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DISEASE DETECTION BY FEATURE EXTRACTION OF ECG SIGNAL BASED ON ANFIS

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Abstract— Electrocardiogram signals are used to determine the operation of heart. Due to their variability, it is quite difficult to examine them directly. Considering this fact, several techniques have been developed by researchers to understand the signals by extracting features from them. The defined wavelet techniques can extract the features but the accuracy in detecting disease has decreased. In order to enhance the classification process of extracted features, ANFIS structure has been introduced in this paper. The proposed ANFIS structure has the capability of training and then evaluating the ECG signals to determine the person with their health status. The proposed algorithm evaluates two different types of diseases i.e. bradycardia and tachycardia. For the experimental analysis total 27 signals have been considered which have been taken from physiobank databases website. From the simulation analysis, it has been concluded that the proposed technique outperforms in comparison with traditional wavelet technique. The performance parameters which have been used to ensure the performance of the individual techniques are Accuracy, Mean Square Error and Root Mean Square Error. Consequently, the proposed technique stands out with 85% accuracy in comparison with traditional technique which relies at 70% only.

Keywords— ECG signals, Wavelet, ANFIS, MSE, RMSE

I. INTRODUCTION

Electrocardiogram is abbreviated as ECG. Electrocardiogram is a biomedical instrument that determines the different operations of heart. Large amount of data can be obtained from Electrocardiogram related to usual and pathological physiology of heart. Although, the Electrocardiograph signals are varying in nature and this is not an easy task to directly examine these. Hence, it is required to implement computer based techniques to analyze the electrocardiogram signal [1]. To analyze the electrocardiogram signal, large amount of time is required and it is very tiresome task as the electrocardiogram signals are varying. The variations in the signals do not occur after fixed period of time and exhibit various time intervals. The visual basis examinations are not completely reliable. Due to this the computer based methods has been invented to analyze the electrocardiogram signal. Whenever heart beat occur, then the heart start depolarization in order to initiate the contraction of heart [2]. The contraction and relaxation of heart produce the electrical signal that has been forwarded to the whole body and can be measured at skin. This is the principle behind the working of Electrocardiogram device. The Electrocardiogram machine records the rhythmic activity of heart with the help of electrodes. The electrodes are attached with the skin and show the recorded data on graph. To monitor the heart activity through ECG, ten types of electrical cables are attached with the human body. Six cables are connected with chest and four others on each limb [3]. The signal recorded by ECG depicts the electrical signal generated in heart due to four types of rhythmic activities: first one is atria depolarization, second one is ventricular depolarization, third one is atria re-polarization, fourth is ventricular re-polarization. In ECG signal, it was observed that there is repetition of complex pattern of waveform and that have frequency of near about 1Hz.

The one cycle of ECG waveform contain PQRST waves. Most of the data that can be used at clinics to analyze the performance of heart is generated in the different time intervals and different amplitudes. In western countries the main cause behind the high death rates is heart diseases. Every year approximately sixteen million people die because of cardiovascular diseases. To reduce the mortality rate due to cardiovascular diseases it is necessary to change our lifestyle like minimum consumption of cholesterol and doing daily basis exercise. Hence, to stop the death due to cardiovascular diseases, it is necessary to detect it at earlier phase. For earlier detection of any cardiovascular disease, it is necessary to visit doctor on regular basis for ECG; this would leads to large amount of patient's information that should be clearly analyzed. In Ordinary techniques to control and analyze variations in ECG signal [4] [5], it is required to visually detect the particular feature is present or not in the ECG waveform. QRS part in the ECG waveform is most important characteristics due to its shape; therefore it has been considered as reference while extracting the different characteristics of ECG waveform. The P-QRS-T wave formed in electrocardiogram signal helps the doctors to examine the large amount of patient's information about cardiovascular activity. Different methods have been developed to obtain the characteristics of the electrocardiogram signal and examine these characteristics [7]. These methods operate by changing the large amount of qualitative analytic technique into highly focused quantitative signal characteristics categorization issue.

