ECG Arrhythmia Classification using Fast Fourier Transform and Principal Component Analysis

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Abstract **- Most of cardiovascular disorders and diseases can be prevented, but death count happens of it rises due to inadequate treatment and misdiagnose. One such kind of disease is popularly known as Arrhythmia. An arrhythmia is a disorder of the heart rate (pulse) or heart rhythm, when it beats too fast it is called as tachycardia and when too slow it is called as bradycardia, therefore the timely detection of arrhythmia proves lifesaving for the cardiac patients. The detection is performed analyzing the electrocardiogram (ECG) signals and extracting some features from them. Arrhythmia comes under the cardiovascular disease. Sometimes it becomes difficult to analyze electrocardiogram (ECG) recording for Arrhythmia detection. So it became need of the hour to develop an error proof method to be applied in the computer to train the system for the detection of Arrhythmia. Here one can seek help of Artificial Neural Network. It starts to be widely used for Speech Recognition, Bioinformatics, Computer Vision, and many others. The Present research puts forth FFT and PCA to classify Arrhythmia. The researchers compared the result to other existing algorithms to show that FFT and PCA methods achieve better accuracy of classification of Arrhythmia.**

Index Terms **- ECGarrhythmia; DWT; Fast Fourier Transformation; Neural Network; Principal Component analysis.**

INTRODUCTION

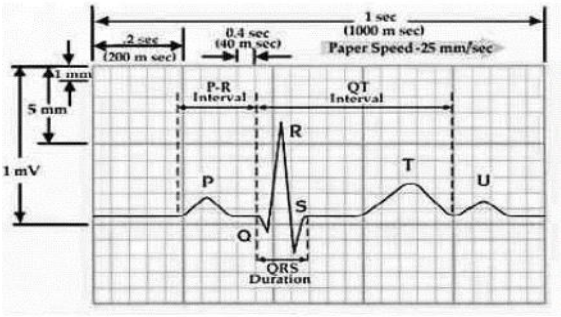

Fig.1.Typical ECG Signal

As indicated by World Health Organization, cardiovascular sickness is the main source of death and handicap. Roughly 17.5 million individuals kicked died from cardiovascular sickness. It is equivalent to 31% of the all-out number of passing in the world in 2012. [1] Despite the fact that most of cardiovascular ailments or disorders can be stopped, deaths keep on ascending because of ill-advised treatment as a result of misdiagnose. One of cardiovascular sickness is arrhythmia. Arrhythmia is an anomaly in the beat of the heartbeat. [2] It causes the inefficiency of heart to pump blood throughout the body. Faster or slower heart palpitations are the usual symptoms for arrhythmia. Other symptoms can be traced as weakness, dizziness, fainting, and usually pain in the chest. But sometimes many patients with arrhythmias do not feel any symptoms. The kinds of arrhythmias incorporate tachycardia (fast), comprising of supraventricular tachycardia, atrial tachycardia (fibrillation and ripple), ventricular tachycardia, and ventricular fibrillation. Also, bradycardia (slow) comprises of AV heart blocks, bundle branch blocks, and tachybrady syndrome. There are specific kinds of arrhythmia where comparative symptoms are found however each requires various medicines. So it becomes compromising when a specialist can't analyse the specific sort of arrhythmia a patient experiences.

ECG is required to diagnose and recognize typical types of arrhythmia because it is a standard tool. Though physical symptoms are helpful to detect arrhythmia ECG is an authentic tool. The electrical activity of the heartbeat can be checked by ECG. The record is appeared as a test paper with waveform signal that represents the rhythm of heart's electrical movement. The most exact apparatus to record heartbeat rhythm is 12-leads ECG. The leads are the

channels of recording, which are lead I, lead II, lead III, aVR, aVL, aVF, V1, V2, V3, V4, V5, and V6. Each channel delivers the record from various angles. The specialist needs to discover the record from the lead which creates the principle signal by perusing different signs with specific method. Typically, every patient has different angles or lead where the fundamental signal is recorded because a fact is that the request for the signals isn't the equivalent. It resembles perceiving the waveform from numerous points. The 12-drives ECG result is appeared in figure1.

