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Processing and Validation of Peak Detection for the Analysis of the ECG Disease Patterns

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Abstract: ***Electrocardiogram, ECG signals, which have been records of heart electrical activities, had lately been employed to categories heart illnesses patterns. Paper first process the raw ECG data using Pan Tompkins standard filtering algorithm for artifacts removal. Then Data on the QRS wave peaks that have been identified and utilized as a criterion for further classification. In ECG HRV variability scenarios. The idea of research is to utilize machine learning (ML) to identify various ECG illness patterns using the chosen QRS feature set detection. The basic suggested method successfully identifies the ECG signal peaks for the Q, R, and S peaks. The visual outcomes show QRS detection efficiency of ECG without artifacts case. Peak detection for the ECG APB pattern is also confirmed.***

Key words: **ECG, ECG artifacts, Pan Tompkins, Peak Detection, Machine Learning, QRS Complex, HRV.**

I. INTRODUCTION

For the identification and treatment of various diseases, electrocardiogram (ECG) information analysis is critical. Varied heart conditions cause different heart rates variations (HRV) therefore, as a response, various ECG patterns. Among the most crucial processes inside the processing of ECG recordings is the understanding and retention of the QRS complex [1]. That R wave is crucial for the assessment of variation in standard heart rate as well as the identification of abnormal cardiac rhythms (HRV).

The temporal time - series data characteristics are extracted and used the simple peak detection method. Inside this explanation, it is proposed to apply machine learning (ML) to recognize different ECG disease patterns that use the selected feature set. The details of the detected peaks of the QRS waves are extracted and used as features for further classification. The description of QRS ECG pulse function and the capturing process ifs showman Figure 1.

Re-polarization, ventricle depolarization, and ventricular reversed polarisation can all be seen in the QRS property's ECG waveform. Figure 1 depicts a comprehensive QRS wave in great detail. Here all steps may result mismatch and cas te artifact in the ECG data or the variation in ECG features.

This paper proposed to study the ECG peak detection algorithm over the two types of the ECG data. The data considered here is the ECG of normal person without any disease. And the second case is consider as the atrial premature beats (APB). It is obvious that in the presece of cariation in heart ECG data the PQS and T waves part with the lower amplitudes may disturbed and the time interval of the lower features are changed.

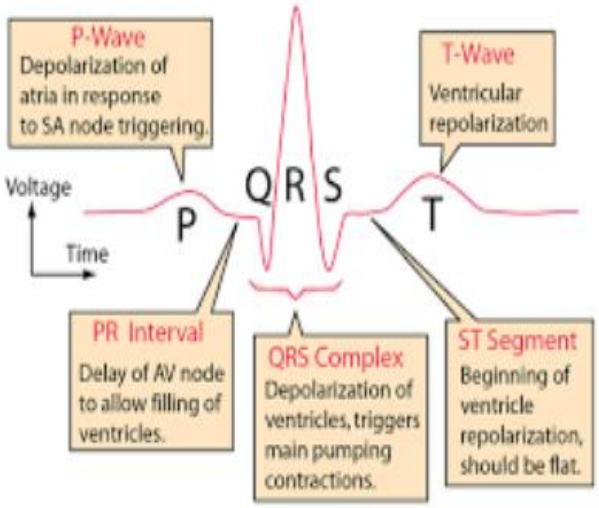

Fig.1. The description of the QRS ECG pulse for the Function

A. ECG and Heart Functioning

In reaction to electromagnetic pulses, human heart will contract and widen to circulate blood around the body. Heart disease, rapid heartbeat, and other heart problems can affect these communications. Through the use of an ECG, doctors can identify heart conditions and detect problems with your heart's electrical system. The ECG signals show the rhythm of the heart's electrical activity during the course of a ventricular contraction graphically.

Initially, the first step of processing is using the data's provided ECG patterns, ECG peaks are determined and confirmed for QRS peak identification.

