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# Baseline Wandering Removal in ECG Signal Using Filters

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## ABSTRACT

The electrocardiogram (ECG) signals consists numerous kinds of noises; they are “electromyographic (EMG) noise, baseline wander (BW), electrode motion artefact, and power line interference”. The EMG noise will be high frequency noise of above 100Hz & might be eliminated by a LPF of “suitable cut-off frequency”. The BW will be low frequency noise of 0.5 to 0.6 Hz. To avoid it, HPF with “cut off frequency” 0.5 to 0.6 Hz might be utilized. The electrode motion artefacts might be suppresses through decreasing movements mad by subject. The power line interference might be eliminated by utilizing “notch filter of 50 or 60Hz cut-off frequency”. This scheme prominence on diverse kinds of basic noise sources in ECG signals &applies easy signal processing methods for eliminating them, alongside amplification of information to 1x,2x,3x,4x and amplifying it accurately without losing the clinical centrality.

**Key words:** ECG, Filters, Noise, frequency, baseline wander (BW), high pass filter (HPF), low pass filter (LPF)

## 1. INTRODUCTION

ECG will be a test, which measures electrical measure of heartbeat. With every beat, an electrical motivation goes through heart. This wave creates muscle to pump blood & squeeze from heart. The regular heartbeat on ECG will signify timing of lower & top chambers.

The upper chambers or left & right atria create primary wave known as “P wave” — following a level line whereas electrical impulse goes to base chambers. The ventricles or left & right bottom chambers create the subsequent wave known as “QRS complex”. The T wave or last wave signifies electrical recuperation or come back to a resting state for ventricles.

The ECG records, electrical activity produced through “heart muscle depolarizations” that propagate in “pulsating electrical waves” towards skin. In spite of fact that electricity amount will be in fact much little, it might be selected reliably with ECG cathodes joined to skin (in microvolts, or uV).

The full ECG arrangement involves at least 4 electrodes that are positioned on 4 extremities or chest as per standard terminology (LA = left arm, LL = left leg, RA = right arm, RL = right leg). Obviously, varieties of this arrangement present to permit low intrusive &much adaptable recordings. The ECG electrodes have regularly wet sensors, need utilization of conductive gel to enhance conductivity among electrodes &skin.

The essential target of this manuscript will be to eliminate BW in ECG signal utilizing the filter. The BW will be a low frequency noise module exist in EG signal. This is predominantly because of breath, and body development. The BW have frequency more than 1Hz. This low frequency noise, BW causes issue in recognition and investigation of peak. Figure 1 shows the BW in ECG Signal.

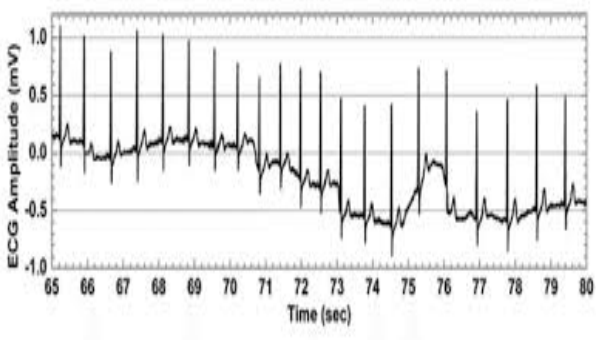


**Figure 1:** Baseline wandering in ECG signal

## 2. RELATED WORK

The processing of signal will be electrical engineering subfield, which concentrates on modifying, investigating, &incorporating signals like images, sound, & biological dimensions. The processing of signal methods might be utilized to enhance storage efficiency, transmission, & subjective quality to recognize modules in measured signal.

Rahul Kher [1] suggested that ECG signals consists numerous kinds of noises they are “electromyographic (EMG) noise, baseline wander, electrode motion artefact, and power line interference”. The EMG noise will be “high frequency noise” of above 100Hz & might be eliminated by a LPF of suitable “cut-off frequency”. The BW will be low frequency noise of 0.5 to 0.6 Hz. To avoid it, HPF with “cut off frequency” 0.5 to 0.6 Hz might be utilized. The electrode motion artefacts might be suppresses through decreasing movements made by subject. The power line interference might be eliminated by utilizing “notch filter of 50 or 60Hz

cut-off frequency". The section presents the kinds of normal noise sources in ECG signals & easy signal processing methods for expelling them.

