Cloud based Monitoring of Muscle fatigue using Beagle Bone Black

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Abstract: Changes in muscle quality can be an imperative go for player and patients in restoration or physiotherapy. Nowdays, the recovery solution relies on upon the assessment after effects of muscle quality, which are routinely evaluated by experienced doctors. To monitor some subjective measures for strength of muscle quality level (MSL), we begin with the study on evaluated electromyography(EMG). In this work a cloud based EMG system for monitoring and guiding people to maintain muscle strength based on muscle fatigue during work outs is proposed. The analysis of the surface electromyography signal recording while a muscle is performing a sustained contraction is a valuable tool for monitoring muscle fatigue. The work is divided into three main parts, EMG Sensor Interfacing for Real time EMG Signals, Beagle Bone Black Processor for Monitoring and Processing of the signals and Internet of things (IOT) for storage of the data on cloud.

Keywords*-sEMG, muscle fatigue, BeagleBone Black, IOT.*

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I. INTRODUCTION

It is very important that web of thing (IOT) and correspondence (IUT) apply them in home healthcare and services. The main advantage would be drastic decrease the total expenditure and cost on medical care or treatments. That is why IOT is perceived as an upheaval in ICT since it began towards a current century information and communication technology (ICT).This technology has to provides the flexibility to connect sensors, motors, recording devices to the Internet . It seems that IOT conceived as an empowering technology to realize mission vision of a global infrastructure of network security. IOT amplifies an Internet in our regular humans lives through remotely interfacing different shrewd questions, and will acquire most critical changes in a way we live, associate with keen gadgets.

II. The System Architecture

In this work, a cloud based remote monitoring and analysis of muscle strength is proposed. This work involves muscle signals strength i.e. surface electromyography, measuring muscle strength through electrodes, and data is to be explore for guiding people via internet.

Experts can access, analyze data, directly from cloud. Python/OpenCV are the open source platforms which will be used along with BeagleBone Black to establish connectivity with cloud. The data will be received from the sensor will be sent over side to the beagle bone black , where pre-processing of the data and feature extraction will done and stored in a file. This file will be uploaded in 'Thingspeak',' xively' or /sensor flare' – a cloud data server in real-time.

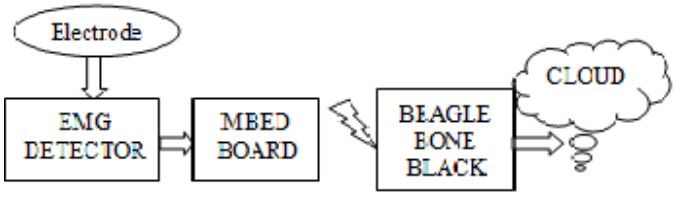

Figure 1.1. BLOCK DIAGRAM

Electrodes are connected to Human body surface, will get signals called EMG. Which can be detected by EMG detector the output of detector would be the PQRS variation graph.This is the input to the Freescale MBED Board, this Preprocess the signals. Mbed Board is connected with Bluetooth Zigbee Model which can send the data to the Beagle Bone Black further this data Processed, feature will gets extracted and send data over cloud. A cloud data is a real- time data, that can be accessed anytime.

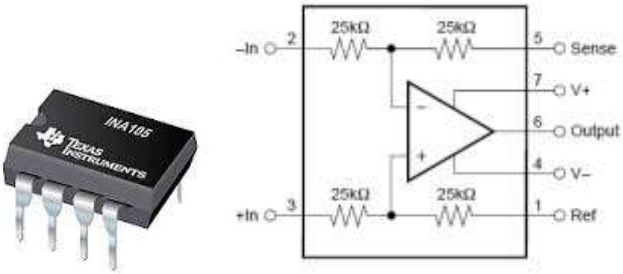

Figure 1.2: INA 105 PINOUT

Analog signals from electrodes are taken into the EMG DETECTOR this DETECTOR includes three main blocks INA105, LPF using Ic 741 and HPF Using IC 741. The INA 105 is a difference amplifier which will measure and slightly amplify the very small voltage differences between the two electrodes placed on muscle. This Amplifier has 1,100,500,1000 gain accuracy and has high CMRR. It works on the gain error 0.01%. It is a low power device. The Gain Formula is

Gain =1+50k/ RG

e.g. RG=100, Gain=500.

The LPF and HPF using IC 741 used as Band Pass Filter Adding a one capacitor and resistors to the basic operational amplifier (op amp) circuit is active filters. The LM741 is 8 pin

IC as shown in below Fig ,which requires Dual Power Supply called +VCC and -VEE.