Sometimes, it is hard to watch electrocardiogram recording to analyse the arrhythmia. In this way, it needs a decent grouping strategy to be applied in the PC as an approach to help the location of arrhythmias. [4] The levels are shaped by non-linear changes from each level of representation, going from raw input to a more elevated level of representation. [3] According to worldwide status report of 2010 of World Health Organization (WHO) on non-transferable infections, cardiovascular maladies (CVDs) are the main source of human death all inclusive and it represents 30% of every single worldwide death because of diseases [1]. In a situation where, an unexpected happens of a heart attack there may arise symptoms like chest pain, dizziness, shortness of breath and palpitation. Proper treatment can be provided immediately to those patients' unusual symptoms if these unusual symptoms can be detected timely and with much ease. So, it becomes crucial to develop simple, efficient and effective method which detects and categorizes various heart disorders. There are numerous sorts of heart arrhythmias which can be distinguished by investigation of the ECG signals. ECG signals have very much characterized P, T waves and QRS complexes. The amplitude and time span of these waves in ECG signals are as often utilized by the doctors or specialists for the manual investigation [2]. Manual examination will be tedious because of large data and there is a chance that expert may miss significant data [2]. Hence, it is critical to create PC based framework that classifies ECG signals and make upgrades in the strategies of ECG examination. In ECG investigation, the focus is to upgrade level of accuracy and incorporate a more number of heart diseases that can be arranged. Numbers of calculations have been proposed to sort ECG heartbeat dependent on the quantity of features fetched from the ECG signals [3].

The objective of the feature extraction stage is to locate the littlest set of features that empowers adequate grouping rates to be accomplished. The investigator can't assess the presentation of set features without training and testing the classifier [3]. In this way, a feature determination is an cyclic and significant procedure that includes training different feature sets until ideal order execution is accomplished [3]. In late year's utilization of Wavelet Transform as a handling and investigating instrument has expanded on the grounds that Fourier Transform examination just gives the spectral data and not temporal data of a signals while Wavelet examination gives a time versus frequency representation of the signal and is proper for non-fixed signals like ECG [2].

II.EXISTING APPRAOCH

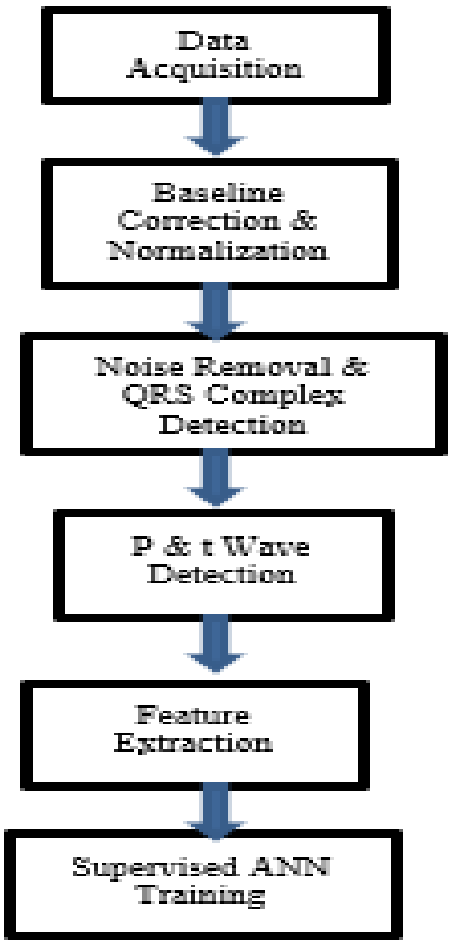

Fig.2.Block Diagram of Existing System

The Levenberg–Marquardt (LM) back propagation algorithm was utilized to train the multilayer feed-forward back propagation network. The association loads are arbitrarily appointed toward the start and logically adjusted to lessen the general framework. Training parameters were picked gently. Most extreme number of ages set is 5000, mean square blunder among target and genuine yield was set 10-4 and learning rate was fixed 0.2. The weight refreshing begins with the output layer and advances in reverse, hence error propagate in reverse from the output hubs to the inward hubs. The mix of weights which limits the error work is viewed as an answer of the learning issue. A few training cycles are given to the system to adjust the weights enough to produce right outputs. Training errors keeps on minimizes as the quantity of epoch's increments.

