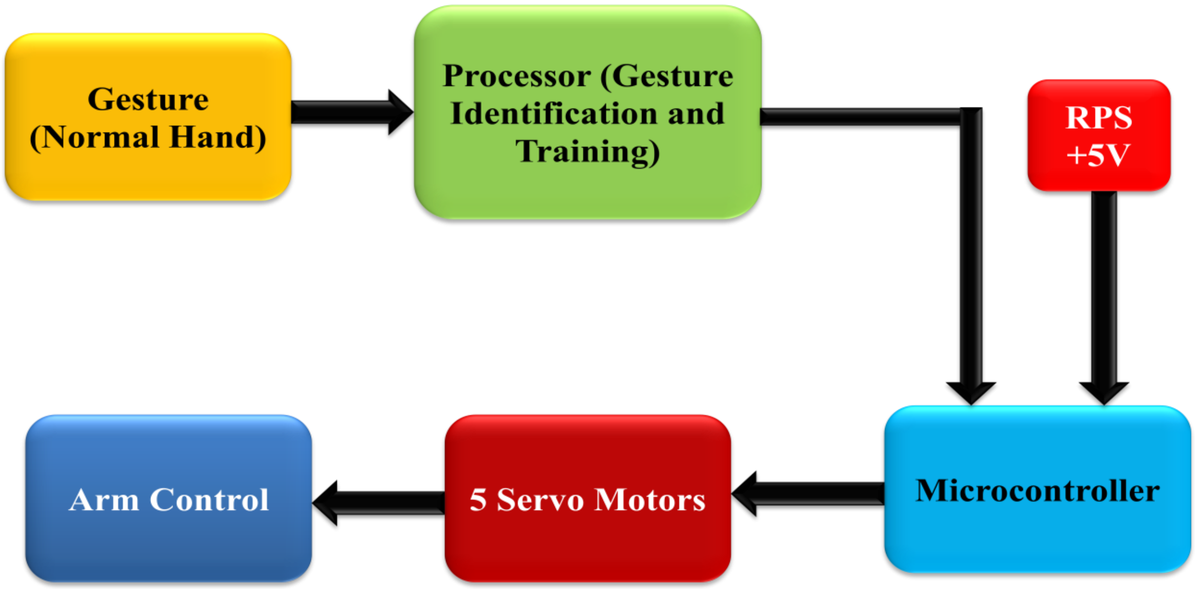

Fig.7: Block Diagram of Gesture based Prosthetic Arm.

4.2. Hardware Materials used in Objective 2 are as follows:

4.2.1. Microcontroller (Arduino UNO): 01 Quantity

Fig.8: Arduino UNO

Specifications: **ATmega328, Operation Voltage,** +5V, Current: 20-50mA, Pins: Analog Input Pins (6), PWM Digital I/O Pins (6), SRAM: 2 KB.

4.2.2. Servo Motor: 05 Quality

Fig.9: Servo Motor

Specifications: **Tower Pro MG90S Micro Servo,** Operation Voltage: 4.5-6V, Dead Band Width: 5µs, Weight: 13.4g.

4.2.3. EMG Sensor Board: 01 Quality

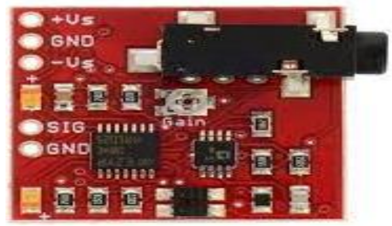

Fig.10: EMG Sensor Board

Specifications: **EMG Muscle Sensor Module with Cable and Electrodes,** Diameter of Electrode Pad: 52mm, Cable Length: 2 feet, Weight: 30gm, Power Supply: ±3.5V.

4.2.4. 7805 Regulator Board: 01 Quality

Fig.11: 7805 Regulator Board

Specifications: **7805 Regulator Breakout Board**, Operation Voltage: 5V, Input Voltage: 14V, Current: 1A.

4.2.5. 3D Printed Prosthetic Arm

Fig.12: Prosthetic Arm

Specifications: **Prosthetic Arm,** Weight: 320 gm, Height: 30 cm, Diameter: 9 cm, Material Type: PLA (Poly Lactic Acid)

4.2.6. Li-ion Rechargeable Battery (1200 mAh): 02 Quality

Fig.13: Li-ion Rechargeable Battery

Specifications: **Li-ion Rechargeable Battery,** Normal Voltage: 3.7V, Battery Capacity: 1200mAh, Charge Voltage Range: 4.2V to 5.5V.

