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FPGA BASED ELECTROCARDIOGRAM (ECG) SIGNAL ANALYSIS USING LINEAR PHASE FINITE IMPULSE RESPONSE FILTER

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Abstract - *This paper presents a design for analyzing the electrocardiogram(ECG) signal .This method employs usage of linear phase finite impulse response filter to find out the type of diseases occurred from the given input ECG signal .In the previous method it cancels the baseline wander noise and to find whether the given input signal is abnormal or not . The remaining circuits employed are DWT (Discrete wavelet transform) and classifier. The proposed system also employs the same and support vector machine. The DWT was utilized as a feature extracted to extract the reduced feature set from the input ECG signal. The back propagation neutral network classifier to classify the given input ECG signal. A system simulation will also be done. The output from the classifier is given to the SVM to detect the type of heart disease. This system is implemented on Xilinx using MATLAB on FPGA (field programming gate array) kit.*

1. INTRODUCTION

Now a day's heart disease and stroke are the leading cause of death around the world. Yet most heart disorders could be prevented if some sort of pre-monitoring and pre-diagnosing can be provided. In early detection of abnormalities in the function of the heart can be valuable for clinicians. Studying the electrocardiogram (ECG) signal provides an insight to understand life-threatening cardiac conditions. Heart diseases are one of the major causes of human deaths all over the world. Therefore, to understand the physiological and functional status of heart, an efficient tools and methods for effective diagnosis of the cardiac disease is required. Electrocardiography (ECG) is a type of tool on which it records the all heart electric activity. This typically is centered on the study of arrhythmia database, which can be any disturbance in the conduction of the cardiac electric impulse. Not every arrhythmia is abnormal or dangerous but some do require immediate therapy to prevent further problems. The ECG information can be recorded using a portable Holter monitor. A Holter monitor currently employs a few electrodes and stores the recorded ECG heart rhythm as they go about their daily activities over a 24–48 h period. The Holter monitor is then returned to a doctor who examines the recordings and determines a diagnosis. Analyzing these recordings is a more time consumption and hence any automated processing of the ECG that assists the cardiologist in determining a diagnosis would be of assistance.

The usual problem of automating ECG analysis occurs from the non-linearity in ECG signals and the large variation in ECG morphologies of different patients. And in many cases, ECG signals are combined by background noises, such as electrode motion artifact and Electromyogram induced noise, which also add more and more difficulty of automatic ECG pattern recognition. So many researches depend on digital signal processing (DSP) techniques as a methodology to design automated ECG signal analysis systems. Most Digital systems use typical main stages for screening ECG signals; those main stages include denoising stages, feature extraction stages, and classification stages and support vector machine. This shows the problem of analyzing of electrocardiography (ECG) signals. A new system for analyzing ECG is presented. It uses least-square linear phase FIR filter (LLFE) methodology. Least-square linear phase FIR filter (LLFE) employs least-square FIR filtering as a method to cut low frequency noise which is embedded in the ECG signals.

2. OBJECTIVE

The main objective of this project: To analyse the ECG signal. To identify the disease occurred in the PQRS wave. To reduce the procedure during treatment. To save the patient before critical stage. To reduce the time consumption during analyses.

3. EXISTING METHOD

This model provides the framework of breakdown of the ECG signal. This method says whether incoming ECG is normal or abnormal signal. Further in this method the disease cannot be detected. The following figure 1 shows the existing diagram.

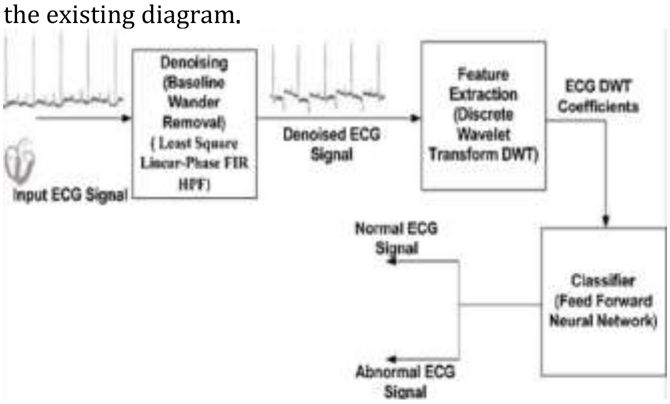


Fig -1: Existing Block Diagram

4. PROPOSED METHOD

In the proposed method we designed to overcome the disadvantage of the existing method. In this we have enhanced to detect certain diseases. To find the disease we have added Support Vector Machine to specify the diseases.

