Shobha Parashar, 10:4
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

A Review On Ecg Signal Noise Reduction And Performance Enhancement Of Signal Parameters In Pqrs Detection

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Abstract- As we know current era is totally based on innovative technology. Medical science is one of the important needs 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 patient. So there is need of some effective filtering 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 paper we present the comparative study between all existing filter.

Key Words- ECG,QRS Etc

I. INTRODUCTION

Electrocardiogram (ECG) is a non-linear non-stationary quasi-periodic time series [**1**]. It is a wide-spread tool to examine the electrical and muscular functions of the heart. It is a time-varying bio-signal reflecting the ionic current flow, which causes contractions and subsequent relaxations in the cardiac fibres and provide indirect insight into the blood flow to the heart muscle [**2**]. It gives information about heart rate, rhythm, and electrical activity. The information contained within ECG is both physiological and pathological, which are integral to the diagnosis of heart diseases. ECG monitoring and subsequent analyses find a lot of applications in the medical domain. However, ECG is susceptible to different types of noises, which might distort the morphological features and the interval aspects of the ECG leading to a false diagnosis and

II. CLASSIFICATION OF THE ECG DENOISING TECHNIQUES

The ECG denoising methods have been classified into different categories, as mentioned in Fig. 2. The first category belongs to ECG de noising using EMD, which is a local and adaptive method in the frequency– time analysis. Empirical mode decomposition (EMD) is a data-driven mechanism which is proposed by Huang et al. [1], suited for non-linear and non-stationary signals [2]. The techniques included in the second and third categories are statistical and are used to extract a statistical-based model of the noisy signal [3]. The second category includes deep-learning-based auto encoder models (DAEs), which aim at regenerating a clean ECG signal from a corrupted version of the same by optimising

the objective function. The wavelet-based methods fall into the third category and use the wavelet transform (WT) as the base for denoising ECG by decomposing the signal, deciding the type of thresholding and reconstructing the signal. The fourth category utilises the sparsity property of ECG for sparse optimisation to denoise ECG signals. An important denoising approach is based on adaptive filtering, which deals with model-based Bayesian filters such as the extended Kalman filter (EKF), Extended Kalman Smoother (EKS), and unscented Kalman Filter (UKF).

The fifth category uses Bayesian filters to introduce changes in the conventional dynamic ECG model of Kalman filter to denoise ECG signals. The last category is hybrid that combines different methods available in the literature. Some filtering techniques like conventional filtering [4] and adaptive filtering [5] help to denoise ECG signals. Non-local means (NLM) has been explored for denoising ECG signals [6]. Also, various optimisation techniques like the total variation regularised least-squares problem or the related fused lasso problem (1DTVD) [7],

MM technique [8], genetic algorithm minimisation of a new noise variation estimate (GAMNVE) [9], and so on, help denoise ECG. Some conventional statistical techniques available in literature are principal component analysis and independent component analysis. ECG denoising based on these methods is well demonstrated in [10].

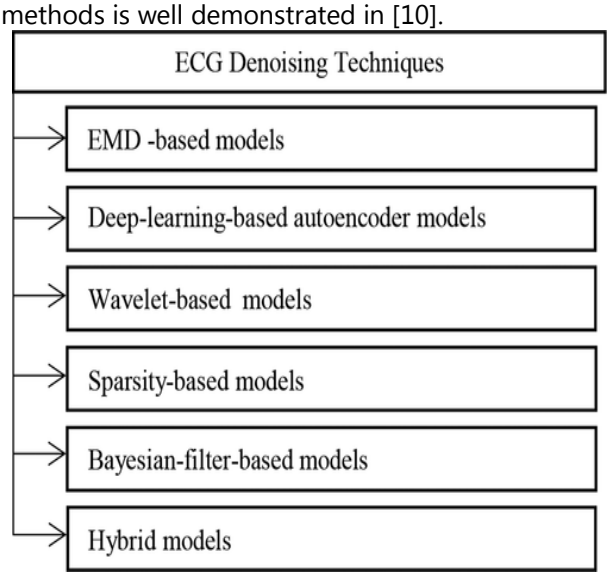

Fig. 1 Classification of ECG signal denoising techniques.

