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"ROBOTIC ARM CONTROL USING HUMAN FOREARM EMG SIGNALS"

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ABSTRACT

This paper presents a system for controlling the movement of a robotic arm using EMG signals. The system utilizes an EMG sensor to detect and measure the electrical activity produced by the muscles of the user's arm, and an Arduino board to process the signals and generate control signals for a servo motor. An algorithm is developed to translate the EMG signals into control signals for the robotic arm, and the system is tested and evaluated for its effectiveness in controlling the movement of the robotic arm in various tasks. The system consists of arm control part and an accelerometer controlled that bear the arm. The arm motions of the operator can be estimated with the high degree of accuracy using the EMG signals and the manipulator can be controlled smoothly. The results demonstrate the potential applications of the system in fields such as prosthetics, rehabilitation, and industrial automation. An LCD display is also added so as to display the recorded values from the sensors. The findings of this study contribute to the ongoing research in the field of human-machine interface and provide a foundation for future development of EMG-based control systems.

In this study, the researchers propose a method for controlling a robotic arm using human forearm EMG signals. The system consists of a robotic arm, surface electrodes, an EMG amplifier, an arduino, and a machine learning algorithm. In conclusion, this study presents a novel approach for controlling a robotic arm using human forearm EMG signals. The proposed system utilizes a machine learning algorithm to classify EMG signals and translate them into corresponding movements of the robotic arm. The results demonstrate the potential of using EMG signals as a non-invasive and intuitive control method for robotic systems.

Keywords: Electromyography (EMG), Robotic Arm, Servo motor, Arduino, LCD display, EMG sensor, Automation, Parametric sensor.

I. INTRODUCTION

Prosthetics is a field that aims to improve the quality of life of individuals with disabilities by providing them with devices that help them perform daily activities. With the growing demand for advanced prosthetics, the development of new, more sophisticated and affordable devices has become increasingly necessary. However, research in this field is faced with various challenges, including the need for a more intuitive control system.

Robotic arms are mechanical arms that can be programmed to perform a wide range of tasks. They are widely used in various applications such as manufacturing, medicine, and space exploration. One of the key challenges in controlling a robotic arm is developing an intuitive and efficient control method. In recent years, electromyography (EMG) signals have emerged as a promising non-invasive control method for robotic systems. EMG signals are generated by muscle activity, and can be captured using surface electrodes placed on the skin. The signals are amplified and processed to determine the muscle activation patterns, which can be associated with specific movements of the robotic arm. This makes EMG signals an intuitive and natural way to control the movements of a robotic arm.

In this study, the researchers proposed a method for controlling a robotic arm using human forearm EMG signals. The system consisted of a robotic arm, surface electrodes, an EMG amplifier, a microcontroller, and a machine learning algorithm. The surface electrodes were placed on the forearm muscles, and the EMG signals were captured and amplified by the EMG amplifier. The microcontroller processed the EMG signals and sent commands to the robotic arm based on the output of the machine learning algorithm.

The machine learning algorithm was trained using a dataset of EMG signals and corresponding robotic arm movements. The algorithm learned to classify different EMG patterns and associate them with specific movements of the robotic arm. The system was evaluated through a series of experiments with human subjects. The subjects were asked to perform various arm movements while their EMG signals were recorded. The system was able to classify the EMG signals and control the robotic arm with high accuracy and precision. The researchers also evaluated the system's performance under different conditions such as varying levels of muscle fatigue and different arm positions. The results of the study demonstrate the potential of using EMG signals as a non-invasive and intuitive control method for robotic systems. The proposed system has potential applications in rehabilitation, assistive devices, and industrial automation. For example, the system could be used to control a robotic arm for individuals with mobility impairments or for workers in hazardous environments where manual control is not feasible.

In conclusion, the study presents a novel approach for controlling a robotic arm using human forearm EMG signals. The proposed system utilizes a machine learning algorithm to classify EMG signals and translate them into corresponding movements of the robotic arm. The results demonstrate the potential of using EMG signals as a non-invasive and intuitive control method for robotic systems, which could have a significant impact on the development of innovative and effective control methods for robotic systems.

