DESIGN & IMPLEMENTATION OF DENOISING OF ECG SYSTEM FOR MEDICAL APPLICATIONS

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Abstract— As we know current era is totally based on innovative technology. Medical science is one of the important need for every human being. As we know ECG signal processing has become a effective tool for research and medical practices. A typical computer based ECG analysis system includes a signal pre-processing, beats detection and feature extraction stages, followed by classification. Automatic identification of arrhythmias from the ECG is one important biomedical application of pattern recognition. As we also know in current era heart is diagnosed is done with the help of ECG. Here ECG signal is recording form of electrical activities which is generated by human heart. Now some time due to some electrical issue may be there is chances of generation of some wrong information of ECG signal which is really too much dangerous for the petatint. So there is need of some effective filtring applications which will filter the output of ECG signal and generate the real ECG signal which will help for human health diagnosigation. So in this thesis we present the comparative study between all exsistng filter and also we propose an effective technique which will maintain level between quality and hardware complexity. Here we will design algorithm level and architecture level where implementation at algorithm is done by using MATLAB tool and architecture leval analysis is done on Xilinx 14.2 using the HDL language of Verilog.

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***Keywords*— ECG, pattern recognition, Heart, diagnosigation.**

1) INTRODUCTION

Physical condition of the heart is diagnosed with the help of ECG. Where ECG is the recording of the electrical activities of the heart generated by heart muscles on body surface. Health of heart is diagnosed in terms of HRV (Heart Rate Variability). It is defined as the variation in the R-R wave where R wave represents the peak of the QRS complex. Till this time numerous software approaches have been adopted for R wave detection. Various algorithms have been suggested by the researchers for detection of the QRS complex based on the noise present in ECG signal. As software processing of the ECG is not very fast so to get rid of this problem we are moving towards the fast hardware processing of the ECG signal.

As original ECG signal contains various type of noise (electrode contact noise, power line interface noise, muscle contraction noise) which can lead to falls detection of the QRS complex which is not desired, so it is very essential to filter the noise (a collective term for fluctuations or disturbances which are not part of wanted signal or Which interfere with its intelligibility or usefulness, such as muscle activity) from the ECG signal. This filtering permits the use of the low threshold thereby increases the detection sensitivity. Digital band pass filter is used to filter out the interference present in the ECG signal. Thus the Digital filters reduce the noise source and improve the signal to noise ratio. Here we designed the fast FIR low pass filter for Electromyogram, here after referred as EMG (Electrical activity due to muscle contractions lasting around 50ms between DC and 10000Hz with an average amplitude of 10% of the Full Scale Deflection (FSD) on the ECG) removal from ECG signal so that signal to noise ratio could be increased and to process data fast.

FIR digital filter works on a digital input (Quantized Analog Signal) and produces a digital output. Designing an FIR filter involves arriving at the filter coefficients, which represents the impulse response of filter. These coefficients, when linearly convoluted with the input signal results in the desired output. We designed Branched Tree Adder (BTA) connection

WAVELET TRANSFORM

Wavelet is a small wave-like oscillation. It has an amplitude that begins at zero, increases and then decreases back to zero. Using wavelet as a mathematical tool, it can be used to extract information from many different kinds of data. Today, wavelet transform becoming very popular and has been widely used in signal and image processing due to its time-frequency localization characteristic. The wavelet transform is totally based on a set of analysis wavelets allowing the decomposition of ECG signal in a set of coefficients. Each wavelet has its own time location, time duration and frequency band.Wavelet transform results wavelet coefficients which corresponds to a measurement of the ECG components in the time requirements and frequency band.[12]

By applying the wavelet transform, ECG signals were decomposed to the approximate (low frequency component) and detailed (high frequency component) information.[12]

