

ECG Signal Processing and Detection using FIR Filtering

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Abstract— The main focus of this paper is to design an advanced Electrocardiogram (ECG) signal monitoring and analysis design. Heart is an important part of the human body. Heart diseases are the important factor which cause of death in the world. An electrocardiogram is a device which graphically records the electrical activity of the heart. It is used to identify normal and abnormal heartbeats. Noise filtering is the next step of the QRS detection. In filtering of signal, we have used one band stop filter and a low pass filter. These filters are used to remove 60 Hz power line and 0.5 Hz baseline wander noises. QRS detection is the final step of the ECG processing. A new method is used to detect the QRS wave which includes the heart rate calculation and R-R time interval. Several analyses performed for the detection of ECG signal verify that Co-simulation is a suitable method to check the HDL module for real time systems.

Key words: QRS detection, HDL module, Electrocardiogram (ECG) signal

I. INTRODUCTION

An electrocardiogram is a device which graphically records the electrical activity of the heart. It is used to identify normal and abnormal heartbeats. In the early 1900s, the EKG (in German elektrokardiogramma) has become an important medical diagnostic device.

The development of the EKG began with the discovery of the electronic potential of living tissue. This electromotive effect was first investigated by Aloysio Luigi in 1787. Through his experiments, he demonstrated that living tissues, particularly muscles, are capable of generating electricity. Afterwards, other scientists studied this effect in electronic potential. The variation of the electronic potential of the beating heart was observed as early as 1856, but it was not until Willem Einthoven invented the string galvanometer that a practical, functioning EKG machine could be made.

Electrocardiogram ECG signal has been widely used for heart diagnoses. In this paper, we presents the design of Heart Arrhythmias Detector using Verilog HDL based on been mapped on small commercially available FPGAs Field Programmable Gate Arrays. Majority of the deaths occurs before emergency services can step in to intervene. In this research work, we have implemented QRS detection device developed by Ahlstrom and Tompkins in Verilog HDL. The generated source has been simulated for validation and tested on software Verilog. We have collected data from MIT-BIH Arrhythmia Database for test of proposed digital system and this data have given MIT-BIH data as an input of our proposed device using test bench software. We have compared our device output with MATLAB output and calculating the error percentage and got desire research key point of RR interval between the peaks of QRS signal.

The proposed system also investigated with different database of MIT-BIH for detect different heart Arrhythmias and proposed device give output exactly same according to our QRS detection algorithm. The spikes and dips in the line tracings are called waves. See a picture of the ECG **and** we had considered all possible cases such as far end signal, near end signal. It is one of the key tests performed when a heart attack (myocardial infarction or MI) is suspected; the ECG can identify whether the heart muscle has been damaged in specific areas, though not all areas of the heart are covered. The ECG cannot reliably measure the pumping ability of the heart, for which ultrasound-based (echocardiography) or nuclear medicine tests are used. It is possible for a human or other animal to be in cardiac arrest, but still have a normal ECG signal (a condition known as pulse less electrical activity).

A normal ECG consists of a P wave, a QRS complex, and a T wave. The P wave is caused by electric currents produced by the depolarization of the atria before their contraction, while the QRS complex is caused by electric currents produced by the depolarization of the ventricles prior to their contraction, during the extending of the depolarization in the ventricular myocardium. The baseline of the electrocardiogram is measured as the portion of the tracing following the T wave and preceding the next P wave and the segment between the P wave and the following QRS complex. In a normal healthy heart, the baseline is equivalent to the isoelectric line (0mV) and represents the periods in the cardiac cycle when there are no currents flowing towards either the positive or negative ends of the ECG leads.

II. LITERATURE REVIEW

A Real-Time QRS Detection Algorithm, a real-time algorithm for detection of the QRS complexes of ECG signals, Jiapu Pan and Wills J. Tompkins described QRS complexes based upon digital analyses of slope, amplitude, and width. A special digital band pass filter reduces false detections caused by the various types of interference present in ECG signals. The noises present in the ECG signal and which factor interfere the ECG signal and also describe the effect of the signal. The MIT-BIH Arrhythmia Database on CD-ROM and software for use with it, reviewed the technology of real-time automated ECG arrhythmia analysis, including principles of algorithm design, and the use of standard ECG databases in development and evaluation.

Gary D. Clifford, Francisco Azuaje, Patrick E. McSharry Advanced Methods and Tools for EC Data Analysis, R.G. Mark, P.S. Schluter. An annotated ECG database for evaluating arrhythmia detectors, D.B. Geselowitz, and G.C. Oliver Development, distribution, and use of the American Heart Association database for ventricular arrhythmia detector evaluation, and described the

arrhythmia database used for the ECG signal Processing and Detection.

60-Hz interference in electrocardiography, described the major problems encountered in recording ECG's is the appearance of unwanted 60-Hz interference in the output, examined the many possible sources of interference, and for each provide a description, an identifying test, and a remedy. This paper described noise purification, sample design for digital ECG, Understanding of The HP ECG Criteria Program, Extended Measurements Report and synthesized the advantages of Math, Multiple Function Analysis, Database and Knowledge Base, and Expert System to explore the mechanism of ECG Feature Elements Identification For Cardiologist Expert Diagnosis.