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.

Digital filters thus reduce the noise source and improve the signal to noise ratio. Here we designed the fast FIR low pass filter for Electromyo gram, 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 Many components of the measured electrocardiogram (ECG) signal originate from different and hypothetically independent sources, independent sources; the joint effect is a linear combination of them presented at the ECG electrodes.

In the ECG signal 3 processing there are several unsolved problems and many existing solutions that need optimization, noise reduction/removal are one of them. There are several techniques for noise removal from the ECG which can be employed to give good performance results in the controlled environment. But in some cases to correctly identify the arrhythmia, long-term ECG monitoring is required, which is often acquired with ambulatory ECG usually recorded with Halter device, where it is difficult to obtain controlled environment setting.

This makes the ECG recording more susceptible to different kind of noises not commonly witnessed at controlled environment. There are several filtering techniques that can be employed to remove some of the noises according to different frequencies, e.g. power interference baseline wandering, etc., but not electrode motion artifacts known in ECG studies as „end" noise which results from the motion of electrode on the patient's skin or due to the movement of the patient itself. The motion artifact is very difficult to be removed by conventional filters because of its ectopic in nature; it takes the shape of the wave which makes it difficult to be removed.

III. LITERATURE REVIEW

Aaron Peace, Exploring decision making 'noise' when interpreting the electrocardiogram in the context of cardiac cath lab activation: In this commentary paper, we discuss the use of the electrocardiogram to help clinicians make diagnostic and patient referral decisions in acute care settings. The paper discusses the factors that are likely to contribute to the variability and noise in the clinical decision making process for catheterization lab activation. These factors include the variable competence in reading ECGs, the intra/inter rater reliability, the lack of standard ECG training, the various ECG machine and filter settings, cognitive biases (such as automation bias which is the tendency to agree with the computer-aided diagnosis or AI diagnosis), the order of the information being received, tiredness or decision fatigue as well as ECG arte facts such as the signal noise or lead misplacement. We also discuss potential research questions and tools that could be used to mitigate this 'noise' and improve the quality of ECG based decision making.

Mohammed MujahidUllaFaiz, Removal of multiple artifacts from ECG signal using cascaded multistage adaptive noise cancellers: Although cascaded multi stage adaptive noise cancellers have been employed before by researchers for multiple artifact removal from the Electro CardioGram (ECG) signal, they all used the same adaptive algorithm in all the cascaded multi-stages for adjusting the adaptive filter weights. In this paper, we propose a cascaded 4-stage adaptive noise canceller for the removal of four artifacts present in the ECG signal, viz. baseline wander, motion artifacts, muscle artifacts, and 60 Hz Power Line Interference (PLI). We have investigated the performance of eight adaptive algorithms, viz.

Least Mean Square (LMS), Least Mean Fourth (LMF), Least Mean Mixed-Norm (LMMN), Sign Regressor Least Mean Square (SRLMS), Sign Error Least Mean Square (SELMS), Sign-Sign Least Mean Square (SSLMS), Sign Regressor Least Mean Fourth (SRLMF), and Sign Regressor Least Mean Mixed-Norm (SRLMMN) in terms of Signal-to-Noise Ratio (SNR) improvement for removing the aforementioned four artifacts from the ECG signal. We employed the LMMN, LMF, LMMN, LMF algorithms in the proposed cascaded 4-stage adaptive noise canceller to remove the respective ECG artifacts as mentioned above. We succeeded in achieving an SNR improvement of 12.7319 dBs. The proposed cascaded 4-stage adaptive noise canceller employing the LMMN, LMF, LMMN, LMF algorithms outperforms those that employ the same algorithm in the four stages. One unique and powerful feature of our proposed cascaded 4-stage adaptive noise canceller is that it employs only those adaptive algorithms in the four stages, which are shown to be effective in removing the respective ECG artifacts as mentioned above. Such a scheme has not been investigated before in the literature.

