Telehealth Monitoring based Myoelectric Prosthetic ARM

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Abstract*:- Powered hand Prostheses with many degrees of freedom are moving from research in to the market for prosthetics. In order to make use of the prostheses full functionality, it is essential to study efficient ways of high dimensional myoelectric control and add some more features to it. The signal taken from the normal hand is given to the servos to make prostheses. This make it more efficient, and real time monitoring allows us to locate and diagnose the patient when he is in need. The development of Telematics prosthetic module using the Global Positioning System (GPS) and Global System for Mobile Communications (GSM) modem is undertaken with the aim of enabling to locate the user (patient) with easy and in a convenient manner. The system will provide the patient to track remotely through the mobile network. This paper describes the development of the Telematics module hardware prototype. Especially, the system will utilize GPS to obtain a patient location and transmit it using GSM modem to the family or doctor number through the mobile network. The proposed system will also be able to identify the accident of patient. Our analysis indicates the visual feedback, control accuracy benefits from filters that reject high EMG amplitudes. In summary, we conclude the findings on myoelectric control principles, virtual tasks can be transferred to real life prosthetic applications.

Keywords—EMG; Pulse rate; LM35; Arduino; Servo Motor; GPS; GSM; Cellphone

I. INTRODUCTION

There have been many different approaches taken in the development of an effective prosthetic hand. Human hand is an indispensable organ of human structure, function, and expression. It is capable of producing complex and expressive articulations. It is a daunting challenge for robotic hand designers to emulate human hand in the applications of prosthetics and robot planning due to the complex neurophysiology of human hand [2]. The acquisition of multiple biosignal makes accurate to control prosthetic and can be detected a critical condition of patient if one of the biosignal is abnormal. Using of GPS and GSM system sends the user location and physical data automatically when he needs. With 3D printed prosthetics gaining popularity with the advent of consumer level 3D printers, practical applications of these prosthetics have also been increasing. Therefore, developing a 3D printable hand that is easy to assemble and control in a non-professional setting with commonplace products such as smartphones is vital for the average amputee [4]. This paper introduces the technology used to track the user and interface it to send the data and location. The motions can be controlled by the user by moving our hand in any direction [3].

II. HARDWARE DESCRIPTION

The below block diagram shows the acquisition of biosignal, controlling servo and sending data.

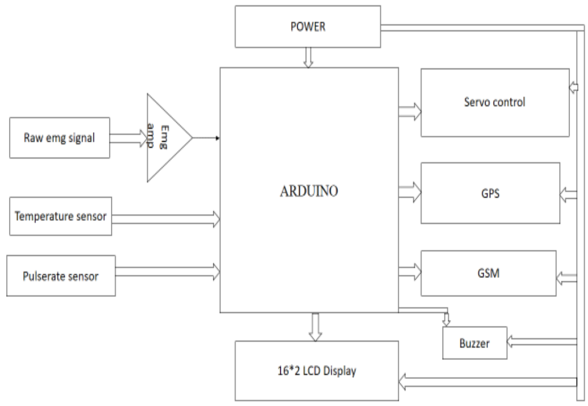

Fig 1: Schematic block diagram

A. EMG Signal Processing

EMG signals were investigated by H. Piper for the first time using galvanometer in 1912. Similar work was performed by Gasser and Erlanger with the help of oscilloscope in 1924. Controlling a powered upper limb prosthesis is an early application of EMG signals. For the first time this application was applied during 1940s and rapid development was experienced in this field throughout 1960s, 1970s, and 1980s. Typically the surface EMG signals are within the range of +/- 5000 microvolts, and the ranges of frequency content are from 6 Hz to 600 Hz, in which the dominant frequency range is from 20 Hz to 150 Hz [2]. Two types of noises are contained by this signal, ambient noise is caused due to the electromagnetic devices and it has a wide range of frequency component, however 50 or 60 Hz is the dominant frequency component. Transducer noise is generated at the skin electrode junction. Electrode converts ionic current from the muscles into the electric current and during the process two types of transducer noises are produced. Direct voltage potential is generated due to the difference in the impedance between the electrode surface and that of the skin, and the alternating voltage, is generated due to the fluctuations in impedance between the skin and the electrode. It can be reduced by using Ag-AgCl electrodes. In order to remove these noises the EMG signal is required to be processed. These processes include preamplification, bandlimitting and rectification and after that the signal becomes usable and is a true depiction of muscular contraction force [5].