III. LITURATURE SURVEY

The current ECG Arrhythmia detection systems have been researched out and studied widely. The existed research has been referred here for the proposed idea of the researchers. The research papers referred to determine various aspects of our proposed system are as follows:

Parham et. al. [1] performs this study with the aim of developing an algorithm to detect and classify six types of electrocardiogram (ECG) signal beats using a neural network classifier.

MaedehKianiSarkaleh and AsadollahShahbahrami [2]" performs this study with the aim of classification of ECG arrhythmias using discrete wavelet transform and neural network Multi-Layer Perceptron (MLP) and detected two types of arrhythmias.

Naveen Kumar Dewangan and S.P.Shukla [3]" developed a computer-based system that will be able to categorize the ECG signals. In this paper artificial neural network (ANN) based classifier is developed, where discrete wavelet transform (DWT) is used for pre-processing and feature extraction purposes and neural network designed is used to classify five types of arrhythmias.

B. Castro et. al. [4] performs this study with the aim of ECG feature extraction using optimal mother wavelet

IV. PROPOSED SYSTEM

The general procedure for the arrhythmia grouping is appeared in Fig. 1 as a flowchart and incorporates steps like ECG Information Collection, Standardization and Base Line Correction, Extra noise reduction and QRS complex Location, Locating of P and T Wave, Feature Collection. At last training of NN with chosen feature set and testing of the neural system. The presentation of the classifier is assessed utilizing distinctive factual parameters. A Feed Forward Back Propagation Neural Network Classifier is used to train the system.

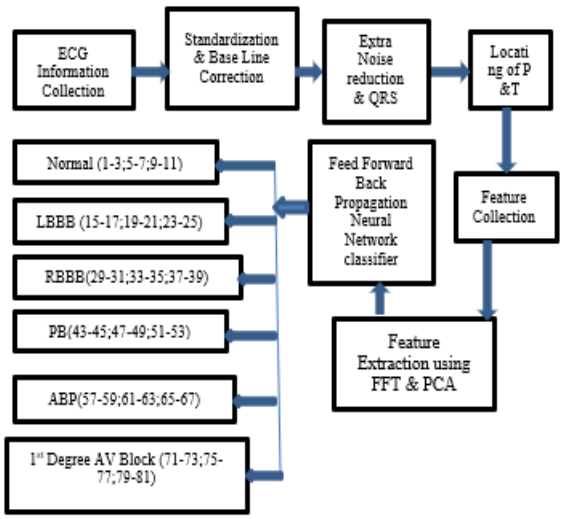

Fig. 3.Flow of the Proposed System

A. ECG Information Collection

The basic information representing various states of heart for training and testing of proposed classifier was acquired from MIT–BIH arrhythmia database. The dataset creation utilized in this work is summed up in Table I. Recordings got in Changed Limb II (MLII) lead arrangements are utilized for examination reason in this work. There are 116137 quantities of QRS complexes in the database. ECG signals got from various patients were band pass sifted at 0.1-100 Hz with 11 piece goals over a 10mV in extend and digitized at examining recurrence of 360 Hz [19].

B. Standardization and Base Line Correction

The ECG signals in this work were standardized utilizing the Eqn. 1. The ECG signal is then remedied for standard utilizing condition Eqn. 2 since it was seen that signs are well over the reference zero Base Line.

