Prosthetic Hand using EMG Signal

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Abstract:- A prosthetic hand is a device used to enable disabled people to perform daily living activities. Low back pain is much more than a physical loss, it affects people's outlook on life and they begin to feel constantly disabled. The progression of these conditions can leave them mentally disabled or, if they can, cause personal death or worse, even if people remember their disability for a while. We create hand movements at the cheapest price to collaborate and enable disabled individuals to become more physically capable.

Keywords:- *Prosthetic Hand Using Electromyography Signal. Movements of the 3D Arm using the Signal of the Human Hand.*

I. INTRODUCTION

Significant progress has been made in the field of joint function in recent years, focusing on improving the function and quality of joint function. An important area of research involves the integration of electromyography (EMG) signals to control hand movements. This method allows the user to have more precise and effective leg control by taking advantage of muscle function. The main goal of the project is to create a prosthetic hand that uses electromyography signals to make a real, natural hand and improve the quality of life of legless patients. In recent years, technology has been quite successful and has provided new solutions to improve the lives of people with leg problems. Among these advances, the integration of electromyography (EMG) signals as manual control is a promising method.

A. Ease of Use

➢ *User-Friendly:*

The primary aim of this project is to design and implement a prosthetic hand system that seamlessly interfaces with EMG signals, allowing users to execute a diverse range of hand movements with precision and naturalness. By harnessing the electrical impulses generated during muscle contraction, this technology holds the potential to bridge the gap between user intent and prosthetic hand action.

➢ *Signal Processing and Pattern Recognition:*

Explore the effectiveness of signal processing algorithms in deciphering user intent from EMG signals. Discuss the accuracy and robustness of these algorithms in different conditions. Assess the accuracy of pattern recognition in distinguishing between different muscle activation patterns. Discuss the impact of environmental factors, fatigue, or other variables on the precision of signal decoding.

B. Evolution in the Era

Explore improvements in EMG signal acquisition technologies, such as the development of high-resolution electrodes and more reliable sensors. Discuss how these advancements contributed to enhanced signal quality and increased the feasibility of EMG-based prosthetic control. Explore advancements in real-time signal processing and the reduction of latency in prosthetic hand control. Discuss how these improvements contributed to more seamless and responsive interaction.

➢ *Technological Frameworks*

The prosthetic hand system was designed to include key components such as EMG sensors, a microcontroller, and actuators for hand movement. EMG(Electromyography) sensors were strategically placed on the user's residual muscles to capture relevant bioelectrical signals during muscle contraction. The chosen microcontroller processed these signals using filtering and feature extraction algorithms. The processed signals were then mapped to specific hand movements through a control algorithm, enabling a seamless interface between the user and the prosthetic hand.

➢ *Signal Acquisition and EMG Signal Processing:*

- Electrode Types: Explore the different types of electrodes used for EMG signal acquisition, such as surface electrodes, intramuscular electrodes, and high-density electrode arrays.
- Signal Processing Hardware: Discuss the hardware components, including amplifiers and filters, used to process and condition the raw EMG signals
- Pattern Recognition Algorithms: Examine various pattern recognition algorithms employed for decoding muscle activation patterns, including linear discriminant analysis (LDA), support vector machines (SVM), and neural networks.
- Real-time Processing: Discuss frameworks and methodologies for achieving real-time processing of EMG signals to enable instantaneous control of prosthetic hands.

➢ *Real-Time Monitoring:*

- Immediate processing of raw EMG signals to enhance quality and reduce noise.
- Real-time algorithms extract relevant features for quick interpretation.

➢ *Adaptation and Learning:*

- The system may incorporate adaptive learning algorithms to adjust to changes in the user's muscle patterns over time.
- Users may undergo training sessions to enhance their proficiency in controlling the prosthetic hand.

II. METHODOLOGY

A. *EMG(Electromyography) Signal Acquisition:*

- Identify and place EMG(Electromyography) sensors strategically on residual muscles of the user's limb. Common locations include the forearm muscles such as the flexor and extensor muscles.
- Choose appropriate EMG(Electromyography) sensors based on factors such as signal quality, comfort, and ease of integration.
- Securely attach the sensors to minimize movement artifacts and ensure consistent signal acquisition.

B. *Signal Processing:*

- Implement a pre-processing stage to filter out noise, including baseline noise and environmental interference.
- Explore various signal processing techniques such as bandpass filtering to extract relevant frequency components of EMG(Electromyography) signals.
- Apply feature extraction algorithms to capture key characteristics of the EMG(Electromyography) signals, enhancing the system's ability to interpret user intent.

C. *Control Algorithm Development:*

- Design a control algorithm that maps processed EMG(Electromyography) signals to specific prosthetic hand movements.
- Consider the use of machine learning techniques for pattern recognition to improve the adaptability and responsiveness of the prosthetic hand.
- Implement a real-time control mechanism to ensure seamless integration between user commands and prosthetic hand actions.

