

Automated ECG medical diagnosis using Artificial Bee Colony and Levenberg - Marquardt Algorithm

Gauri Chopra¹, Manoj Soni²

P.G. Student, Department of Mechanical and Automation Engineering, IGDTUW, New Delhi, India¹

Associate Professor, Department of Mechanical and Automation Engineering, IGDTUW, New Delhi, India²

ABSTRACT: Electrocardiogram (ECG), is a non-invasive technique used as a primary diagnostic tool for cardiovascular diseases. A cleaned ECG signal provides necessary information about the electrophysiology of the heart diseases and ischemic changes that may occur. Earlier methods have been developed by authors to predict heart disease on the basis of ECG but as each method has its own advantage as well disadvantage. Hence, in this research, the best training method i.e. neural network has been utilized for classification on the basis of validation checks or epochs with an optimization technique. The purpose of this research work is to classify the disease dataset using Artificial Bee colony (ABC) Algorithm and train by Neural Network on the basis of the features extracted and also to test the image on the basis of the features at the database and the features extracted of the image to be tested. The advantage of proposed method is to minimize the large peak of R-wave, which helps to identify the R-peaks more accurately. Database from physionet.org has been used for performance analysis. Several experiments have been performed on the test dataset and it is observed that Levenberg-Marquardt Algorithm classifies ECG beats better as compared to back propagation neural network (BPNN). FAR, FRR and accuracy parameters are used for detecting the ECG disease. By using these techniques, 95.89% accuracy is achieved.

KEYWORDS: ABC algorithm, ECG signals, Levenberg-Marquardt Algorithm, MATLAB.

I. INTRODUCTION

Electrocardiogram (ECG) represents the electrical activity of heart, showing the regular contraction and relaxation of heart muscle [1]. The analysis of ECG waveform is used for diagnosing various heart abnormalities. ECG waveform consist of five basic waves P, Q, R, S, and T waves and sometimes U waves as shown in Fig. 1. The P wave represents atrial depolarization, Q, R and S wave is commonly known as QRS complex which represents the ventricular depolarization and T wave represents the repolarisation of ventricle.

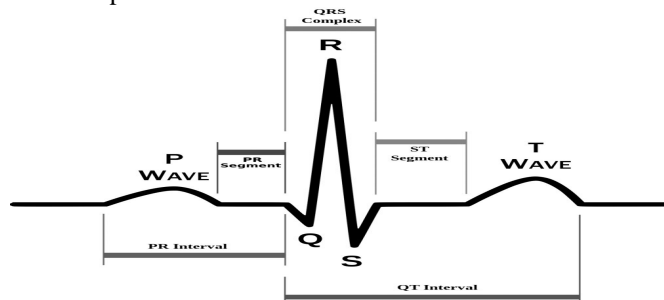


Fig. 1: ECG Waveform

Signal processing has contributed to a new understanding of the ECG and its dynamic properties as produced by change in rhythm and beat morphology [4]. All types of ECG analysis, whether it takes latent ECG analysis, stress

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

testing, ambulatory monitor or concentrated care monitoring which are the essential set of algorithms, state the signal with respect to dissimilar types of noise and artefacts [6]. Although these algorithms are regularly implemented to operate in sequential order as produced by the QRS detector and are sometimes incorporated into the other algorithms to improve performance [7].

The complication of every algorithm varies from purpose to purpose as noise filtering in ambulatory monitoring is much more complex than that of resting ECG analysis [9]. Once the sequence is shaped by the basic set of algorithms, a wide range of ECG applications exists where it required using signal processing that quantifies heart beat and beat morphology properties. The algorithm consists of four stages: a pre-processing stage, data representation stage, identification stage and decision making stage as shown in Fig. 2.

