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Design & Development Of An Intelligent Prosthetic Hand For Transradial Amputee

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Abstract: **Develop a robot arm using common materials. Students will explore design, construction, teamwork, and materials selection and use. So that it can be used to make peoples life better who are limited to thedaily activities because of lost of medical anatomy and so that we can spread the smile and make this world a better place to live.**

***Keywords*-** **Prosthetic hand, EMG, AVR, Motor, servo.**

I. INTRODUCTION

Robots play a critical -- and growing -- role in modern medicine, from training the next generation of doctors, dentists, and nurses, to comforting and protecting elderly patients in the early stages of dementia. Using robots, medical professionals can make smaller incisions for shorter surgeries, reducing hospital stays and improving patients' prognoses and saving costs. As robots become even smaller and developers continue to further integrate the devices with artificial intelligent resembles something from a Hollywood sci-fi movie, but Hybrid Assistive Limb 5, or HAL 5, as it is known, is an artificially powered eco skeleton that helps double the amount of weight someone can carry unaided. Developed by Yoshiyuki Sankai, a professor at Tsukuba University of Japan, the invention is backed by venture capitalist firm Cyberdyne. Expanding beyond Japan, last year Odense University Hospital announced it would use HAL 5for clinical trials on worker augmentation. The medical community wants more. For example, physicians want more devices that perform their functions autonomously; they'd like to see automated scrub and circulating nurses; they encourage the implementation of tele-consulting solutions within the operating room, and they'd like to see automation in tissue suturing, bonding and anesthesiology, according to the Robot Review.

II. WHAT IS A PROSTHESIS?

A prosthesis is an artificial limb (an artificial substitute) that replaces a missing leg or arm due to disease, accidents, or congenital defects.Main types of artificial limbs.

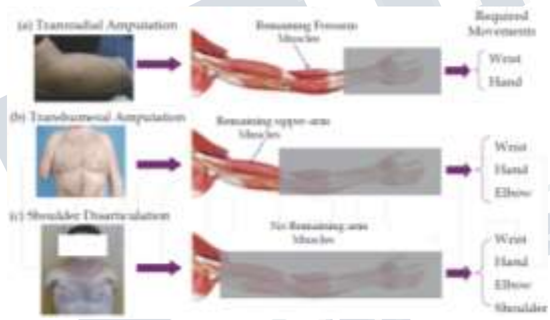

Fig 1.0

A person's prosthesis should be designed and assembled according to the patient's appearance and functional needs. For instance, a patient may need a transradial prosthesis, but need to choose between an aesthetic functional device, a myoelectric device, a body-powered device, or an activity specific device. The patient's future goals and economical capabilities may help them choose between one or more devices.

Over the years there have been advancements in artificial limbs. New plastics and other materials, such as carbon fiber, have allowed artificial limbs to be stronger and lighter, limiting the amount of extra energy necessary to operate the limb. This is especially important for transfemoral amputees. Additional materials have allowed artificial limbs to look much more realistic, which is important to transradial and transhumeral amputees because they are more likely to have the artificial limb exposed.

III. SERVO MOTOR

Fig 1.1

A.What's Inside the Servo?

To fully understand how the servo works, you need to take a look under the hood. Inside there is a pretty simple set-up: a small DC motor, potentiometer and a control circuit. The motor is attached by gears to the control wheel. As the motor rotates, the potentiometer's resistance changes, so the control circuit can precisely regulate how much movement there is and in which direction. When the shaft of the motor is at the desired position, power supplied to the motor is stopped. If not, the motor is turned in the appropriate direction. The desired position is sent via electrical pulses through the signal wire. The motor's speed is proportional to the difference between its actual position and desired position. So if the motor is near the desired position, it will turn slowly, otherwise it will turn fast. This is called **proportional control.** This means the motor will only run as hard as necessary to accomplish the task at hand, a very efficient little guy.

B.How is the Servo Controlled?

Servos are controlled by sending an electrical pulse of variable width, or **pulse width modulation** (PWM), through the control wire. There is a minimum pulse, a maximum pulse and a repetition rate. A servo motor can usually only turn 90° in either direction for a total of 180° movement. The motor's neutral position is defined as the position where the servo has the same amount of potential rotation in the both the clockwise or counter-clockwise direction. The PWM sent to the motordetermines position of the shaft, and based on the duration of the pulse sent via the control wire the rotor will turn to the desired position. The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns. For example, a 1.5ms pulse will make the motor turn to the 90° position. Shorter than 1.5ms moves it to 0° and any longer than 1.5ms will turn the servo to 180°, as diagramed below.