Eglė Butkevičiūtė, The unsupervised pattern recognition for the ECG signal features detection: Smart devices and cloud-based technologies allow continuous non-invasive bio-signal recordings in daily life activities. There are many programs and applications that allow monitoring health condition and sharing that information with other people. However, bio-signals that are recorded in real nonstationary conditions are highly contaminated with noise that depends on various activities. Improper signal processing algorithms may lead to a faulty diagnosis or inaccurate decision-making

results. Movement contaminated bio-signals require adaptive filtering and feature extraction algorithms because low frequency trends are mostly unstable, and the noise may cause higher impulses than the signal itself. That is why ordinary ECG signal parameters extraction algorithms fail in real time signal processing.

In this research signals were filtered using two different methods: Butterworth filter for the high frequency noise reduction and BEADS algorithm for the low frequency noise removal. A new ECG feature extraction algorithm was proposed that is based on the unsupervised MTEO algorithm together with additional local extremum search. The proposed algorithm was compared with other methods on the MIT-BIH database. The additional comparison was made with Pan-Tompkins and *k*-TEO algorithms on ECG signals that were recorded in movement. Several examples are presented that show how each algorithm performs during training sessions with various intensity levels. The suggested method performed in linear time complexity that made it sufficient for the real time data processing. The obtained ECG parameter values could be used for diagnostics and fatigue recognition in health monitoring processes.

Hemant Amhia , Designing an Optimum and Reduced Order Filter for Efficient ECG QRS Peak Detection and Classification of Arrhythmia Data: Electrocardiogram (ECG) is commonly used biological signals that show an important role in cardiac analysis. +e interpretation and acquisition of QRS complex are significant measures of ECG data dispensation. +e R wave has a vital character in the analysis of cardiac rhythm irregularities as well as in the determination of heart rate variability (HRV). +is manuscript is proposed to design a new artificial-intelligence-based approach of QRS peak detection and classification of the ECG data. +e design of reduced order IIR filter is proposed for the low pass smoothening of the ECG signal data. +e min-max optimization is used for optimizing the filter coefficient to design the reduced order filter. In this research paper, elimination of baseline wondering and the power line interferences from the ECG signal is of main attention. +e result presented that the accuracy is increased by around 13% over the basic Pan–Tompkins method and around 8% over the existing FIR-filter-based classification rules.

Anitha S. Prasad, **Graphene nano-platelets polyvinyl alcohol nano composite electrode for real time ECG signal acquisition:** This paper highlights the development of graphene nano plate lets polyvinyl alcohol(GNP@PVA) nano composite electrode to acquire real time Electro cardiogram(ECG) signal.

In order to create GNP@PVA nano composite, solution casting was used. By drop casting the GNP@PVA nano composite onto a commercial silver/silver chloride (Ag/AgCl) electrode with different GNP concentrations, namely 0, 0.5, 0.75, and 1 wt/wt% are created. The 3-lead ECG system is designed using Arduino microcontroller, GNP@PVA electrode and AD8232 sensor. To investigate the physical, spectral, and microcrystalline characteristics of the prepared nano composites, the prepared GNP@PVA electrode is subjected to various analyses, including scanning electron microscope (SEM) analysis, X-ray diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR) and Raman spectroscopy. The results demonstrated that ECG signals acquired by GNP@PVA (1%) has increased R peak value along with high sensitivity.

To validate the performance and efficiency of designed GNP@PVA electrode, the acquired real time ECG signal is compared with commercial Ag/AgCl electrode. In contrast to commercial Ag/AgCl electrode, the designed GNP@PVA dry electrode has high signal to noise ratio of 21 due to high conductivity. Linhai Ma Liang Liang, A regularization method to improve adversarial robustness of neural networks for ECG signal classification: With the advancement of machine leaning technologies, Deep Neural Networks (DNNs) have been utilized for automated interpretation of Electrocardiogram (ECG) signals to identify potential abnormalities in a patient's heart within a second. Studies have shown that the accuracy of DNNs for ECG signal classification could reach human-expert cardiologist level if a sufficiently large training dataset is available.