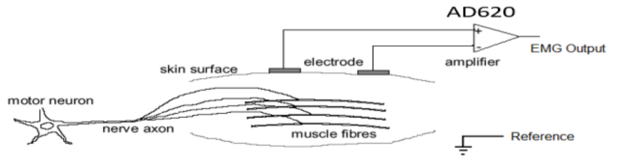

Figure 1.1: EMG signal acquisition process

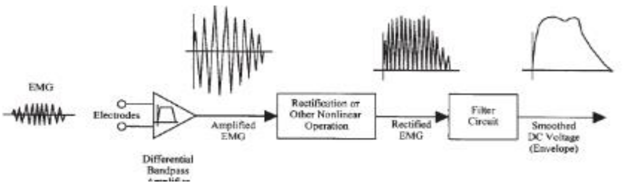

Fig. 1.2: Schematic showing conventional myoelectric signal processing [2]

AD620 is a differential amplifier is used as an emg amplifier which removes ambient noise. Two diodes have been employed in the circuit at the input to provide safety to the circuitry and the device. Usually the voltage across a muscle is of the tune of mV. A diode will "turn on" at 0.7 V. If ever more than 0.7 V is present across the inputs (may be due to short circuit), a current passage with much less resistance than our body will be provided by the diodes [2]. Band pass filter has been taken from the research paper [6] which is designed for the frequencies of 20 Hz to 650 Hz. First is a High Pass Filter of 20 Hz, it helps attenuate small frequencies which are there due to motion artifact. Then is the Low Pass Filter having a limit of 650 Hz frequency as it guarantees optimum performance, since no signal content is lost also the higher frequencies are filtered.

B. Temperature sensor LM35

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in °C).It can measure temperature more accurately than a using a thermistor. The sensor circuitry is sealed and not subject to oxidation. The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified. The LM35 has an output voltage that is proportional to the Celsius temperature. The LM35 does not require any external calibration or trimming and maintains an accuracy of +/-0.4°C at room temperature and +/-0.8°C over a range of 0°C to +100°C.Another important characteristic of the LM35 is that it draws only 60 micro amps from its supply and possesses a low self-heating capability.The LM35 comes in many different packages such as TO-92 plastic transistor-like package,T0-46 metal can transistor-like package,8-lead surface mount SO-8 small outline package.

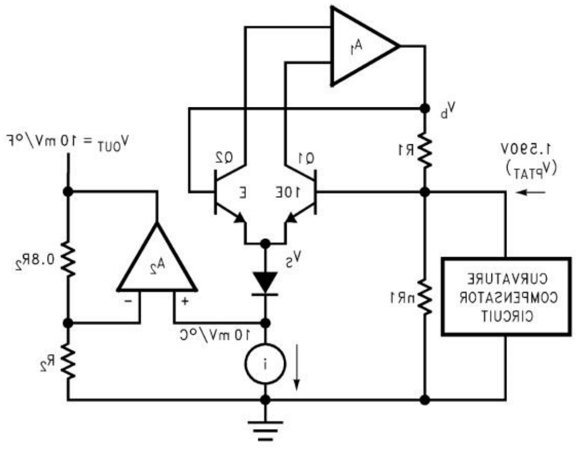

Figure 1.3: Working Principle of LM35 [7]

There are two transistors in the center of the drawing. One has ten times the emitter area of the other. This means it has one tenth of the current density, since the same current is going through both transistors. This causes a voltage across the resistor R1 that is proportional to the absolute temperature, and is almost linear across the range.The "almost" part is taken care of by a special circuit that straightens out the slightly curved graph of voltage versus temperature [7].

The amplifier at the top ensures that the voltage at the base of the left transistor (Q1) is proportional to absolute temperature (PTAT) by comparing the output of the two transistors. The amplifier at the right converts absolute temperature (measured in Kelvin) into either Fahrenheit or Celsius, depending on the part (LM34 or LM35).The little circle with the "i" in it is a constant current source circuit. The two resistors are calibrated in the factory to produce a highly accurate temperature sensor.

C. Pulse Sensor

Pulse Sensor is a well-designed plug-and-play heart-rate sensor for Arduino. It can be used by students, artists, athletes, makers, and game & mobile developers who want to easily incorporate live heart rate data into their projects. The sensor clips onto a fingertip or earlobe and plugs right into Arduino. It also includes an open-source monitoring app that graphs your pulse in real time.The Pulse Sensor can be connected to arduino, or plugged into a breadboard.The front of the sensor is the pretty side with the Heart logo. This is the side that makes contact with the skin. On the front you see a small round hole, which is where the LED shines through from the back, and there is also a little square just under the LED.