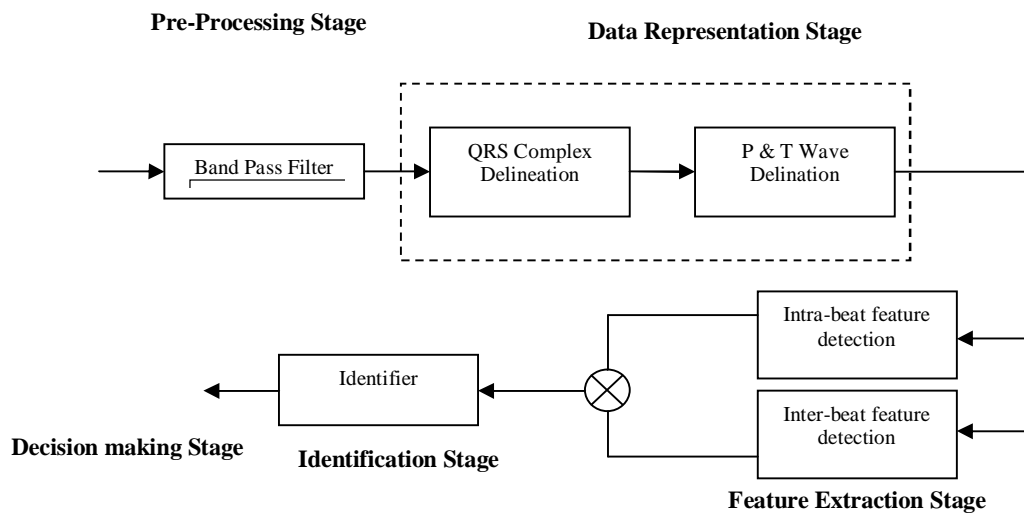


Fig. 2: Basic algorithm for ECG signal

Millions of ECGs are taken for the diagnosis of various classes of patients, where ECG can provide a lot of information regarding the abnormality in the concerned patient; ECGs are analyzed by the physicians and interpreted depending upon their experience [10]. The interpretation may vary by physician to physician [11-12]. Hence, this work is all about the automation and consistency in the analysis of the ECG signals so that they must be diagnosed and interpreted accurately irrespective of the physicians. This would help to start an early treatment for the problems and many lives could be saved. This research has tried to solve the problem of finding the exact feature of ECG signal and optimization of feature set. Therefore, ECG signal presents modelling along with classification of six diseases called Tachycardia, Bradycardia, Atrial, Sinus, Artificial Pace maker and Minor pace attack using ABC and NN.

II. RELATED WORK

Afsar et al. (2007) has explained a method for the automatic detection of ST Segment deviation for the diagnosis of Coronary Heart Disease using ambulatory ECG recording through the request of lead dependent Karhunen Loaves Transform bases for dimensionality reduction of ST Segment Data. Zhang et al. (2008) has described multi resolution sub group that is used for the analysis of transient's nature of biomedical signals. The use of a wavelet transform domain filtering produced an adaptive demonizing tool implemented in ECG signal analysis. Jiayin Kang et al. (2010) presented a method to quantifying the particular dentist plaque within digital enamel images employing mean shift. This planned method has been applied to the specialized medical databases comprising 30 objects. Ashanti Chattopadhyay et al. (2012) has described ECG peak detection which are essential for unlike disease purpose or heart malfunctioning is defined. Here simulation approach is attempted. System prototype design is attempted. In simulation approach ECG data analysis & peak detection is done. Jayant et al. (2011) described baseline wandering noise that can cover some central features of the ECG signal; hence it is popular to remove this noise for proper analysis of the ECG

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

signal. This research presents different approaches like baseline noise elimination in the electrocardiogram signals which include methods based on use of project pursuit gradient. Dhage et al. (2014) has established an automatic method for the extraction of Fetal Electro cardiogram from abdominal electrocardiogram demo. FECG is a fragile signal from the kind ECG circuitously measured by surface electrode placed on mother's abdomen. The Fetal signals are covered in other interference signal. Extracting FECG from the well-built background nosiness has a central value in clinical application. Since, lots of explore work has been perform in this field, some of these are Threshold and Filtering method, NN method, Wavelet Transform and other. The proposed advance involves Independent Analysis technique for FECG extraction.