However, it is known that, in the field of computer vision, DNNs are not robust to adversarial noises that may cause DNNs to make wrong class-label predictions. In this work, we confirm that DNNs are not robust to adversarial noises in ECG signal classification applications, and we propose a novel regularization method to improve DNN robustness

by minimizing the noise-to-signal ratio. Our method is evaluated on two public datasets: the MIT-BIH dataset and the CPSC2018 dataset, and the evaluation results show that our method can significantly enhance DNN robustness against adversarial noises generated by Projected Gradient Descent (PGD) and Smooth Adversarial Perturbation (SAP) adversarial attacks, with a minimal reduction of accuracy on clean data. Our method may serve as the baseline for designing new methods to defend against adversarial attacks for life-critical applications depending on ECG interpretation. The code of thi**s work is publicly available at** github.com /SarielMa/ Robust_ DNN_for_ ECG.

William A.Chisholm, **Coordinating the einth oven body impedance model for ECG signals with IEC 60479–1:2018 electrocution heart current factors:** The Einthoven electrical circuit for electrocardiogram (ECG) measurement has been modeled as a 2.5 mA impulse current source at the heart, feeding a 13-resistor network. This model can be inverted to establish heart threat currents from electrocution potentials applied at extremities. Using designation of R (right), L (left), H (hand) and L (leg), electrical safety standard IEC 60479–1:2018 defines risk factors for LH-RH and LL-RL paths compared to reference LH-LL path. Heart current reduction factors can be fitted by adjusting some resistor values and by adding a cross-hip resistance to make nodes at each hip. Reciprocity suggests an approach to validate IEC heart current factors by comparing ECG signal magnitudes for different contacts. Hypothetically, the LH-RH ECG signal should be 10x larger than the LL-RL signal if their IEC heart current split factors are correct. In-vivo tests verify some of the electrocution heart current factors using three-lead and two-lead ECG instruments.

Ahmed S. Eltrass, **Novel cascade filter design of improved sparse low-rank matrix estimation and kernel adaptive filtering for ECG denoising and artifacts cancellation:** Electro Cardio Gram (ECG) signals are highly vulnerable to disturbances caused by noise and artifact sources which can degrade the ECG signal quality and increase the difficulty in obtaining reliable and accurate clinical interpretations for heart conditions. This paper introduces, for the first time, the Improved Sparse Low-Rank (ISLR) algorithm for suppressing white/colored noises, and the Kernel Recursive Least Squares with Approximate Linear Dependency (ALDKRLS) algorithm for eliminating various artifact sources.

A novel automated multi-stage filter is introduced for suppressing artifact components in the first stage using ALDKRLS and eliminating noise sources in the subsequent stage using ISLR. The robustness of the suggested multi-stage filter is demonstrated by eliminating noise and artifact components individually and when both present concurrently using real ECG data. Experimental results elucidate the outstanding accuracy of the suggested framework in eliminating interference sources and keeping the essential and important characteristics of the original ECG data. Also, the application of the suggested framework in practical systems is examined by investigating a new efficient ECG multi-class classification system before and after suppressing noise and artifact interferences. Results show that the suggested framework manages not only to eliminate effectively noise and artifact components, but also to achieve very accurate ECG diagnosis results by maintaining the essential characteristics of the ECG signal that differentiate different heart disorders. This elucidates the usefulness of the proposed multi-stage filter as a promising preprocessing tool for obtaining high-resolution ECG data and consequently enhancing the diagnosis performance of several heart diseases. YanruiJin, A novel attentional deep neural network-based assessment method for ECG quality: ECG quality assessment is of great significance to reduce false alarms in automatic arrhythmia and other cardiovascular diseases diagnoses and reduce the workload of clinicians. Recently, developing an automatic noise rejection algorithm attracts much attention. Nowadays, many researchers have applied deep learning (DL) algorithms into evaluating ECG quality. However, traditional DL approaches improve model accuracy but cannot show the concerned area of ECG signals during detection process. Hence, this paper presents dual attentional convolutional long short-term memory neural network (DAC-LSTM) to evaluate ECG quality.

Firstly, convolutional and bidirectional long short-term memory layers are utilized for acquiring numerous deep features from ECG recordings. And then, for enhancing model interpretability, dual-layer attention mechanisms, including channel-based attention mechanism and time-based attention mechanism, are built to visually show the attention of the model to different leads and different periods on

the multi-leads ECG signals. Finally, compared with baseline models and the existing methods, DAC-LSTM achieves 76.47% of specificity, 97.59% of sensitivity, and 94.0% of accuracy, especially improving 3.35% accuracy on average and 4.27% sensitivity on average on the commonly used ECG dataset. Generally, DAC-LSTM achieves competitive and interpretable performance and has the potential for practical ECG quality assessment.