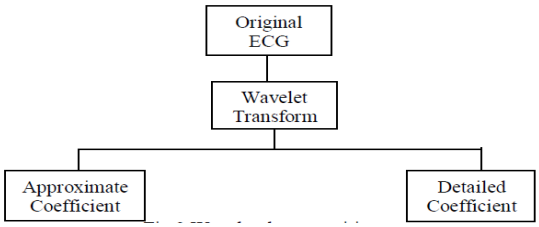


Fig.1.Wavelet decomposition

HAAR WAVELET

Discussion of wavelets begins with Haar wavelet, the first and simplest. Haar wavelet is discontinuous, and resembles a step function. It represents the same wavelet as Daubechies db1. The first DWT was invented by the Hungarian mathematician Alfred Haar. For an input represented by a list of numbers, Haar wavelet transform may be considered to simply pair up the input values, storing the difference and passing the sum. This process is repeated recursively, pairing up the sums to provide the next scale, finally resulting in differences and one final sum. Simplest form of compression is Haar wavelet transform, which involves averaging and differencing terms, storing detail coefficients, eliminating data, and reconstructing the matrix such that the resulting matrix is similar to the initial matrix.

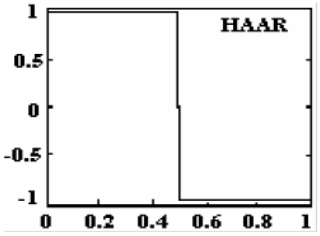


Fig .2. Haar Wavelet

DAUBECHIES WAVELETS

Daubechies, one of the brightest stars in the world of wavelet research, invented what are called compactly supported orthonormal wavelet. Names of Daubechies family wavelets are written as dbN , where N is the order, and db **is** the "surname" of the wavelet. The first order daubechies wavelet i.e.db1 is the same as Haar wavelet. Here is the wavelet functions psi of the next nine members of the family.

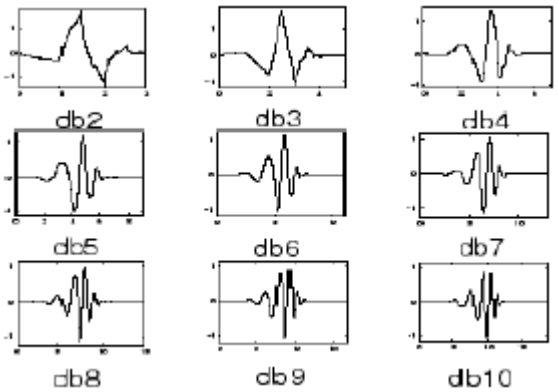


Fig .3. Waveforms of various versions of Daubechies Wavelet

LOW PASS FILTER

Generally a digital filter system consists of an analog to digital converter (for input signal sampling), microprocessor (specialized digital signal processor for signal processing), and for converting digital signal back to analog, a digital-to-analog converter.

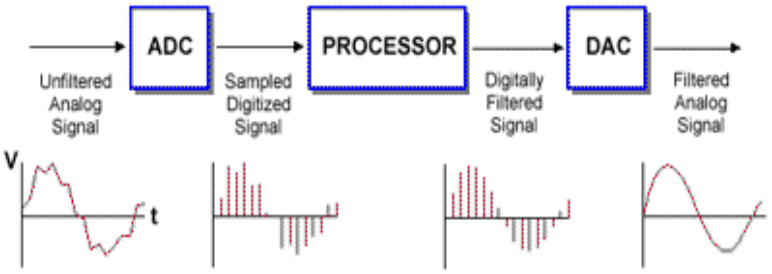


Fig.4. Operation Of Digital FIR Filter.

GAUSSIAN FILTERING

Gaussian filtering is a filter which is used to blur images and remove detail and noise. It is similar to the mean filter. It uses a kernel different from Gaussian filter .In one dimension, the Gaussian function is:

$$\frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}}$$

Where, σ is the standard deviation of the distribution The distribution is assumed to have a mean of 0.

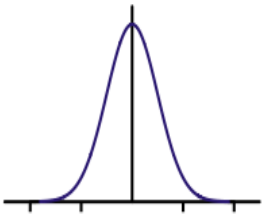


Fig1.5.Shape of the impulse response of a typical Gaussian filter

The Gaussian function is used in various research areas:
1. It defines a probability distribution for noise or data.
2. It is a smoothing operator.
3. It is used in mathematics.