Jinzhong Song, et.al, [2] is suggested a novel model based on "wavelet transform, QRS barycenter fitting, & regional model". Initially, wavelet transform as coarse correction is utilized to eliminate baseline wandering. Furthermore, QRS barycenter fitting was applied as complete revision. At last, the regional method in this manuscript is demonstrated to execute best than function fitting & filtering models in "baseline wandering rectification" after "long term ST database (LTST) verification". Moreover, the suggested strategy will be simple to complete, and in present use.

ZHAO Yan-na et.al.[3] suggested to evacuate 3 kinds of noise in ECG signal, they are "power line interference", baseline drift, & EMG interference. Techniques are "Decompose ECG signal" into 8 layers utilizing "Coif4 wavelet remove baseline drift utilizing wavelet construction method", and then evacuate EMG & powerline interference utilizing enhanced threshold model. They select few signals from "MIT-BIH Arrhythmia Database"; the outcomes demonstrate our technique might adequately eliminate the declared noise at similar time maintain R wave data.

The work [4] presents that 2 filters that are in digital are identified and build effectively in diminishing these 2 sorts of pollution of signal. Moreover, it introduced cut off frequency lower than rate of heart beat. Further, the minimal calculation overhead forms this execution of filter aimed at several executions of channel on minimum digital processor signal charge. Because of artefact muscle signal, generated by movement of muscle skeleton, takes some amount of space of spectrum as signal generated.

MaTinati, et.al, [5] presented the BW removal will be deliberated a classical issue. The comparison will be made &part of "wavelet binary tree" relating to much energy wavelet spaces will be selected. This method is verified utilizing the information record from MIT/BIH database and great outcomes have acquired. In this manuscript, we introduced a method dependent on WT for evacuating baseline drifts in ECG signals.

Xiang-kui Wan et.al, [6] introduced and approved a consolidated method of wavelet transform & mathematical morphology for limited (high SNR & low MSE). This offers the chance to concentrate very less complexes, & therefore, it will be appropriate for information preprocessing for exact ECG trademark extraction.

Francisco et. al, [7] described for quantitative assessment, the accompanying comparability measurements were utilized: sum of squares of distances, absolute maximum distance, & RMSD percentage. A few examinations are executed utilizing real ECG signals from QT database, synthetic ECG signals produced by ECGSYM programming, real BLW produced from noise stress test database, artificial BLW PRODUCED by software. The better outcomes are gotten by strategy dependent on "FIR high-pass channel with a cut-off frequency" of 0.67 Hz.

Jayantet. al, [8] introduced various methodologies for executing baseline noise evacuation in ECG signal that incorporate strategies dependent on utilization of median filters, cubic spline curve fitting, adaptive filters, linear spline curve fitting, project pursuit gradient ascent, wavelet adaptive filters, digital filters, & experimental mode decomposition.

Sonali et.al, [9] introduced different methodologies for baseline noise elimination in ECG signal that incorporate techniques dependent on wavelet adaptive filtering, cubic spline curve fitting, HPF, median filtering, adaptive filtering, use of project pursuit gradient ascent, zero phase filtering, linear spline curve fitting, Savitzky-Golay Polynomial approach, moving average approach, & experimental mode decomposition. Median filtering offers benefit that signal will be not inaccurate in nonappearance of baseline difference & computationally effective.

Nicolas Pilia et.al, [10] incorporated and discover the better executing model. Despite the fact that all strategies change ST portion up to few extent, they are proved to best than leaving BW unfiltered.

Omkar Singh et.al, [11] suggested techniques have contrasted with "empirical mode decomposition (EMD) based PLI cancellation" strategies. A sum of 6 strategies for PLI decrease dependent on EWT & EMD is investigated and their outcomes are introduced in this manuscript. The "EWT-based de-noising techniques" have much effective &low computational complexity as contrasted with "EMD-based de-noising strategies".

Antonio Fasano et.al, [12] suggested a new method to its elimination that will be dependent on "Quadratic Variation Reduction (QVR)". The methodology has very encouraging assets &demonstrated to be efficient in eliminating BW, whereas conserving ST section level. It needs assurance of detrending factor. In this manuscript, we infer a "linear time-invariant filter" approximating QVR. The filter holds similar optimality assets as QVR. In addition, it gives a measure to picking the best possible estimation of parameter overseeing QVR, as an element of spectral attributes ofBW noise. The experimental outcomes demonstrate that filter will be efficient in eliminating BW, whereas presenting minor bending in ST section.

