INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 4, Issue 2)

Available online at: www.ijariit.com

A Review on: Arrhythmia Classification Based on ECG Signal using LMA Classifier

Shikha Sharma
shikhaa.2304@gmail.com
L.R. Institute of Engineering and Technology, Solan, Himachal Pradesh

Aman Kumar
aman11304832@gmail.com
L.R. Institute of Engineering and Technology, Solan, Himachal Pradesh

Astha Gautam
asthagautam@hotmail.com
L.R. Institute of Engineering and Technology, Solan, Himachal Pradesh

ABSTRACT

Electrocardiogram (ECG), a non-invasive technique is 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. The detection of cardiac arrhythmias in the ECG signal consists of detection of QRS complex in ECG signal, feature extraction from detected QRS complexes and classification of beats using extracted feature set from QRS complexes. Transmission of signals across public receiver networks is another request in which a large amount of data is implicated. For both detection and transmission of ECG signal, data compression is an important operation and represents another purpose of ECG signal processing. Hence, in this research work, the best training method i.e. Levenberg Marquardt algorithm will be 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 Bacterial Foraging Optimization (BFO) Algorithm and trained by Levenberg Marquardt algorithm 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 waveform, will be tested. The advantage of the proposed method is to minimize the error rate of the classification which occurs due to an insignificant count of R-peaks.

Keywords: *ECG Signals, Bacterial Foraging Optimization (BFO), Levenberg-Marquardt Algorithm (LMA), and MATLAB.*

1. INTRODUCTION

Signal processing is immense popular systems for ECG analysis. The aim of ECG signals processing is to provide the perfection of accuracy, reproducibility and the removal of information not available from the signal. In many situations, the ECG is recorded during exhausting conditions such that the signal is despoiled by different types of noises; sometimes originate from another physiological process of the body. Therefore, noise reduction represents another significant purpose of ECG signal processing; in fact, the waveforms of attention are sometimes, so greatly masked by the noise that their occurrence can only be exposed once suitable signal processing has first been functional [6].

Electrocardiographic signals may be recorded on a long timescale for the purpose to identify irregularly occurring fighting in the heart beat. Transmission of signals across public receiver networks is another request in which a large amount of data are implicated. For both locations, data compression is an important operation and represents another purpose of ECG signal processing.

Signal processing has contributed to a new understanding of the ECG [7] and its dynamic properties as uttered by a change in rhythm and beat morphology. For example, methods have been developed that distinguish oscillations connected to the cardiovascular system and reflected by subtle variation in heart rate. The discovery of low-level changes in T wave amplitude is an additional example of an oscillatory performance that has been established as a pointer of increased risk for abrupt life-threatening disease i.e. arrhythmias. Neither of these two oscillatory signal properties can be apparent by the naked eye from a typical ECG printout.

All types of ECG analysis, whether it takes resting ECG analysis, stress testing, ambulatory monitor or concentrated care monitoring are the essential set of algorithms that state the signal with respect to dissimilar types of noise and artifacts [8]. Although, these algorithms are regularly implemented to operate in sequential order as produced by the QRS detector are sometimes incorporated into the other algorithms to augment performance. The intricacy of every procedure varies from purpose to purpose so that noise filtering performs in ambulatory monitoring which is much more complex than that resting ECG analysis. Once the sequence shaped by the basic set of algorithms is obtainable, a wide range of ECG application exists where it is an attention to the use signal processing for quantifies heart beat and beat morphology properties [9].

