Intelligent ECG System for Removal of Noise in Biomedical Application

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ABSTRACT

Electrocardiogram (ECG) signal plays a vital role in the monitoring and diagnosis of the health conditions of heart. ECG wave suffers from several noise and interferences. The noise and interferences include power line noise is due to improper grounding, baseline wander is caused due to patient movement, contact noise, motion artifact is caused due to shivering and muscle contraction is caused due to high tension. So filters play a very important role in removing the significant ones. The use of filters considerably improves signal quality during recording. The objective of this work is to design an FIR digital filter for reducing interference, with hanning window function.

Keywords: ECG, hanning window, IOT.

INTRODUCTION

In There are more than 80 million individuals in the States have some type of cardiovascular illness (CVD) for instance; coronary illness, stroke, hypertension, or heart disappointment and a great many others are at expanded danger for these ailments [1].One of the main techniques for diagnosing heart disease is based on the Electrocardiogram. Electrocardiogram is a graphical representation of electrical activity of the human heart.ECG signs are made out of P wave, QRS complex, T wave and any deviation in these parameters demonstrate irregularities present in heart. The standard ECG sign is appeared in Fig. 1.P wave is a sequential depolarization of the right and left atria. Duration of the p wave should be less than 0.12s. QRS complex is a right and left ventricular depolarization. QRS duration should be less than 0.10s. PR interval is a time interval from onset of atrial depolarization (P wave) to onset of ventricular muscle depolarization (QRS complex). The time interval between PR waves is 120-200ms. T wave is a ventricular repolarization. The time duration of T wave is ~200ms. P−Q interval is the time interval between the beginning of the P wave and the beginning of the QRS complex. "ST segment" is a misnomer, because a discrete ST segment distinct from the T wave is often not seen. The duration of the ST segment is 70-80ms.

Signal Acquisition:
Electrocardiography (ECG) is the acquisition of electrical activity of the heart captured over time by an external electrode attached to the skin. Each of the cell membrane that forms the outer covering of the heart cell has an associated charge which is depolarized during every heartbeat. These appear as tiny electrical signals on the skin which can be detected and amplified by the ECG.

Lead System
In ECG lead refers to the voltage between two electrodes. In 12 Lead ECG total 10 surface electrodes are attached to various specified positions on the body. A suitable gel is used to provide impedance match between the electrodes and the skin. The 10 electrodes are classified as: 4 limb electrodes, Right Arm (RA), Left Arm (LA), Left Leg (LL) and Right Leg (RL); and 6 chest electrodes, V1-V6. A total of 12 Leads are

derived from these 10 electrodes. These 12 leads are classified as 3 limb leads, 3 augmented limb leads and 6 precordial leads. Out of this 12 leads, limb leads are bipolar while all other leads are unipolar leads.

Lead System

In this proposed architecture, 3-Lead ECG technique is used. Here 3 electrodes are connected on the patient's body. That is one electrode on the right wrist, another electrode on the left wrist and another one on the right leg ankle which will gives the information about the HR. 3-lead system provides the 3 views of the heart. That is 1-lateral and 2-inferor. The three lead ECG continues to be used in emergency department, telemetry monitoring, during medical procedures. 3-lead system is used because it consumes low power, mobility in operation and compact in size.

Filtering

Filters are used in order to remove the commotions which are present the signal. This noise may come from electrode/body interface, muscle noise, electrical noise from equipment in the environment and from within the ECG equipment itself, such as from internal dc/dc converters. Most cardiac monitors will choose the appropriate filter based on the situation.

LITERATURE SURVEY

1. Syed Zahurul Islam et al., in this paper AC and DC noises have been implemented according to their basic properties [2]. After that, these noises have been mixed with ECG signal and nullify these noises using the LMS and the RLS algorithms. Performance study has been done between these algorithms based on their parameters and the effect of filter length and the corresponding correlation coefficient. Results indicate that the DC bias noises cannot be handled by the LMS filtering whereas the RLS can handle both types of noises. It has been found that the RLS algorithm generally performs better irrespective of the nature of the signal and the noise. The RLS is particularly useful in the case of signals where abrupt changes of amplitude or frequency may occur such as DC noises.