ECGsignal = ECGsignal/|(ECGsignal)max| (1)

ECGsignal = ECGsignal - mean(ECGsignal) (2)

C. Extra noise reduction and QRS complex Location

Three, five and eight level de-noising is performed using DWT on ECG signals acquired after example correction and normalization. Rackets, for instance, Electromyogram (EMG), power-line impedance (PLI) and benchmark wandering (BLW) are expelled by removing de-noised signal at level eight from de-noised signal at level three. De-noised signal at level five is deducted from the denoised signal at level three to gain QRS edifice. The squaring activity is performed on coming about sign to improve the for the most part high recurrence QRS complex. The yield shows a couple of tops inside the length of a single QRS complex that is the explanation smoothing of the yield of the principal movement is done using a moving-window consolidation channel. A window width of N=30 was taken for inspecting repeat of 360 Hz. Hard thresholding was then applied over the high repeat QRS to expel the detached loud apexes. Proposed limit regard is given as: Edge = greatest (x3) × mean(x3) (3) Where x3 is yield obtained in the wake of moving window coordination. A journey for the most extraordinary above edge on de-noised signal gives the veritable area of the R top. By then minima are looked on either side of perceived R top to restrict Q and S centres.

D. Locating of P and T Wave

The P and T wave are distinguished utilizing windowing method. The search window begins at 200 ms previously and closes 70 ms before the area of R top. At that point to discover beginning and off arrangement of P wave, a retrogressive and forward search is made to discover the minima from the purpose of limit of P wave with reasonable search window. T wave is identified similarly. As P wave just distinction is that currently search window begins after the area of R top.

E. Feature Collection

After discovery of different waves and complexes in ECG signals, four morphological highlights for example RR intervals of continuous two ECG beats, QRS term, R top and PR intervals of every ECG beats were determined. Difference of details coefficients (d1 to d8) of every ECG beats was likewise acquired by eight level decomposition of signals got after base line correction activity utilizing DWT.A list of feature set of twelve highlights were made by taking these four morphological highlights alongside eight wavelet highlights from each individual heartbeat of ECG signal which categorized the specific kind of arrhythmia.

In the proposed strategy while applying the Fast Fourier Transformation - FFT, every ECG signal is Fourier Transformed but before registering the Fourier change, Hamming window is utilized with Fourier Change as it has better side flap concealment attributes [10]. The length of the window is taken as the quantity of tests inside the chosen 3 second intervals. The choice of the FFT coefficients that utilized in the characterization is a basic subject. In this way, the best number of FFT coefficients will be controlled by experimentation. We found that we get best outcomes with 80 coefficients of FFT.

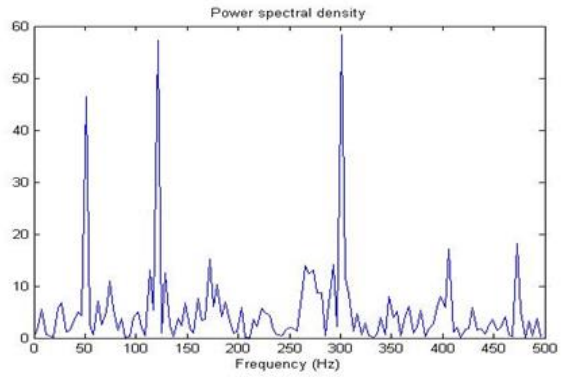

Fig.4. Frequency of Signal

Computerized signal processors use FFT for wide uses. Maybe one of the most intriguing applications is to take the noise full waveform got from a 3-lead electrocardiogram of the heart and afterward applying a FFT calculation to yield the PQRST wave of the heart's rhythm.

In its least difficult structure, the FFT is simply a Fourier Transform transformation done from the time area to the frequency area. Be that as it may, it is a calculation done at a lot higher speed than what a Continuous-Time Fourier Transform would require in processing time. This makes the FFT thought for microprocessor-based instruments used to separate periodic waveforms, for example, heart rhythms from a noisy source. The noise source on account of the ECG instrument is inalienable broadband noise that

exists on the ECG leads as got on the patient's body and the encompassing electromagnetic vitality field in the instrument.