Table I
Comparative Review of Existing Techniques

AUTHOR	FINDINGS	LIMITATIONS
Addanus Djohan	New ECG signal compression algorithm uses a discrete symmetric wavelet transform. This proposed compression scheme may find applications in digital Holter recalling, in ECG signal archiving and in ECG data transmission through channels	Not give a valid compression ratio.
Emna Rabhi	New algorithm for personal identification from their Electrocardiograms (ECG). The analysis of different groups separately showed that the best recognition performance is 96.45% for all morphological descriptors and the results of experiments showed that the proposed hybrid approach has led to an overall maximum of 98.97%.	Cannot used for the larger work
Hadeer El-Saadawy	The resulting wavelet coefficients are reduced using Principle Component Analysis (PCA) and then classified into five main categories using Support Vector Machine (SVM) classifiers, representing 15 classes. In addition, in order to improve the reliability of the proposed method, not only the overall accuracy but also the average accuracy of each class is considered. The average accuracy and overall accuracy of the MIT-BIH database were 96.35% and 99.5%, respectively.	Less efficient in work.
Mohammed AlMahamdya	Actual ECG signals at noise levels from 5dB SNR to 45dB SNR.	Filters do not on different ranges.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

Sarang L. Joshi	Equiripple notch filter is the best choice to remove power line interference while to remove motion artifact and EMG noise we should select discrete Meyer wavelet and apply the improved thresholding function which combines features of hard and soft thresholding	Not good for decomposition approach.
Seenaa	Family selection for ECG signals denoising applications. Since the application for wavelet transform in electro-cardiology is relatively a new field of research, many modern aspects of the wavelet	Not improved for clinical use and did not work on novel processing technique.
Shweta H. Jambukia	Neural networks are good candidates for ECG classification in terms of classification accuracy on training and test datasets.	Less efficient

III.SIMULATION MODEL

This work has dealt with the ECG signal modelling with the six diseases classification known as Tachycardia, Bradycardia, Sinus Atrial, Artificial Pace maker and Minor pace attack using ABC and NN. In the end, performance of the system is being measured using following parameters:

False Accept Rate (FAR): FAR is the type of error in the pattern recognition system which is measured by:

$$FAR = \frac{\text{Total Number of Features} - \text{Total Number of Falsely Accepted Features}}{\text{Total Number of Features}}$$

False rejection rate (FRR): The FRR of the system is rate of falsely rejected feature with respect to the total feature. Its formula is given as:

$$FRR = \frac{\text{Total Number of Features} - \text{Total Number of Falsely Rejected Features}}{\text{Total Number of Features}}$$

Accuracy: Accuracy is a general term used to describe how accurate a system performs. Its formula is given as:

$$Accuracy = 100 - (FAR + FRR)$$

The problem of this research work is to classify the Heart disease dataset using optimization algorithm i.e. ABC algorithm and train the Neural Network on the basis of the features extracted and as well to check the image on the basis of the features at the database and the features extracted of the signal to be tested.

The subsequent steps shown in fig. 3 demonstrate the variety of phases that need to be accomplished:

Step 1: Upload ECG signal dataset of six diseases namely: tachycardia, bradacardia, Atrial, Artificial Pace maker, Sinus and Minor pace attack.

Step 2: Extract feature from the uploaded ECG signal based on the threshold value according to the QRS peaks.

Step3: Develop a code for the ABC optimization algorithm to optimize the features according to the fitness function of ABC algorithm. So set the novel fitness function in the ABC optimization algorithm.

Step 4: Initialize artificial neural network for classification purpose using two phases, namely,

- Training phase

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

• Testing Phase

Step-5: Train uploaded ECG signals according to their feature using ANN.

Step-6: Load Test Sample and repeat Step 2 and 3 after that classify the Diseases according to categories which are generated during the training phase.

Step-7: Calculate performance metrics like FAR, FRR, Accuracy to check proposed system efficiency.

