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Low Cost Heart Multi Parameter Monitoring and Arrhythmia Analysis Using MATLAB

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***Abstract*— Recent years percentage of heart related diseases are in peak limit and to analysis heart diseases, ECG (electrocardiogram) one of best method to acquisition of ECG signals.The ECG devices are huge demand in market but when we deal with the cost, size and power its required to be minimized.In this paper present the ECG, Blood pressure, stethoscope signal acquisition using MPM board with C8051F380 development board and compare its power consumption with previous reference works. Output of MPM board is stored as .txt format and displayed the signals in MATLAB GUI.Finally processing of ECG .txt file using the pan Tompkins algorithm to track the QRS value and analyzing the arrhythmia using MATLAB graphical user interface (GUI).**

***Index Terms*— Cardiovascular diseases (CVD), USB-6008, TI AD8232, MPM board**

I. INTRODUCTION

Heart related diseases are one of the major deaths taking cause in worldwide. According to world health organization (WHO) they announced that CVD is one of the major causes for death. According to the survey 17.5 million people died from CVDs in 2012 and represented about 31% of global death, from that around 7.4 million people are died due to coronary heart diseases and 6.7 million people due to heart stoke. In emergency time at hospital when patients are needed the quick treatment for their diseases it's not possible for hospital to spontaneously find the heart related diseases. Some patients are waiting at hospital due to negligence of hospital people.

The heart related treatments are done through electrocardiogram (ECG) procedure, classical ECG procedure follows by the Ag/Agcl Electrode placed on the skin based on the Einthoven's triangle law and due to depolarization, polarization effect of skin electrode senses the variation in signal whose signal level is weak ranging 5 millivolt and frequency range is lies on below the 300Hz.There are different method of placing a electrode on skin one of the best method is 12-lead ECG[1],The analog front end devices are connected to electrode such as AD8232 which are include the ECG acquisition circuitry and filtering circuitry which are eliminate the all basic noise present in signal[2]. The USB-6008 NI development ECG acquisition devices are useful in this area [3] and overview can see in lab view.

II. LITERATURE SURVEY

From the Observation most of the paper mentioned the ECG acquisition is done through the AD8232 series ECG devices [1] and further papers are description of microcontroller based works. The Microcontroller based ECG data acquisition where the acquisition of ECG data is done by using low consumption of microcontroller and in this paper they are compared the power consumption utilization with earlier work [4].In second paper we can note down that using PIC series microcontroller ECG acquisition done using PIC Pulse width modulation pins and displayed that in LABVIEW tool by taking the ECG data in audio format file (.WAV) [5].Clinical based the ECG acquisition are done using simple ADC circuitry and some filtered ,amplifier circuitry and demonstrated in LABVIEW tool[6].

Further paper referred based on the heart related diseases such as Arrhythmia and detection of arrhythmia using wavelet transformation using MATLAB and they are specifically taken the samples from the MIT-BIT to determine the QRS detection value for each samples [7].The algorithm such as pan Tomkins algorithms is used to find the QRS value and trace the heart diseases based on heart rate and QRS values [8]. Next paper they are taken the survey on heart patients, here they used pan Tompkins algorithm to get the real time R-R interval for accurately [9].

III.BLOCK DIAGRAM

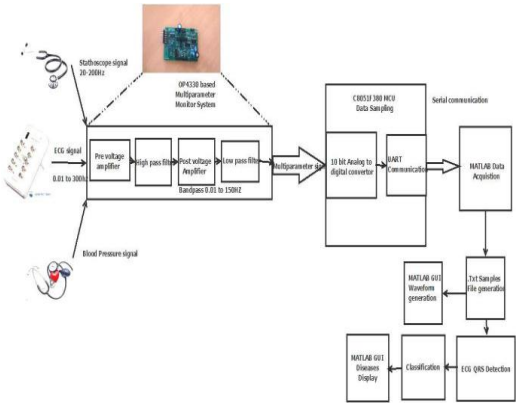


Fig 1. Block diagram

The figure 1 shows the objective of this paper, the three signals are taken from the ECG simulator, Statho and Blood pressure from user end side one after other respectively. The signals acquisition done through MPM board. This MPM board contains the simple Opamps circuit using an OP4330 IC. The output of the MPM board is analog in nature. Three signals are converted into digital signal using a ADC(Analog to digital convertor) with the sample rate of 1kHz in C8051F380 development Microcontroller and send to PC through the serial communication using a MATLAB where the reconstruction of the signals are done by formatting the signal in hexadecimal format(.TXT) and reproduce the three signal using a MATLAB GUI.