METHODOLOGY

In this section we present the methodology . As we already know there is need of fast system with good quality maintain system. In this work basically we did the comparative analysis between different kind of existing design for ECG noise removal application. Here we also present a new ecg filter architecture by the use kf error truncation logic in terms of architecture level. In this section we represent the methodology of this thesis; here we present the logic behind the denoising of ECG signal using different types of existing filters. Here we are using some very well know existing filters those are:

1. **FIR Filter**
2. **Gaussian Filter**
3. **Discrete Wavelate Transformation**
    a. **Db2**
    b. **Db4**
    c. **Db8**
    d. **Harr**

According to previous research work generally researchers are use DWT db2, db4 but in this work we will use Db8. Now according to our approach at initial stage we will load an ECG file which have two dimension, so we will take first dimension because it have all information about the signal. Now we will pass that particular signal with one 200Hz with amplitude of 20 which is a noise signals. So, after this stage it will generate noisy ECG signal now we will apply our existing different types of filter which will generate filtrate output. Now for the quality measurement we are use PSNR, where we will get comparative result between all previous approach, according to our approach we use Db8 which will give very good result as compare to previous existing technique.

Proposed Block Diagram for DWT Based Reverse biorthogonal Filter:

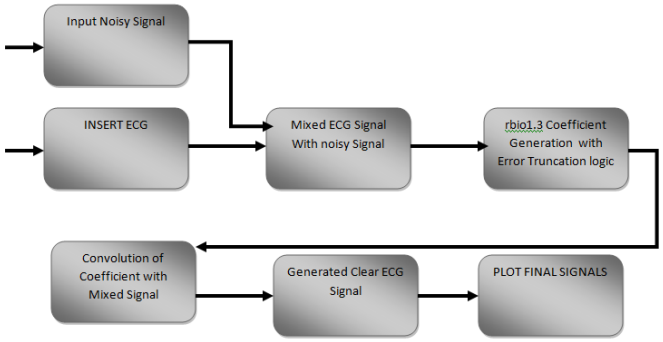


Fig 6. Output Waveform of Proposed DWT

As we can see in this block diagram here we will provide an input of ECG signal which is taking from one medical data base. Now here we create an noisy ECG signal with the help of another kind of signal which is generated an noise now we will combine noisy signal with input ECG signal so at output it will generate the noisy ECG signal. Now after that we will apply error truncation logic based rbio1.3 coefficient we applied . Through this approach basically we change the existing coefficient value because we want to convert our architecture in terms of fixed point.. We perform convolution operation with the noisy ECG signal and rbio1.3 coefficient. At last it will generate the filterer ECG signal which will neglect the noisy part from that signal. At last we will plot the all signal and perform the PSNR analysis for checking the efficiency of this approach.

RESULTS & ANALYSIS:

In this paper basically we target the analysis of Noisy ECG signal and pass one that signal with different filtring approche like Gaussian , FIR, Wavelate DB2, Db4, and DB8. Here basically we take two different type of data base of standered ECG signal and we did snr analysis for those analysis we use Matlab tool. The following figure shows the waveform of various filters and analyzed to see the performances. After generating .m file in MATLAB, the generated file is run matalb and found the following results of input.

1.Output Waveform of DWT-db2.