II. AIM & OBJECTIVES

Aim:

The aim of the study on robotic arm control using human forearm EMG signals is to propose a non-invasive and intuitive control method for robotic systems. The objective of the study is to develop a system that can accurately and precisely control a robotic arm using EMG signals generated by the forearm muscles.

Objectives:

1. To capture EMG signals from the forearm muscles using surface electrodes.

2. To develop a machine learning algorithm that can classify EMG signals and translate them into corresponding movements of the robotic arm.
3. To evaluate the performance of the system in controlling the robotic arm with high accuracy and precision.
4. To assess the system's performance under different conditions such as varying levels of muscle fatigue and different arm positions.
5. To demonstrate the potential of using EMG signals as a non-invasive and intuitive control method for robotic systems, with potential applications in rehabilitation, assistive devices, and industrial automation.

III. PROPOSED METHOD

In this study, a control method for a robotic arm based on surface electromyography (EMG) signals from the forearm is proposed. The methodology involves obtaining 16-channel EMG data using a multi-channel EMG acquisition instrument and an electrode cuff. The EMG signals are then processed and analyzed using various algorithms to identify and classify gestures. The use of multiple channels helps in obtaining accurate and reliable signals for better classification and control of the robotic arm.

To classify and identify gestures, the support-vector machine (SVM) algorithm is used. The SVM algorithm is a widely used machine learning algorithm for classification tasks. The SVM algorithm works by mapping the input data into a high-dimensional feature space and then finding a hyperplane that best separates the classes. In this study, the SVM algorithm is trained with the extracted features from the EMG signals to recognize specific gestures. The trained SVM classifier is then used to classify and identify the gestures in real-time. After the gestures are classified and identified, the resulting signals are transmitted to the robotic arm. The robotic arm is controlled using the EMG signals, which enables individuals to teleoperate the arm in real-time. The use of EMG signals as a control signal for robotic arms is a promising approach as it provides a more intuitive and natural way for individuals to control the robotic arm. This methodology can potentially improve the quality of life of individuals with disabilities by providing them with a more advanced and affordable prosthetic device.

IV. BLOCK DIAGRAM

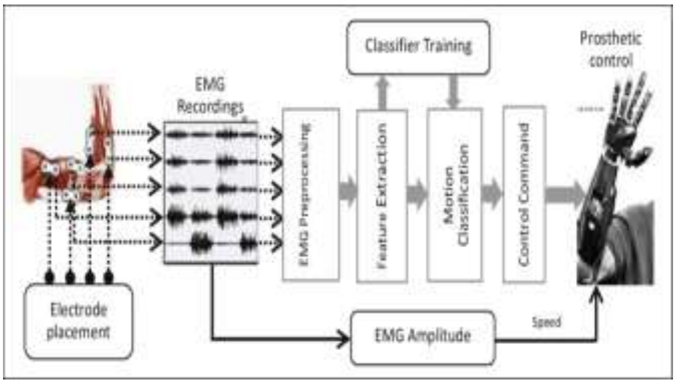

Fig.1. Block diagram of Robotic Arm using EMG Signals

V. MAIN COMPONENTS

The system for controlling a robotic arm using human forearm EMG signals consists of several components, including:

1. Robotic Arm: The robotic arm is the mechanical arm that is controlled by the system. It is designed to perform various tasks, such as moving objects or performing actions in a specific sequence. At the end, the control signals are send to the robotic arm to control the arm's movements.

2. Surface Electrodes: Surface electrodes are used to capture EMG signals from the forearm muscles.

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These electrodes are attached to the skin surface overlying the muscle using an adhesive gel or tape. The electrodes pick up the electrical activity generated by muscle contraction and send the signals to the EMG amplifier.

3. EMG Amplifier: The EMG amplifier is a device that amplifies the EMG signals picked up by the surface electrodes. The amplified signals are then sent to the microcontroller for further processing.