Hardev Singh Pal, Electrocar diogram signal compression using tunable-Q wavelet transform and meta-heuristic optimization techniques: Electrocardiogram (ECG) signals are the biomedical signals commonly used in the prognosis of cardiovascular diseases. ECG recordings need to be stored and transferred when telemedicine-based healthcare systems are required. These data are stored in a digitized format at higher bits per sample that requires ample space for storage. Therefore, this motivated us to develop efficient compression methodologies for ECG signals. In this regard, this work proposes compression techniques using the optimized tunable-Q wavelet transform (TQWT). For this purpose, TQWT parameters are optimized using several meta-heuristic optimization algorithms such as variants of PSO, ABC and its hybrid with PSO, GWO and its hybrid with PSO, and Sparse PSO.

These hybrid methods and Sparse PSO have been utilized for the first time to optimize TQWT. Subsequently, thresholding and quantization are performed by using a dead-zone quantizer (DZQ). The quantized coefficients are encoded by utilizing a lossless compression technique run-length encoding (RLE). The proposed algorithms have been examined on the MIT-BIH arrhythmia database. It is clear from the results that significant compression has been achieved when compared to existing techniques. The performance of the proposed algorithms has been evaluated in terms of various evaluation parameters that are compression ratio (CR), percent-root-mean square difference (PRD), signal-to-noise ratio (SNR), and quality score (QS).

Soumyendu Banerjee, A new real-time lossless data compression algorithm for ECG and PPG signals: Data compression is a useful process in tele-monitoring applications, in which lesser number of bits are needed to represent the same data. In this work, a run-time lossless compression of single-channel Electrocardiogram (ECG) and Photo plethysmo gram (PPG) signals is proposed, maintaining all dominant features. The single-channel data are first quantized using optimal quantization level, so that fewer number of bits are needed to represent it, maintaining low quantization error.

Then, second order delta encoding and run-length encoding (RLE) based data compression are proposed in this work. A new approach of using 'buffer array' along with RLE is also introduced, so that minimum bits are needed to store. This algorithm was tested on various single-lead ECG and PPG signals available in Physionet. An average compression ratio (CR) was achieved of 6.52, 3.82, and 2.49 for 547 PTBDB ECG records, 48 MITDB ECG records, and 53 MIMIC-II PPG records, respectively. This algorithm was also performed on single-channel ECG, collected from 10 healthy volunteers using AD8232 ECG module, with 125 Hz sampling frequency and 10-bit data resolution, which resulted in average CR of 2.34.

YajianGan, A new method to reduce motion artifact in electrocardiogram based on an innovative skin-electrode impedance model: The electrocardiogram (ECG) is sensitive to human body motions when it is measured with dry metal electrodes. A common hypothesis in previous literature dealing with these subjects postulate that this is due to the skin-electrode impedance variability. This paper aims to verify this hypothesis by investigating the origin of the noise in the ECG signal and finding suitable solutions to reduce this disturbance. For this reason, experiments are proposed here to explore the relationship between the skin-electrode impedance and the ECG for several motions.

Results demonstrate that the noise due to human body motions in ECG equally comes from the electrochemical equilibrium break of the reduction–oxidation reaction at the skin-electrode interface. Moreover, it has been shown that motions lead to sweat thickness variations and equally to skin-electrodes capacitance variations. To model this phenomenon, an electrical model based on a variable capacitor is introduced. Finally, a significant noise reduction solution based on the monitoring of this capacitor is proposed.

Nataliya Tulyakova, Real-time filtering adaptive algorithms for non-stationary noise in

electrocardiograms: A non-stationary noise with a previously unknown intensity level often contaminates electrocardiogram (ECG) signals. Therefore, provision of high quality suppression of the non-stationary noise in ECG is a vital task to be performed. A new lightweight adaptive method has been proposed for real-time filtering of non-stationary (from the point of view of its variance) noise in ECG with noise- and signal-dependent switching filters, appropriate for processing a local vicinity of the current input signal sample. This method does not require time for filter parameters adaptation and a priori information about the noise variance.