4.2.7. Block Diagram of Myosensor EMG Sensor based Prosthetic Arm.

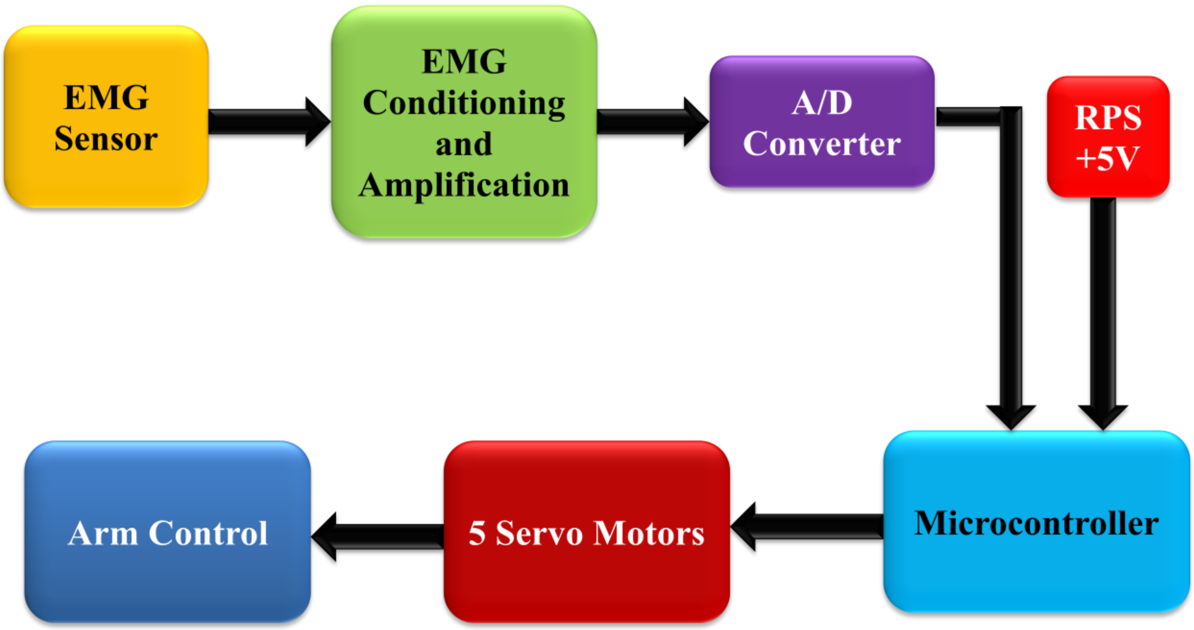

Fig.14: Block Diagram of Myosensor EMG Sensor based Prosthetic Arm.