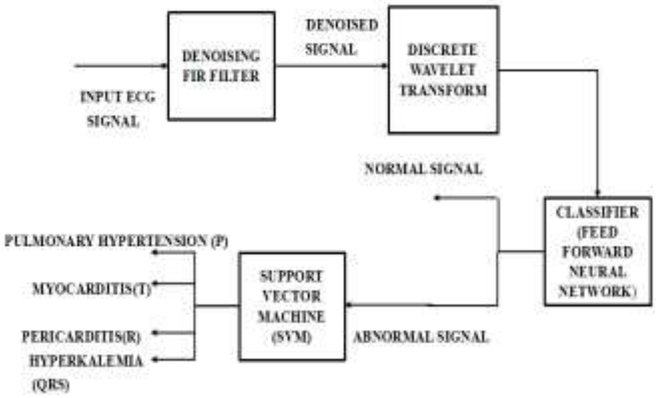


Fig -2: Propose Block Diagram

5. DESIGN OF COMPONENTS

5.1 INPUT SIGNALS

The input signal is extracted from the Arrhythmia database. The records are digitized at 360 samples per second. ECG signal is contaminated with various noises such as electrode motion and Electromyogram induced noises. Due to the presence of noises it is difficult to recognize the pattern.

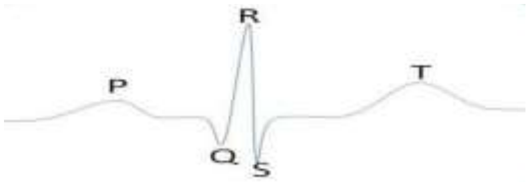


Fig-3: Normal ECG Signal

5.2 FINITE IMPULSE RESPONSE FILTER

This ECG signals has two main types of noise: Low frequency noise represented in baseline wander noise; High frequency noise such as power-line interference noise and muscle contraction. The high frequency noise is removed by discarding the first detail component resulting from wavelet transform decomposition in the feature extraction. The low frequency noise is represented by baseline wandering noise.

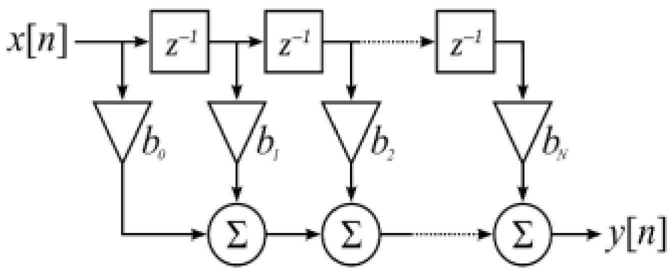


Fig -4: FIR Filter

5.3 DISCRETE WAVELET TRANSFORM

The feature extraction is done by wavelet transform decomposition. The input signal is filtered by the low-pass and the high-pass filters. The outputs from the low pass are called the approximation coefficients and it's represented by a3 in the fig, while the outputs from the high-pass are called the detail coefficients represented by d1, d2, d3. The LP output is further filtered until enough decomposition are reached. The continuous ECG signals are transformed into individual ECG beats.

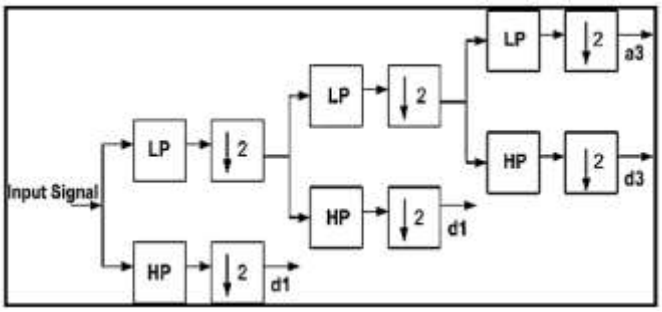


Fig-5: Wavelet transform filter structure

5.4 CLASSIFIER

It is based on feed forward back-propagation neural network. It is first and simple artificial neural network. It is unidirectional forward network. The signal passes from input nodes through the hidden nodes and reaches output node. There is no loop or cycle.