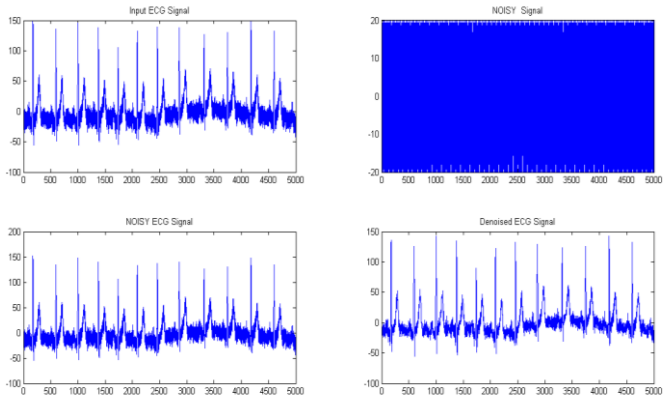
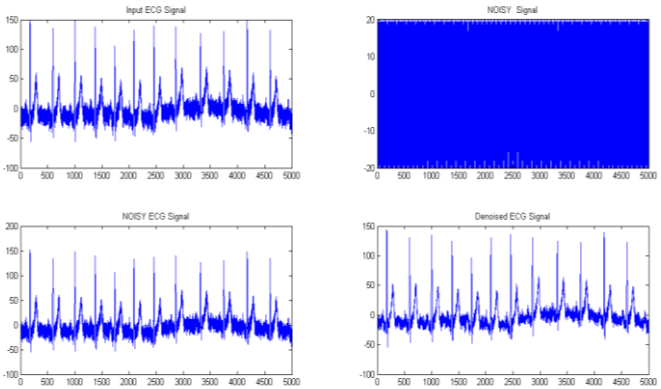