A one- and a two-pass algorithm on the simple optimal Savitzky&Golay filters and on the linear averaging filter have been developed on the basis of the proposed method. There is also an algorithm suggested applying a re-filtering only when the identifiers used in the method define a not low noise level. The integral and local statistical estimates of filters' efficiency have been obtained from numerical simulations over mean-square error (MSE), maximum absolute error (MAE), and signal-to-noise ratio (SNR) for a model ECG signal under different levels of Gaussian noise. Filtering efficiency was estimated with the real signals taken from physionet.org database. The filter parameters were chosen by numerical simulations for a typical P-QRS-T cycle with corresponding signal sampling rate and scale considered. For a wide range from low to high noise levels (input SNR belongs to the interval from 25 to 0 dB), the statistical estimates of efficiency have been obtained as follows: for an ECG sampled at 360 Hz (taken from NSTDB), inside QRS-complex, the SNR increases by 2.5–6.7 dB, the MSE decreases in 1.7–4.3 times and the MAE decreases in 1.3–2.2 times; inside the segments prior to and following QRS-complex, the SNR, on an average, increase by 8.6–13.2 dB and the MSE decreases in 7.1–19.2 times, and the MAE decreases in 2.4–5.1 times. For an ECG sampled at 1 kHz (taken from PTB), inside QRS-complex, the SNR increases by 5.2–8 dB, the MSE and the MAE decrease in 3.2–6 times and 1.9–2.7 times, respectively; outside QRS, the SNR increases by 10.2–15.8 dB, the MSE and the MAE decrease in 10.5–36 times and in 2.6–5.2 times, respectively. For an ECG sampled at 250 Hz (from CUDB), the local indicators of efficiency are: inside QRS-complex, the SNR increases by 2.9–6.6 dB, the MSE and the MAE decrease in 1.8–4 times and in 1.4–2.3 times, respectively; outside QRS-complex, the SNR, on an average, increase by 4.7–11.6 dB, the MSE and the MAE decrease in 3.3–10.9 times and in1.7–3.9 times. Additionally, the filters' efficiency has been estimated as to suppression of real electromyo graphic (EMG) noise with significantly different variance and the proposed algorithms have been compared with other filters. A noise-free ECGs during 5 min sampled at 360 Hz were contaminated with highly non-stationary EMG noise from a muscle artifact (MA) record of different intensity (input SNR varies from 20 to −5 dB), the SNR improvement at the proposed algorithm output is 10–14 dB. The calculated quantitative estimates of efficiency confirm the high quality of non-stationary EMG noise suppression obtained with the adaptive algorithms suggested. Minute signal distortions and a high degree of noise suppression have been demonstrated. Good performance and high filter quality for various real signals with non-stationary EMG noise have been shown. ECG amplitude-time parameters and waveforms, including pathological changes, are shown to be well-preserved.

ArashRasti-Meymandi, A deep learning-based framework For ECG signal denoising based on stacked cardiac cycle tensor: The Electrocardiogram (ECG) signal is one of the frequently used non-invasive physiological measurement techniques for heart diagnosis. However, ECG signal is often contaminated with various noise and artifacts which make the diagnosis a challenging task. Recent deep learning models have had promising results in dealing with the noises, however, they only considered the 1D time series of the ECG signal.

This paper presents a novel deep learning-based Electrocardiogram (ECG) denoising approach based on the periodicity of the ECG signals. In this work, ECG cardiac cycles are stacked together to form a 2D signal which will be fed to a convolutional neural network (CNN) model. Accordingly, the correlation between cardiac cycles can be exploited, resulting in an efficient and robust ECG denoising. The proposed CNN model is equipped with a novel local/non-local cycle observation (LNC) module to account for the correlation between the cycles. The proposed framework is applied to the publicly available MIT-BIH Arrhythmia database.