2. Smita Kasar et al., The classification of ECG signals is an important application Since the ECG signals, while recording are contaminated by several noises it is necessary to pre-process the signals prior to classification [3]. The ECG signal can be processed in time domain as well as in frequency domain. The present paper shows the performance of removal of noise like baseline wander and power line interference from the signal using Band Pass filter and Notch filter. Two filtering methods are applied on 12 different ECG signals. The first filtering method, Band pass filter gives SNR in the range of -1.6 to 1.4dB for signals. The SNR using second method with the Notch filter gives SNR in the range of 0.2 to 1.9dB. SNR values of both methods are compared and analyzed. The Notch filter gives better results as compared to Band pass Filter.

3. Mustapha EI hanine et al., The most common noises in Electrocardiogram (ECG) signal processing are baseline wandering and the 50 or 60 Hz power line interferences [4]. In order to remove these two major sources of noises, we have used the recent powerful Discrete Wavelet Transform (DWT). The results indicate that DWT is a good method for filtering noises without changing the morphology of ECG because the duration, amplitude and shape of the P wave, QRS complex and T wave are not modified. Hence, this process allows cardiovascular experts to make a proper analysis. And can be applied to all types of ECG signals, whether normal or presenting arrhythmias.

4. Zhongguo Liu et al., "ECG Signal Denoising Based on Morphological Filtering", 2011 IEEE. Electrocardiographic (ECG) signal are often contaminated with different types of noise and base-line drift. A morphological filtering approach was put forward to remove the noise of the ECG signals [5]. The morphological filtering approach is simple, fast and real-time in processing, and it keeps the ECG signal shape unchanged while removing the noise. However, the difficult part in applying morphological filtering approach is selection of appropriate structuring elements. Though structuring element is related to the frequency of the signal, the principal component frequency of ECG signal is varied to different persons because of individual differences, and so the structuring elements vary widely. We can combine

morphological filters and adaptive filters according to the individual differences to choose the most appropriate structuring element.

5. Md. Maniruzzaman et al., The 50 Hz power line is one of the main sources of interference in ECG signal measurement, and it distorts the original ECG signal while recording [6]. Recently, adaptive filtering has become one of the effective and popular methods for the processing and analysis of the ECG signal. We have used different adaptive filter algorithms, such as, Least-Mean-Square (LMS), Block LMS (BLMS), Delay LMS (DLMS), Ad joint LMS, Filtered-X (XLMS), Normalized LMS (NLMS) and Fast Fourier Transform BLMS (FFT BLMS). It reveals that among all the adaptive filters, the adaptive NLMS filter removes the 50 Hz power line interference more effectively. The obtained SNR of reconstructed signal of LMS filter is lower than that of the NLMS filter. So, the NLMS adaptive filter is more appreciable for removing the power line interference from the ECG signal.

DESIGN METHOLODGY

The present model is explained in the fig 2. This model is generally designed for the person who is experiencing the heart problems. This model generally comprises of three electrode terminals which are connected to the patient. One terminal of electrode is associated with right hand, another terminal of electrode is associated with left hand and another terminal of electrode is associated with right leg. 3-Lead system mostly deals with the rule of "Einthoven's triangle". The terminal which is associated with the right leg is considered as the source of perspective terminal. Lead I, II, III will get the variations from the terminals which are attached to right hand, right leg and left hand respectively.At that point these 3-particular data are feed to the high-voltage protection block. This unit is generally outlined for the security reason. Safety is always the number one design concern of the ECG designer. Both the patient and the operator must be protected from power surges or overvoltage coming from the ac mains and from any current path through the ECG electrodes that could exceed the recommended limit of 10 μA rms. Output of the high-voltage unit is feed to the frequency rejection unit helps to evacuate the frequencies which are greater than 100Hz. Then frequency rejection output is given to the instrumentation amplifier unit. An amplifier is an electronic device that can increase the power of a signal. An instrumentation amplifier is a type of differential amplifierthat has been outfitted with input buffer amplifiers, which eliminate the need for input impedance matching and thus make the amplifier particularly suitable for use in measurement and test equipment. This block amplifies the sign with the gain of 101db. The output of the instrumentation amplifier unit is feed to high pass channel to remove the low frequency commotions like baseline wander etc. Next high pass filter output is feed to the regulated unit which helps to control gain of the signal. if gain varies then amplitude of the signal also changes. Then output of the regulated unit is given to the high-pass filter. High pass filter output is feed to Bessel-worth analog third order filter with the fc=40Hz. Here 40Hz is picked in light of the fact that PLI is around 50Hz. If you choose the fc more than 40Hz more commotion may happen in the ECG signal. Then Bessel worth filter will produce output which is in the form of analog. Output of the Bessel worth filter is given to A-D converter which changes the analog signal to the digital signal. Then analog to digital converter output is given to the microcontroller. Changed data is assembled into packets for window technique. By then the packets are send to the further unit. The collected packets are changed over into a wave organize after the window technique.