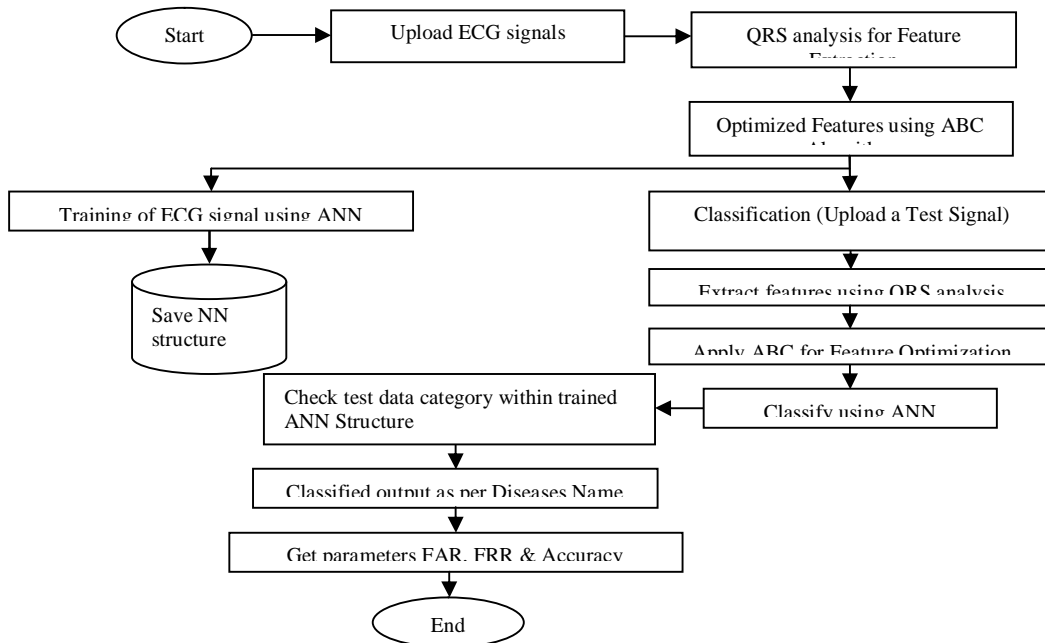


Fig. 3: Simulation Model

IV. SIMULATION RESULTS

Following results has been obtained after the evaluation of the simulation work:

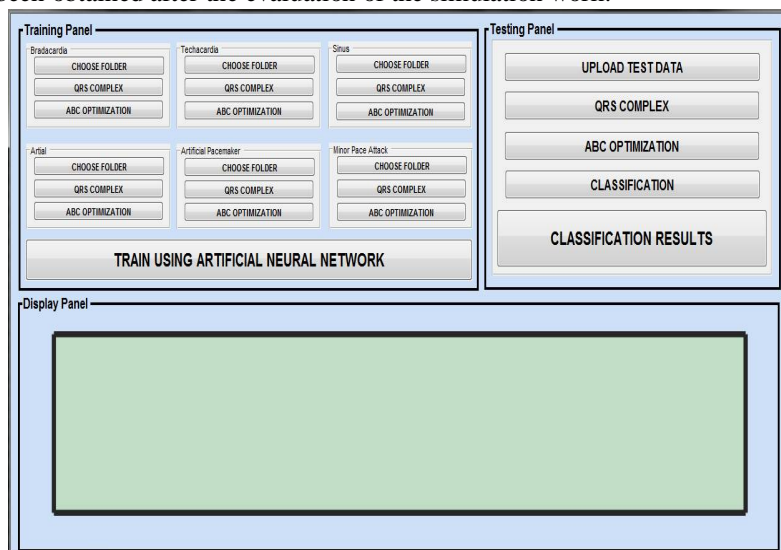


Fig. 4: Working panel

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

Above figure i.e fig. 4 shows the main window of the proposed ECG Disease Detection System. The system is mainly categorized into three steps: Feature Extraction & optimization, training and testing. In above figure there are six section (i) Bradacardia (ii) Techacardia (iii)Sinus (iv)Artial (v)Artial Pacemaker (Vi)Minor Pace attack. Every section has three sub-sections namely; choose folder, QRS Complex and ABC optimization. Choose folder is used to select the folder and upload the information of ECG signal. QRS complex is used for feature extraction. The extracted feature is improved by using optimization technique known as ABC optimization. The testing panel is shown in the right hand side of the working panel. It consists of different working buttons named as: upload test data, QRS complex, ABC optimization, Classification and classification results.