Fig 7. Output Waveform of DWT-db2

2. Output Waveform of DWT-db4.



2) Fig 8. Output Waveform of DWT-db4

3. Output Waveform of DWT HARR wavelet.

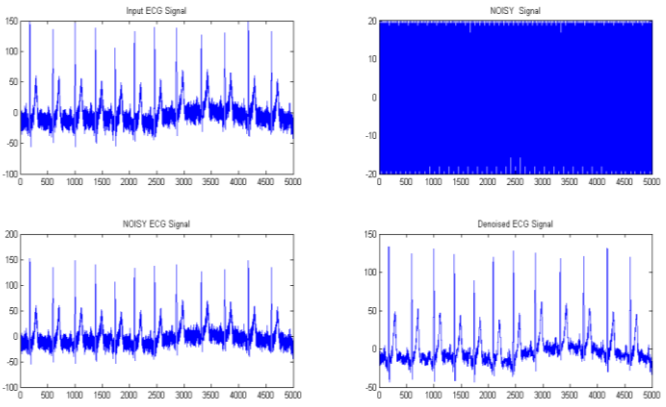


Fig 9. Output Waveform of DWT HAAR wavelet

4. Output Waveform of GAUSSIAN filter.

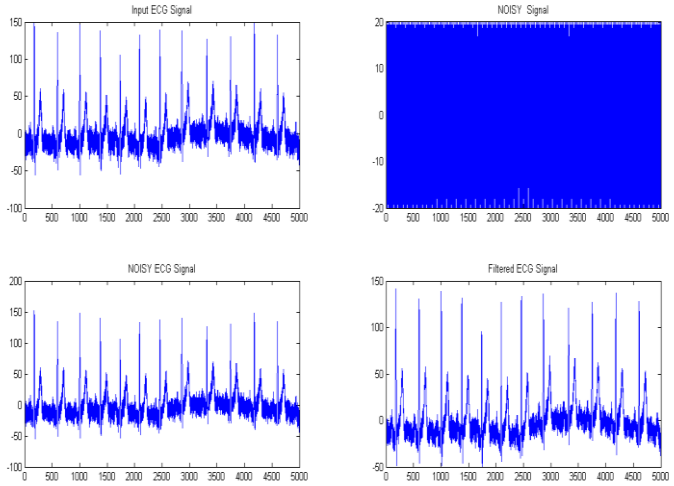


Fig 10. Output Waveform of GAUSSIAN filter

5. Output Waveform of FIR filter.

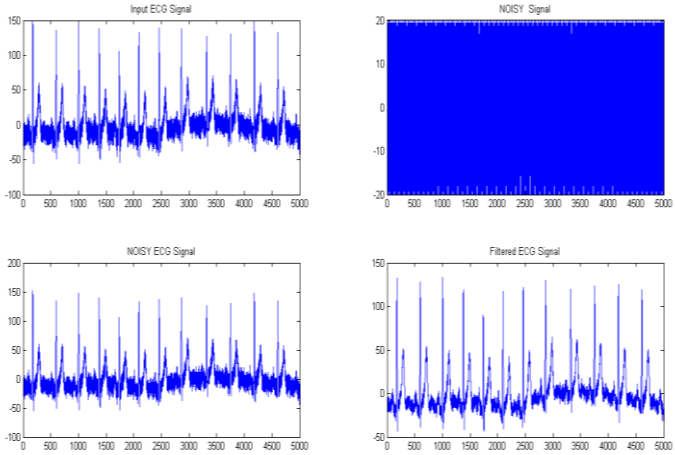


Fig 11. Output Waveform of FIR filter

6. Output Waveform of Proposed

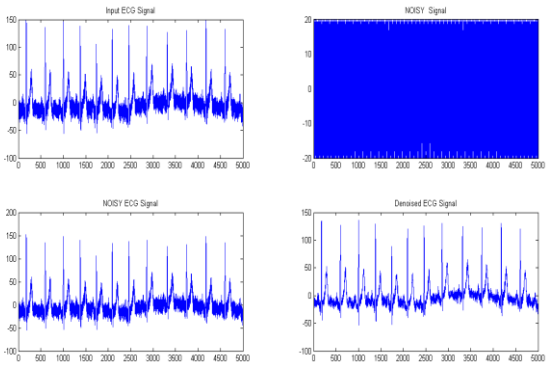
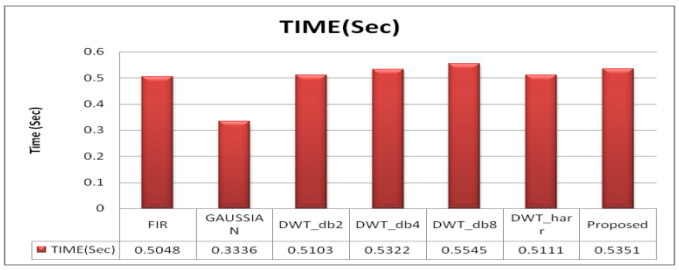


Fig 12.Output Waveform of Proposed DWT

RESULT IN THE FORM OF BAR GRAPH

Time Complexity:



PSNR:

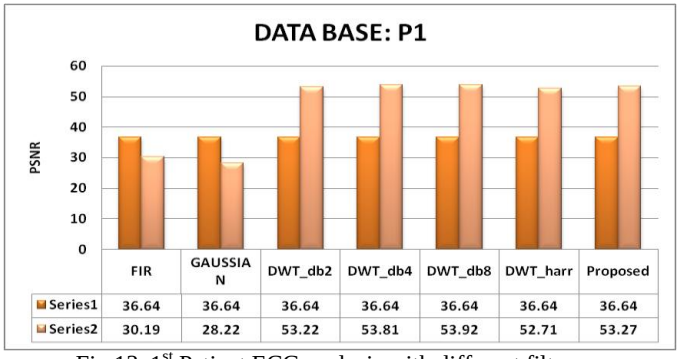


Fig 13. 1st Patient ECG analysis with different filters

2.

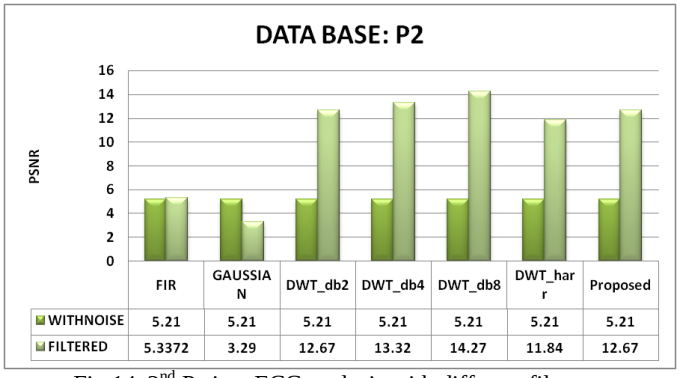


Fig 14. 2nd Patient ECG analysis with different filters

After analyzing these bar graph, waveform we can easily conclude that proposed gives best result for the removal of noise according to PSNR at 200 Hz signal sinusoidal.