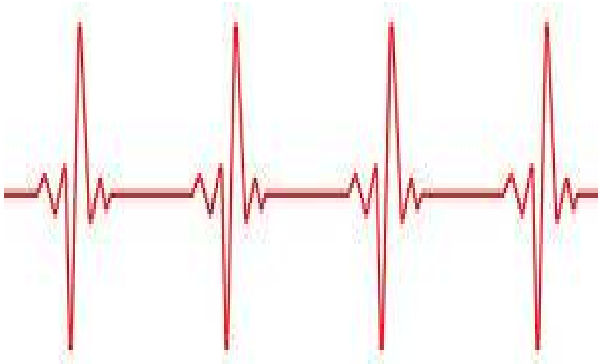

Fig.2. Examples of standard EGG signal waves as applicable to healthy human heart

The wave description of typical ECG signal samples as they relate to a healthy man's heart is shown in the Figure 2. It can be observed that for the healthy human the rhythm of the ECG signal is fixed and all the QRS waves have the same time. But in the presence of the HRV the pattern and features of these waves varied. Thus are required to study further.

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II. REVIEW OF RELATED WORK

For such ECG illness categorization, a variety of extracting the features and classification models has been used. The research done here was set in motion by the summary. Karpagachelvi, S. et al. It is explained in the research schemes how to remove characteristics out of an ECG signal using a range of approaches and modifications that have already been previously published in the literature. Furthermore, this article compares various methods developed by scientists to eliminate characteristics from ECG signals.

Afseen Naaz et al. [2] examined and discussed a number of important ECG extraction of features strategies that have already been previously disclosed [2]. It is plainly clear first from conversations that one of the key techniques for eradicating the QRS complex and other characteristic of ECG datasets is the mathematical transformation. One of the extra features suggested by Sumanta Kuila et al. [3] is an ECG-based fingerprint recognition system that evaluates the raw ECG signal. The technique is aided by a variety of noise-reduction filters including waves that also have undergone time-domain evaluation to identify ECG features.

An ADALINE neural network of four distinct neurons or one output unit can distinguish R-peaks in ECG continuously with a good accuracy of more than 99%, according to investigation by Kim, Jeong-Hwan et al. Gorav Kumar Malik et al. [5] in their study make the suggestion to develop an autonomously arrhythmia classification technique using a number of ECG signal parameters.

They discussed how well the SVM classification result suggests that the Electrocardiogram feature might be used as a reliable indication of cardiac problems. In order to determine the applicability of the MATLAB Phone or tablet for mobile applications and if it can function on any phone network, VadimGliner et al. [6] integrated an authentic Electrocardiogram R peak detector in the MATLAB Mobile application to low false positive and instead minimal false rejection proof of identity in the presentation of the most popular common arrhythmia, atrial fibrillation.

In their study, Dr. M. AntoBennet et al.[7] describe how to set up a wireless Wearable monitoring program and a strategy for classifying heart disorders. Reviewing several techniques and transformations that had previously been mentioned in the literature for such collection of characteristics out of an ECG signal was the main objective of Mayank Kumar Gautama: et al. [8].

Additionally, a comparison of different methods for erasing the characteristic from such an ECG signal is included in this paper. Apurva Kulkarni et al. [9] suggested conducting research on R clarification regarding that use the Pan Tompkins approach. A evaluation of transformations came next. According to Carlos Lastre-Domngue et al. [10], unconstrained response to bounded impulses (UFIR) filtering should be smoothed out. They have designed this filtering to have an adaptable aggregated horizon, which is perfect for sluggish ECG movements and minimal for the fast excursions.

One-dimensional learning based 1-D system has been proposed by Mohammad Mahmudur Rahman Khan et al. It is advised to use CNN to automatically classify five different types of ventricular tachycardia from an ECG. In order to improve performance, the ECG data went through a number of pretreatment procedures (de noising, peak detection, and heartbeat segmentation). [R12] A novel Long Short-Term Memory (LSTM)-based ECG classification algorithm is proposed by Saeed Saadatnejad et al. [12] research, outperforming past attempts in terms of classifying efficiency.

