A Comprehensive Analysis of Wireless Mobile Based Tele-Monitoring System for Myocardial Malfunctioning

[1]S.Palanivel Rajan, [2]Dr.R.Sukanesh, [3]A.Ramprasad, [3]M.Jeyakumar, [3]G.Shanmuga Raja

[1] Assistant Professor, Department of ECE, Kamaraj College of Engineering and Technology,Virudhunagar, Tamilnadu, India.
[2] Professor, Department of ECE, Thiagarajar College of Engineering, Madurai, Tamilnadu, India.
[3] Final Year Research Student, Department of ECE, Kamaraj College of Engineering and Technology, Virudhunagar, Tamilnadu, India.

Abstract

The cardiac arrest is one of the leading causes for sudden death. The chance of occurrence of severe myocardial problem increases after the first attack. Detecting the one set of malfunctioning is ever challenging. Our paper intends to benefit those at high risk of myocardial can be detected early and give attention to the patient. In case of any critical or abnormal condition, the device alerts the patient and doctor. The proposed model is applied mainly for elder people of heart rate. The goal is to provide early Heart detection so that the patient will be given medical attention with in a few critical hours. Thus it greatly improves the chance of survival of the victim.

Indexterms *– Biomedical communication, Electrocardiography (ECG), Global System for mobile (GSM), QRS Detection, Wireless transmission.*

1. INTRODUCTION

According to the recent survey of WHO (World Health Organization), Myocardial malfunctioning is the major cause for all the sudden cardiac deaths all over the world. There is about 5 lakhs number of deaths in India every year and in millions in world wide. Each year the American Heart Association (AHA), National Institute of Health takes the survey to up date the statistic on death due to heart diseases, strokes and other vascular diseases. It is useful to take preventive actions based on the survey for the future. In 2007 overall death rate from Cardio Vascular Disease (CVD) was 251.2 per 100000. In this year the death rate increases as 27.8% from the last survey. On the basis of this survey 2200 peoples were died each day, on average of 1 death for every 39 seconds. In 2011 survey,it tells that obesity is the major cause for the cardiac attacks. The adult age groups are largely affected with this. Among children 2 to 19 years of age, 31.9% are over weighted and obese. For >= 20 years of age, 67.37% are over weighted and obese from the total population. The rate of death increases every year. The myocardial infraction happens due to large stress, strain, increased fat, increased chemical content in the body, blockages in the blood vessels, obesity etc. All of this cannot be avoided due to the modern life style. So the only way to increase the life of the victim is to detect the myocardial infraction early. So that the patient will be given medical attention as soon as possible. Our aim is to create an equipment to be use to detect the heart attack early. The proposed model is mainly used of the elderly population of heart rate and the critical conditioning patients. The goal is to detect the heart attack early so that the patient will be given medical attention within the first few critical hours, thus greatly improves his or her chance of survival. The device can acquire the ECG from the patient body. The raw ECG is preprocessed and post processed and it is given as input to the HR retrieval. In this the ECG is converted to heart rate based. Then the HR is given as input to the PIC Microcontroller, if any abnormalities occurred then accordingly the alert signal is given to indicate the critical conditioning of the patient.

2. EXISTING SYSTEM

Creating a wireless sensor network system,[1] that can be continuously monitoring and detecting the cardiovascular disease. Sending the ECG wave of the patient to his mobile and to the central node

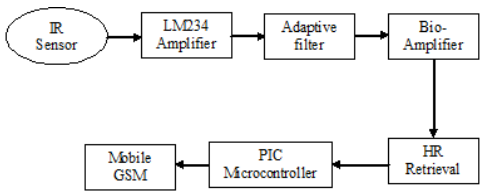
which transmit the wave to doctor. Using the pervasive technology, [5] it is possible to collect the user symptoms and one set of heart attack by analyzing ECG recordings. Three different models are proposed to detect the pathological degeneration. They are cell model,heart model, chest model. This model cannot be finished yet because it requires lots of unknown parameters. Monitoring the cardiovascular patient is not a valuable practice to prevent further risks. Thus the early detection is needed. This paper proposed the model to analysis the electrocardiography using the advancement in the wireless technology. Holter is the device used here to detect the malfunctioning. The GSM is attached to the Holter to use this device widespread myocardial ischemia diagnosis and therapeutic and preventive procedures were detected and it was mainly based on the ST vs HR relations.