If one has to build a basic 3-lead ECG finder utilizing 3 wire leads with adhesive and conductive terminals and an oscilloscope, one would just observe a tremendous mess of random noise on the scope's display[14]. Yet, the heart beat is there, It simply an issue of removing the occasional waveforms that include the genuine PQRST wave shape and disposing of the noise. It isn't sufficiently basic to sift through the noise with strong state channels. The heart signal is a complex waveform of numerous Fourier recurrence parts in the equivalent spectra band as the noise. Separating the noise implies the needed signals is likewise sifted. Enter the Fast Fourier Transform. At long last, underneath is what is looked for.

Principal Component Analysis (PCA) is utilized to compute the essential parts of the ECG signals as PCA is a proficient procedure for dimensionality decrease in multivariate factual investigation. The objective of PCA is to locate a set of orthogonal components that limit the mistake in the reproduced information. An equivalent detailing of PCA is to locate a equivalent set of vectors that boost the difference of the projected data. As it were, PCA looks for a change of the information into another edge of reference with minimum mistake as could be expected under the circumstances, utilizing fewer factors than the original information. For instance, individuals regularly use PCA to decrease the dimensionality of information that is, changing m sensor readings into a set of n significant factors in those readings. In this way, however before utilizing it the ECG signals will be pre-handled to acquire the magnitude of their Fourier transformation, to diminish the quantity of parts coming about because of various movements of a similar sign. Hamming window will be utilized with Fourier Transform due to their better side projection concealment qualities [10]. At that point the element vector from all signs in the preparation database will be gathered and used to characterize the element space of the issue, at that point making the PCA on the element space to get its essential segments to diminish its measurement. The central segments are determined as the eigenvectors of the covariance grid of the information [11]. The determination of the quantity of PCA coefficients that utilized in the grouping is a basic subject. So we will utilize various quantities of principal parts as contributions to the classifier and get the accuracy of every one of them. We found that we get best outcomes with 15 PCA coefficients.

F. Input and Target Pattern Formation

We utilized a feed forward back propagation multi-layered neural network. The quantity of input neurons is fixed by the quantity of components in the input feature vector. The input vector is developed by taking the modulus of complex numbers. The yield layer will be 6 neurons for all techniques which decide the quantity of classes wanted (LBBB, RBBB, PB, APB, AVB and N). The quantity of neurons in the hidden layer is be changed by the technique that will be utilized for grouping and will be determined by an experimentation strategy.

G. Testing

For testing the outcomes 126 beats of various classes of ECG beats are utilized. Table I shows the sample information of ECG signal, which is utilized to test networks output to perceive beat class. Every network made and trained is checked with 21 beats of same class and 21 beat every one of different class and testing confusion matrix is made. In the case of during the test, result is inside any range (t1, t2, t3) as appeared in diagram in Fig.1 then this shows the concerned beat is of that class (either N or L or R or APB or PB or AVB) and whenever recreated output isn't coordinated with target it shows unclassified beat.

Simulation in MATLAB would be done to show that the grouping accuracy is more if both morphological features and wavelet coefficients are together utilized for training the neural system than just morphological element or wavelet coefficients. The proposed neural system (NN) based worldwide classifier will give upgraded execution sensitivity, specificity, positive predictive value, negative predictive value and classification accuracy. It will be demonstrated that presentation of classifier can expanded if the quantity of neurons in the hidden layer is essentially expanded.

V.CONCLUSION AND FUTURE SCOPE

NN classifier plays a significant job in managing grouping issues when settling on choices in clinical

applications. The capacity to figure out how to decide results from the training data is a major part of classification. NN model was utilized to identify ECG types with FFT and PCA features as sources of info.

The NN classifier model introduced in this examination is trained utilizing algorithm. The consequences of alongside PCA were seen as better than past strategy that utilizes DWT for calculation of features. Future research and advancement may keep on being centred on further enhancements of the reliability and responsiveness. The quantity of hidden layer neurons and set of features which gives ideal execution was discovered tentatively utilizing hit and trial strategy and that could be additionally investigated in future.

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