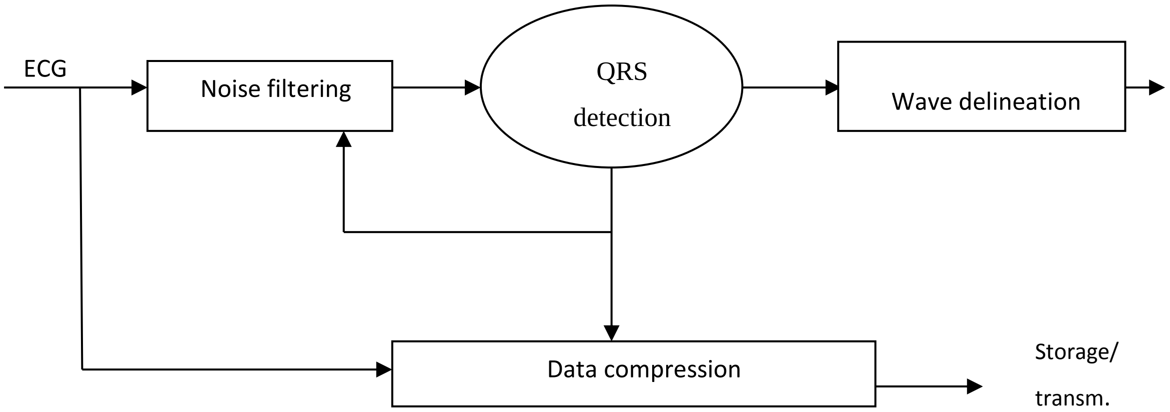

Figure 1: Basic algorithm of ECG signal

2. LITRERATURE SURVEY

YantingShen et al. (2016) have utilized machine learning methods for analyzing ECG data for the improvement of risk evaluation of cardiovascular diseases. The author has performed the investigation with the detection of abnormality with three one class classification techniques and for the prediction of probabilities of arrhythmia, normality, ischemia, and hypertrophy with the usage of multiclass approach. The author has considered five possible descriptions for one class classification in case of normality and has utilized ten automatically extracted features of ECG with four blood pressure features. The one class technique has identified abnormality considering an area of under curve of 0.83 and 75.6 % of accuracy. In case of 4-class classification, the author has utilized 86 features with 72 more features being extracted from ECG. The accuracy of the research for four class classification has reached 75.1 % [21].

Odinaka et al. (2015) examined the voltage generated from the heart signal using an electrocardiogram (ECG). Information security becomes the key issue when the user tried to link the wireless body sensor network with the healthcare social network by means of mobile facilities. In this research, the author has worked on a secured electrocardiogram (ECG) signal transmission method to avoid further injuries for patients with heart diseases from human affecting tension. From the result evaluation, it has been seen that around 82 % accuracy with 2% error rate has been obtained. Although, some of the drawbacks have been obtained proposed algorithm works well [19].

M.H. Vafaie et al. (2014)has presented a novel classification method for classifying ECG signals more accurately on the basis of a dynamic model for ECG signal. In the presented work, a fuzzy classifier has been constructed and it has been concluded that the proposed classifier has segregated ECG with 93.34 % of accuracy. For the improvement, GA (Genetic algorithm) has been applied by which the accuracy has been increased with 98.67 of percentage. The work being shown the accuracy of ECG classification with more accurate arrhythmia detection [20].

Dhage et al. (2014) have 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 a surface electrode placed on mother's abdomen. The Fetal signals are covered by other interference signal. Extracting FECG from the well-built background nosiness has a central value in the clinical application. Since, a lot of explore work has been performed in this field, some of these are: Threshold & Filtering method, NN method, Wavelet Transform and other. Authors have proposed an Independent Analysis technique for FECG extraction. An essentially ICA works in dissimilar parameter Kurtosis and Negentropy. After the extraction of ECG signal, fetal R peak is located using Threshold-free detection technique which involves R-R moving interval. The algorithm is implemented on 20 recorded signals using MATLAB [17].

Gaikwad et al. (2014) described that ECG as the major tool used by the physician for identifying and for an understanding of Heart condition. The ECG should be free from noise and of good excellence for the correct diagnosis. In real time situation, ECG is despoiled by a lot of types of artefacts in which elevated frequency noise is one of them. Authors' main aim is to remove the noise from the ECG signal of high frequency; with the help of low pass filter having cut of frequency is 100Hz. The sample period used is .001sec. [18].

3. PROBLEM FORMULATION

Electrocardiogram represents electrical activity of the compassion. Sinus tachycardia and Sinus Bradycardia are among the most common ECG abnormality. Millions of ECGs are in use for the diagnosis of various lessons of patients, where ECG can give a lot of information regarding the abnormality in the concerned patient; ECGs are analyzed by the physicians and interpreted depending upon their knowledge. The understanding may vary by a physician to a medical doctor. Hence, this labor is all about the mechanization and consistency in the analysis of the ECG signals so that they must be diagnosed and interpreted accurately irrespective of the physician. This would help to create an early action intended for the problems and many lives might be saved.