ECG Signal Processing and heart rate frequency Detection Methods described utilization of digital signal filtering on electrocardiogram (ECG) and designed filters are focused on removing supply network 50 Hz frequency and breathing muscle artefacts.

III. METHODOLOGY

ECG is the important part of the Biomedical Engineering. The important factors which interfere the signals are either noises from human body or noises from the instruments used for the ECG data recording. Filtering of these signals is very important factor, and only after that processing is done. Signals are taken from the heart then these signals pass from the filters and after that QRS complex detection algorithm is used for the detection purpose.

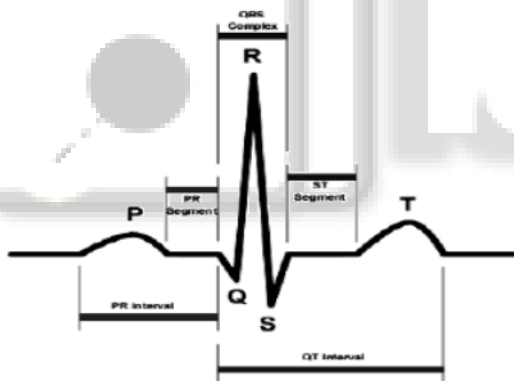


Fig. 1: ECG Signal

The database contains ECG data from patients and recorded from the different electrodes, and is used to evaluate the performance of the filter and detection. The digitization rate (360 samples per second per channel) was chosen to accommodate the use of simple digital notch filters to remove 60 Hz (mains frequency) interference.

The ECG leads varied among subjects means person to person as expected in clinical practice, since surgical dressings and variations in anatomy do not permit use of the same electrode placement in all cases. In most records, one channel is a modified limb lead II (MLII), obtained by placing the electrodes on the chest as is standard practice for ambulatory ECG recording, and the other channel is usually V1 (sometimes V2, V4, or V5, depending on the subject).

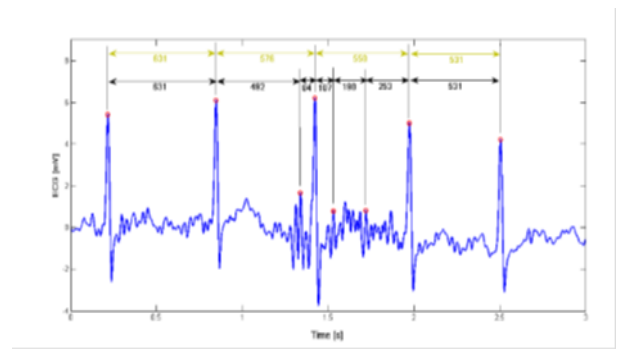


Fig. 2: ECG Wave

IV. RESULTS

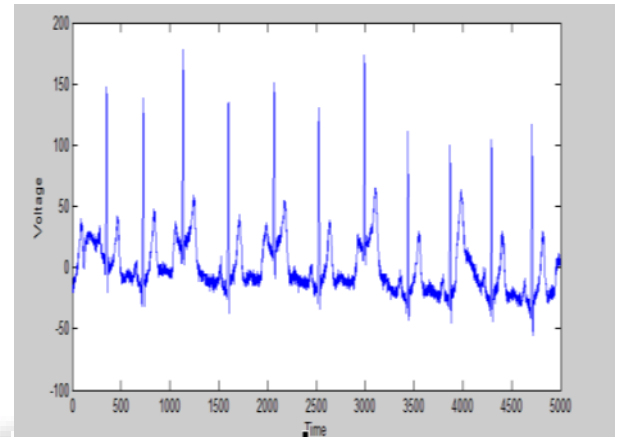


Fig. 1: Input Signal

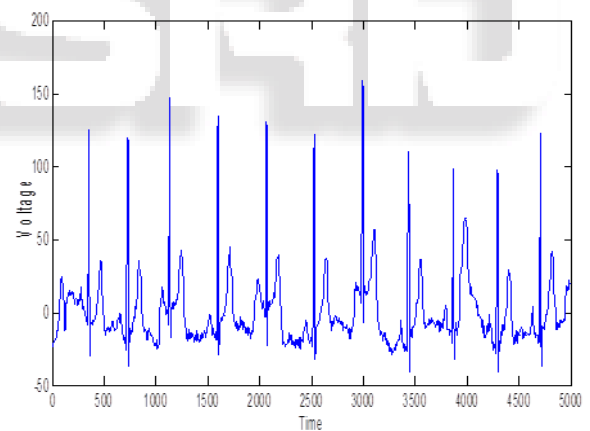


Fig. 2: Filtered Signal after BSF (Band Stop filtering)

