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ACTUATION METHODOLOGY FOR PROSTHETIC ARM

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Abstract: Prosthetics are an important bio-medical field, which also includes the mechatronics system. The paper explains the efficient real-world implementation of a prosthetic arm. Especially this paper explains the upper arm defected patients which means the upper portion of the elbow defected patients. We are introducing an actuation methodology for modeling prosthetic arms.

Index Terms - Prosthetics, Myoelectric sensor, KNN algorithm, Machine Learning

I. INTRODUCTION

The prosthetics is a mechatronics system that is used to compensate for defective body parts. Through this paper, we explain the efficient use of a prosthetic arm. The paper is subdivided into various parts, each part explains the various aspects of the prosthetic arm. The sensing part of the prosthetics uses a myoelectric non-invasive sensing method. In this project, we used two myoelectric sensors.

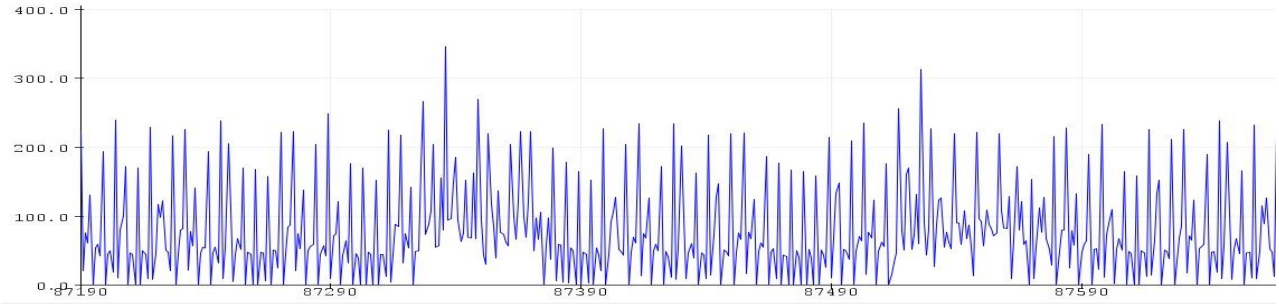
II. HAND POSTURE

A prosthetic arm is a mechatronics device that contains a sensor, controller, and actuator. In each activity, we use different hand postures to attain an efficient completion of the work. For example, during writing, we hold the pen in one hand posture and the ball is held in hand by different hand posture. The set of hand postures used by an individual depends on their profession. In paper [3], we can see the different picture of hand posture used during their project.

Each hand posture depends on the stepper angle value assigned in the processor. We can use switch conditional statements for making different postures of the hand. Each posture is assigned to a particular digital value. The syntax of the switch statement is dependent on the program used to design the prosthetic arm.

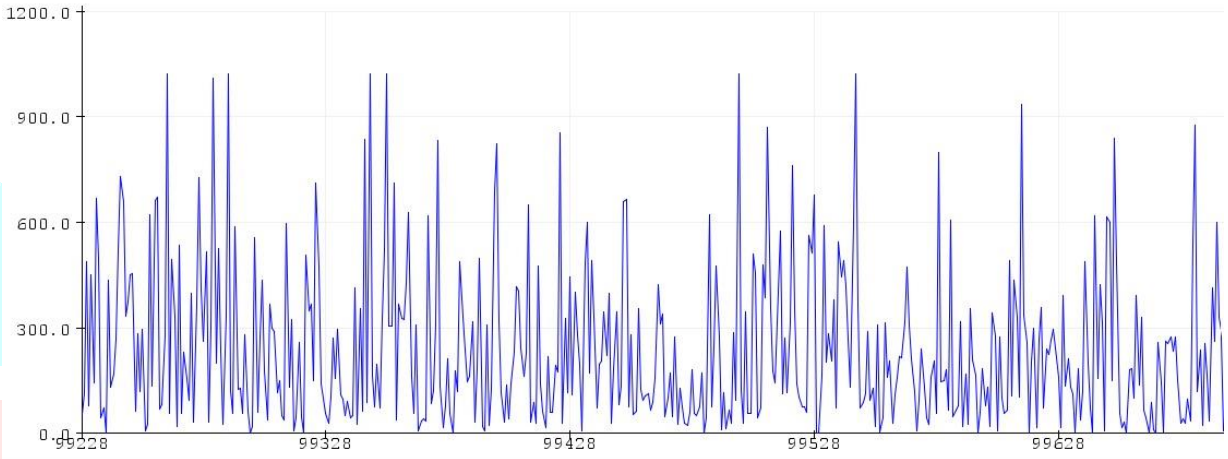
III. BICEPS AND TRICEPS VALUE PLOTTING

The biceps and triceps value is taken by two myoelectric sensors. The sensor value is read as a voltage value, which varies from 0 to 1024. The blow figure shows various voltages according to the muscle contraction and extension of a single sensor.