5. RESULTS AND CONCLUSION

5.1. Results of Gesture based Prosthetic Arm.

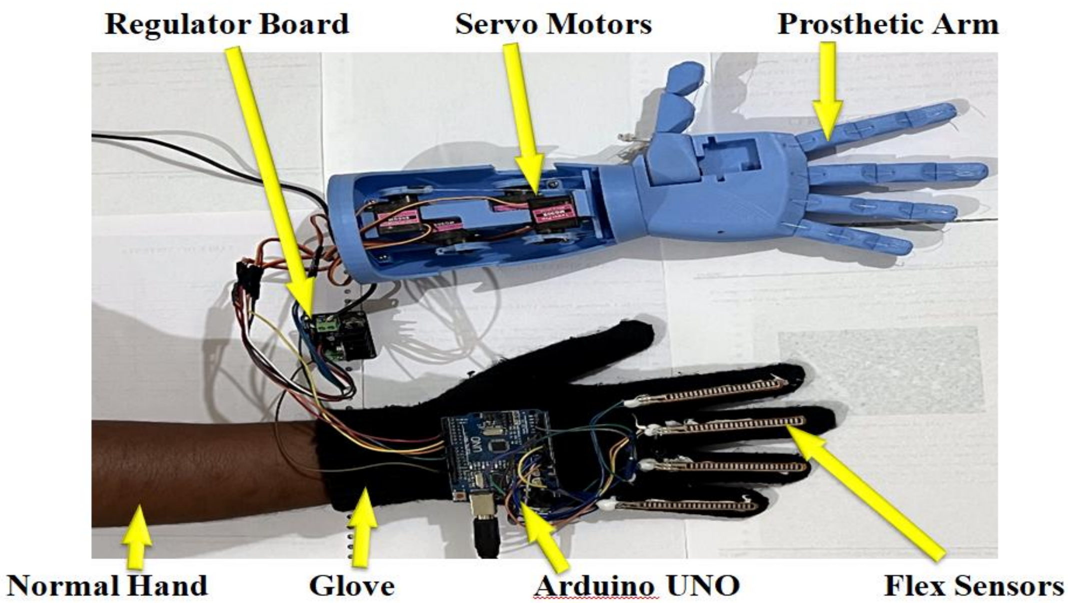

Fig.15: Result of Gesture based Prosthetic Arm

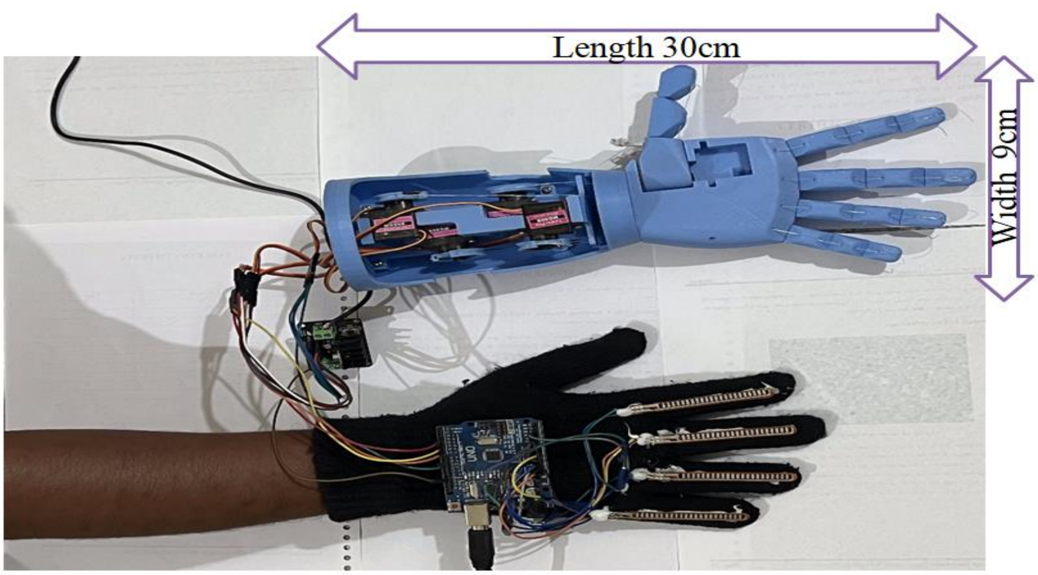

Fig.16: Dimensions of Gesture based Prosthetic Arm

5.2. Results of EMG based Prosthetic Arm

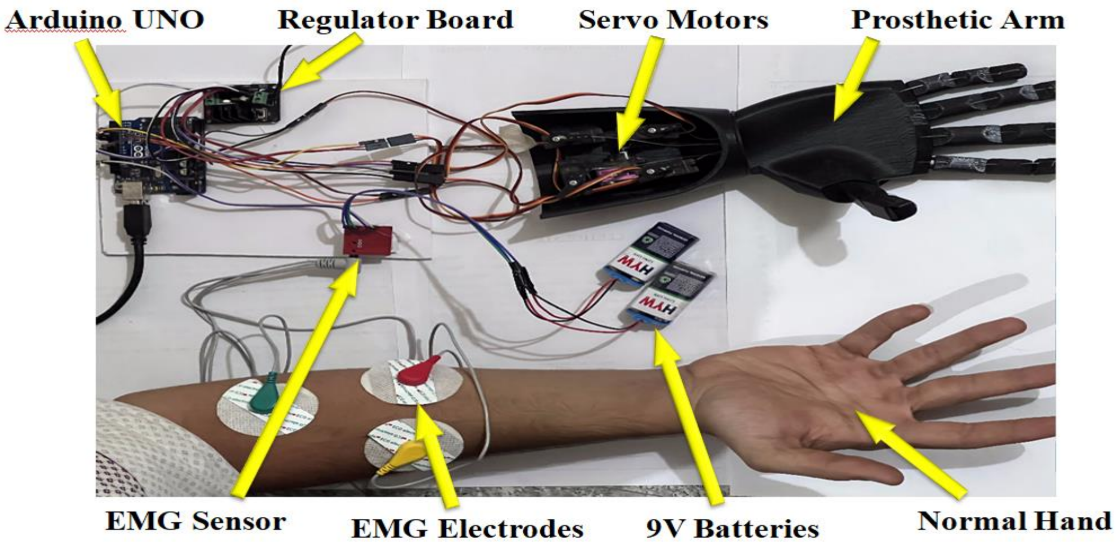

Fig.17: Result of EMG based Prosthetic Arm

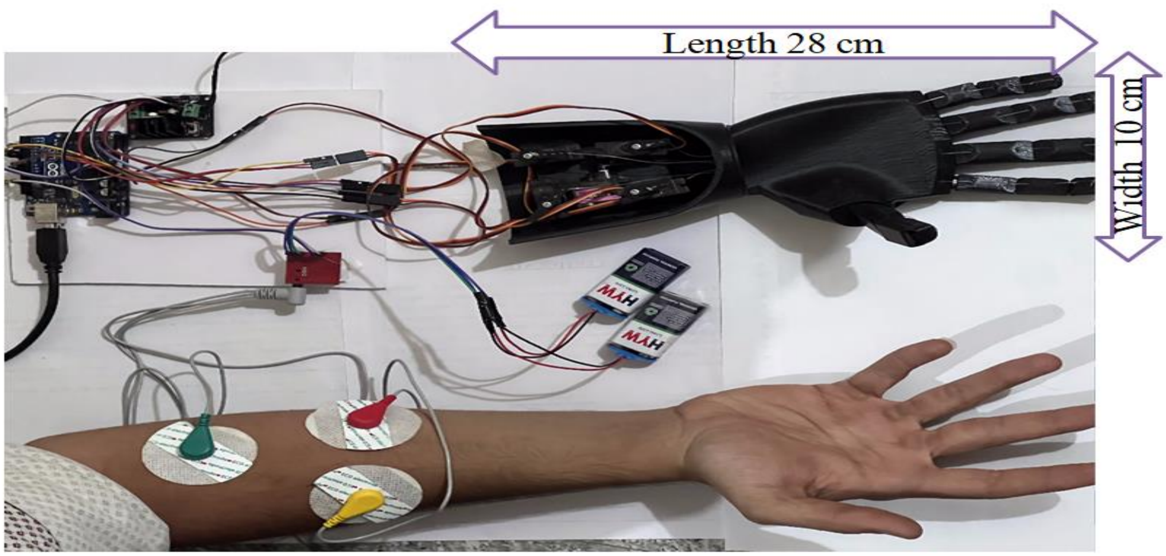

Fig.18: Dimensions of EMG based Prosthetic Arm

5.3. Conclusions

Based on the objectives planned the outcome is achieved.

EMG: In conclusion, the Myosensor-based prosthetic arm control system has enormous potential to revolutionise the prosthetics industry by giving people who have lost limbs the chance to reclaim intuitive and practical control over their prosthetic limbs.

More advanced and user-friendly prosthetic devices will surely be possible with continued research and development, ultimately improving the quality of life for individuals who need them.

Gesture: In conclusion, the creation of 3D printed prototype prosthetic arm for lower arm amputees that uses gesture-based control is a significant advancement in the field of prosthetics. This ground-breaking approach combines the advantages of 3D printing technology, personalization, and intuitive control, providing a promising way to enhance the lives of those who have had their lower arms amputated.

This prototype has the potential to revolutionize the prosthetics market, enable lower arm amputees to regain functional independence, and improve their general well-being with further development and improvement.

6. SCOPE FOR FUTURE WORK

- ✓ Wireless Bluetooth for gesture based control of arm.
- ✓ For arm design, socket can be introduced.
- ✓ EEG based control can be introduced.
- ✓ MYOWARE sensor can be introduced for EMG based arm control.