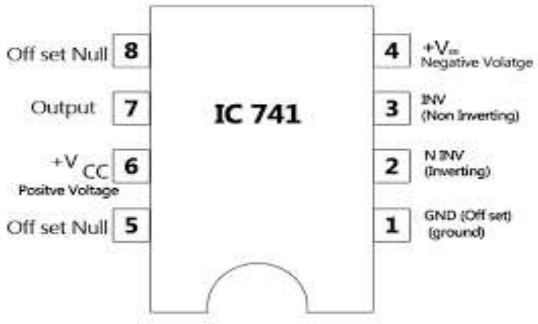

Fig.No.1.3Pin Dig. Of IC 741

To power up our circuit we will need both a positive and negative voltage power supply. We are making that using two negative 9V batteries. Active Filter is frequency selective circuit. It passes the selective band of frequency or attenuates a all other frequencies outside the band. Here we designed filter for frequency band between 5 to 500 Hz. The schematic is shown in Fig 1.4 below

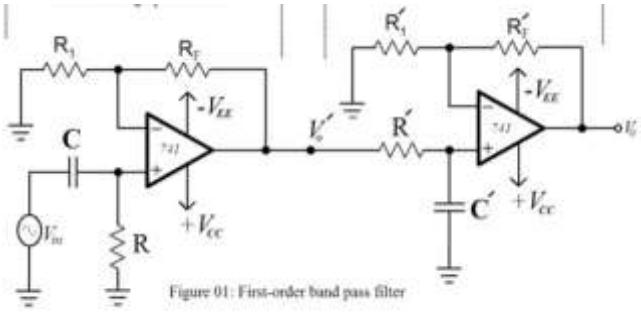

Fig. No.1.4. Circuit Dig. Of first order Band Pass Filter

2.1) Mbed LPC11U24

The ARM Cortex-M processor family is a scope of adaptable and perfect, vitality proficient, simple to utilize processors intended to help engineers address the issues of tomorrow's keen and associated inserted applications. Those requests incorporate conveying more elements at a lower cost, expanding network, better code reuse and enhanced vitality productivity. The Cortex-M family is advanced for expense and power touchy MCU and blended sign gadgets for applications, for example, Internet of Things, network, engine control, keen metering, human interface gadgets, car and mechanical control frameworks, residential family unit machines, buyer items and therapeutic instrumentation [1].

2)Zigbee communication protocol realizing

In this paper, we use the Xbee-24 has range 30m in urban area and that extends to 100m.With sensitivity of -100dBm. The digital frequency part, the direct sequence spread spectrum (DSSS) technology and it can easily realize 802.15.4 short-range wireless communication standard compatible, and which greatly improve the reliability of wireless communications. [2].

The trans-receiver models here is the Xb-24 model one should at transmitter side while other should be receiver side to get the data send by sensors. Zigbee should sends handshaking signals.

B. Beagle Bone Black

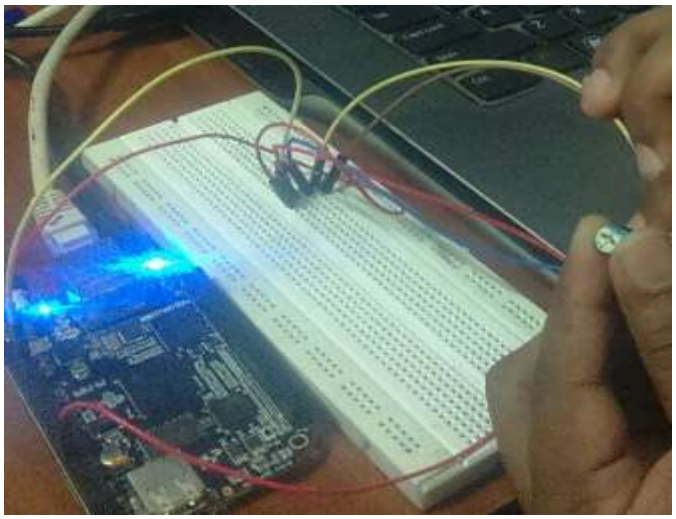

Figure 1.6 Sensor interfacing with Beagle Bone Black

In this project we are using the BeagleBone Black which is based on the ARM Cortex-A8 based processor. Access is easy that is simply connect it to the router through an Ethernet cable and both Python feature inbuilt ADC. BeagleBone Black has 512 MB DDR3 RAM, 256 MB NAND Flash memory and 4 GB -8bit eMMC on board flash storage memory and 1 GHZ frequency. BeagleBone Black is compatible with software debian, windows and Ubuntu and the ability to run Python, Ruby directly in Cloud 9 IDE . Beagle Bone Black having 69 GPIO pins, 2 SPI, 3 CAN bus, 4 serial ports.