The QRS detection and Arrhythmia analysis are done using the MATLAB by taking the Hexdecimal value of ECG .txt file.Using the Pan Tompkins algorithm[8] track the QRS values and from that calculated the R-R distance to estimate the heart rate and type of Arrhythmia.

Table 1 Type of arrhythmia

Arrhythmia	Features and Abnormalities
Normal sinus rhythm	Rate: Normal(60–100bpm) Rhythm: Regular PWaves: Normal PRInterval: Normal(0.12–.20sec) QRS: Normal (0.06–0.10 sec)
Sinus bradycardia	Rate: Slow(<60bpm) Rhythm: Regular PWaves: Normal PRInterval: Normal QRS: Normal Slowing of SA node
Atrial Tachycardia	Rate:150–250bpm Rhythm:Regular P Waves: Normal, but differ in shape from sinus Pwaves PR Interval: May be short (<0.12 sec) in rapid rates QRS: Normal, but can be aberrant at times A rapid atrial rate overrides the SA node and becomes the dominant pacemaker. Some ST wave and T wave abnormalities may be present
Idioventricular Rhythm	Rate: 20–40 bpm(accelerated 41-100 bpm) Rhythm: Regular P Waves: None PR Interval: None QRS: Wide (>0.10 sec), bizarre appearance All other pacemakers fail to function or impulses cannot reach ventricles because of a block in the conduction system

IV.PAN AND TOMPKINS ALGORITHM

The pan And Tompkins algorithm basically to trace out the QRS points by using following steps [9]

- Elimination of skin noise by using high and low pass filter
- Differentiator operation
- Squaring operation
- Moving window Integrator(Cumulative sum operation)