C.Motor Units

1. The functional unit of the neuromuscular system
   – Terminal axon of motor endplate
   – Synapse
   – Post-synaptic membrane of associated muscle fiber
2. Classification of motor units varies
   – Physiological analysis
   – Mechanical/velocity of contraction (twitch) analysis

D.Mechanical/Velocity of Contraction (Twitch) Classification

1. Slow twitch motor units recruited first
   – Postural control
   – Finely graded movements
2. Fast twitch units recruited last
   – Rapid, powerful, impulsive movements

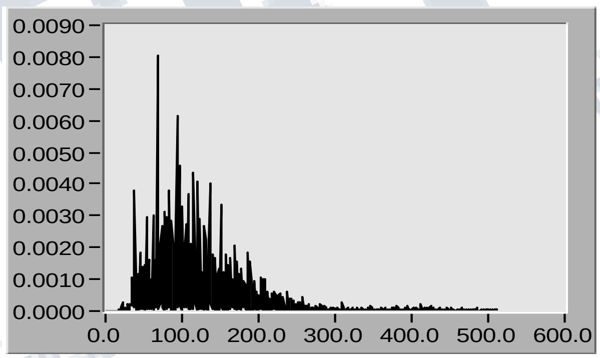

Fig 1.2

IV. AVR MICROCONTROLLER

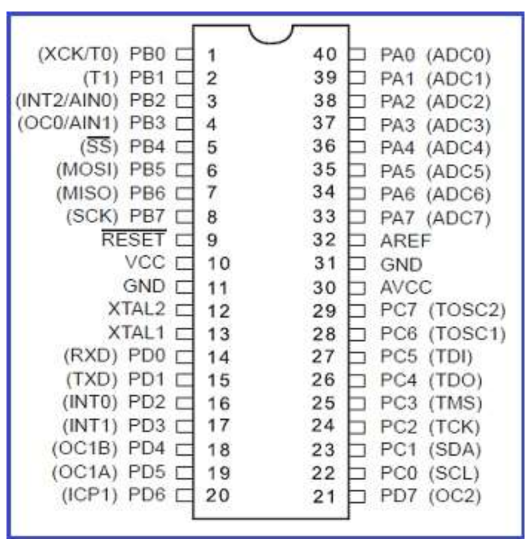

Fig 1.3

Does this mean that the microcontroller is another name for a computer…? The answer is NO!The computer on one hand is designed to perform all the general purpose tasks on a single machine like you can use a computer to run a software to perform calculations or you can use a computer to store some multimedia file or to access internet through the browser, whereas the microcontrollers are meant to perform only the specific tasks, for e.g., switching the AC off automatically when room temperature drops to a certain defined limit and again turning it ON when temperature rises above the defined limit.There are number of popular families of microcontrollers which are used in different applications as per their capability and feasibility to perform the desired task, most common of these are 8051, **AVR** and PIC microcontrollers. In this article we will introduce you with **AVR** family of microcontrollers.

Electromyography (EMG) is an electrodiagnostic medicine technique for evaluating and recording the electrical activity produced byskeletal muscles. EMG is performed using an instrument called an electromyograph, to produce a record called anelectromyogram. An electromyograph detects the electrical potential generated by muscle cells when these cells are electrically or neurologically activated. The signals can be analyzed to detect medical abnormalities, activation level, or recruitment order, or to analyze the biomechanics of human or animal movement.

V. EMG SIGNAL PROCESSING

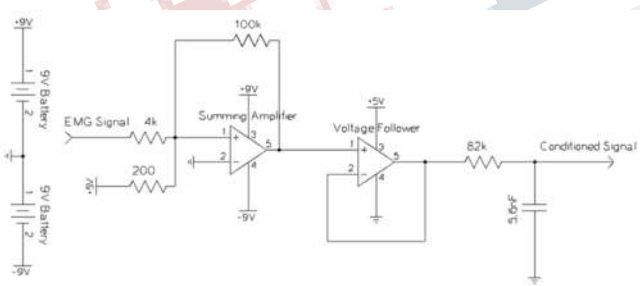

Fig 1.4

Rectification is the translation of the raw EMG signal to a single polarity frequency (usually positive). The purpose of rectifying a signal is to ensure the raw signal does not average zero, due to the raw EMG signal having positive and negative components. It facilitates the signals and process and calculates the mean, integration and the fast fourier transform (FFT). The two types of rectification of signals refer to what happens to the EMG wave when it is processed. These types include full length frequency and half length. Full length frequency adds the EMG signal below the baseline (usually negative polarity) to the signal above the baseline making a conditioned signal that is all positive. This is the preferred method of rectification because it conserves all signal energy for analysis, usually in the positive polarity. Half length rectification deletes the EMG signal below the baseline. In doing so, the average of the data is no longer zero therefore it can be used in statistical analyses. The only difference between the two types of rectification is that full-wave rectification takes the absolute value of the signal array of data points. Electrical discharge (signals) from muscles recorded with electrodes Indwelling: needle or fine wire and Surface: mono- or bipolar. The Signals are low amplitude voltages at relatively low frequencies (75 - 250 Hz) of firing (mV, uV) Signals are Pre-amplified (e.g., gain = 35) ,Amplified (e.g., gain = 5000)Displayed on a monitor or oscilloscope Evaluated in real-time and Stored on HD/tape for subsequent analysis There are several Types of EMG Analysis Clinical/diagnostic using needle electrodes (usually bipolar) , Research/movement analysis using surface or fine wire electrodes, On/off phenomena ,Timing, Signal quantification (integration/area under a curve),Force analysis