II. PROBLEM FORMULATION

ECG is a process which is done for the purpose of monitoring the functionality of electrical motions of heart over the variations of time. It helps in detecting the coronary heart disease, speed rate of the heartbeat, heart failure, cardiomyopathy and congenital heart defects. Several algorithms have been proposed till now in order to detect heart diseases. But in the traditional techniques no artificial intelligent system has used in order to detect disease due to which these techniques are not able to generate highly efficient results. Secondly, existing techniques have used wavelet transformation which includes manual evaluation for detection of heart diseases. Furthermore threshold values have been changing and decision making was difficult on the basis of threshold value because of variations. Due to all these facts, a new technique has been proposed.

III. PROPOSED WORK

Owing to various issues in the traditional techniques an automatic system has been designed which is able to detect disease on the basis of extracted features. Thus the basic requirement of the proposed system is extracted features of ECG signal. Extracted features are given to the system and then it generates the result which shows us if the person has been suffering from a disease or not. For this purpose firstly, the features are extracted from the signals using wavelet transform. After feature extraction artificial neural network and fuzzy logic has been designed for classification. Consequently, results are obtained from the system which shows us if the person is suffering from a heart disease or not.

IV. METHODOLOGY

The block diagram of the proposed work is mentioned as Figure 1 that explained the steps which are followed to acquire optimum results.

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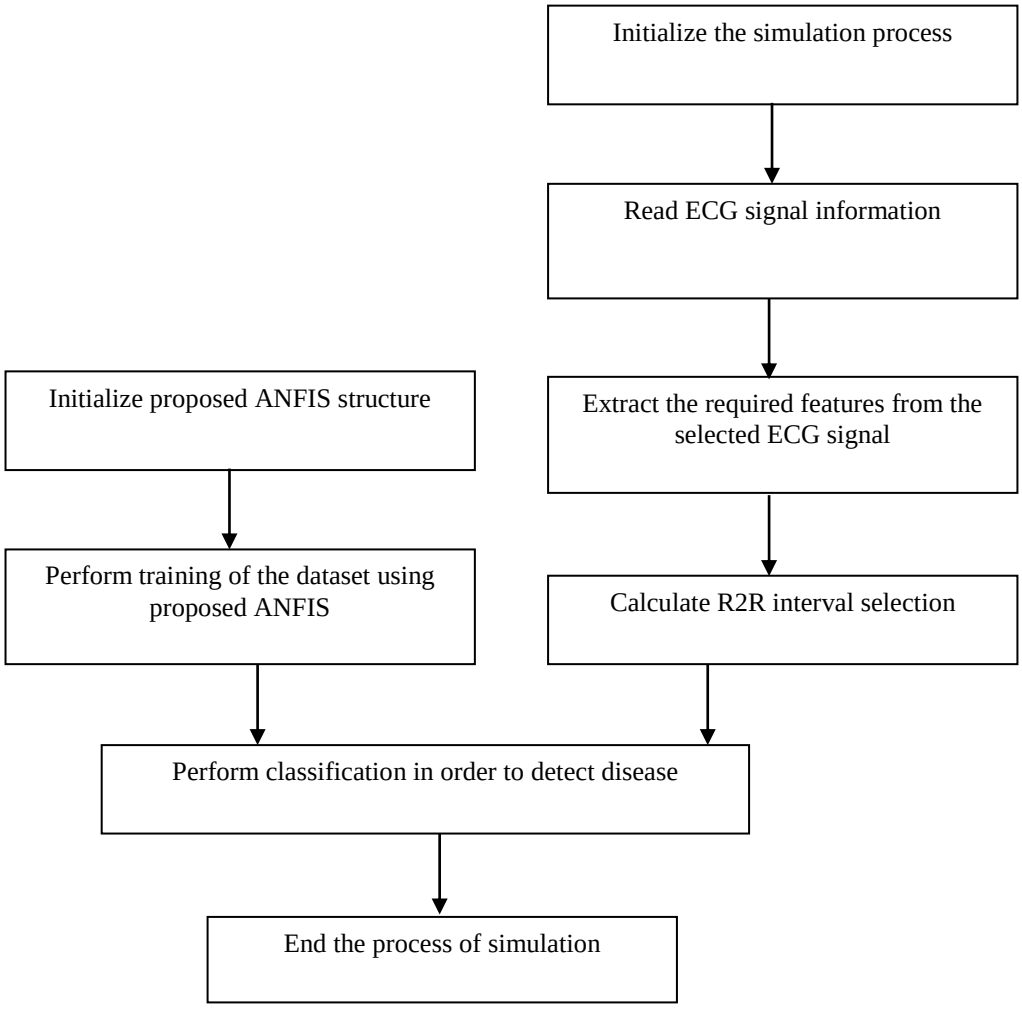