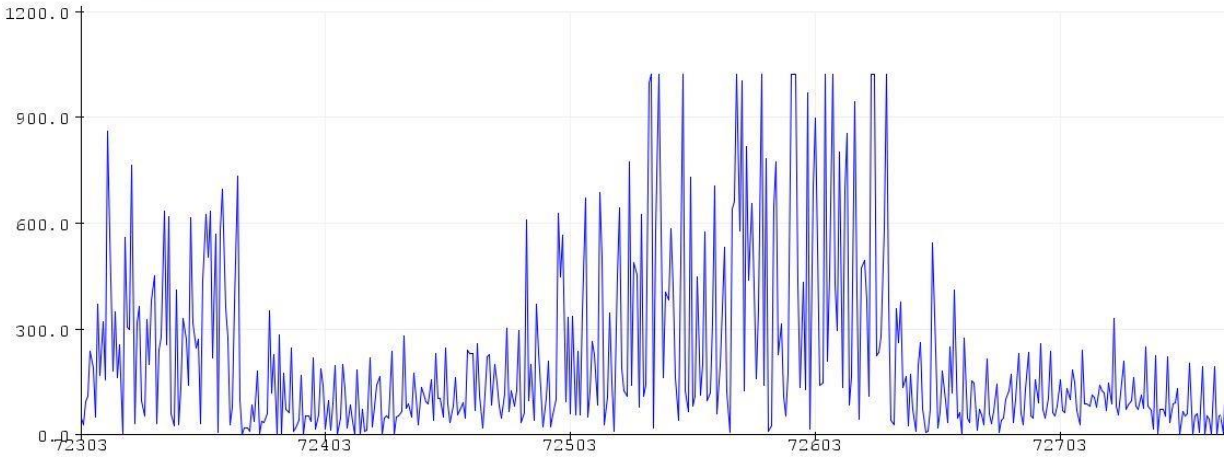
Fig(i) Extension

The above figure Fig(i), shows the voltage during extension, which means normal case muscle is in relaxed condition. The value of voltage during this period ranges around 400 units in the Arduino plot.



Fig(ii) Contraction

The above figure fig(ii), shows the voltage during contraction, which means the muscle is in fully contracted condition. The value of voltage during this period ranges to 1024 units in the Arduino IDE plot.



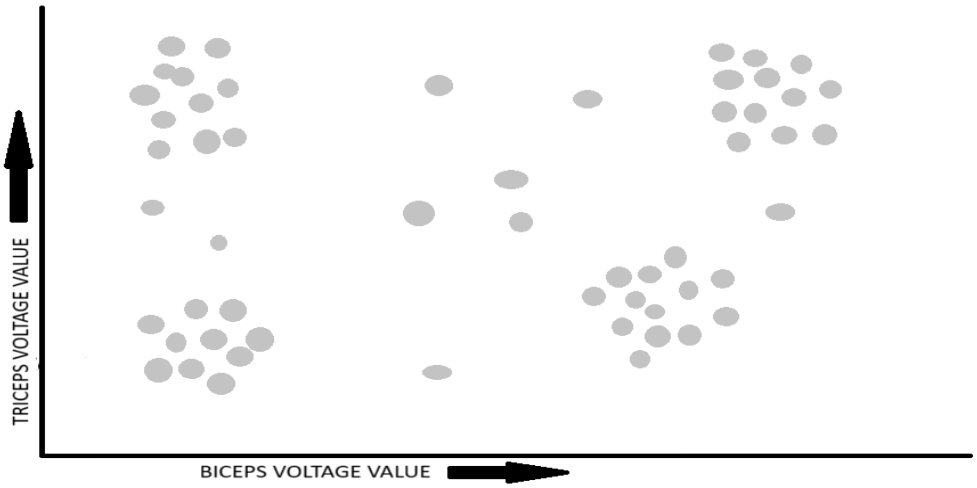
Fig(iii) Extension & Contraction

Figure Fig (iii), shows the range variation from extension to contraction. In our case, it ranges from 400 – 1024 units. The above three figures are the different conditions of muscle taken from a single sensor.

For actuating the prosthetic arm in different postures we need the combined voltage value of two different muscles. We have taken the muscle value from the biceps and triceps. First, we plot the triceps value in the x-y graph.