Figure 1.4: Pulse sensor in arm

The square is an ambient light sensor, exactly like the one used in cellphones, tablets, and laptops, to adjust the screen brightness in different light conditions. The LED shines light into the fingertip or earlobe, or other capillary tissue, and sensor reads the light that bounces back. The back of the sensor is where the rest of the parts are mounted [8].

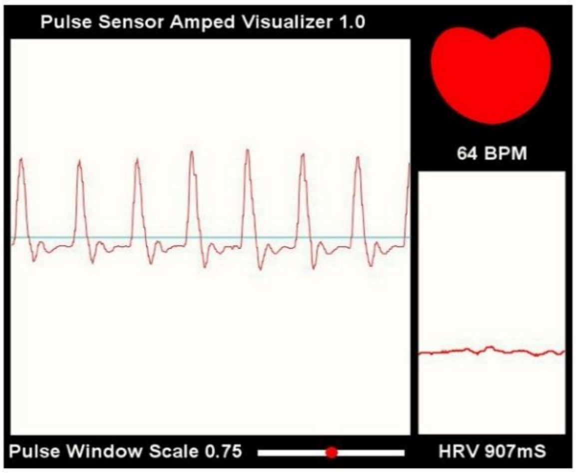

Figure 1.5: Pulse Wave [8]

D. Microcontroller

Microcontroller is the heart of the designed unit, which handles all the signals. All other blocks are interfaced to it. The most common version of Arduino is the Arduino Uno. The Arduino Mega is a microcontroller board based on the ATmega2560. The MEGA 2560 is designed for more complex projects. With 54 digital I/O pins, 16 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. The device has throughput approaching 1 MIPS per MHz and a larger space for your sketch it is the recommended board for 3D printers and robotics projects. TheATmega2560 is a single-chip microcontroller created by Atmel in the mega AVR family.

Figure 1.6: Arduino Mega 2560[9]

Arduino Mega	*Features*
Microcontroller	AVR ATmega 2560 (8bit)
Power Supply	7-12V (Inbuilt Regulator for Controller)
Digital I/O Pins	54
Analog I/O Pins	16
Total Digital I/O	70 (Digital + Analog)
Clock Speed	16 MHz (Factory set to 1Mhz)
Flash Memory	128 KB
SRAM	8 KB
Communication	USB (Programming with ATmega 8), ICSP (programming), SPI, I2C and USART

All the biosignals are given to the analog pin of Arduino which converts into digital value which can be seen in serial monitor. The analog value are coded with the arduino coding and convert into the normal value. Threshold setting is maintained in a code. When emg signal cross the threshold value, digital pins are maintained to allow the signal to servo motor.

E. Servo Motor

The servo motor is most commonly used for high technology devices in the industrial application like automation technology. It is a self contained electrical device, that rotate parts of a machine with high efficiency and great precision. The output shaft of this motor can be moved to a particular angle. Servo motors are mainly used in home electronics, toys, cars, airplanes, etc. It works on 5V supply and signal from arduino. In contraction process emg signal gets peak which allows to rotate the servo motor and comes into original position in relaxation of muscle.

Figure 1.7: Servo motor

F. Liquid Crystal Display

A 16x2 LCD is used for displaying electromyography value, pulse rate, temperature and location value (latitude and longitude). A +5V DC supply is given to activate LCD. A location value is display only when patient is in critical condition.

G. GPS and GPRS Shield

The Global Positioning System (GPS) is the Global Navigation System (GNSS) that receives signal from at least three satellites to compute its two dimensional (latitude and longitude) position. Therefore, GPS is a key technology for getting position. GPS was developed by the United States Department of Defense. The GPS in vehicle tracking systems is employed to provide users the coordinates of the location anywhere on earth. The GSM/GPRS module is responsible of establishing connections between a tracking system and a remote user for transmitting the information of vehicle's location, using TCP/IP connection through the GSM/GPRS network [10].

Figure 1.8: GPS and GSM module [11]

Figure 1.8 shows the GSM and GPRS shield with GPS and GSM/GPRS module. At first GPS technology gives satellite navigation through a high-gain SMD antenna. Then the microcontroller based Arduino is interfaced with an embedded SIM908 chip. The SIM908 chip on the GSM and GPRS shield is a compact quad-band cellular module. The SIM card assists the system to send messages to cell phone. It is controlled via AT commands. The location of a vehicle can be monitored anytime with signal coverage [10].