Fig 1 Block Diagram of the proposed technique

The Methodology of proposed work has been explained in the following steps:

1. Initially, start the process of simulation where the signal will be selected from the medical database.
2. Apply wavelet based technique over the selected ECG signal in order to extract the required features from it.
3. Now evaluate the R2R interval selection in order to detect the gap between individual heart rate.
4. Likewise initialize the ANFIS structure which is the combination of neural network and fuzzy logics.
5. The proposed system calculates the person's health status using the training process in ANFIS.
6. After performing the training of ANFIS, classification has been done in which it detects the disease from the selected Patient's ECG signal.
7. Lastly, end the process of simulation and calculate performance parameter which ensures the actual quality of the proposed technique in terms of traditional method.

V. RESULTS AND DISCUSSION

In this section of the paper results are obtained after applying proposed technique on the data samples. Results show the accuracy or the performance of the dataset obtained through the patient. This section gives description of the proposed algorithm that is represented with the help of GUI. In

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the proposed work new method is proposed for detection of disease in the medical database so that heath of the patient can be diagnosed at earlier stage and prevention has been performed. Artificial neural network with fuzzy logics has combined together and termed as an ANFIS structure to check the accuracy and performance of the proposed technique.

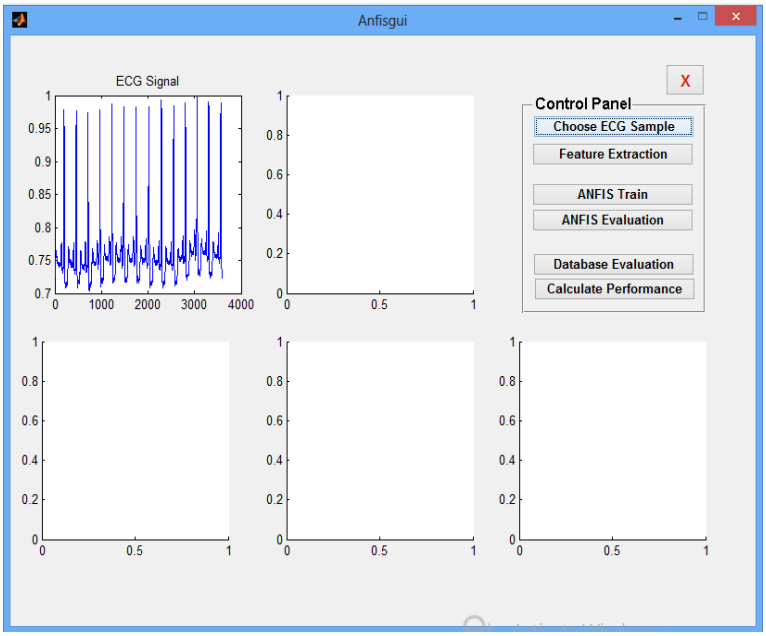

Fig 2. GUI interface of the proposed model

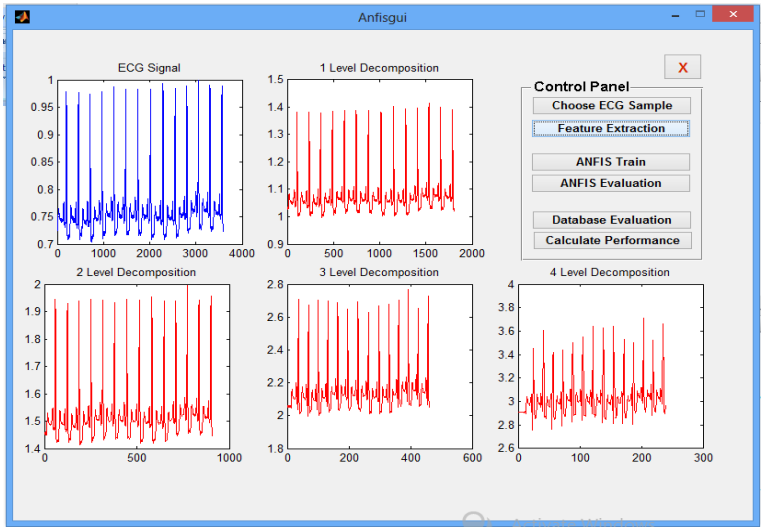

Fig 3 Extraction of feature

The figure 2 depicts the GUI interface of the proposed method where it shows the ECG signal which has been selected by the user from the database of different persons. The selected signal varies from 0 to 1 at different intervals.

The figure 3 illustrates the feature extraction method. In order to extract the features from the selected ECG signal, click on the respective button on the control panel. This feature will decompose the ECG signal into different levels. For the proposed method, 4-level decomposition has been considered to extract the features from the signal and to know the health condition of the person.

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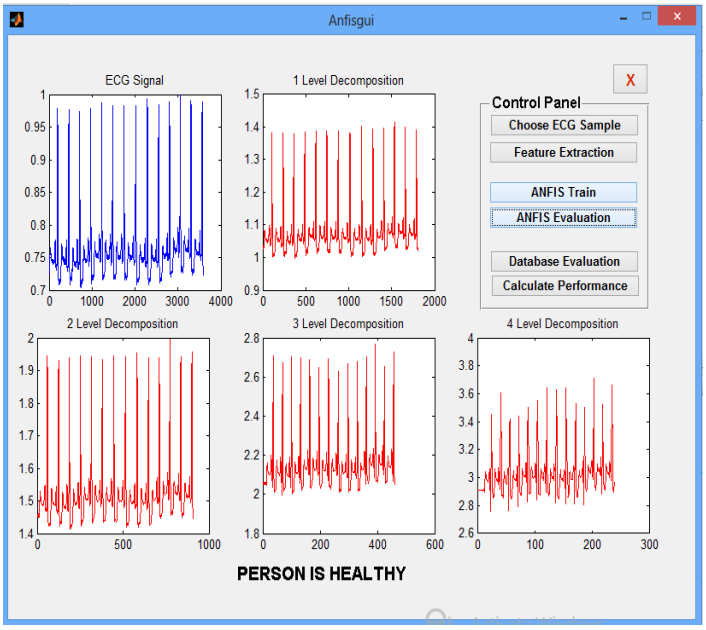

Fig 4 Evaluation of ANFIS structure

After extracting the features from the signal, next training of these signals will be done using ANFIS which is Adaptive neuro fuzzy inference system. Once the training has been done, evaluation through ANFIS will be performed.