Fig(iv) Testing

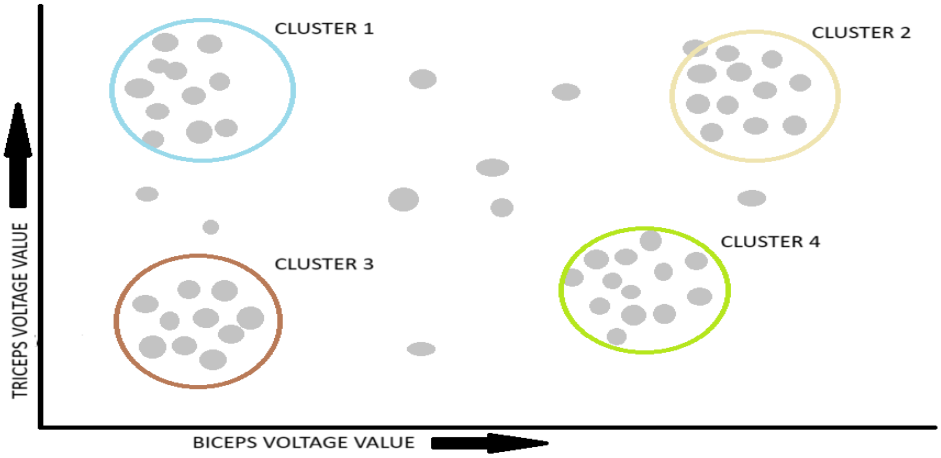
Fig(vi), shows the testing of single muscle's sensor values taken from team members of the project. This figure shows a demo, actually in the paper explains the values of sensors taken from the triceps and biceps muscles.



Fig(v) Plotting sensor value

The plotting of muscle values is done by the controller internally. A skin surface electrode is placed in the skin, which is directly connected to an instrumental amplifier specially designed for the acquisition of myographic signal. The instrumental amplifier is then connected to the controller to process the data and actuate according to the sensor value. The Fig(iv) shows the plotting sensor values of the biceps and triceps muscles.

IV. ESTIMATING EACH CLUSTER:



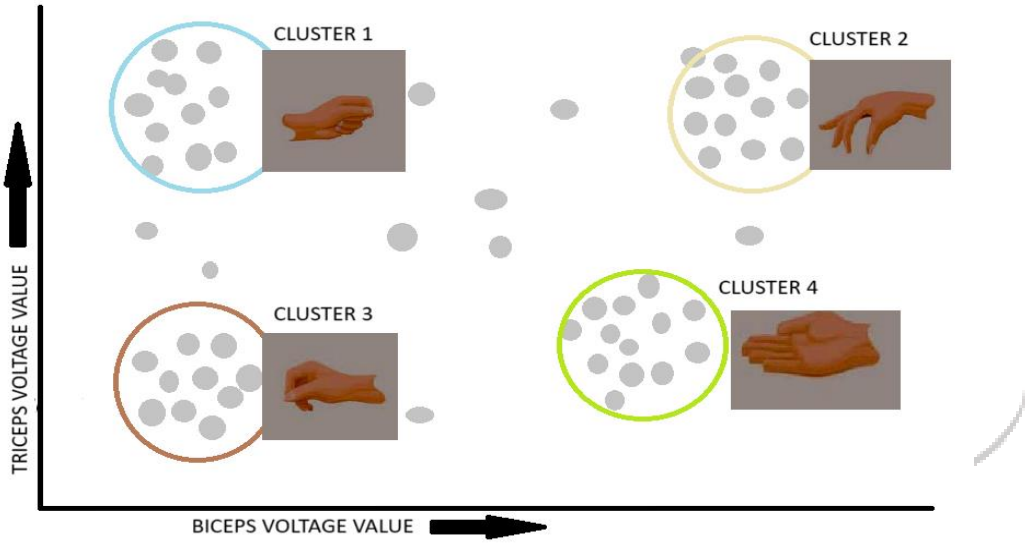
Fig(vi) clustering

The muscle contraction and extension values are different for different patients, the are two methods for clustering the plotted sensor value from the triceps and biceps. The paper [2], the machine learning-based actuation in the prosthetic arm.

- Manual Clustering: we can manually set the cluster by the mathematical inequality function, and we can set the limit manually.
- Machine Learning-based Clustering: ML-based clustering is done using the KNN algorithm. It is an efficient method of clustering in ML. Proper training and time are required for efficient clustering.

V. ASSIGNING HAND POSTURE IN EACH CLUSTER

After clustering the data we need to assign each posture to clusters. The logic in this is if the real-time value is within the nth cluster, actuates the nth posture.



Fig(vii) Assigning posture to each cluster

VI. CONCLUSION

By implementing this device, we can restore the ability to do everyday activities. Improve the standard of living of patients.

The customization options, intuitive controls, and versatility in grip patterns contribute to a more natural user experience.

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