3. PROBLEM FORMULATED

By analyzing the above papers the following problems can be formulated. In the traditional medical method the mobility of both the doctor and the patient are restricted. All the existing methods are web based, without internet they cannot be used. Some of the system gives the false alarm due to some constraints. The existing system use costly hardware components and complex software tools.

4. PROPOSED WORK

4.1 Block diagram



The ECG signal from the patient body by using IR sensors. The obtained signal must contain some internal and external noises. The voltage level of the myocardial waves is in millivolts. With this range the pre-processing and post processing is not possible at all. So the obtained signal must be amplified and filtered. For the filtering purpose the adaptive filter is used. Then for providing amplification and isolation to the patients the bioamplifier is used. Then the obtained analog signal is converted into digital signal using PIC microcontroller. In this type of controller the A/D circuit is made inbuilt. Then the omparison of QRS complex amplitude levels are done accordingly the alarm signal is activated.

4.2 LM234

The LM234 is a 3 terminal device and its operating current level from 1JA to 10mA. The operating voltage level from 0.8V to 30V and the regulation is 0.02%/V. LM234 draws no reverse current and it can be used as a linear temperature sensor. The applications of LM234 are current limiter, micro-power bias network, buffer for photoconductive cell, current mode temperature sensing and constant-gain bias for bipolar stage.

4.3 ADAPTIVE FILTER

Even though the ECG wave is pick by using high technical and efficient sensors. It is impossible to have noise free ECG signal. But if the noise level is too high then it lead to the wrong estimation about the state of the heart and patients health. Due to this lot of power and time get wasted for the processing of the signal. Thus the filter section is very important. Some types of noises are P and T wave noise, Power line interference, EMG from muscle, Operating room condition. Mostly the filter option is band pass filter. But it is not suitable if it is used for all the age groups. So we choose the adaptive filter which changes its nature according to the time and range. It does not need any prior knowledge about the signal and the nature of the noise.

4.4 BIO-AMPLIFIER

It is the combination of the instrumentation amplifier and power amplifier. The instrumentation amplifier alone is not enough to get the amplified QRS complex we need power amplifier. So we use power amplifier. It is a amplifier used for providing isolations and amplifies the QRS complex alone.

4.5 PIC MICROCONTROLLER

A microcontroller is a complete microprocessor system built on a single IC. Microcontrollers were built to meet a need for microprocessor to be put in low cost. Building a complete microprocessor system in a single chip substantially reduce the cost of building the products. Here we use PIC microcontroller, which has an inbuilt analog

to digital converter. The PIC have a set of registers that can be function as a purpose of general RAM. Special control registers for hardware resources are mapped to data space. All PIC can handle the data in 8-bit chunks. The addressability unit of the code space is different as the data space. Actually the code space can be implemented as ROM, EPROM and flash ROM. Generally, external code memory is indirectly addressable because of lacking external memory interface. The instructions can be vary from low end PIC to high-end PIC, whether the low-end and high end PIC have an instructions vary from about 35 instructions and over 80 instructions respectively. The features of the PIC micro controller are code efficiency, safety, instruction set, speed, static operation, drive capability. The advantages of PIC microcontroller are small instruction set to learn, built in oscillator with selectable speed, inexpensive microcontrollers, wide range of interfaces including USB and Ethernet.

5. ECG DETECTION ALGORITHM AVAILABLE FOR TELEMETRY APPLICATIONS

From this various detection algorithms are available. Some of them are listed below

- Turning point algorithm
- Aztec algorithm
- Fan algorithm
- QRS Detection algorithm

For the storage of the wave, to save the memory space the redundancy is eliminated but with some constraints.

6. QRS DETECTION ALGORITHM

For this detection algorithm we design a band pass filter from a special class of digital filter which requires only coefficient. It is very difficult to design digital band pass filter directly so we design a cascaded connection of low pass and high pass filter. It attenuates the low frequency characteristics of P and T waves and baseline drifts and high frequency.