H. Buzzer

A buzzer or beeper is an audio signalling device, which may be mechanical, electromechanical, or piezoelectric (*piezo* for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke. Here when the patient is in critical condition buzzer gives a alarm. It operates on V dc supply.

Figure 1.9: Buzzer

III. METHOD

A. Circuit Diagram

The system operates with the EMG signal and use the operational amplifier (AD620) to process signal which is filtered by band pass filter and given to controller.The different bio signal such as pulse rate, temperature are acquisition to analyse and display.

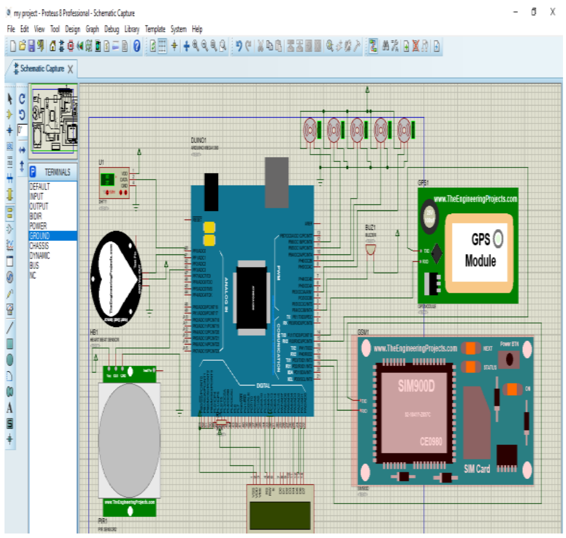

Figure 2.1: Circuit Diagram

Servo motors are using to move the finger (contraction and relaxation) which is controlled by the emg signal. The motors are connecting to the microcontroller and motors runs with the threshold value of emg signal.This system use the GSM mobile network to send the bio signal value and GPS to track the user in the case of patient accident, heart attack, etc.

B. 3D Printed arms

The prosthetic should be able to connect to a socket that internally contains surface EMG (sEMG) electrodes to obtain signals from the muscles that are used to generate mechanical movement of the hand. Six sEMG are used, one to control each finger and one for ground to connect to a circuit that has been developed to separately amplify, filter, and rectify each signal to control the movement of the fingers [12]. The robotic prosthetic hand is being developedas a low cost 3D printed prosthesis to acquire real time sEMG signals from forearm, detect muscle activity of each fingers and generate pulse-width modulation signals for servo motor of the individual finger of the robotic hand. 3D printed prosthetic arm is shown below.

Figure 2.2: 3D printed prosthetic arm [13]

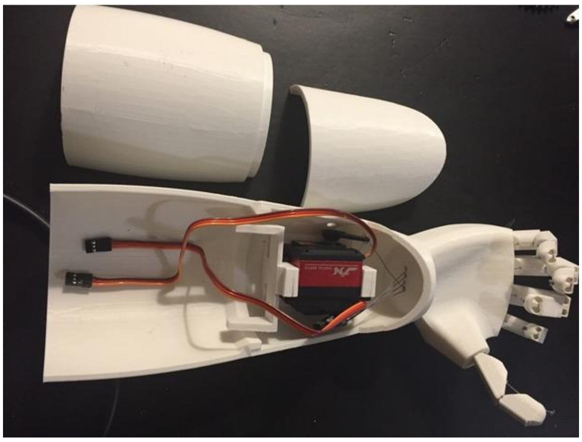

Figure 2.3: Assembling 3D printed prosthetic arm

IV. ADVANTAGES AND APPLICATIONS

- It use low cost op-amp amplifier (AD620) with high accuracy output and decrease the cost of arm.
- Power consumption of the system is low. It operates in 5V dc supply for all component.
- Able to send patient physical data from remote area.
- It is real time monitoring system which sends the patent data within a few seconds.
- It helps to find out the user location from longitude and latitude.
- It provides more security when criminal attack also in abnormal condition.

V. CONCLUSION

This paper conclude that the data presented in this section suggest there is considerable structure in the myoelectric signal during the onset of a contraction. Furthermore, the other biosignal acquisition helps the patient monitoring from far distance. The automated message sending to the family provides the user secure. Setting threshold in Arduino code operate the GPS and GSM system automatically and buzzer gets on which gives alarm. The objective of this project consisted of the creation of an inexpensive 3D-printed robotic prosthetic hand powered by Arduino that could perform several gestures.

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