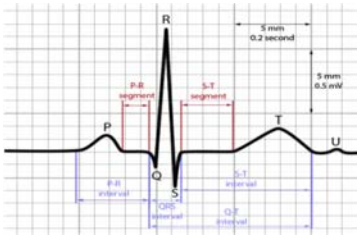
ECG SIGNAL NOISE REDUCTION USING FPGA

Dipeeka Kalamkar[1], Prof. S.S. Patil[2]
ENTC Department, SIT Lonavala, Pune, Maharashtra, India

Abstract
Electrocardiogram (ECG) flag is utilized as a part of medicinal and social insurance field to check the heart beat rate of patient to analyze different sorts of sicknesses. This work expects to execute choice that fulfills the prerequisite about framework adaptability, versatility, speed upgrade and lower equipment cost. Already some work is done utilizing MATLAB device yet this work proposes ECG flag sifting utilizing VHDL. It is seen to have created better sifting outcomes with change in the style of middle channel. Memory prerequisite is additionally diminished by lessening channel window measure. Additionally, middle channel is exceptionally productive in evacuating motivations.
Keywords: ECG, QRS, VHDL, Median filter, Savitzky-Golay filter, Averaging filter.

I. INTRODUCTION

Electrocardiography (ECG/EKG) is a restorative symptomatic test which catches the heart's working as electrical flag, helping in understanding the cadenced way of heart pulsates and any abnormalities related with it. The electric flag portrayal of heart's exercises is called an "Electrocardiogram". The heart muscles contract and extend making electrical signs which are gotten by means of the sino-artrial hub. These electrical driving forces are identified by an ECG screen. It is non-shifty and exceptionally basic methods a man experiences while experiencing any difficulty with trunk torment, breathing and so on. Electrical signs are activated because of heart muscle depolarization which happens amid each pulse. Every heart muscle cell has a negative charge around it, which is along its layer when the heart is very still. Depolarization is the way toward diminishing this negative accuse to zero of the assistance of inscriptions like Na+ and Ca++.



•The P wave speaks to the atrial constrictions.

•QRS complex speaks to the ventricular constrictions. The R crest demonstrates a pulse.

•The T wave is the last normal wave in an ECG. This electrical flag is delivered when the ventricles are depolarizing.

•The letters utilized as a part of the ECG flag depiction don't have shortenings in medicinal.

II. LITERATURE SURVEY

This work proposes technique which is not based on frequency band. It uses the technique of spike removal which is also used in Audio Signal Processing. The largest change/spike in ECG signal is QRS. The median filter window is set in a such way that QRS complex will be completely removed. Ogireddy, VSS Reddy and Dr. I Santi Prabhadescribed - Noise Suppression from ECG signal using LMS and RLS technique. In this paper, FPGA based filtering algorithms are applied to remove noise from ECG signal.

III. RELATED WORK

A) Existing Method:

Generally, creating ECG signals from catching heart thumps include utilizing prompts identify heart rate.

The terminal sensors are put on over the trunk, which records heart's movement spoken to as the standard 12-lead electrocardiogram. The

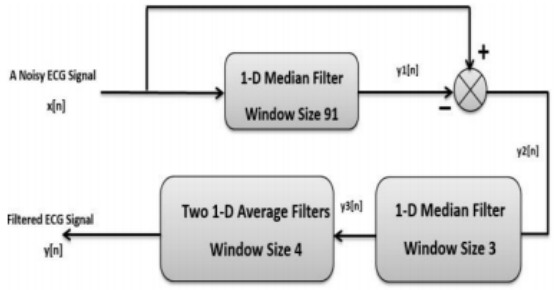
electrical flags then get passed on to an information lumberjack framework which then plays out all the fundamental flag preparing. Yield of this is shown on screen as ECG waveform. This technique is broadly utilized as a part of doctor's facilities, symptomatic focuses and so on.

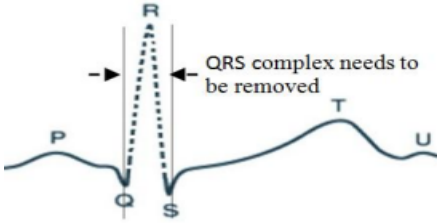
Beat Oximetry-Oximeters work by the standards of spectrophotometry: the relative ingestion of red (consumed by deoxygenated blood) and infrared (consumed by oxygenated blood) light of the systolic segment of the retention waveform connects to blood vessel blood oxygen immersions. Estimations of relative light retention are made various circumstances consistently and these are prepared by the machine to give another perusing each 0.5-1 second that midpoints out the readings throughout the most recent three seconds.
Two light-discharging diodes, red and infrared, are situated with the goal that they are inverse their individual locators through 5-10 mm of tissue. Tests are typically situated on the fingertip, in spite of the fact that ear cartilage and brow are once in a while utilized as options. Assimilation of radiation as a component of wavelength is figured. Assimilation of both the lights contrasts altogether for oxygenated and deoxygenated blood as it relies on upon the measure of oxygen present. In light of it, the gadget can decide a pulse or a heartbeat. In Smartphone applications, the camera is utilized to radiate light. Putting's at the tip of one's finger on the camera is same as setting it on a sensor of a heartbeat oximetry gadget. The application triggers the telephone to discharge light of specific wavelengths and afterward computes the heart rate.