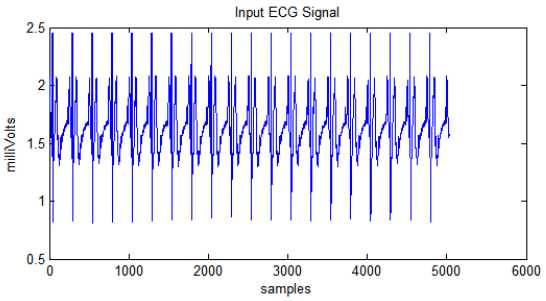


Fig 2. Input ECG signal

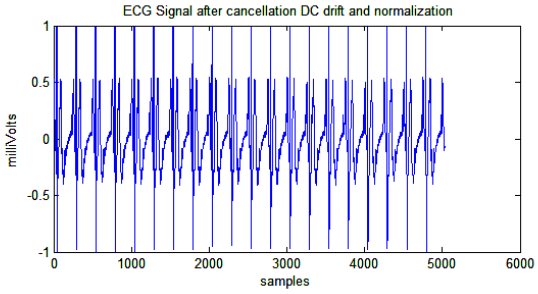


Fig 3.after Normalized and DC shift

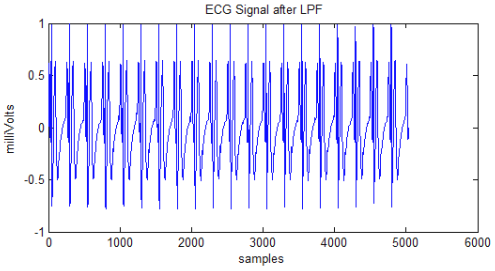


Fig 4.After Low pass filter

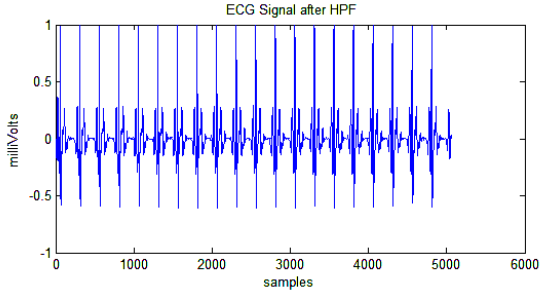


Fig 5.After High pass filter

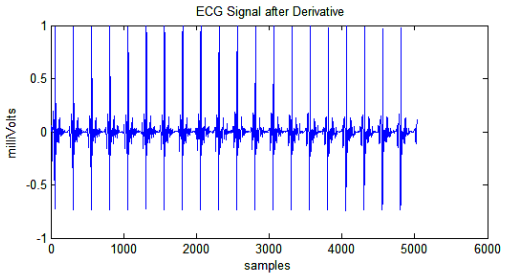


Fig 6.After Derivative

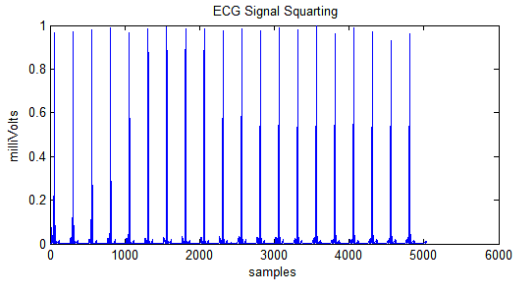


Fig 7.After Integrator operation

V COMPONENTS REQUIRED

Multi parameter Module and Arrhythmia analysis required these following components

- MPM board
- SI C8051F380 MCU
- CP2102 Based USB to RS232 convertor.
- MATLAB Tool

1) ECG signal generator

ECG signal generator generate the different range of heart rate signal depend on the user consistence and its comes with the 12-lead ECG.Depend on the user requirement either they can use as 3-lead, 6-lead or 12-lead.

2) MPM board

MPM boards are used to take the 3 basic heart related signal and it's designed using OP4330 opamps circuit.All the analog front ends are designed in this board.Using the 3-lead ECG mechanism MPM board give the output in analog form.

3) Silicon lab C8051F380 Development board

The MCU system controller core is the CIP-51 microcontroller. The CIP-51 is fully compatible with the MCS-51™ instruction set; standard 803x/805x assemblers and compilers can be used to develop software. The MCU family has a superset of all the peripherals included with a standard 8051. The CIP-51also includes on-chip debug hardware, and interfaces directly with the analog and digital subsystems providing a complete data acquisition or control-system solution in a single integrated circuit.

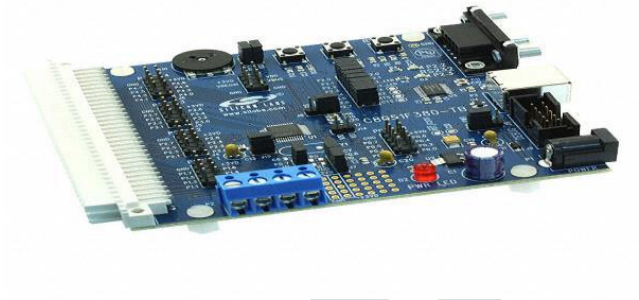
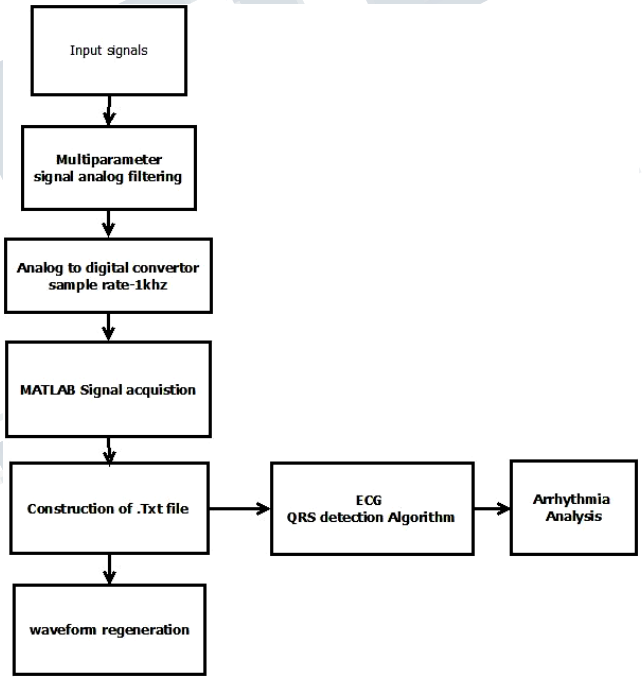