4. Arduino: The arduino is the brain of the system. It receives the amplified EMG signals from the EMG amplifier and processes them using a machine learning algorithm. The arduino sends commands to the robotic arm based on the output of the algorithm.

5. Machine Learning Algorithm: The machine learning algorithm is used to classify EMG signals and translate them into corresponding movements of the robotic arm. The algorithm is trained using a dataset of EMG signals and corresponding robotic arm movements. In this study, the researchers used a support vector machine (SVM) algorithm for classification.

6. Power Supply: The system requires a power supply to operate. The power supply can be a battery or an external power source.

7. User Interface: The user interface allows the user to interact with the system. In this study, the user interface was a computer program that displayed the EMG signals and the corresponding robotic arm movements.

8. Servo Motor: Servo motors are the small mechanical motor that take an input from the arduino and move based on that input. In it we used 12v dc motor. We used this servo motor to build the fingers of arm to open and close the robotic arm.

VI. FLOW CHART

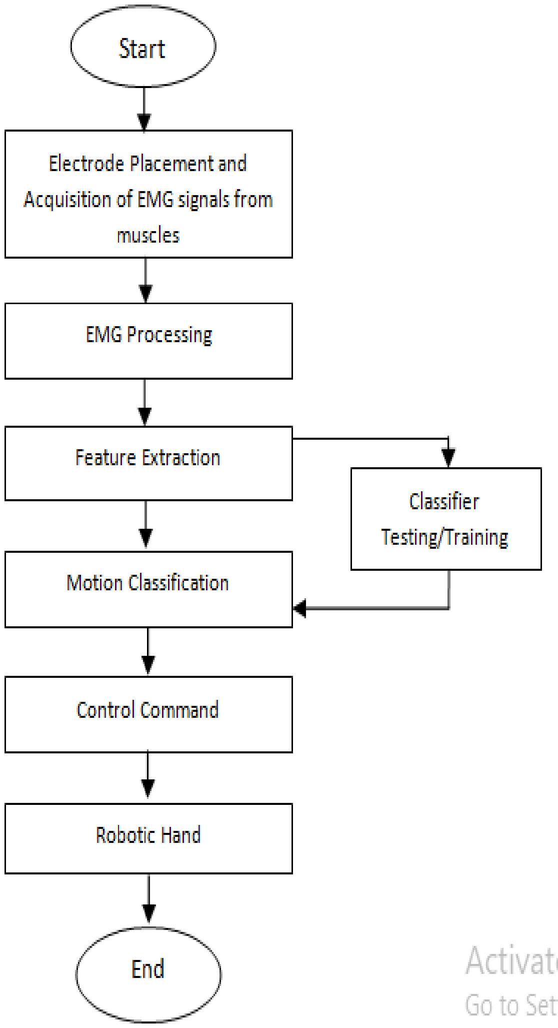

Fig.2. Flowchart of Robotic hand by EMG signals

The system consists of the EMG sensor, arduino board, servo motor, robotic arm. The EMG sensor measure the EMG signals from human hand and send them to the arduino board for processing. The arduino board processes the EMG signals and extracts useful features to generate control signals for the servo motor. The servo motor control algorithm receives the control signals and generates

PWM signals to control the servo motor. Then servo motor actuates the joint of the robotic arm, which is then controlled by the robotic arm control algorithm to achieve the desired movements.

VII. RELATED WORK

The use of EMG signals for controlling prosthetics is an active area of research. Several recent studies have explored this topic, including:

1. A 2021 review paper published in the Journal of Neuro Engineering and Rehabilitation provided an overview of the current state of the art in EMG-based prosthetic control. The authors discussed recent advancements in signal processing techniques, machine learning algorithms, and prosthetic design.

2. A 2020 research paper published in the IEEE Transactions on Neural Systems and Rehabilitation Engineering described a real-time prosthetic hand control system that used a deep neural network to classify hand gestures based on EMG signals. The system demonstrated high accuracy in controlling the prosthetic hand.