## 3. PROPOSED SYSTEM

The noises generated along with ECG signals are from both low frequency and high frequency. Numerous "adaptive filter structures" have been proposed for noise cancellation. The proposed system implements the ECG signal processing by applying IIR filters i.e., IIR LPF, HPF and notch filters. The

low-pass & high-pass channels together are called as bandpass filter, literally permitting just a "specific frequency band" to go through. The notch filter will be used to remove line frequency &normally imprinted on ECG. The "common mode rejection" will be regularly done right-leg drive, where a reverse signal of 3limb electrodes will be sent back through right leg electrode. To remove BW that is low frequency noise it is better to utilize HPF. The BW will be low frequency noise of 0.5 to 0.6 Hz. To avoid it, HPF with "cut off frequency" 0.5 to 0.6 Hz might be utilized. The power line interference might be eliminated by utilizing "notch filter of 50 or 60Hz cut-off frequency". The EMG noise will be high frequency noise of above 100Hz & might be eliminated by a LPF of suitable "cut-off frequency". The electrode motion artefacts might be suppresses through decreasing movements made by subject. We are presenting the kinds of general "noise sources in ECG signals"& easy signal processing methods for eliminating them.

The BW will be effect whereas the "x-axis of signal" seems to "wander" or go up & down instead of be straight. This makes complete signal to exchange from its typical base. In ECG signal, BW will be caused due to unsuitable electrodes, movement of patient, & breathing.

The BW frequency substance will be extent of 0.5 Hz. But, expanded development of body while stress test increment BW frequency substance.

Methods for Elimination of BW:

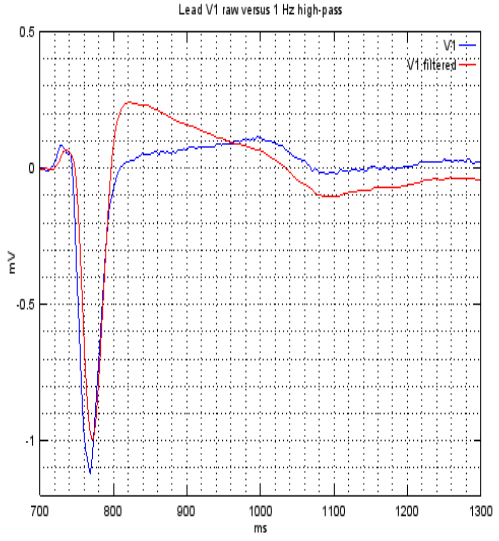


**Figure 2:** Lead V1 raw versus 1 Hz high-pass

The figure 2 and 3 shows the comparison of ST/T-waves among filtered V1 (red) & raw V1 (blue).The regular monitor mode 1Hz analog high-pass filter is simulated utilizing 4$^{th}$ order butter worth filter &GNU Octave 3.6. [13].

The minimal harmonics were having maximum amplitude than the higher harmonics, hence any variation to their stage would be signified as ECG. Moreover, they have introduced that the baseline ECGs varies with normal repolarization vectors & depolarization higher distortion feature with maximum filtering pass.

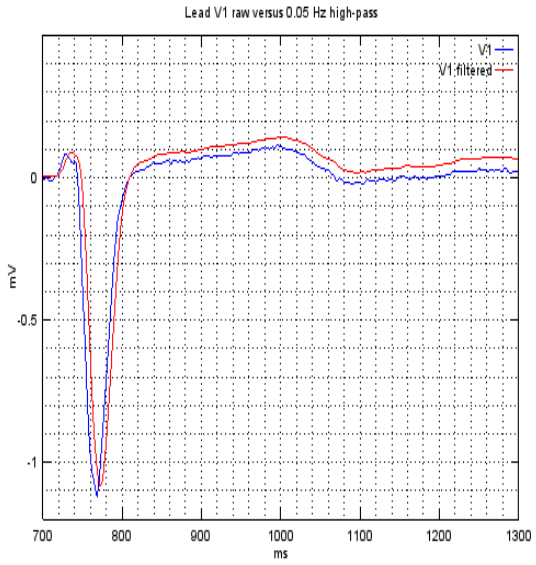


**Figure 3:** Lead V1 raw versus 0.05 Hz high-pass

If linear phase HPF will be utilized, like on might be high as 0.67Hz without influencing at ordinary heart pulses. Nevertheless, due to this filter configuration needs delays that don't allow real time presentation of ECG, they were not regularly utilized in heart monitors[14]. Whether, non-linear HPF will be utilized, cut-off must be set to 0.05 Hz to diminish.