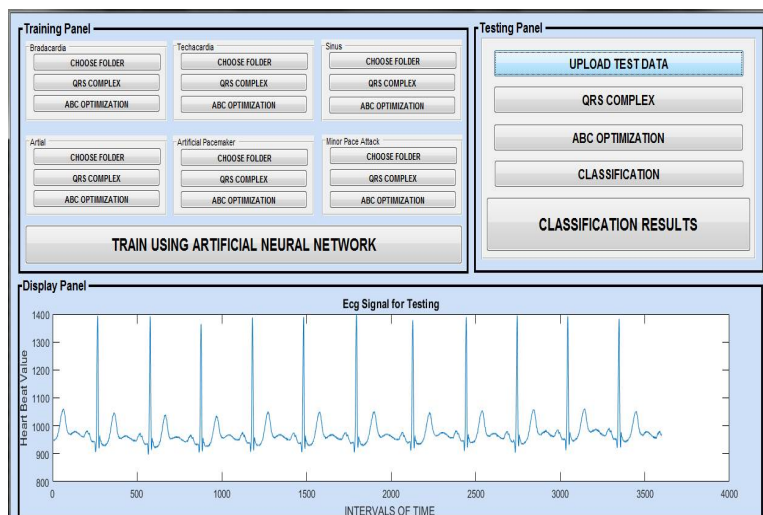


Fig. 5: Upload test data

In the testing panel, when we click on upload test data the ECG sample database taken from physionet.org is uploaded. The uploaded signal shown in the above figure i.e Fig 5 has time on x-axis and means peak value of ECG signal is on y axis.

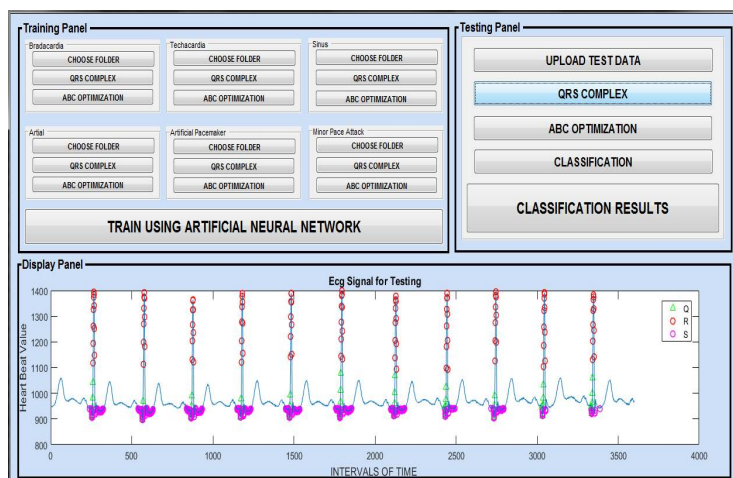


Fig. 6: QRS Peak of uploaded signal

After uploading the sample, next step is to extract features as depicted in Fig. 6. When we click on QRS complex, the above waveform is displayed on the screen. Here, the green circle represents the Q peak of ECG signal, red circle

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

represents the R peak of ECG signal and Magenta circle represent the S peak of the ECG signal. These signals are being found on the basis of threshold technique.