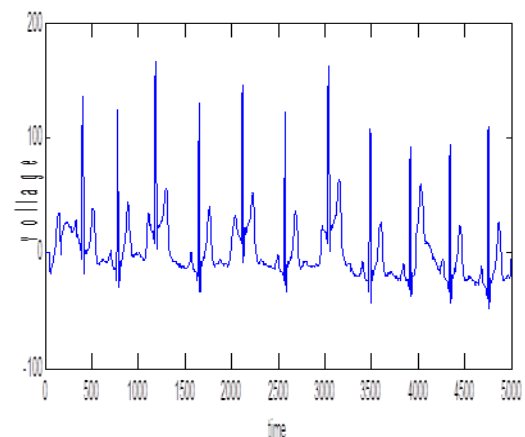


Fig. 3: Filtered Signal after Low pass Filtering

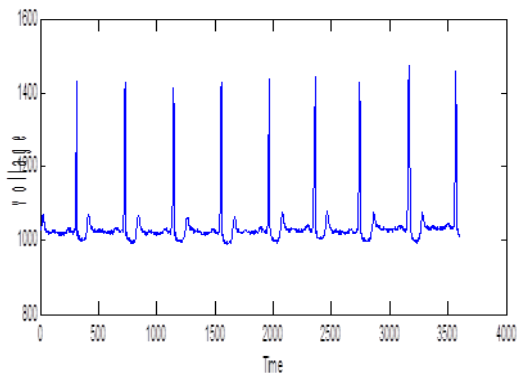


Fig. 4: Raw input signal

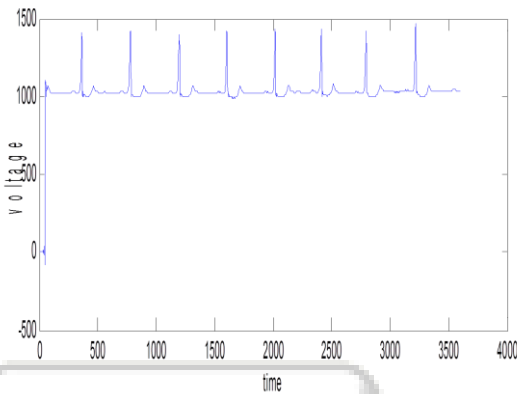


Fig 5: Filtered Signals

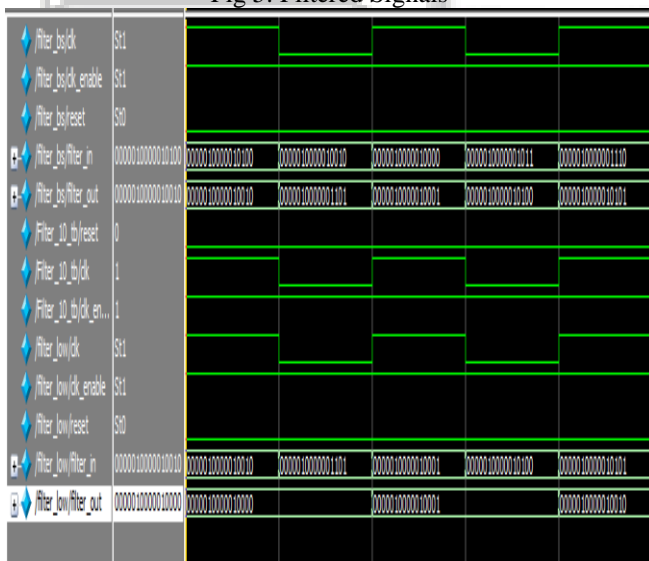


Fig. 6: Simulation Result of Filtered signal

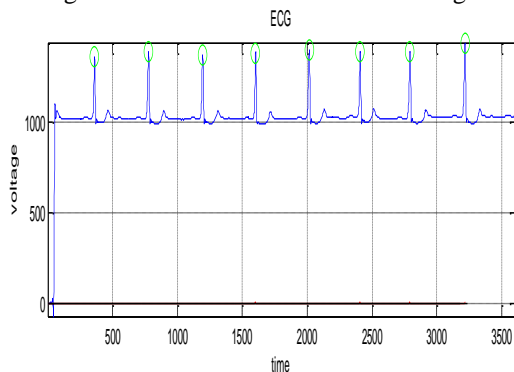


Fig. 7: Final ECG signal with R peak localization

V. CONCLUSION

Noises are the important factor which affects the ECG signal. Power line noise, baseline wander noise and Muscle contractions are the basic noises which interfere with the ECG signal. According to the literature survey, various filtering techniques are used to remove the noises. Out of these techniques, window method is efficient way to remove the noises. Noise removal is the basic building block of the QRS complex detection. QRS complex detection is done in three steps Noise detection, Noise removal and QRS complex detection. MIT / BIH arrhythmias database has been used for the performance analysis.

QRS detection is the last step of the ECG processing. A new method is used to detect the QRS wave which includes the heart rate calculation and R-R time interval with maxima and minima values. Several analyses performed for the detection of ECG signal verify that Co-simulation is a suitable method to check the HDL module for real time systems.

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