Azmi Shawkat Abdulbaqi et al. [13] provide a full explanation of the Dual-Tree (CWT) technique for de-noising an ECG signal. The article also discusses how to extract several elements from the suggested defined and rebuilt signal, including time interval measurements, anatomical, and object recognition pinpoint location. Najlaa Jannah et al [14] studies used multi-lead observations followed signal decompression in the Fourier domain to show the superiority of CSVM over classical SVM in simultaneously distinguishing distinct arrhythmia kinds. The methodology was created by using MATLAB as well python.

Summary of Work

The various researches in the field of ECG peak detection and classification are summarized and is tabulated in the Table 1.The various features of ECG are mentioned in Table 1.

III. PROPOSED PEAK DETECTION

The QRS peak detection is essential for the diagnosis of diseases as well as the estimation of heart rate variability (HRV) (HRV). Its proposed to detect the peaks for recognition of HRV is significantly influenced by the temporal record analysis; The ECG heart rhythms of the aberrant ECG readings are categorized using the MIT-BIH standardized Arrhythmia ECG mattresses dataset.

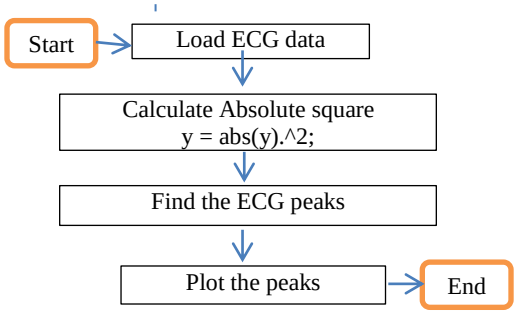

Fig. 3 ECG peak detection flow chart

The flow chart of the basic process of the ECG peak detection is shown in the Figure 3. The peaks are detected for the absolute square ECG signal option for efficiently.

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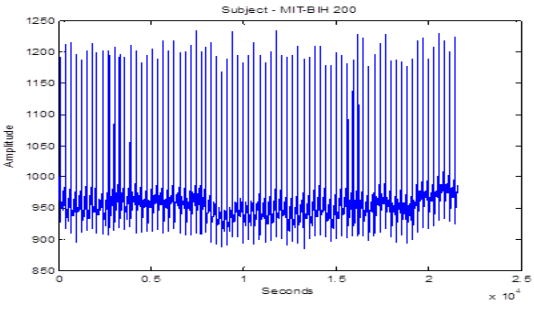
Table 1 Summary of the ECG Survey and Methodologies

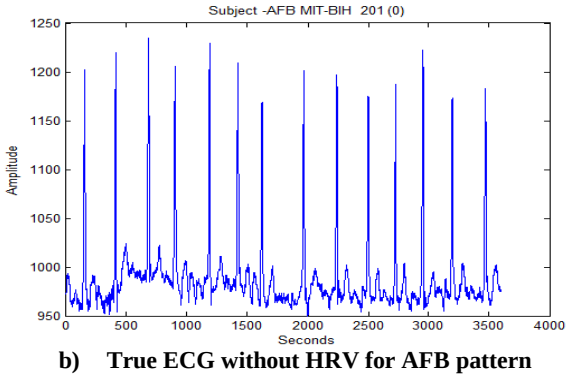
S.No	Author's Name	Methodology	Evaluation Parameter
1.	S. Karpagachelvi et. al [1]	Presented various Feature extraction methodologies from ECG data. Such as SVM and ANN.	Performance is measured based on the range of Simplicity Accuracy and Productivity
2.	SumantaKuilar et al [3]	The proposed to perform the biometric recognition system based on feature extraction on P-QRS-T signal ECG which processes the raw ECG signal.	Accuracy achieved 95.245%, Specificity, true positive 81.361%, Recall, Precision
3.	Jeong-Hwan kim et al [4]	Propose R-peaks in ECG can be automatically detected with the high accuracy of more than 98% with the NN use of ADALINE network.	Accuracy, Specificity, true positive. True negative's
4.	Gorav Kumar Malik et al [5]	proposed detection of arrhythmias in ECG signals using feature Extradition as well as SVM learning	The clinical decision accuracy must be on as high as possible. The features are based on the PR Interval, ST Interval D,. QT Interval, TP Interval, HRV, and Energy
5.	Dr. M. AntoBennet et al [7]	The creation of a cardiac diseases classification method and real-time portable ECG monitoring system	Using time and frequency based features set. As low frequency component (LF) index ratio LF/HF Power Spectral Density (PSD), time domain HRV
6.	Apurva Kulkarni, et al [9]	The Pan Tompkins method was used to detect R peaks..	For both pathological and normal cases, several statistical as well as morphological features were identified. Features used are R-R interval, HRV, mean, variance, median, skewness, and kurtosis
7.	Carlos Lastre- Dom-nguez et al [10]	Have used unbiased finite impulse response (UFIR) filter	The performance is evaluated using P-wave, QRS-complex, and T-wave, Accuracy of SVM is used as performance measure. SNR and MSE estimation is used for parameter performance
8	Jannah N. et al [14]	The proposed work provides a useful methodology for multi-lead ECG analysis and classification of arrhythmia conditions based on CSVM classification following DFT signal pre-filtering.	The advantage of CSVM over standard SVM in simultaneously detecting different types of arrhythmias on the basis of multi-lead recordings following signal compression in the Fourier domain. Implementation of the algorithms was performed in MATLAB. The CSVM classification algorithm provided.