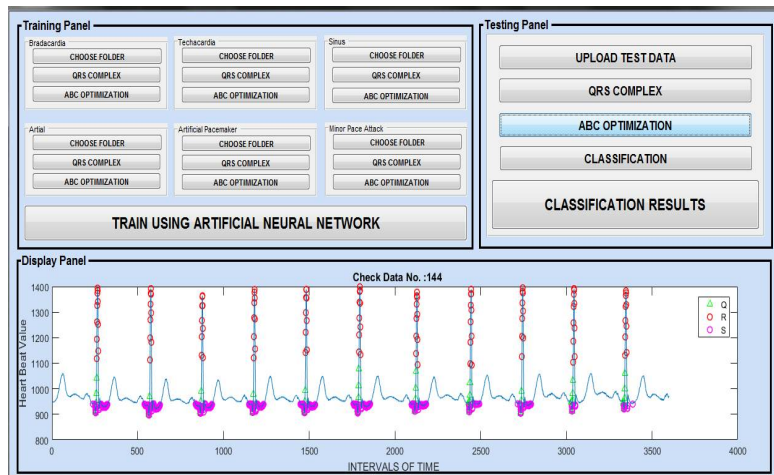


Fig. 7: Optimization panel

After extracting the feature of the bradacardia signal (Q, R, and S), the signal is improved by using ABC optimization technique. This is a novel swarm optimization algorithm known as Artificial Bee Colony (ABC) being inspired from the foraging intelligence of honey bees. The (ABC) has the advantage of using fewer control parameters as compared to other swarm optimization Algorithms. The optimized features are than compared with trained dataset, and disease is classified accordingly when be click on classification button. The classification results show how accurately the disease of patient is classified.

In the proposed work, the cardiac disorders were classified into six categories namely (i) Bradacardia (ii) Techcardia (iii)Sinus (iv)Atrial (v)Atrial Pacemaker (vi)Minor Pace attack. For effective training, it is desirable that the training data set be uniformly spread throughout the class domains. The available data can be used iteratively, until the error function is reduced to minimum.

**Table II
Performance parameters for Bradacardia cardiac disorder**

S. No.	FAR	FRR	ACCURACY
1	0.87	0.79	96.38
2	0.86	0.84	95.38
3	0.85	0.83	93.80
4	0.93	0.75	96.12
5	0.86	0.76	96.43
6	0.88	0.78	95.21
7	0.89	0.79	98.54
8	0.90	0.80	96.23
9	0.93	0.83	97.45
10	0.90	0.81	93.45

The graph of FRR for Bradacardia disorder is shown in Fig. 8(A). From the graph, it is concluded that along x-axis there are number of iterations for which the system has run and along y-axis, it displays FRR value of the proposed work. The average value of the proposed work is 0.798.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

The graph of FAR for Bradacardia disorder is shown in Fig. 8(B). The graph has number o filtrations along x-axis for which the system has run and along y-axis, it displays FAR value of the proposed work. The observed average value of FAR is 0.887.

The graph obtained for accuracy of Bradycardia has been displayed above in Fig. 8(C). The graph has number of iterations along x-axis and accuracy value along y-axis. The average value of accuracy obtained for the proposed work is 95.89. Accuracy of proposed work is dependent on FAR and FRR parameters. Our aim for proposed work is to decrease the FAR and FRR value using the ABC algorithm to find best feature set of uploaded data. Accuracy of proposed work is inversely proportional of the error of proposed system like FAR and FRR. Research work has proposed neural network which is a classification technique used for identifying the decision of a group and ABC algorithm as an optimization technique which is used for the reduction purpose in our work for reducing the R-peaks.

