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DESIGN OF ELECTROCARDIOGRAM (ECG) SYSTEM ON FPGA

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Abstract- **Our system involves the analysis and evaluation of electrocardiogram, which measures the output from an unknown system as they are affected by various combinations of inputs with the objective to learn the nature and characteristics of human body. The analysis of electrocardiogram is of great importance to the medical practices. This is due to the fact that a large percentage of deaths occurring in the world are mostly due to the disorder associated with cardiovascular system. ECG signal both for the normal and abnormal conditions was collected using MATLAB. The value of both normal and abnormal is set in the chip. In FPGA, the heartbeat of the person was measured using heartbeat sensor. The heartbeat of the person was measured using heartbeat sensor the threshold value is maximum, status of the patient is abnormal condition. In abnormal condition the buzzer sound will be produced.**

Keywords: **ECG, FPGA, FIR filter, Heart beat sensor.**

I. INTRODUCTION

The electrocardiogram or ECG (sometimes called EKG) is today used worldwide as a relatively simple way of diagnosing heart conditions. An electrocardiogram is a recording of the small electric waves being generated during heart activity. The main tasks in ECG signal analysis are the detection of QRS complex and the estimation of instantaneous heart rate. They are many hardware implementation approaches to ECG (or EKG) monitoring systems. They are micro-controller based ECG, DSP based medical development kits which include Electrocardiogram and Pulse oxiometere.It is limited by performance by clock rate. Compared to microcontroller, DSP based medical kit and ASIC, FPGAs are low cost and reconfigurable property, have a low time to market.

II. BLOCK DIAGRAM

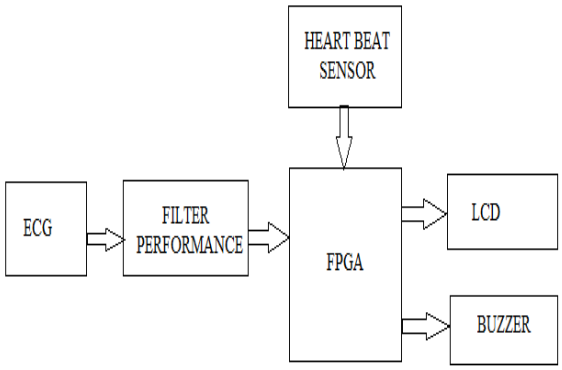

Fig. 1 Block diagram of ECG monitoring system

III. ELECTROCARDIOGRAM

An electrocardiogram (EKG or ECG) is a test that checks for problems with the electrical activity of your heart. An EKG translates the heart's electrical activity into line tracings on paper. The spikes and dips in the line tracing are called waves.

The heart is a muscular pump made up of four chambers. The two upper chambers are called atria, and the two lower chambers are called ventricles. A natural electrical system causes the heart muscle to

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contract and pump blood through the heart to the lungs and the rest of the body.

A. Waves for Electrocardiogram

The ECG signal consists of P, Q, R, S, T waves. The function of each wave is

- The P wave represents the atrial contractions.
- QRS complex represents the ventricular contractions. The R peak indicates a heartbeat.
- The T wave is the last common wave in an ECG. This electrical signal is produced when the ventricles are repolarizing.
- The letters used in the ECG signal description do not have abbreviations in medical terminology.

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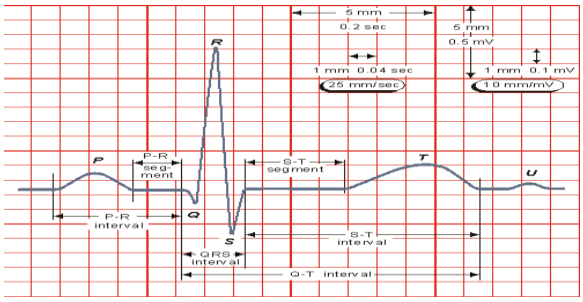

Fig.2 ECG Signal Characteristics

i. P Wave

The P wave is the first wave of electrocardiogram and represents the spread of electrical impulse through the atrial (depolarization). Its duration is not more than 0.11 seconds. Its amplitude of not more than 3mm in height and gently rounded, not pointed or notched.

ii. P-R Interval

The P-R interval is measured from the beginning of the P wave to the beginning of the QRS complex. The normal duration for this is 0.12-0.20 seconds. Normally this interval varies with heart rate and is shorter at faster rates.