IV. EXPECTED RESULT OF EEMD DECOMPOSITION

The validation of results for the ECG peak detection and the outcomes are presented in this section. Using the suggested method, the Q, R, and S peaks of the ECG signal can be detected effectively in all four cases. The results of .ECG of normal rhythm and the ECG with HRV for AFB pattern are evaluated and plotted for the QRS peak detection. Figure 4 shows the input ECG data. While the Figure 5 represents the respective results of the ECG peak detecting using the standard find peak function option.

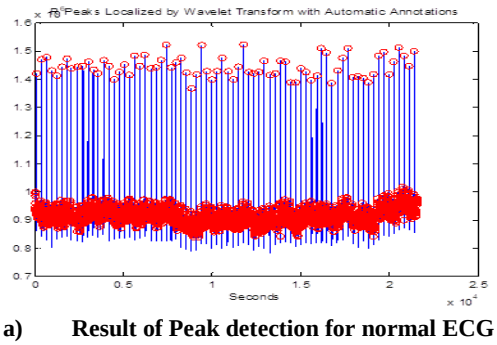


a) ECG or=f normal rhyhm



b) True ECG without HRV for AFB pattern

Fig.4.Input ECG patterns plots



a) Result of Peak detection for normal ECG

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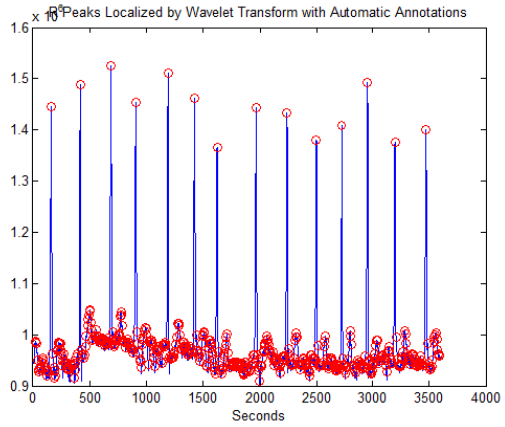

b) ECG Peak detection over the AFB pattern

Fig.5. Results of peak detection for ECG data

V. CONCLUSIONS AND FUTURE SCOPE

In this study, a brand-new method for classifying and detecting QRS peaks in ECG data is provided. In this paper the basis of the arrhythmia database, it is suggested to create and evaluate ECG signal classification algorithms for the categorization of cardiac disease. The proposed method for classifying and detecting QRS peaks is straightforward and appropriate for usage in real-time applications.

The results of .ECG of normal rhythm and the ECG with HRV for AFB pattern are evaluated and plotted for the QRS peak detection. In the future research and sequential efficient methodology will be designed for accurate disease detection from ECG data.

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