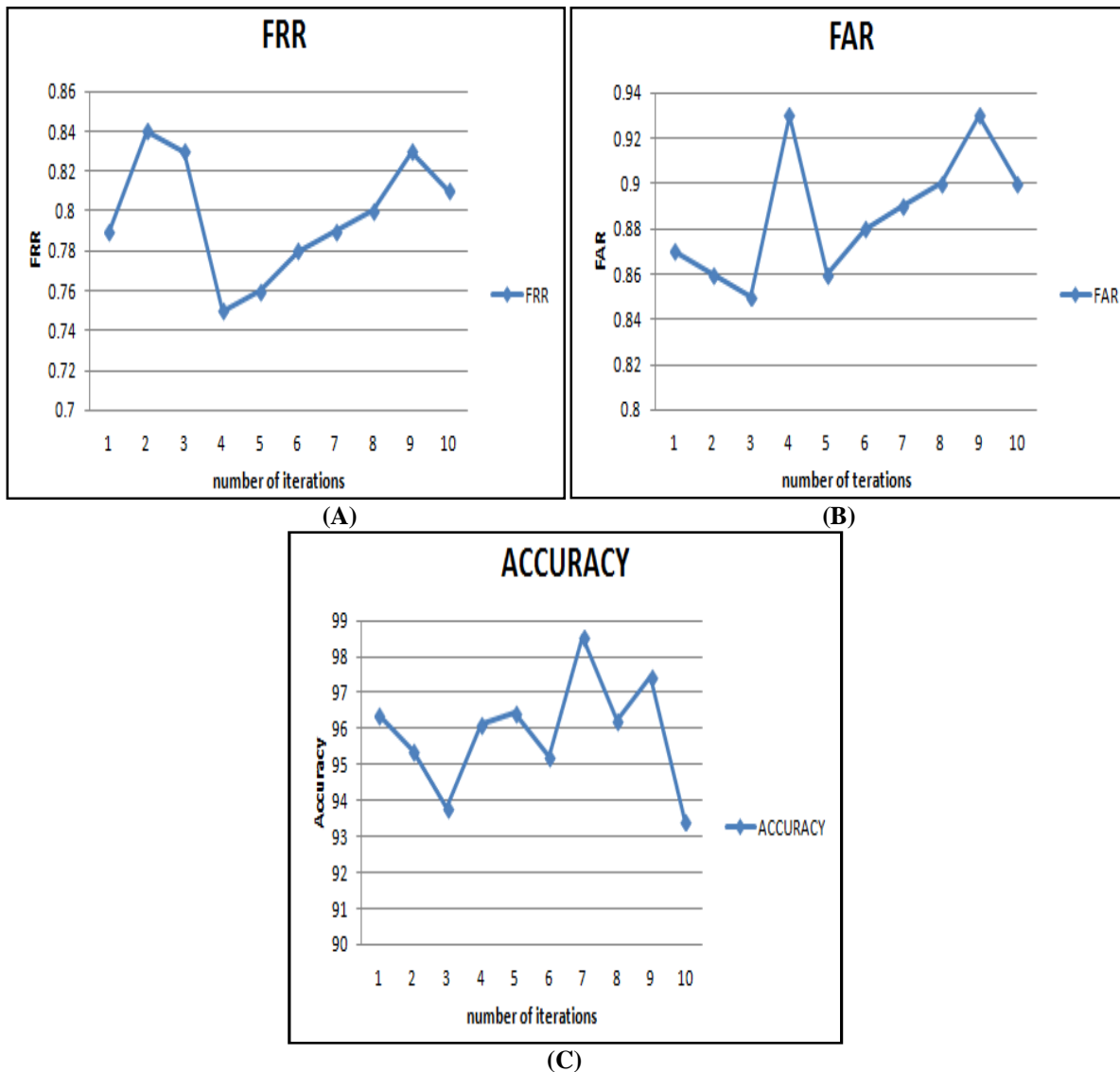


Fig. 8: (A)FRR of Bradacardia, (B)FAR of Bradacardia, (C)Accuracy of Bradacardia

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

V. CONCLUSION

Since, the ECG signals are used for detecting the cardiac diseases and the improvement in ECG feature extraction has become important for diagnosing the long recording. An ECG signal is a graphical representation of the cardiac movement for computing the cardiac diseases and to ensure the abnormalities in the heart. The objective of this research work is to categorize the disease dataset using ABC algorithm and to train the Neural Network on the source of the features extracted and moreover to test the image on the origin of the features at the database and the features extract of the image to be tested. This research is based on studying the implemented approaches in the ECG diseases and then to propose a novel technique /algorithm for classification of six cardiac disorders named as Sinus Bradycardia, Atrial, Atrial Pacemaker, Minor Pace attack and Tachycardia dependent on neural network and the ABC algorithm. Clinical databases have accumulated large quantities of information regarding patients and their medical situation. Heart Disease is the disease that mainly affects the heart. Most of the losses are due to heart diseases. This research presents the ECG Disease Detection System based on ABC, and Neural Network, in which detection is based on three parameters accuracy, FAR and FRR. Simulation results have shown that the obtained value of FAR, FRR and accuracy in favour of proposed tested waveform is 0.887 for FAR, 0.798 for FRR and 95.89 % for accuracy.