HANNING WINDOW

Hanning window is a digital FIR filter used to remove the interferences. The hanning window function can be expressed as:

CONCLUSIONS

There are various artifacts which get added to the ECG signal and change the original signal; therefore there is a need of removal of these artifacts from the original signal. So filters are mainly used to remove the noises which are present in the ECG. These filters are used to remove the PLI and MC and low frequency noise in the ECG signal.

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REFERENCES

[1] Priya L et al., "Filtering ECG Signal using LMS Algorithm for Wireless ECG Transmission"

[2] Syed Zahurul Islam et al., "Performance Study of Adaptive Filtering Algorithms for Noise Cancellation of ECG Signal", 2009 IEEE.

[3] Smita Kasar et al., "Performance of Digital filters for noise removal from ECG signals in Time domain", Vol. 2, Issue 4, April 2014.

[4] Mustapha EI hanine et al., "electrocardiogram Signal De- noising Using Discrete Wavelet Transform". 2014 IEEE.

[5] Zhongguo Liu et al., "ECG Signal De-noising Based on Morphological Filtering", 2011 IEEE.

[6] Md. Maniruzzaman et al., "Least-Mean-Square Algorithm Based Adaptive Filters for Removing Power Line Interference from ECG Signal". 2012 IEEE.

Figure 1: Electrical events of the heart

Figure 2: Proposed block Diagram

Figure 3: original ECG signal

Figure 4: ECG signal corrupted by external noise

Figure 5: Filtered signal using hanning window

the recent years, Internet has become the most important thing in daily life. Around two billion users around the world use Internet for exchanging emails, using social networking applications, sharing large amount of data, playing games and many other things. As the use of Internet is growing day-by-day, another big area is emerging to use Internet as a global platform for allowing the machines and smart objects to communicate, compute and coordinate, called Internet of things (IoT). Fig1 shows the Evolution of internet in 5 phases and fig2 shows the definition of internet of things.

Distributed network architecture: Distributed Network Architecture is the arrangement of devices in a network that are capable of working in both jointly and independently as required.

The benefits of Distributed Network Architecture are scalability, efficiency, cost and reliability.

Home automation:A Home Automation system connects various electrical devices in the house to a control unit. This permits the person to control them at the touch of a button from inside and outside the home. Home Automation Systems increase the level of comfort, security and energy management. It also has the added advantage of controlling the devices through smart phones to allow full control of any connected component.

Home automation may include control of lighting, heating, ventilation, air conditioning, security locks of gates and doors and other systems, to provide improved convenience, comfort, energy efficiency and security.

LITERATURE SURVEY

1.L.Tan *et al* - The main communication form on the Internet is human-human. But it is foreseeable that in a near soon that any object will have a unique way of identification and can be addressed so that every object can be connected. The Internet will become to the Internet of Things. The communicate forms will expand from human-human to human-human, human-thing and thing-thing (also called M2M).This will bring a new ubiquitous computing and communication era and change people's life extremely. Radio Frequency Identification techniques (RFID) and related identification

technologies will be the cornerstones of the upcoming Internet of Things (IOT).

2.Miao Wu- In this paper different types of architectures are proposed. Three-layer structure has certain significance to understand technical architecture of the Internet of Things at the initial stage of its development, but it cannot completely explain its structure and the connotation. So five-layer architecture can help scholars and developers to better understand the Internet of Things.

3.Rozita T- This paper investigates the potential of 'Full Home Control', which is the aim of the Home Automation Systems in near future. The analysis and implementation of the home automation technology using Global System for Mobile Communication (GSM) modem to control home appliances such as light, conditional system, and security system via Short Message Service (SMS) text messages is presented in this paper.

4.M Zhang- This paper proposes IoT architectural model which introduces a more generic IoT architecture by integrating both the RFID and WSN and Web Service infrastructures.

DESIGN METHODOLOGY

The microcontroller used is 18F46K22. Diverse peripherals are connected with microcontroller using IO line and correspondence port. LCD is connected with microcontroller to display information like, temperature, sensor status etc. Temperature sensor used is DS1820B which is a modernized, one wire sensor. Microcontroller can send "Start" summon to temperature sensor then temperature sensor converts the temperature information. Once the change is done it sends a signal to the microcontroller saying completed. Microcontroller gets the changed over data from the temperature sensor and showcases it on LCD.