As shown in the above figure the sensor in connected to the BeagleBone Black and the output data of the sensor in stored on the cloud by using the Ethernet cable. Thingspeak cloud platform is used for storage purpose.

IV. SYSTEM INTERFACING

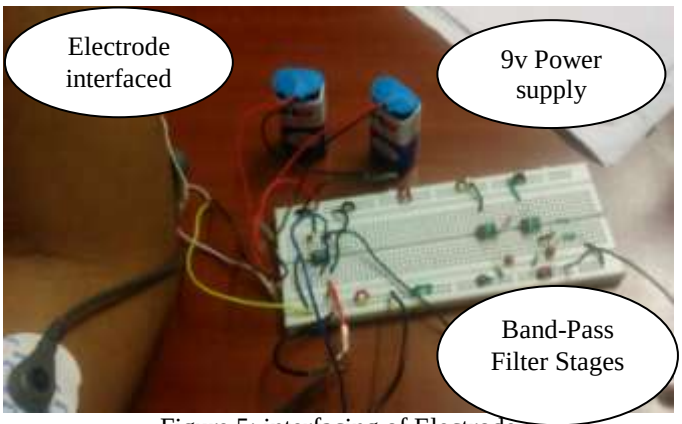

Figure 5: interfacing of Electrode

The electrodes are placed near elbow and forearm as shown above. 2 and 3 pins of amplifier inverting and non- inverting respectively is connected with the electrodes, from which the signals gets amplified, filtered out. The checking of amplifier gain output is done at pin no.6.The adjustment of gain is through resistor as well as trimmer. cloud data server in real-time.

V. SYSTEM TEST

I] Output of the Instrumentation amplifier

input volt =0.8*0.5=0.40mv

Input freq (Hz)	o/p volt (mV)	Practical gain
8	31.1	0.77
10	30	0.75
20	29.3	0.73
40	29.1	0.72
50	28.9	0.72
100	28.8	0.72
200	28.8	0.72
500	28.8	0.72

Fig.No.1.7.Table calculated Gain of amplifier.

The above Fig. Shows gain of amplifier almost constant for the different frequencies and there is small variation in output voltage with respect to change input frequency.

Thinkspeak Data Output.

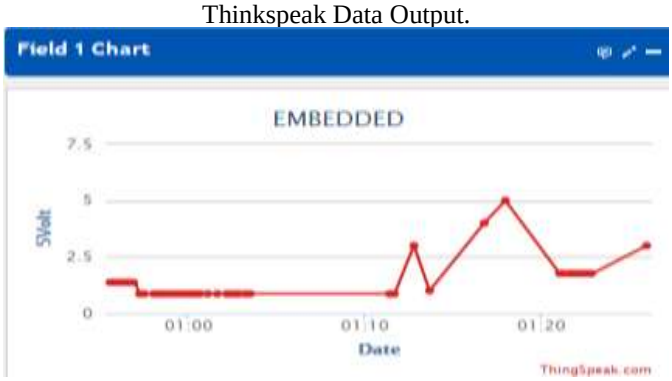

Fig.6. Data on cloud server

The data got from the sensor is sent to beagle bone and is stored in .txt document. At that point data send over Thingspeak cloud, data stored continuously as appeared in above diagram.

VI. CONCLUSION

Electrodes are interfaced with the Amplifier and then noisy signal will filter out using band pass filter. Then the signal will transmit through the zigbee on BeagleBone Black and the data is stored on cloud platform.

VII. REFERENCE

[1] Assessment of Muscle Fatigue During Biking Marco Knaflit, *Member, IEEE*, Filippo Molinari, VOL. 11, NO. 1, MARCH 2003.

[2] Non-Invasive Electromyography-Based Fatigue Detection and Performance Analysis on *m. biceps, brachii* Muscle 2011 IEEE International Conference on Control System, Computing and Engineering, 23 - 25 Nov. 2012, Penang, Malaysia.

[3] "Fault tolerant ,adaptable IOT-based Architecture for Health Monitoring and derivation of Muscle Fatigue Index for Biceps Muscle Based on Surface Electromyography Temporal Characteristics " IEEE conference in Biomedical and Sciences Sarawak, Malaysia. 2014.

[4] "What is Zigbee," Zigbee Alliance. P.J. Chitamu., (2012). www.ieeeexplore.com

[5] http://beagleboard.org/BLACK .

[6] Bernard Kai-Ping Koh, Peng-Yong Kong, "Performance Study on ZigBee-Based Wireless Personal Area Networks for Real-Time Health Monitoring," ETRI Journal, v.28, n.4, pp.537-540, Aug. 2006.