**ADVANTAGES**

- The filtered ECG signal is generated without any distortion.
- It can be implemented with any type of ECGs.
- Magnified and amplified ECG is obtained without losing any clinical significance**.**

## 4. RESULTS

The dataset has been taken from Physionet-https://physionet.org/content/ecgiddb/1.0.0/, and converted to CSV files, and by using python language we implemented the code.

The following figure 4. Shows the Removal of base line wandering using IIR HPF for 100000 values. And Figure 5 shows the Removal of base line wandering using IIR HPF for 1000 values.

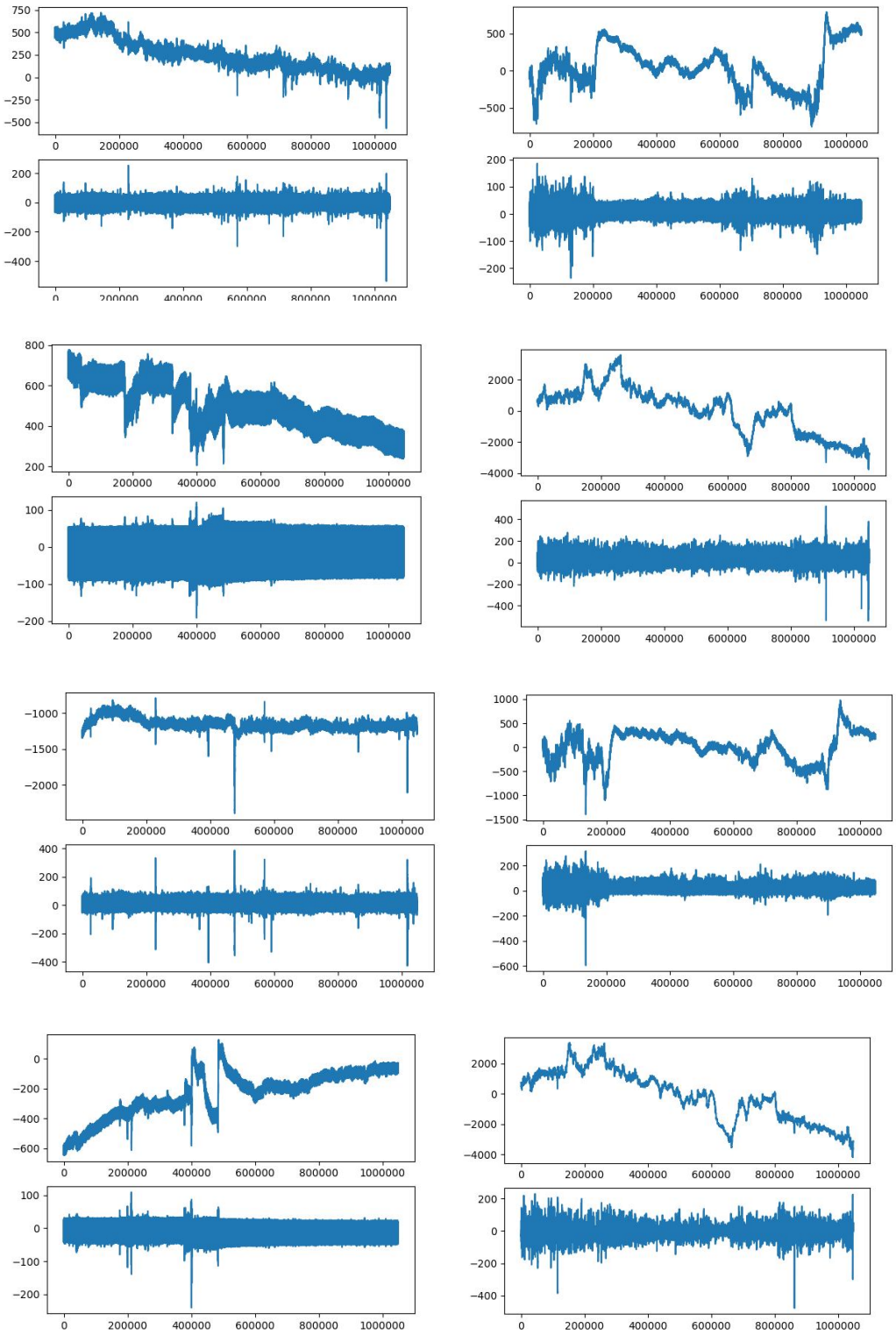

**Figure 4:** Removal of base line wandering using IIR HPF for 100000 values

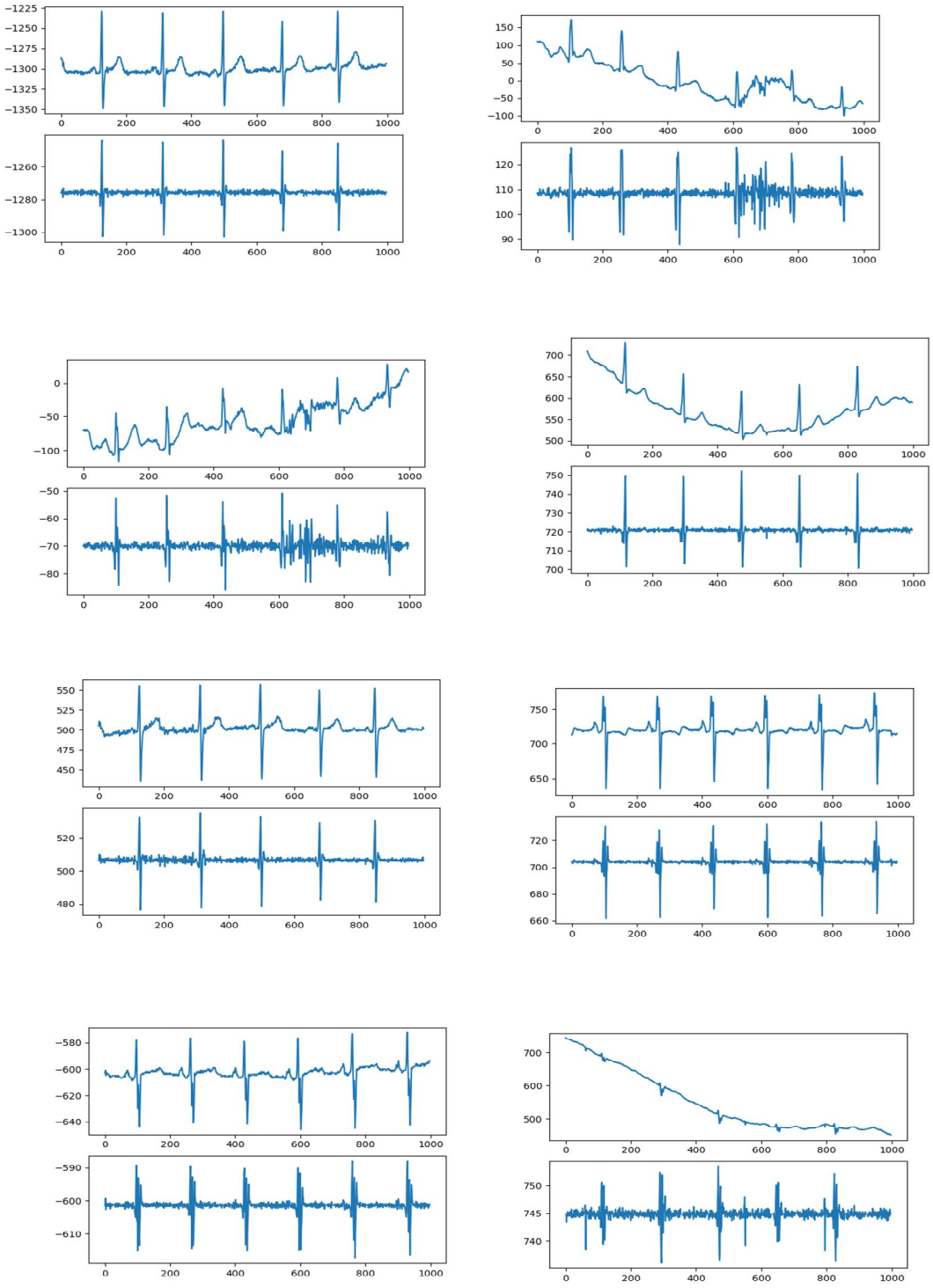

**Figure 5:** Removal of base line wandering using IIR notch filter for 1000 values

## 5. CONCLUSION

The BW noise creates the investigation of ECG information critical. It will be desirable to eliminate this noise for suitable investigation &show of ECG signal. There are various filters to eliminate this noise. The "finite impulse response (FR) filters, infinite impulse response (IIR) filters", adaptive, & interpolation filters have executed to suppress the baseline noise in this survey. The BW noise suppression might be done in 2 different ways, they are online & offline. In online filtering, signal will be filtered as it will be recorded. In offline filtering, the complete signal will be recorded & complete record will be filtered. It is fundamental when visualization & real time processing have needed as in ECG stress analysis, in which signal will be simultaneously monitored & filtered to analyse the impacts of stress on heart electrical activity. We have performed practical on IIR filter to remove noise in ECG Signal. The project has been executed and satisfied all the requirements. We have found a great difference in the graph using HPF compare to low-pass and notch filters.