5.5. SUPPORT VECTOR MACHINE

A Support-Vector Machine is an excellent machine learning algorithm that examine data used for classification and regression analysis. SVM's store the predefined values of P, Q, R and S signal values in the database. The signals are given in 4:1 MUX provide output based on the value stored in the predefined database. The following figure shows the support vector machine structure.

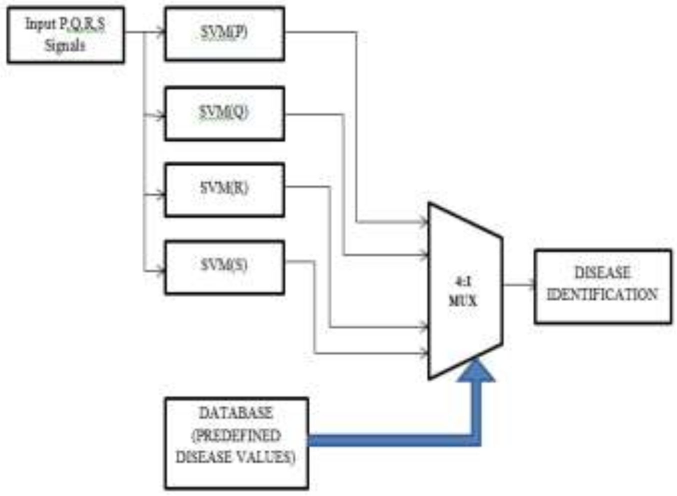


Fig-6: Support Vector Machine Block

6. REQUIREMENTS

6.1 SOFTWARE

6.1.1 Xilinx System Generator

Xilinx System Generator is an FPGA programming tool provided by Xilinx. It is specifically focused on Xilinx FPGAs, enabling the developers to work in Simulink environment and to generate parameterized cores particularly optimized for Xilinx FPGAs. The tool comes built in with Xilinx ISE Design Suite (System Edition) and Xilinx Viv ado HL (System Edition). By default, the Xilinx Block set contains over 90 DSP blocks, ranging from simple adders, multipliers etc.

6.1.2 MATLAB

MATLAB is a multi-paradigm numerical computing environment and proprietary programming language developed by Math Works. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages

6.2 HARDWARE

6.2.1 FPGA Spartan 6

Prompted by the development of new types of sophisticated field-programmable devices (FPDs), the process of designing digital hardware has changed dramatically over the past few years. Unlike previous generations of technology, in which board-level designs included large numbers of SSI chips containing basic gates, virtually every digital design produced today consists mostly of high-density devices.

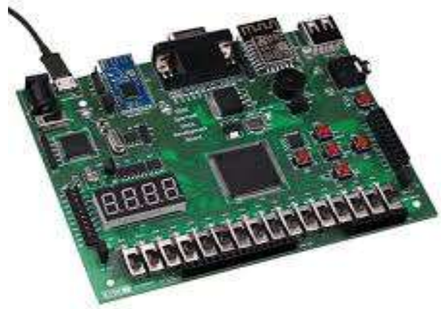
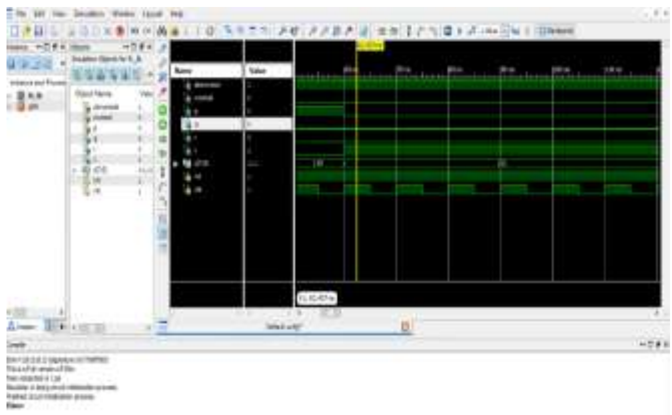


Fig-7: FGPA Spartan 6

7. OUTPUT



8. CONCLUSION

The FIR developed in this paper for ECG signals de-noising and DWT has demonstrated an ability to outperform the linear predictor-based one, which is recognized as one of the best techniques for ECG signals. The results are more reliable and less prone to large deviations from average values. As compared to the previous methods this seems to be more accurate and easy to detect the abnormalities in the ECG signal.

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