Many works have been done previously but this work presents Electrocardiogram (ECG) classification to diagnose patient's condition is essential.

4. PROPOSED METHODOLOGY

The significance of the proposed work is to highlight the importance of the optimization techniques in the fusion of biomedical properties. The objectives of the research work have been defined below;

- To study and explore about ECG signal analysis with their pros and cons for the human heart.
- To study the previous implemented approaches in ECG disease classification concept for the analysis of R peak.
- To propose a novel algorithm for classification based on BFO for feature optimization, LMA for classification of Sinus tachycardia and Sinus Bradycardia.

Evaluate the performance of the system using Precision, Recall, F-measure and Accuracy metrics.

The methodology of the process can be understood with the following flow diagram which clearly explains the work in steps:

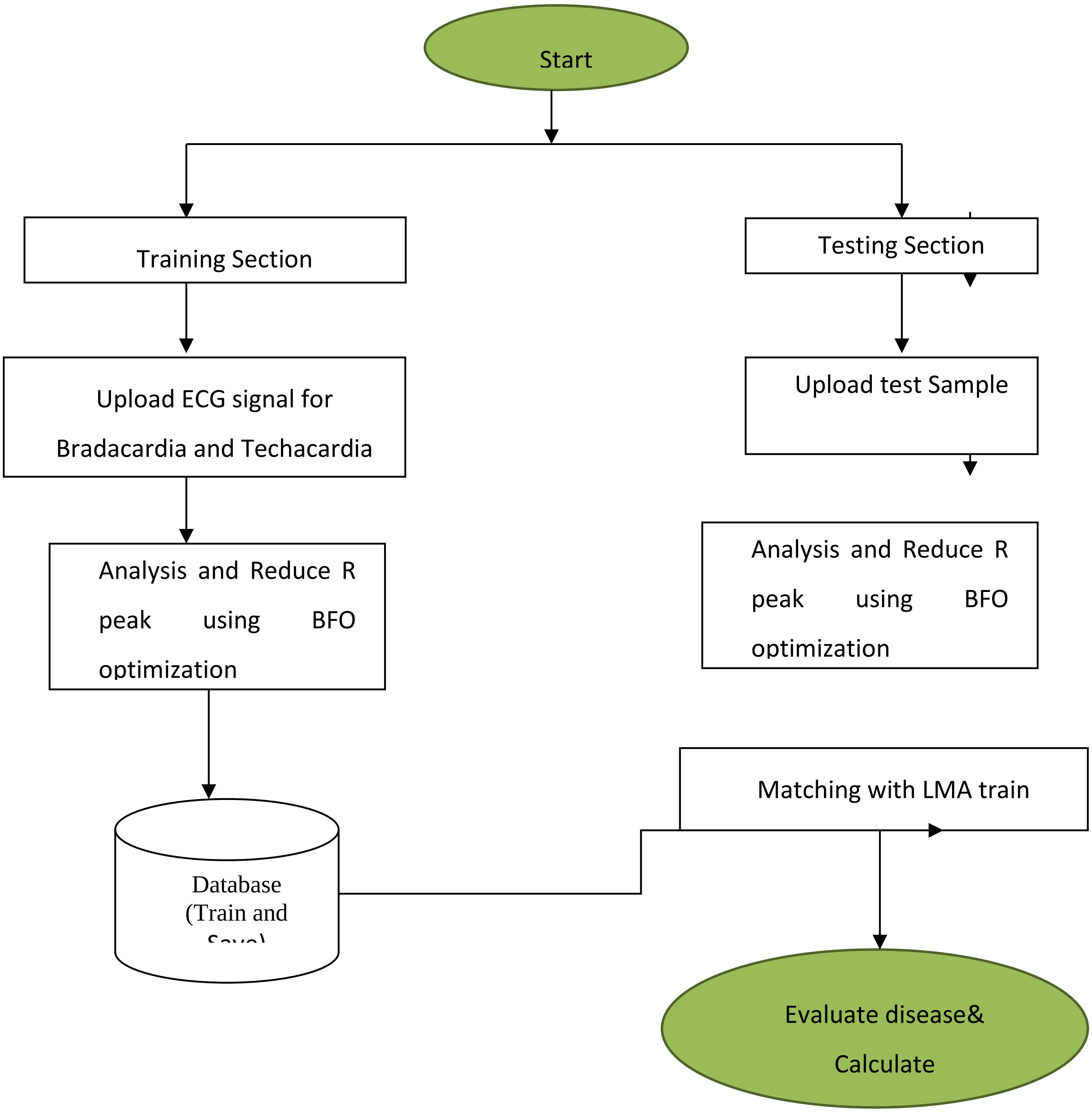

Figure 2: Proposed work Flowchart

IV (A). PROPOSED TECHNIQUES

BFO (BACTERIAL FORAGING OPTIMIZATION)

BFO algorithm is first projected by Passinoin 2002 [13]. It is motivated by the foraging and Chemo tactic behaviors of bacteria, especially the Escherichia coli (E. coli). Locomotion can be achieved during the process of real bacteria forging through the tensile flagella set. Flagella help an E.colibacterium to fall or swim, that are two essential operations performed by a bacterium at the instance of foraging. When they revolve the flagella in the clockwise direction, every flagellum pulls over the cell. That results in the moving of flagella separately and lastly the bacterium tumbles with smaller amount of tumbling while in a damaging place it tumbles repeatedly to find a nutrient gradient. Stirring the flagella in the counterclockwise direction helps the bacterium to swim at a very speedy rate. In the above-mentioned algorithm, the bacterium undergoes chemo taxis, where they like to shift towards a nutrient gradient and shun harmful atmosphere. Usually, the bacteria shift for a longer distance in a gracious situation [14].

LMA (LEVENBERG–MARQUARDT ALGORITHM)

The Levenberg–Marquardt algorithm which was independently developed by Kenneth Levenberg and Donald Marquardt provides a numerical solution to the problem of minimizing a nonlinear function. It is fast and has stable convergence [15]. In the artificial neural-networks field, this algorithm is suitable for training small- and medium-sized problems.