iii. QRS Complex

Probably the most important complex in the electrocardiogram is the QRS. It represents the Spread of the electrical impulse through the ventricular muscle. The first deflection, if it is negative (downward) is labeled the Q wave .The first positive (upright) deflection is labeled the R wave, whether it is predeceded by a Q wave or not. A negative deflection following an R wave is labeled an S wave.

iv. S-T Segment

The S-T segment follows the QRS Complex. The point at which it begins us called the J (junction) point. Its interval relative to the baseline under normal circumstances the S-T segment is isoelectric or level with the T-P segment. It normally gently curves into the T wave.

v. T Wave

The T wave represents the period of recovery for the ventricles depolarization. It has three features direction, shape and height. The normal of T wave is slightly rounded and slightly asymmetrical. Sharply pointed or grossly notched T waves should cause suspicion the height of the T wave also has diagnostic importance.

B. FIR Filter

FIR, or Finite Impulse Response, filters have the distinctive trait that their impulse response lasts for a finite duration of time as opposed to IIR, or Infinite Impulse Response, filters whose impulse response is infinite in duration. This trait is due to the fact that there are no feedback paths in the filter. All Z transform terms are in the numerator. Z transforms written in the Z^{-1} notation only contain a "1" in the denominator. Z transforms written in the Z^{1} notation, as in Filter Solutions, only have a Z^{N} in the denominator,

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where N is the number of states in the filter.

These algorithms usually first derive smaller length fast parallel filters and then cascade or iterate them to design parallel finite-impulse response (FIR) filters with long block sizes.

IV. DESCRIPTION

A. FPGA

A field-programmable gate array (FPGA) is an integrated circuit designed to be configured by the customer or designer after manufacturing, hence "field-programmable". The FPGA configuration is generally specified using a hardware description language (HDL), similar to that used for an application-specific integrated circuit (ASIC) FPGAs can be used to implement any logical function that an ASIC could perform.

The ability to update the functionality after shipping, partial of the portion of the design and the low non-recurring engineering costs relative to an ASIC design (notwithstanding the generally higher unit cost), offer advantages for many applications. FPGAs contain programmable logic components called "logic blocks", and a hierarchy of reconfigurable interconnects that allow the blocks to be "wired together" somewhat like many (changeable) logic gates that can be inter-wired in (many) different configurations. Logic blocks can be configured to perform complex combinational functions, or merely simple logic gates like AND and XOR.

B. Heartbeat Sensor

Heart beat sensor is designed to give digital output of heart beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats per minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse.

Connect regulated DC power supply of 5 Volts. Black wire is Ground, Next middle wire is Brown which is output and Red wire is positive supply. These wires are also marked on PCB. To test sensor you only need power the sensor by connect two wires +5V and GND. you can leave the output wire as it is. When Beat LED is off the output is at 0V. Put finger on the marked position, and you can view the beat LED blinking on each heart beat. The output is active high for each beat and can be given directly to microcontroller for interfacing applications.

C. Buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as mouse click or keystroke.

D. LCD

LCD is the Liquid Crystal Display used to display the values. In this project we use 16 x 2 LCD displaying the value in the screen. It has 16 pins. It supports 16 characters per rows and total number of rows is 2. This LCD will be interfaced to the FPGA and so the LCD will be display the output of the FPGA.

V. RESULT

ECG signal both for the normal and abnormal conditions was collected using MATLAB. To denoise the signals, we use FIR filter for both the signals. Then the denoised signal will be amplified in order to strengthen the denoised signal output. The amplified data are converted to serial binary data (0's and 1's), since FPGA allows only serial data to pass through. The LCD is used for displaying the person heart beat values. PC monitoring is used for continuous monitoring of normal and abnormal signal conditions. If abnormal condition occurs then it will be indicated with the help of buzzer.

VI. CONCLUSION

The proposed system periodically monitors the ECG signal of the elderly heart patients. Under abnormal conditions, it sends an alarm to the concerned hospitals and further treatment can be given immediately. Thus this project eliminates the transportation of the heart patients during the Golden Hour. It also neglects the fear of the patient and gives Confidents when they are alone. This project "DESIGN OF ELECTROCARDIOGRAM (ECG) SYSTEM ON FPGA" will definitely help the patients

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having the cardiovascular diseases in monitoring their heart condition.

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