REFERENCES

- [1] "ECG compression using discrete transform symmetric wavelet", 1995 IEEE-EMBC and CMBEC.
- [2] Emna Rabhi, Zied Lachiri, "SVM based on personal identification system using Electrocardiograms", Arxiv preprint arxiv: 1306.5099, 2013.
- [3] Hadeer El-Saadawy, Manal Tantawi, Howida A. Shedeed and Mohamed F.Tolba, "Electrocardiogram (ECG) Classification Based On Dynamic Beats Segmentation", infos'16, 2016, Giza, Egypt ACM 2016.
- [4] L.Cromwell, F.J. Weebell, "Biomedical instruments and Measurements", Prentice Hall of India, New Delhi.
- [5] Mohammed AlMahamdy, H. Bryan Riley PhD, "Performance Study of Different Denoising Methods for ECG Signals", Procedia Computer Science, Vol. 37, pp. 325 – 332, Science Direct, 2014.
- [6] Sarang L. Joshi, Rambabu A.Vatti, Rupali V.Tornekar, "A Survey on ECG Signal Denoising Techniques", International Conference on Communication Systems and Network Technologies, IEEE, 2013.
- [7] Seena V, Jerrin.Yomas, "A review on feature extraction and denoising of ECG signal using wavelet transform", IEEE, 2014.
- [8] Shweta H. Jambukia, V.K.Dhabi, Harshadkumar B. Prajapati, "Classification of ECG signals using Machine Learning Techniques: A Survey", International Conference on Advances in Computer Engineering and Applications (ICACEA) IMS Engineering College, Ghaziabad, India, IEEE, 2015.
- [9] S.Z. Mahodabadi, A. Ahmadian, M.D.Abolhismail, "ECG Feature Extraction Based on Multi Resolution Wavelet Transform", Proceedings of the 2005 IEEE Engineering and Medicine and Biology, 27th annual conference, 2005
- [10] Tanveer Syeda-Mahmood, David Beymer, and Fei Wang, "Shape-based Matching of ECG Recordings", the authors are with the Healthcare Informatics Group, IBM Almaden Research Center, and 650 Harry Road, San Jose, CA 95120 USA.
- [11] V.N.Raj, Dr. T.Vekaswarlu, "ECG signal denoising using Undecimated wavelet transform", ICET, 2011.
- [12] Ashanti Chattopadhyay, "Design and Simulation Approach Introduced to ECG Peak Detection with Study on Different Cardiovascular Diseases", International Journal of Scientific and Research Publications, Vol. 2, Issue 12, December 2012.
- [13] Afsar, F. A., and M. Arif, "Detection of ST Segment Deviation Episodes in the ECG using KLT with an Ensemble Neural Classifier", Emerging Technologies, International Conference, IEEE, 2007.
- [14] Dhage, Neha, and Swati Madhe, "An automated methodology for FECC extraction and Fetal Heart Rate monitoring using Independent Component Analysis", Advanced Communication Control and Computing Technologies (ICACCCT), IEEE, 2014.
- [15] Jayant, Ankit, Tripti Singh, and Manpreet Kaur, "Different Techniques to Remove Baseline Wander from ECG Signal", IJCA Conference, pp. 30-43, 2011.
- [16] Zhang, Wei, Tie Ma, and Linlin Ge, "Enhancement of ECG Signals by Multi-Resolution Sub-Band Filter", Bioinformatics and Biomedical Engineering, ICBB, The 2nd International Conference, IEEE, 2008.
- [17] Jiayin Kang; Zhicheng Ji, "Dental plaque quantification using mean-shift-based image segmentation", in Computer Communication Control and Automation (3CA), International Symposium on, vol.1, no., pp.470-473, 5-7 May 2010.