Temperature sensor is used for room temperature to control fan as a close circle and another temperature sensor is used to control the peltier. PIR advancement sensor recognizes living things which creates warm infrared radiation and it gives the information to the microcontroller saying some advancement is distinguished.

Microcontroller sends the SOS message to the relating customer by method for GSM.

LPG sensor recognizes spillage of isobutene, propane and liquid petroleum gas to keep any unsafe impact in view of spillage. Right when spillage is recognized it sounds an alert to caution the all inclusive community and sends a SOS message to the relating customer.

FIRE sensor perceives close warm infrared detectable fire and gives the information to the microcontroller. Right when fire is remembered it sounds a caution and sends the message to the customer.

Solid State Relay is a sensitive switch to turn ON and OFF electrical devices like light, fan etc

Max 232 is a voltage converter amidst microcontroller and Wi-Fi or GSM. GSM takes a AT requests which can send and get SMS. SIM900A GSM is a triband module which can work at 3 one of a kind frequencies.

Wi-Fi ESP8266 is a 802.11.b/g/n position Wi-Fi. Here Wi-Fi is used to send a graphical information regarding the sensor status and control information to the user

TEST RESULTS

The webpage for controlling the fan and light according to the status of the temperature sensor is shown in fig4. The webpage is created using html coding.

Lcd used to display the temperature status is shown in fig5. The temperature sensor and lcd is connected to the microcontroller. The status of the sensor is visible on lcd. The coding used for this is mikroC.

CONCLUSIONS

Nowadays due to busy lifestyle people are not able to concentrate on household operations which may lead in damages, theft or wastage of the resources. So it is required

to use Internet to switch on and off, several household devices, from wherever we are, to save electrical energy, for convenience and for comfort using specific protocol and architecture.

REFERENCES

[1] C. Perera *et al.*," Context Aware Computing for The Internet of Things: A Survey," ieee communications surveys & tutorials, vol. 16, no. 1, first quarter 2014, pp 414 – 417.

[2] L.Tan *et al.*,"Future Internet: The Internet of Things" 2010 3rd International Conference on Advanced Computer Theory and Engineering(ICACTE), pp 376 – 380.

[3] Miao Wu *et al.*,"Research on the architecture of Internet of things,"2010 3rd International Conference on Advanced Computer Theory and Engineering(ICACTE), pp 484 – 487.

[4] Omar.S *et.al.*," Towards Internet of Things: Survey and Future Vision,"International Journal of Computer Networks (IJCN), Volume (5) : Issue (1) : 2013, pp 1 – 3.

[5] A. P. Castellani *et al.*, "Architecture and protocols for the Internet of Things: A case study," in Proc. 8th IEEE Int. Conf. Pervasive Comput.Commun. Workshops (PERCOM), 2010, pp. 678–683.

[6] M. Zhang *et al.*, "Architecture of Internet of Things and its Key Technology Integration Based-on RFID," 2012 Fifth International Symposium on Computational Intelligence and Design, pp 294 - 297.

[7] Rozita. T *et al.*, "Smart GSM Based Home Automation System," 2013 IEEE Conference on Systems, Process & Control (ICSPC2013), December 2013, Kuala Lumpur, Malaysia, pp 306 - 309.

[8] Niksa. S *et al.*, "Smart Home Automation System for Energy Efficient Housing," MIPRO 2014, May 2014, Opatija, Croatia, pp 166 – 170.