Various experiments on different noise conditions have been conducted to evaluate the effectiveness of the design. The results have shown the superiority of our framework over the existing state-of-the-art approaches in terms of the Root-Mean-Square Error (RMSE) and improvement in Signal-To-Noise Ratio (SNRimp).

R. BharathiVidhya, Pre-processing ECG signals for smart home material application: Health monitoring plays a vital role with regards to early detection, prevention of any form of illness which will promote good health and overall, well-being of the people. Nowadays Smart home systems, IoT based monitoring systems, medical bracelets, Invasive/non-invasive medical sensors are widely used to monitor the physical health of the people. Electrocardiogram signals (ECG) which are used to access the electrical function of the heart.

Proper monitoring of ECG signals will help us to prevent major heart illness. It also helps us to ensure the oxygen pumping ability of the heart which is very essential to maintain the required oxygen saturation level of the body. ECG recordings are in general prone to various type of noises. Turbulent ECG signals may also lead to wrong detection and evaluation. Thus, preprocessing of recorded signals plays a major role in health monitoring. This paper aims to denoise the ECG signals by using filters in an efficient manner. Performance analysis of the filters are evaluated by comparing the level of variation of the signal and the noise which is expressed in terms of SNR, Correlation coefficient (COR), Mean Absolute errors (MAE), Mean Square Error (MSE). Our preprocessing approach has been valuated using ECG signals from Physionet database.

Neta Rosenfeld, Using ECG signals for hypotensive episode prediction in trauma patients: *Background and objectives:* Bleeding is the leading cause of death among trauma patients both in military and civilian scenarios, and it is also the most common cause of preventable death. Identifying a casualty who suffers from an internal bleeding and may deteriorate rapidly and develop hemorrhagic shock and multiorgan failure is a profound challenge. Blood pressure and heart rate are the main vital signs used nowadays for the casualty clinical evaluation in the battlefield and in intensive care unit. However, these vitals tend to deteriorate at a relatively late stage, when the ability to prevent hazardous complications is limited. Identifying, treating, and rapidly evacuating such casualties might mitigate these complications. In this work, we try to improve a state-of-the-art method for early identification of Hypotensive Episode (HE), by adding electrocardiogram signals to several vital signs.

Methods*:* In this research, we propose to extend the state-of-the-art HE early detection method, In-Window Segmentation (InWise), by adding new types of features extracted from ECG signals. The new predictive features can be extracted from ECG signals both manually and automatically by a convolutional auto-encoder. In addition to InWise, we are trying to predict HE using a Transformer model. The Transformer is using the encoder output as an embedding of the ECG signal. The proposed approach is evaluated on trauma patients data from the MIMIC III database.

Results: We evaluated the In Wise prediction algorithm using four different groups of features. The first feature group contains the 93 original features extracted from vital signs. The second group contains, in addition to the original features, 24 features extracted manually from ECG signal (117 features in total). The third group contains the original features and 20 ECG features extracted by the AE (113 features in total), and the last group is the union of all three previous groups containing 137 features. The results show that each model, which has used ECG data, is outperforming the original InWise model, in terms of AUC and sensitivity with p-value <0.001 (by 0.7% in AUC and up to 3.8% in sensitivity). The model which has used all three feature types (vital signs, manual ECG and AE ECG), outperforms the original model both in terms of accuracy and specificity with p-value <0.001 (by 0.3% and 0.4% respectively).

IV. CONCLUSION

The survey includes the works and findings done by various researchers on ECG signal denoising techniques, various types of noises such as power line interference, baseline wander, electrode contact noise, Electromyogram (EMG) noise and motion artifacts. Adaptive filtering is the best choice if the input signal has low frequency SNR. But Filtered Residue algorithm provides better output if the amount of noise is moderate.

Wavelet denoising methods can be used for ECG signals with large beat to beat variation.EMD and moving average filter is an effective technique to remove high frequency Additive white Gaussian noise. Here we are working on the ECG signal which have the noise issue due to electrical and environment effect so there is lots of approaches which are try to reduce the noise issue but as we saw those approaches are not up to the mark in terms of all parameters like quality, area, time and power consumption so here we are try to develop a new algorithm for denoise of ECG signal using our proposed filter. We are expecting that our filter will make justification in terms of quality, area, power and speed.

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