HARDWARE LEVEL ANALYSIS: In this section we present the hardware result for our design approach. Here basically we design three types of filters which are:

1. FIR Filter
2. Gaussian Filter
3. Discrete Wavelet Transformation
4. Proposed DWT

Here We are using Vitrex 6 (FPGA)which is 45nm technology based using this technology We design all filters and did the comparative power, area, speed analysis:

1. LOGIC BLOCKS:

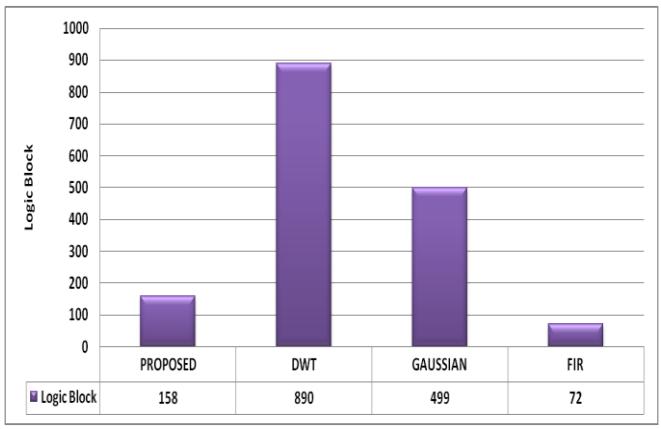


Fig 15.Logic blocks used in different filters

2. FRECQUENCY

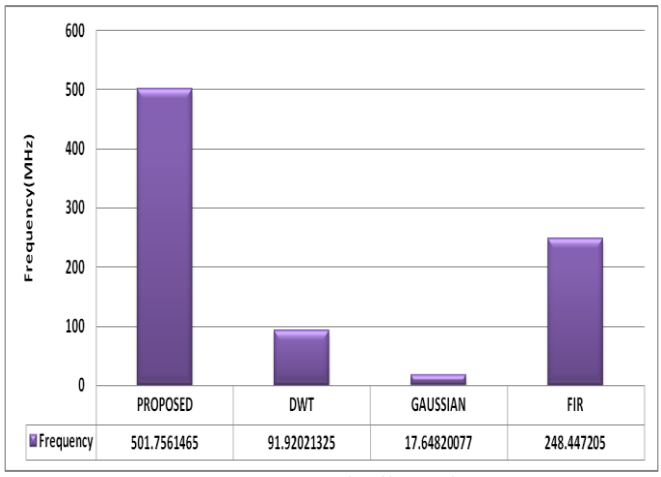


Fig 16.Frequency of different filters

3. Delay

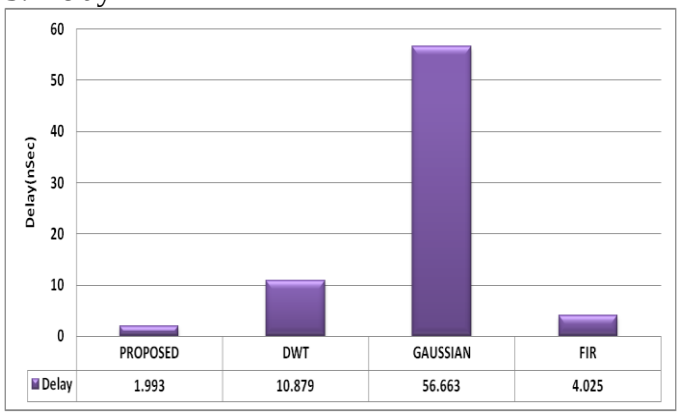


Fig 17.Delays of different filters

CONCLUSION

Elimination of noises from ECG signals is a challenging problem by virtue of the fact that it may cause serious problem in the visual inspection of the signal. Various filter Db-2, Db-4 FIR filter, Gaussian used for the removal of noises, but according to the analysis done Daubechies (Db-8) of Discrete wavelet transforms proves best. Excellent performance can be seen in the bar graph. For hardware point DWT is costly approach but if we are talking about medical application so there is need of more accurate result which is only generated by DWT approach. Here we proposed a new technique which follows error trucntaion logic according to this approach we are good in quality level and we also reduce hardware approximate 200% as compare to pervious approach.

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