Title of Project: GESTURE CONTROL MULTI FUNCTION ROBOTIC LIMB USING MUSCLE SENSOR

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Introduction
In the last two decades, there has been a tremendous surge of activity in robotics, both in terms of research and development.

Robotics can be described as the current pinnacle of technical development. Robotics is a confluence science using the continuing advancements of mechanical engineering, material science, sensor fabrication, manufacturing techniques, and advanced algorithms. The study and practice of robotics will expose a dabbler or professional to hundreds of different avenues of study. For some, the romanticism of robotics brings forth an almost magical curiosity of the world leading to creation of amazing machines. A journey of a lifetime awaits in robotics.

Robotics can be defined as the science or study of the technology primarily associated with the design, fabrication, theory, and application of robots. While other fields contribute the mathematics, the techniques, and the components, robotics creates the magical end product. The practical applications of robots drive development of robotics and drive advancements in other sciences in turn. Crafters and researchers in robotics study more than just robotics.

The promise of robotics is easy to describe but hard for the mind to grasp. Robots hold the promise of moving and transforming materials with the same elan and ease as a computer program transforms data. Today, robots mine minerals, assemble semi-processed materials into automobile components, and assemble those components into automobiles. On the immediate horizon are self-driving cars, robotics to handle household chores, and assemble specialized machines on demand. It is not unreasonable to imagine robots that are given some task, such as reclaim desert into photovoltaic cells and arable land, and left to make their own way. Then the promise of robotics exceeds the mind's grasp.

In summary, robotics is the field related to science and technology primarily related to robotics. It stands tall by standing the accomplishments of many other fields of study.

This period has been accompanied by a technological maturation of robots as well, from the simple pick and place and painting and welding robots, to more sophisticated assembly robots for inserting integrated circuit chips onto printed circuit boards, to mobile carts for parts handling and delivery.

Objectives

- A wearable bionic arm for physically challenged.
- Bionic arm which replicates all the gesture of human wrist (5 DOF). Control of bionic hand through human muscle movement.
- Unlocking doors with NFC which is integrated to bionic arm. Turning on switches through NFC (contactless process)
- Blood pressure monitoring.
- LOW BP indication.
- OLED display for status indication.
- Food and tablet remainder.
- Displaying the temperature of objects, surroundings and its users' body.
- Turning TV on and off.
Methodology:

The first step in the process is to acquire EMG signals from the person’s arm using surface electrodes. EMG signals are acquired by using two channel MyoWare Muscle Sensor kit having three electrodes, two electrodes are for signal recording and the third electrode works as reference electrode. After deciding the target muscle (biceps or forearm), one of the electrode is placed in the middle portion of the muscle body and other electrode should line up at the end of muscle and in the direction of the muscle length. Reference electrode is placed on the wrist as this position of the electrode is found to be optimal. Silver/Silver Chloride (Ag/AgCl) electrodes with circular diameter of 10 mm were used. The distance between the centres of conductive areas of the bipolar electrodes was maintained between 1 and 1.5 cm. The electrodes were pre-gelled to reduce the electrode skin impedance. The skin was cleansed with a sanitizer before the electrodes were placed. The acquired EMG signals are processed to remove noise and other unwanted signal artefacts and to extract certain statistical features reflecting the forearm movements. Further the processed EMG signals are used to recognize the forearm movement and identify the states of forearm as a flexion or extension. Based on the state of the forearm, the actuators of the orthotic robotic arm are controlled. The actuators and supporting robotic arm helps to move the forearm of the paralyzed patients. Also, the robotic arm has safety controller for involuntary arm movements, where actuators are not activated if semi flexion or extension movements are detected. A Smart watch is embedded on robotic arm, which will measure its users body temperature, surrounding temperature and the temperature of the objects it holds using temperature sensor and to make its user to remember his/her food and medicine from time to time and it also measure blood pleasure using pulse sensor. These are all displayed using OLED display.