D. *Prosthetic Hand Design and Actuation:*

- Select or design a prosthetic hand model that aligns with the intended functionality and user requirements.
- Integrate actuators such as motors or servos into the prosthetic hand for controlled movement.
- Establish a communication interface between the control algorithm and the prosthetic hand actuators.

➢ *Algorithm Used*

- Step 1 - We should have all the equipment used in the project, including 5 servo motors, 3D printing hand, two sub-18V batteries, necessary cables, EMG, three EMG stickers and an Arduino Nano.
- Step 2 **-** All connections must be completed correctly.
- Step 3 – Upload the program to the Arduino board.
- Step 4 **-** Attach EMG sticker and apply electricity.
- Step 5 – After moving the hand, we can see the result.

➢ *Implementation*

Electrical pulses measured on the skin surface may have different values depending on the strength of the muscles. EMG sensors are placed on various parts of the forehead to detect EMG signals. Although the location and orientation of muscle sensor electrodes have a significant impact on signal strength, both theoretical anatomy and the study of human muscles have carefully selected the location of the electrode. The electrode patch will be in the middle of the muscle and follow the direction of the muscle fibers. Placing the sensor in another location will change the strength and performance of the sensor signal. The digital representation of muscle electrical impulses is the electromyogram signal. Myoelectricity refers to the electrical activity of the muscle. When a person wants to stretch a muscle, their brain sends neuromuscular or electrical signals called impulses to the muscles. Now the muscle continues to use the motor or muscle bundle to generate force behind the muscle. The more flexible the base, the more motor power it mobilizes and the more muscle power it creates, and the greater the number of motor units, the more electricity the muscle produces. When the brain sends a pulse, the EMG tag is sent to the EMG to be read and sent to the Arduino.

➢ *Working*

The way the Arduino is designed is that the servo motor moves in one direction when a reading crosses a threshold. Choose SG90 servo motor for finger drive. This compact and simple engine was chosen because it has all the necessary features such as small size, light weight, built-in gearbox and low cost. Initially, it was designed for a rotation angle of 180 degrees and 90 degrees in all directions in this case.

Prosthetic hands using electromyography signals work by capturing electrical signals produced by the user's muscles. Electrodes placed on the skin detect electromyographic signals during muscle contractions, which are then processed to increase their effectiveness and provide relevant properties. Advanced pattern recognition algorithms determine the characteristics of flight by connecting different muscles to specific movements. The decoded signal is used to control the command that tells the prosthetic arm's motor to perform the corresponding function, such as opening or closing the hand. Thanks to adaptive learning, the system adapts in real time to changes in the user's muscles, ensuring individuality and control of the prosthetic neck. Seamless integration of EMG

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signals allows users to interact with their hands in a static and efficient manner, improving performance and user satisfaction.