## FUTURE WORK

Our future work is to remove the "**EMG noise, power line interference, and Electrode motion artifacts"**. The powerline interference might be eliminated by utilizing a "notch filter of 50 or 60 Hz cut-off frequency". The EMG noise will be "high frequency noise" of above 100 Hz & therefore might be eliminated by "low-pass filter" of suitable "cut-off frequency". The "electrode motion artefacts" might be suppressed by diminishing activities made by subject. This manuscript presents kinds of general noise sources in easy signal processing methods &ECG signals for eliminating them.

## REFERENCES


[1] Rahul Kher,"Signal Processing Techniques for Removing Noise from ECG Signals", March 12,2019.

[2] Jinzhong Song, Hong Yan, Yanjun Li and Kaiyu Mu, "Research on electrocardiogram baseline wandering correction based on wavelet transform, QRS barycenter fitting, and regional method", 30 Sep 2010.

[3] **ZHAO Yan-na, WEI Long, XU Fang-zhou, ZHAO Jie, TIAN Jie, WANG Yue, "**ECG Signal Denoising Algorithm Based on Wavelet Transform", 2016.

[4] V. de Pinto," Filters for the reduction of baseline wander and muscle artifact in the ECG", J. Electro cardiol. 25: 40- 48.

[5] MA Tinati, B Mozaffary, "A wavelet packets approach to electrocardiograph baseline drift cancellation" International journal of biomedical imaging, 2006 - hindawi.com.

[6] Xiang-kui Wan, Haibo Wu, FeiQiao, Feng-cong L, Yan Li, Yue-wen Yan and Jia-xin Wei, "Electrocardiogram Baseline Wander Suppression Based on the Combination of Morphological and Wavelet Transformation Based Filtering", 03 Mar 2019.