6.1 Low Pass filter

The transfer function of the second order filter is $H(z)=(1-z^{-6})/(1-z^{-1})^2$

This filter has purely linear phase response. Power line is highly attenuated. All the frequencies are attenuated by more than 250db. Any 60Hz noise or muscle noises are highly attenuated. The transfer function of the second order filter is

$H(z)=(1-z^{-6})/(1-z^{-1})^2$ ----------(1)

The difference equation of the filter is

$Y(nT)=2y(nT-T)-y(nT-2T)+x(nT)-2x(nT6T)+x(nT- 12T)$ ----------(2)

6.2 High pass filter

The high pass filter is implemented by subtracting the low pass filter from all pass filter with delay. The low pass filter is an integer coefficient filter with transfer function,

$H_{lp}(z)=Y(z)/X(z)=1-z^{-32}/1-z^{-1}$ ----------(3)

6.3 Derivatives

After the filtering process the signal is differentiated to get the clear information about the slope of the QRS complex. A five point derivative gas a transfer function of

$H(z)=0.1(2+z^{-1}-z^{-3}-2z^{-4})$ ----------(4)

and the difference equation is given by

$Y(nT)=[2x(nT)+x(nT-T)-x(nT-3T)-2x(nT-4T)]/8$ ----------(5)

6.4 Squaring function

The squaring function is a non linear function. The equation that implement this function $Y(nT)=[x(nT)]^2$

This operation makes all the data point in the processed signal to positive and also amplifies the output of the derivative non-linearly. In this operation the output of this stage is hard limited to certain level which is based on the number of bits used to represent the data type of the signal.

6.5 Moving window integral

The slope of the R wave alone is not a guaranteed way to detect the QRS events. Many abnormal QRS complex has large amplitude and long duration. This type of complex cannot be detected using the information about slope of the R wave only. For extract more information about the QRS complex this type of moving integral is used. It is implemented with the difference equation

$Y(nT)=1/N[x(nT-(N-1)T)+x(nT-(N-2)T)+...$
$\ldots\ldots+x(nT)]$ ----------(6)

Where, N - number of samples in the width of the moving integral.

The size of the moving window is chosen by experiment, if the size is too high then the QRS complex merges with the T wave. If the size is too small then the QRS complex produces several peaks at the output. The first two algorithms are only useful for data reduction with this we are only able to

reduce the memory space needed to store the ECG wave. We need an effective algorithm to detect the QRS complex from the ECG signal. Because we are only analyzing the QRS complex which causes high risk to the patients. Thus we are indeed to choose the QRS detection algorithm.

7. INTERFACING MICROCONTROLLER WITH MOBILE PHONES

For interfacing purpose some commands must be needed. Here we use PIC microcontroller. For that we need **ATTENTION (AT)** command to interface with the mobile phone. The AT Command prefix must be set at the beginning of each command line. To terminate the command line enter <CR>.Commands are usually followed by a response that includes "<CR><LF><response><CR><LF>.

8. RESULTS AND DISCUSSION

From all the above discussion we implement the QRS detection system and the alerting mechanism in the LABVIEW. LABVIEW is a software tool used to simulate the system and get the response to know how well the system is working according to our expectation. LABVIEW is highly reliable and user friendly, both the electrical and electronic device systems can be simulated. Here we use ECG simulator to create a standard ECG signal. The signal is then filtered and amplified and processed to detect the QRS complex. Here the peaks and valleys of the ECG signal is found and analyzed. The duration of the process can be selected manually. If the peak is found then the location of the peak and the amplitude level of the peak is calculated.