Fig 9.C8051F380-TB development board

VI. FLOW DIAGRAM



The flowchart is explained about the acquisition and processing part of the paper. Arrhythmia detection separately done by calculating the R-R distance by using the Pan and Tompkins algorithm

VII RESULT AND COMPARISON

The flowchart is explained about the acquisition and processing part of the paper. Arrhythmia detection separately done by calculating the R-R distance by using the Pan and Tompkins algorithm.

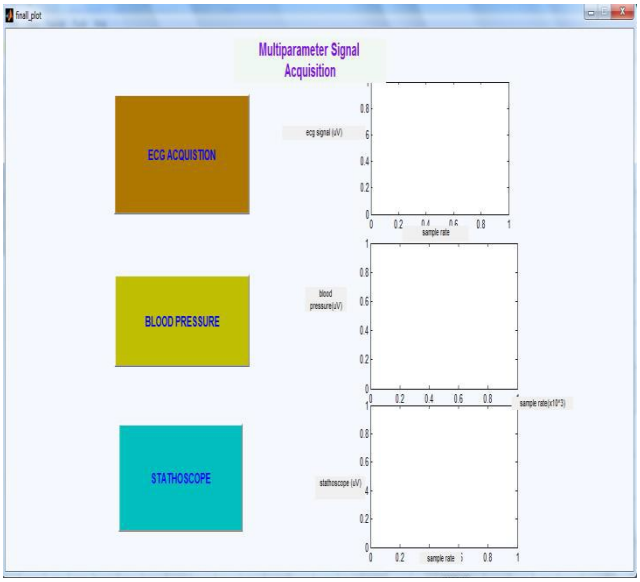


Fig 11 MATLAB GUI before signal acquisition

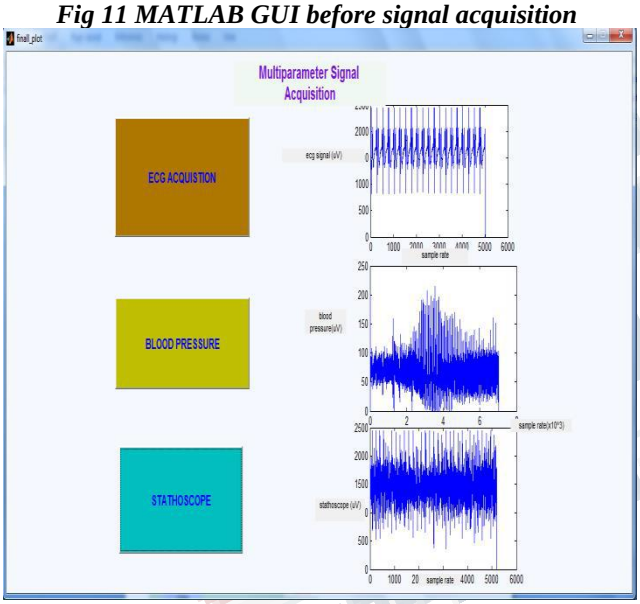


Fig 12 MATLAB GUI after signal acquisition

The figure 12 describes the Multi parameter acquisition signal such as ECG, Blood pressure, stethoscope signals. All three signals are sampled at a rate of 1 kHz.