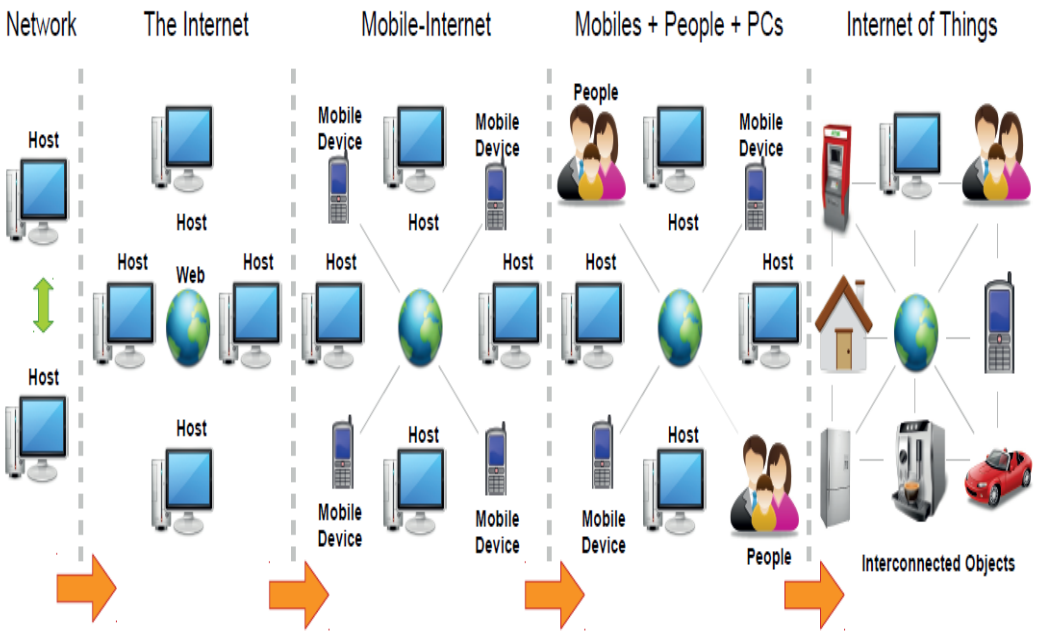

Fig1: Evolution of internet in 5 phases

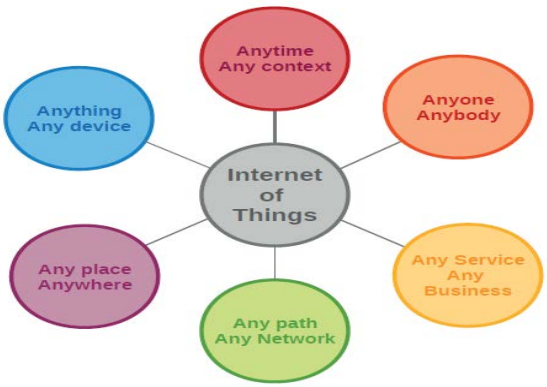

Fig 2 : IOT definition

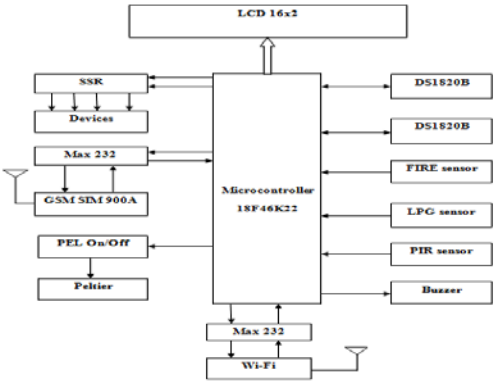

Fig3: block diagram

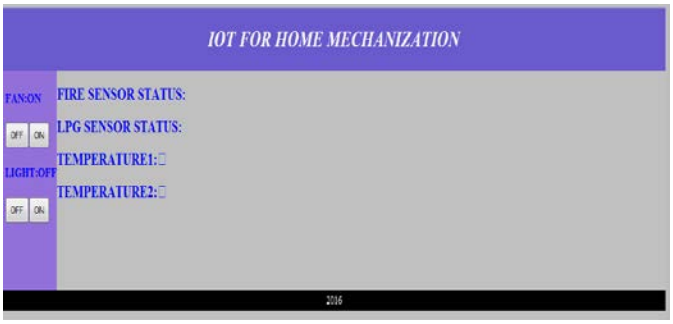

Fig4: web page

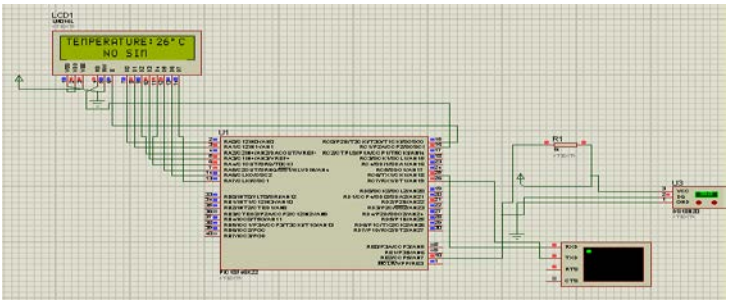

Fig5: simulation of temperature sensor