B) Proposed System:
(i) Analysis of ECG signs gathered, which incorporate wide band and thin band clamor impedance to upgrade the separating impact.
(ii) FPGA base ECG flag sifting to enhance execution of ECG observing framework, and to add to the better judgment of the ECG's demonstrative exactness.
(iii) Using VHDL code and running it on a FPGA board executing these channels - Median Filter with various window sizes, SGolay Filter, Averaging computerized channel.

IV. DESIGN AND IMPLEMENTATION ON FPGA

This work has utilized info ECG motion from MATLAB. We can likewise utilize MIT database for test signals. This created signs are examined at 360 specimens/sec. As said before, this work utilizes the spike expulsion system utilized as a part of sound flag preparing. These spikes are evacuated utilizing middle channel. The window of middle channel is chosen according to the width of spike. The biggest spike in ECG flag is QRS complex. The width of middle channel is chosen by the width of QRS mind boggling and also width of P and T waves, with the goal that it will be expelled after first phase of middle channel.
First Stage Median Filter (Window Size 91)





The output of 1st stage median filter is calculated as below

- Design memory unit with size N.
- Store all previous input samples in memory unit.
- Arrange all memory elements in ascending or descending order.

$$y1[n] = median\{x[n], x[n-1], \ldots\ldots\ldots, x[n-N]\}$$

Where N is the width of median filter. Here N is 91.

Then mid value is assigned to output. If N is odd then

$$y1[n] = x\left[n - \frac{N-1}{2}\right]$$

If N is even then

$$y1[n] = \frac{1}{2}\left(x\left[n - \frac{N}{2}\right] + x\left[(n+1) - \frac{N}{2}\right]\right)$$

Fig. Shows the QRS complex need to be removed using median filter.

Above chart demonstrates consequence of middle channel, which demonstrates that it has expelled the part of QRS complex, P wave and T wave. It is only identification of standard of ECG flag. On the off chance that this is subtracted from unique flag, then benchmark pondering will be expelled.

Second Stage Median Filter (Window Size 3)

In this stage another middle channel is utilized to decrease the high recurrence commotion related with ECG flag. This work utilizes window estimate 3, which will diminish little spikes related flag whose width is 1 test. This can likewise decrease spikes of width more than 1 test and not as much as width of QRS complex by expanding size of second middle channel. The yield of 2rd phase middle channel is figured as takes after

- Design memory unit with size 3.
- Store all past info tests in memory unit.
- Arrange all memory components in rising or dropping request.

$$y3[n] = median\{y2[n], y2[n-1], y2[n-2]\}$$

At that point mid esteem is doled out to yield.

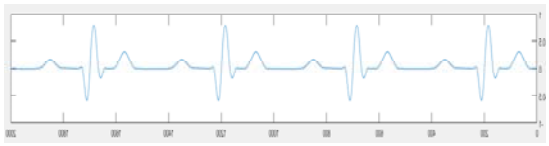
Third Stage Averaging Filters (Window Size 4)

This is a discretionary execution, however this work has added to smoothen the outcome. The window size of this channel can be changed according to our need. This is straightforward FIR channel. This work has utilized two averaging channels with window estimate 4. Henceforth the aggregate window size is 8. Be that as it may, it is watched if two 4 point averaging channels are utilized rather than direct 8 point single averaging channel, it gives better outcome. The yield of normal channel is as per the following.

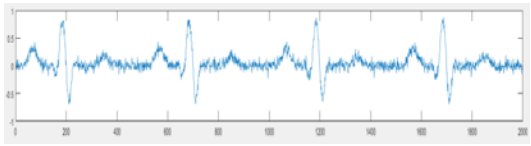
$$y[n] = \frac{1}{M}(y3[n], y3[n-1], y3[n-2], \ldots\ldots\ldots\ldots, y3[n-M])$$

Where M is width of averaging filter. Here M is 4.

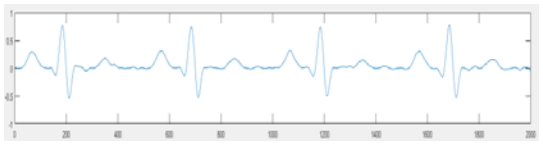
V. VALIDITION AND RESULT



Original ECG Signal



ECG Signal with 50 Hz Noise



ECG Signal filtered out with SGOLE Filter and MEDIAN filter

VI. RESULT & CONCLUSION

ECG single and commotion was produced utilizing MATLAB and this loud ECG flag separating was executed in VHDL with the FPGA board. We could expel commotion from ECG motion with the mix of Median, SGOLE, and averaging channel. The nature of commotion sifting relies on the mix of channels and window sizes. This can be further calibrated. With a great deal less expenses and framework memory prerequisites, we could accomplish coveted outcomes.

REFERENCES:

[1]. ECG Interpretation http://www.medicaltextbooksrevealed.com/files/11156-53.pdf

[2]]. Understanding ECGs http://usasam.amedd.army.mil/fmc/Study/UnderstandingECG.pdf

[3]. An ECG Primer http://www.skillstat.com/PDF/ssecgPrimer.pdf

[4]. ECG Processing – R Peak Detection http://www.librow.com/cases/case-2

[5]. ECG Signal Analysis: Enhancement and R-Peak Detection http://ethesis .nitrkl.ac.in/1932/1/B.Tech_Project_Report_ Swagatika _Priyadarshini%2810609017%29.pdf