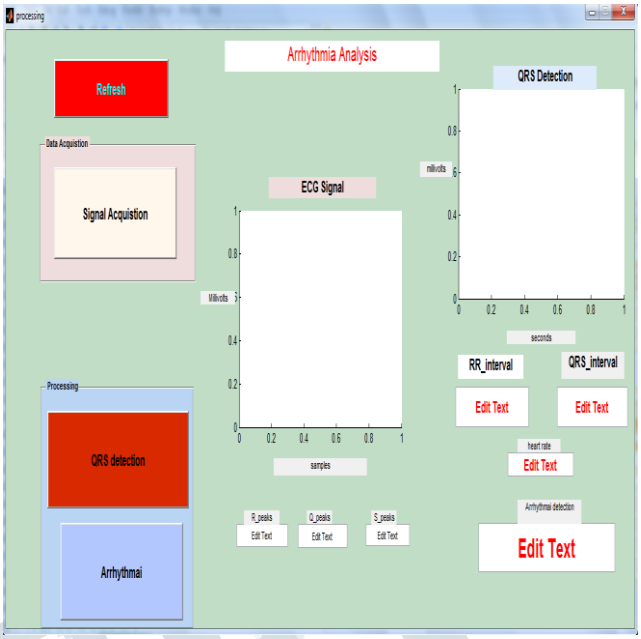


Fig 13 MATLAB GUI Arrhythmia analysis window

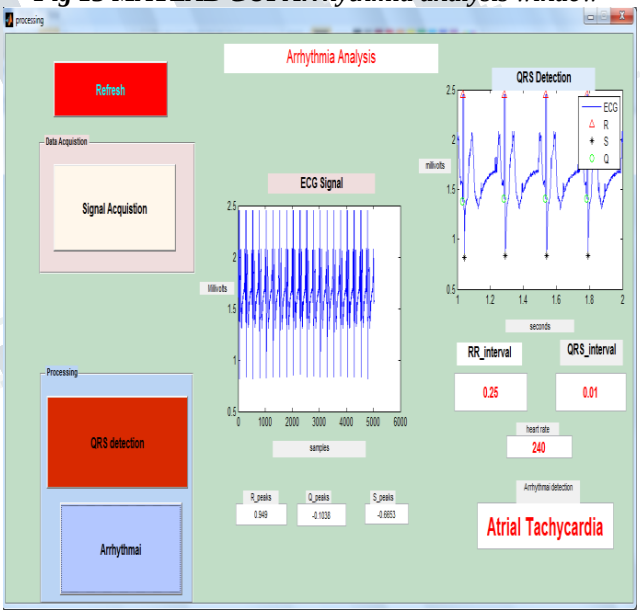


Fig 14 MATLAB GUI output Arrhythmia analysis

The Figure 14 described about the QRS detection and Arrhythmia analysis which is matched with the case of arrhythmia which are listed in Table 1.

A. Comparing present work with reference work

The power consumption of ECG design module is important while we consider in physical world. In this section comparing the present work with the reference paper [4]

Table 2 Power consumption table

Present Work		Reference work	
Components	Power Consumption	Components	Power consumption
SI C8051F380 MCU	525 m W	MSP430 G2553	990µW
OP4330 based MPM Board	962.5 µ W (5 OPAMPS)	ADS1292 Chip	840µW
Total	525.9m W		1.83 mW

From the Table 2 describe the power consumption of ECG module comparing with reference paper[4] work .The present work taking little more power then reference work but advantage of present work is from single MPM board can used to read the heart multi parameter signals which can reduce the size and cost of module.

VIII CONCLUSION AND FUTURE WORK

The conclusion of this paper is Multi paramater of heart can be read from the physical real time sensors placed on the human body and using the ECG signal analyzing the Arrhythmia diseases. Future work of this paper is just purely concentrating on the low power consumption devices side for this paper to lesser utilization of power for more efficient.

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