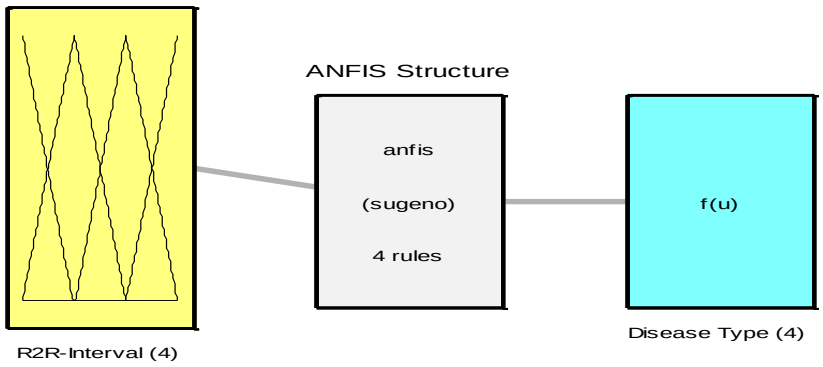

Fig 5 ANFIS structure of the proposed model

When the ANFIS Evaluation button is selected from the control panel from the figure 3, output will be shown where the ANFIS structure is designed in which R2R interval has been taken as the input parameter (see figure 5). This input parameter is sent to the ANFIS structure based on which 4 rules have been created and then on these bases an output is produced. For the proposed work, one input parameter is taken and correspondingly one output is acquired. And this output will be the health of the person either healthy or unhealthy.

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The performance parameters are calculated in this work to compare the performance of the individual technique i.e. traditional and proposed method. The graphs of these parameters are obtained by clicking on the "calculate performance " button on the graphical user interface of the proposed model. The parameters which have been considered for the evaluation are Accuracy, MSE and RMSE. The results acquired after evaluating the proposed (ANFIS) and traditional (DWT) have been shown below.

From the figure 6 it is clearly shown that proposed ANFIS outperforms the traditional DWT method. The accuracy acquired from the proposed is better and efficient in comparison with DWT.

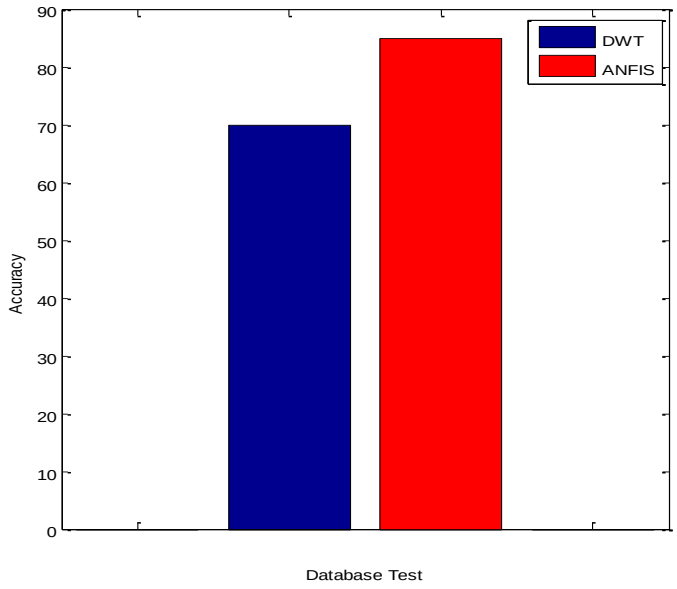

Fig 6 Comparison between traditional and proposed method

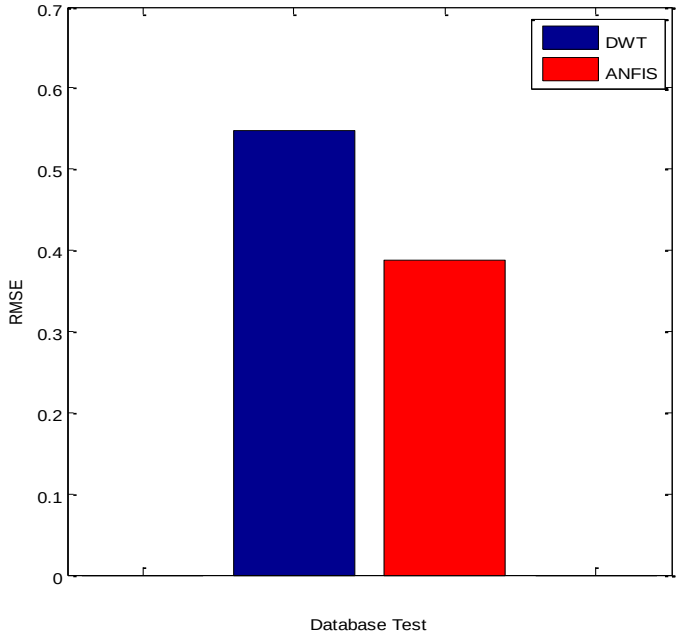

Fig 7 Comparison between traditional and proposed method in terms of RMSE

The technique which will have the least RMSE value will be the best technique for detection of disease from ECG signal. From the figure 7 it is clearly shown that traditional technique acquired