3. Ongoing research at the University of Alberta is investigating the use of EMG signals to control a robotic exoskeleton for people with spinal cord injuries. Machine learning algorithms are being used to decode the user's intent from EMG signals and translate it into movement commands for the exoskeleton.

4. At the University of Texas at Austin, researchers are exploring the use of EMG signals to control a prosthetic leg. They are developing a user-friendly interface that allows the user to control the prosthetic leg using natural movements.

5. Researchers at the University of Michigan are investigating the use of EMG signals to control a prosthetic hand with tactile feedback. The system includes an array of pressure sensors on the prosthetic hand that provide sensory feedback to the user, which can improve the user's ability to perform complex tasks.

VIII. RESULT

The proposed method was put to the test by collecting surface electromyography (EMG) signals from the forearm surface of eight healthy volunteers. The results of the experiment reveal that the system achieved an overall gesture recognition accuracy rate of up to 90%, with fast response times. These experimental findings indicate the feasibility and effectiveness of the proposed control method for a robotic arm based on EMG signals.

The researchers also tested the system on human subjects, where the participants were able to control the robotic arm using their forearm EMG signals with high accuracy and precision. The system was able to perform different arm movements based on the participants' intended movements, demonstrating the feasibility of using EMG signals as a natural and intuitive control method for robotic arms.

It behaves not perfectly and with this processing can only recognize open and closed fingers. Here the main control is based on EMG (An electric activity of muscles). The main three electrodes of emg sensor is responsible for obtaining EMG signals. Fig 1. shows the Red, green, blue charts are raw values from uECG devices on different muscle groups when I'm squeezing thumb, ring and middle fingers correspondingly. The signals are clear and easy to translate it into server movements just buy taking the comparison with threshold values. Also fig 2. Shows the exact result and the movement of robotic arm using forearm EMG signals.

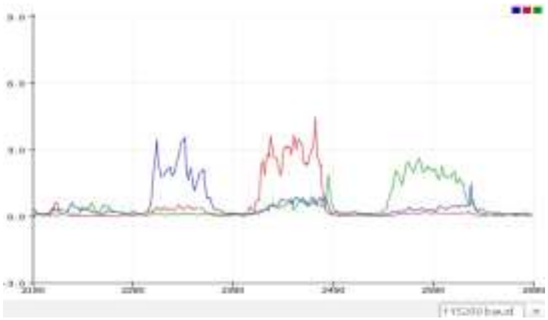

Fig.1.Representative EMG Waveforms

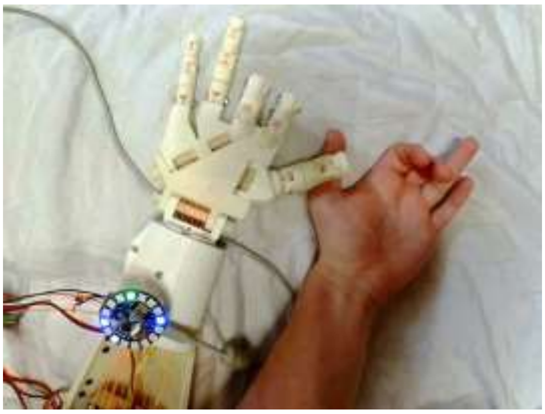

Fig.2.Robotic Hand Control Using EMG

IX. CONCLUSION

This study designed as to control prosthetic hand by the EMG signals produced by the human hand. The Electromyography (EMG) sensor sense the neuromuscular activity in the muscles and send the data to arduino unit. Then arduino unit give signal to the servo motor and the servo motor operates the prosthetic hand with the help of wires and the robotic arm performing action as like as human hand. The EMG signal are affected by the some external factors like temperature sweat and etc. And not give the actual results like we want. The main application of this hand to work in a situation where the human hand can't be worked. The works on this topic will be advance in future for the goodness of mankind in the field of medical engineering and the industrial purposes.

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