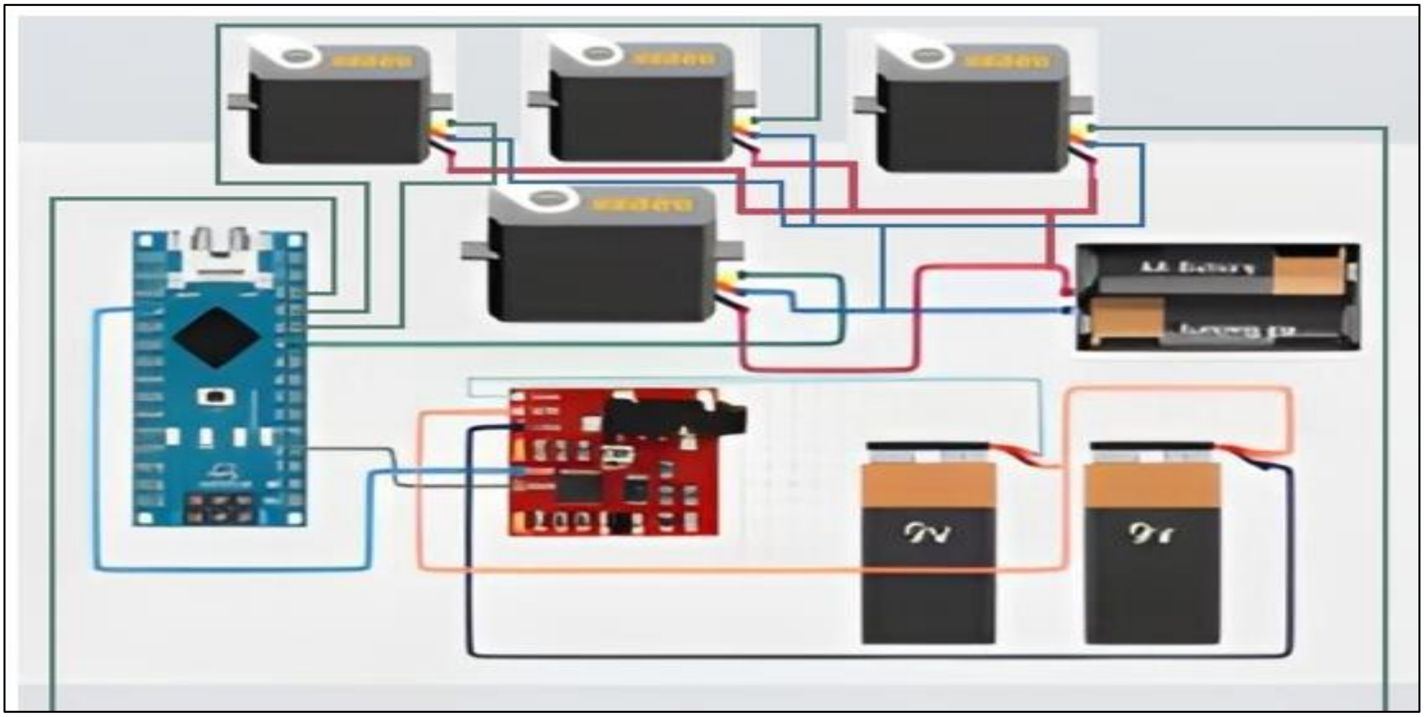

Fig 1: Circuit Diagram

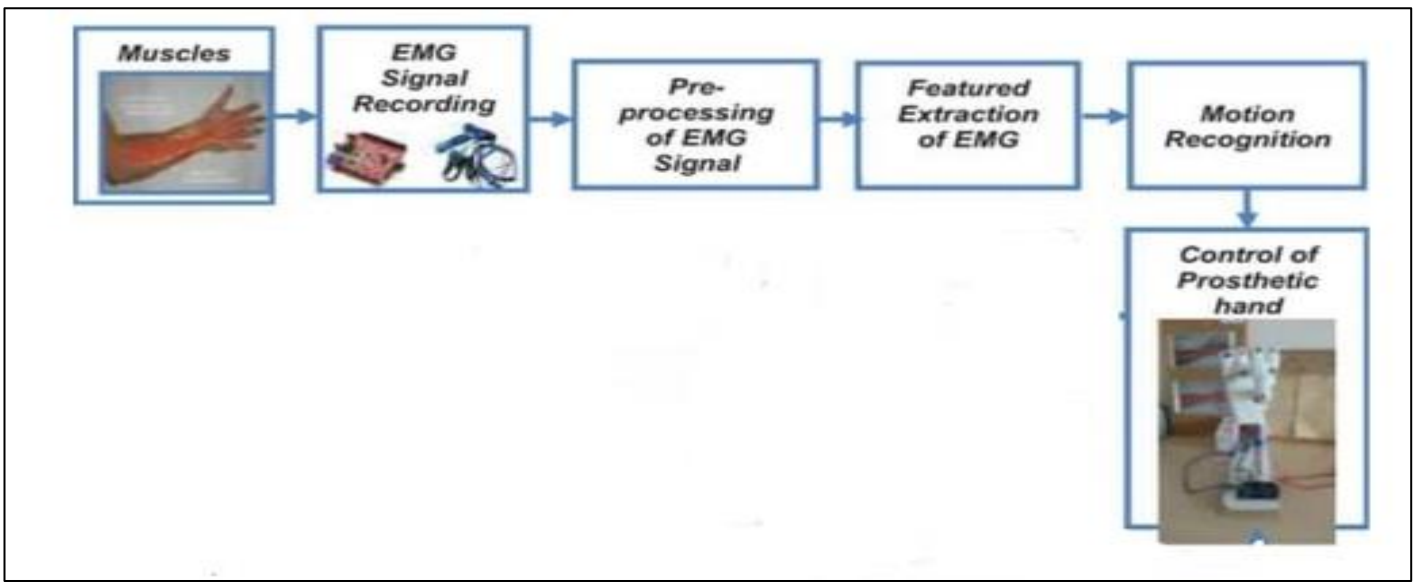

Fig 2: Block Diagram

III. CONCLUSION

In conclusion, our endeavor to develop prosthetic hands using EMG(Electromyography) signals has resulted in a system that not only meets the technical benchmarks of accuracy and responsiveness but also prioritizes the user experience. As we reflect on the journey from conceptualization to implementation, we recognize the transformative potential of our work in empowering individuals with limb loss. The lessons learned and insights gained will undoubtedly propel further innovation, fostering a future where prosthetic technology seamlessly integrates with the diverse needs and capabilities of its users.

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