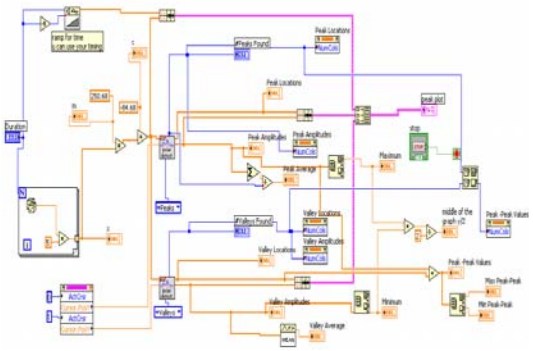


Fig.: 1 – LabVIEW Design for Peak Detection of ECG

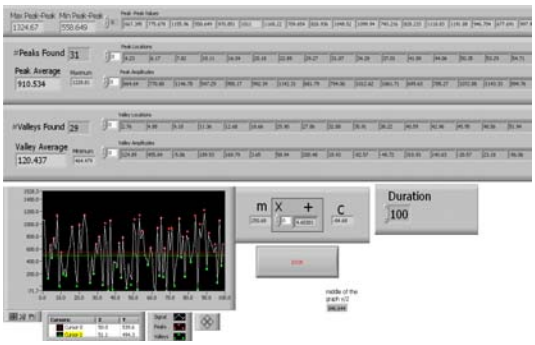


Fig.: 2 –Output for Peak Detection of ECG

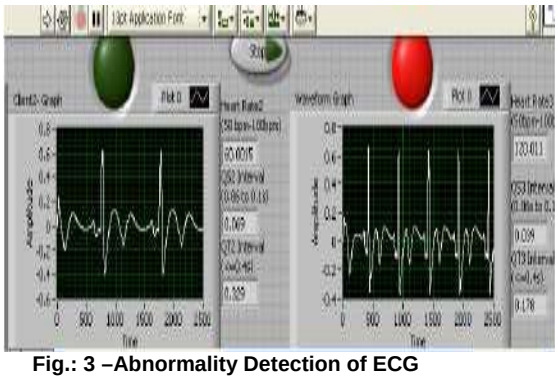


Fig.: 3 –Abnormality Detection of ECG

If more than one peak is found then average for the peaks can be calculated and the maximum peak value is calculated and all this are calculated for the valleys also. Then the maximum peak to peak value and minimum peak to peak value is generated. The LABVIEW is the best tool for analyzing the ECG for the single user; it is analyzed based on the following procedure. The RED and GREEN color points in the above windows denote the peaks and valleys in the ECG signal. The RED denotes the peaks and the GREEN denotes the valleys. The QRS detection is done either between the two GREEN points or between the two GREEN and one RED point.The first one is based on the analysis of the time period of the QRS and the second one is based on the amplitude of the QRS complex. If the heart rate is normal then the GREEN light will be glow, if the heart rate is abnormal then automatically the RED light will glow. The sample is shown in the above screen, In that the ECG signal is varied manually by using the ECG simulator and then check the response. The GREEN light is glow for the normal heart of 60 and the RED light is glow for the abnormal heart rate of 120.This shows that this method is well suited and

optimal for the detection of myocardial infarctions early.

9. CONCLUSION

The progress in science and technology is a Nonstop process. New things and new technology are being developed. The proposed telemonitoring system work based on the PIC microcontroller is more compact, user friendly and less complex. The feature make this system is the base for future system.

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AUTHORS PROFILE

S. Palanivel Rajan pursuing his Ph.D in the faculty of Information and Communication Engineering from Anna University. M.E degree in Communication Systems from Thiagarajar College of Engineering, Madurai, Tamilnadu. B.E degree in Electronics and Communication Engineering from Raja College of Engineering and Technology, Madurai, Tamilnadu. He is presently working as Assistant Professor in the Dept. of Electronics and Communication Engineering at Kamaraj College of Engineering and Technology, Virudhunagar, Tamilnadu. His interest includes Bio-Signal Processing, Telemetry, Wireless Networks and Wireless Communication. He has contributed 42 technical papers in various journals and conferences. He is a life member of ISTE, IE (I), IACSIT, ITE, IAAA, IAENG and Associate Member of IETE**.**

Dr.(Mrs).R.Sukanesh received his Ph.D in Information and Communication Engineering from Madurai Kamaraj University in 1999. M.E degree in Communication Systems from P.S.G. College of Technology, Coimbatore, Tamilnadu in 1985. B.E degree in Electronics and Communication Engineering from Govt. College of Technology, Coimbatore, Tamilnadu in 1982. She is presently working as Professor in the Dept. of Electronics and Communication Engineering at Thiagarajar College of Engineering, Madurai, Tamilnadu. Her interests include, Bio-Signal Processing, Wireless Communication and Networks, Neural Networks and Soft Computing Techniques. He has contributed more than 115 technical papers in various journals and conferences. He is a life member of ISTE, BMESI**,** IABMS**,** Fellow of IE (FIE), and IAENG. She has 02 sponsored projects from DST and UGC.

A.Ramprasad, pursuing his Bachelor of Engineering in the Stream of Electronics and communication Engineering in Kamaraj college of Engineering and technology. His areas of interest are Wireless communication, Wireless networks. He is an active student member of IETE and ISECE.

M.Jeyakumar, pursuing his Bachelor of Engineering in the stream of Electronics and Communication Engineering in the Kamaraj college of Engineering and technology. His area of interest are wireless communication, Wireless networks. Student member of IETE and ISECE.

G.Shanmuga Raja, pursuing his Bachelor of Engineering in the stream of Electronics and Communication Engineering in the kamaraj college of Engineering and technology. His area of interest are wireless communication, Wireless networks. Student member of IETE and ISECE.