0.55 whereas the proposed technique attained 0.39 which is quite lesser than the traditional method. Consequently, it has been declared that proposed technique outperforms the traditional method in terms of RMSE.

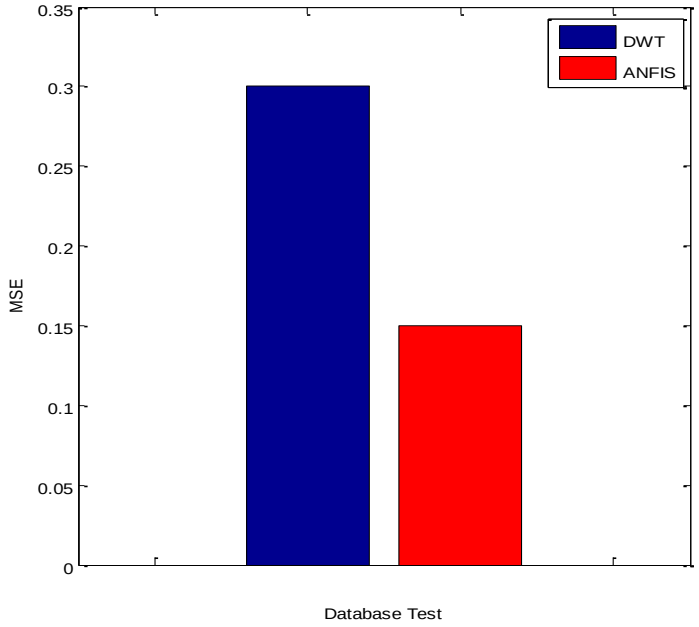

Fig 8 Comparison between traditional and proposed method in terms of MSE parameter

The comparison between traditional and proposed technique has done based on the MSE parameter. From the figure 8 it has been clearly shown that proposed technique outperformed the traditional technique as the proposed acquired less MSE in comparison with traditional technique.

VI. CONCLUSION AND FUTURE SCOPE

In order to determine the health of the person, a new method has been proposed in this work. The proposed method is based on the artificial neural network which is combined with the fuzzy logics such as ANFIS structure. The foremost steps which are followed by the proposed method is feature extraction and decompose into four different level of decomposition such as level 1, level2, level 3 and level 4. After extracting the required features from the signal, the proposed method has been applied over it and then its performance has been evaluated. The proposed technique is compared with the traditional wavelet based disease detection technique in terms of different performance parameters such as Accuracy, MSE and RMSE. From the results acquired it has been concluded that proposed technique performs far better than the traditional technique. The overall accuracy of the proposed technique is 85% whereas in the traditional technique it is just 70%. Moreover, the Mean Square Error of the proposed method is reduced at 0.15. Alternatively, the traditional method has higher MSE which is not efficient for the system i.e. 0.3. In addition to this, another parameter which is used for the valuation is RMSE. The RMSE of the proposed technique rely on 0.39 whereas in the traditional it produced RMSE at 0.55. Consequently, from the results it has been declared that proposed technique performs proficiently and effectively in comparison with the traditional technique. In the proposed method user does not need to interpret for the evaluation of the health of the person but if we consider the traditional method then, human interpretation is required in estimating the person's health by estimating the heart beat values.

From the results acquired after applying the proposed technique ensures its effectiveness but in future more enhancements can be performed such as proposed neuro-fuzzy system can be enhanced

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with advanced optimization techniques which can provide more accuracy in detecting the current health status of the person.

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