VI. EFFECT OF AP

Causes a release of Ca^{+} from the sarcoplasmic reticulum triggering the molecular interaction of actin and myosin resulting in sacromere (microanatomical level) and gross muscle shorting (macroanatomicallevel) with resultant tension production

EMG electrically detects AP's as small voltages

1. Records potential difference as a wave of depolarization traverses under one and than the other electrode
2. The result is two monophasic waves

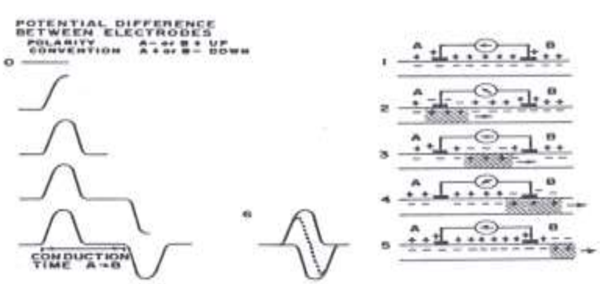

Fig 1.5

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Fig 1.6

Methodology /gestures

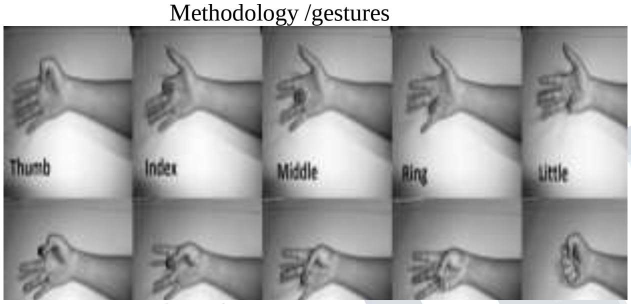

Fig 1.7

VII. 3D DESIGN

Fig 1.8

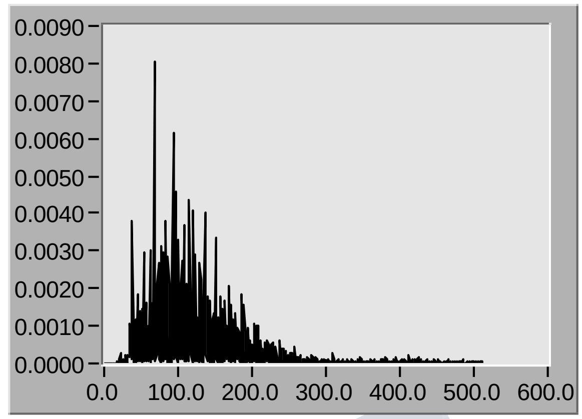

Fig 1.9 Power Spectrum

VIII. BLOCK DIAGRAM

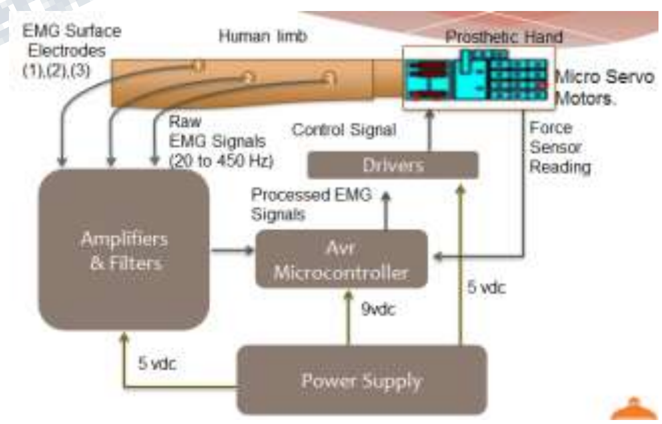

Fig 1.10

IX. CONCLUSION

The research on robotic hands is going on since so many years and all research is heading towards only towards one vision and that is how can make this technology efficient and responsive like real human body and theyare all trying and exploring new ways to make it happen .many people got an inspiration from this ongoing research hopefully one day there will be all efficient robotic hand we come to make a difference in people lives who lost their hand or legs in accidents and war heroes who fought for their country

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