**BLOCK DIAGRAMS**

**ELECTROMYOGRAPHY BLOCK**

![Block Diagram](image)
Conclusions

The proposed work is a novel human–robot interface for robot teleoperation is introduced. EMG signals recorded from muscles of the upper limb were used for extracting kinematic variables (i.e., joint angles) in order to control an anthropomorphic robot arm in real time. The novelty of the method proposed here can be centered around two main issues that are discussed in the following.

First, the dimensionality reduction is quite significant, since it not only revealed some interesting aspects regarding the 3-D movements studied, but it also aided the matching between the EMG signals and motion since signal correlations were extracted, and the number of variables was drastically reduced. The latter led to the fact that a simple linear model with hidden states proved quite successful in mapping EMG signals to arm motion. The fact that the 3-D arm motion is somehow constrained by the use of only two independent variables that describe arm motion does not hinder the applicability of the method. This is based on the suggestion of motor synergies, which allows those 2 DOFs decoded to be represented back in the high-dimensional space, where four human joint angles are actuated, concluding to motion of the human arm in the 3-D Cartesian space with limited though workspace.

The second important issue presented here is that, to the best of our knowledge, this is the first time a continuous profile of the 3-D arm motion is extracted using only EMG signals. Most previous works extract only discrete information about motion, while there are some works that estimate continuous arm motion; however, they are constrained to isometric movements, single DOF, or very smooth motions [5]. In this paper, the method was tested for motions in the 3-D space, with variable speed profiles. Moreover, this paper proposes a methodology that can be easily trained to each user and takes little time to build the decoding model, while the computational load during real-time operation is negligible.

Scope for Future Studies
For an amputee, upper limbs loss has many different consequences. Due to the hand loss, the number of work and life opportunities is greatly reduced for them. Hence, research into creating a prosthetic hand which can be conveniently controlled by EMG signal from arm is of great value. Therefore, the goal of this project was to create a lowcost 3D printed prosthetic hand by using Electromyography data collected from the forearm.

The design partly met the project’s expectation and goals set at the beginning. Initially, this project has four main targets. The first target is building a device in the form of a prosthetic hand which can help an upper limb loss amputee perform simple daily tasks. The device can only partly fulfil this target, because all the EMG signal measurement of different hand gestures were conducted on a person who does not loss his/her hand. In reality, the muscle group activities and EMG signal of an amputee may significantly differ from the one who still has a hand. There is a high probability that the device will not operate correctly when the user is an amputee. Secondly, the size needs to be adjustable and the weight needs to be light. The total weight of the device is around 412 grams which is really low and suitable for most of the users. However, the current mechanics design of the device does not allow the size to be adjustable, there are some new design updates planned. Thirdly, the device should help the patients to “feel” the signal from the touch sensors. This target was achieved using a vibration motor which is attached to the patient forearm. Whenever any of the force’s sensors are activated, the vibration motor will be turned on to give the notification for the user about the grip’s force. Finally, the price needs to be cheaper than the other commercial products in the market. In fact, the final price of the device is only around 190 € which is much cheaper compared to most of the other available electronics prosthetic which can be cost thousands of euros such as Bebionic of Ottobock Ltd.

Although the final device has fulfilled most of the initial targets, there are many details of the current model that need to be redesigned in order to use it for real-life cases. Firstly, it is possible to save the device’s weight up to 20% by using carbon fibre filament and choosing another internal filling structure technique. Secondly, the flexible filament that was used to create the prosthetic hand joints is not flexible enough to return the hand in rest position after the movement, another flexible material needs to be chosen to replace the current one. Thirdly, the wire management is this model has been badly done, the wires are placed everywhere in the gauntlet of the hand. This problem can be solved by replacing the wire with ribbon cable of flat flex PCB and the connection to the PCB board should be made by a single line connector instead of many connectors distributed across the PCB. Finally, the EMG data signal processing needs to be studied and applied for the device in order to eliminate the calibration mode since the calibration mode brings a lot of inconveniences for the user now.