[7] Francisco Perdigon Romero, Liset Vazquez Romaguera, Carlos RománVázquez-Seisdedos, Cícero Ferreira Fernandes Costa Filho, MarlyGuimarãesFernandes Costa, João Evangelista Neto[5], "Baseline wander removal methods for ECG signals: A comparative study", 30 Jul 2018.

[8] A. Jayant, T. Singh and M. Kaur[3], "Different Techniques to Remove Baseline Wander from ECG Signal", Int. J. of Emerging Research in Management & Technology, 2013.

[9] Sonali, PayalPatial, " Different Techniques of Baseline Wandering Removal" Vol. 2 Issue 5, May-2013.

[10] Nicolas Pilia,Axel Loewe, Walther H. W. Schulze and Olaf Dössel, "Comparison of Baseline Wander Removal Techniques considering the Preservation of ST Changes in the Ischemic ECG", Jan 2017

[11] Omkar Singh and Ramesh Kumar Sunkaria, "Powerline interference reduction in ECG signals using empirical wavelet transform and adaptive filtering" ,21 Nov 2014.

[12] Antonio Fasano and Valeria Villani**,** "Baseline wander removal in ECG and AHA recommendations", Jan 2013

[13] Rachana Dhannawat , Dr. Archana B.Patankar , "A New Faster, Better Pixels Weighted Don't Care Filter for Image Denoising and Deblurring", International Journal of Advanced Trends in Computer Science and Engineering, Volume 9 No.2, March - April 2020. https://doi.org/10.30534/ijatcse /2020/212922020.

[14] Beer Singh , Asheesh Kumar Tiwari , Dr. Sushil kumar Agrawal, "State Variable based Tow Thomas Biquad filter using Gm-C Universal design using 180nm CMOS Technology" , International Journal of Advanced Trends in Computer Science and Engineering, Volume 9 No.2, March - April 2020. https://doi.org/10.30534/ijatcse/2020/149922020