The LMA is used in many software applications for solving generic curve-fitting problems. However, as for many fitting algorithms, the LMA finds only a local minimum, which is not necessarily the global minimum. The LMA interpolates between the Gauss–Newton algorithm (GNA) and the method of gradient descent. The LMA is more robust than the GNA, which means that in many cases it finds a solution even if it starts very far off the final minimum. For well-behaved functions and reasonable starting parameters, the LMA tends to be a bit slower than the GNA. LMA can also be viewed as Gauss–Newton using a trust region approach [16].

The Levenberg-Marquardt algorithm is a very simple, but robust, method for approximating a function. Basically, it consists of solving the equation:

$$(J^tJ + \Lambda i)\delta = J^tE$$

Where J is the Jacobian matrix for the system, λ is the Levenberg's damping factor, δ is the weight update vector that we want to find and E is the error vector containing the output errors for each input vector used on training the network. The δ tells us by how much we should change our network weights to achieve a (possibly) better solution. The J^tJ matrix can also be known as the approximated Hessian.

The λ damping factor is adjusted at each iteration, and guides the optimization process. If reduction of E is rapid, a smaller value can be used, bringing the algorithm closer to the Gauss–Newton algorithm, whereas if iteration gives an insufficient reduction in the residual, λ can be increased, giving a step closer to the gradient descent direction.

5. CONCLUSION

We have presented in this paper a survey on different techniques that aim at removing various types of noise corrupting ECG signal. The examination of the ECG has been comprehensively used for diagnosing many cardiac diseases.Various techniques and transformations have been proposed earlier in literature for extracting a feature from ECG. This proposed paper provides an over view of various ECG feature extraction techniques and algorithms proposed in the literature. The feature extraction technique or algorithm developed for ECG must be highly accurate and should ensure fast extraction of features from the ECG signal.. The future work mainly concentrates on developing an algorithm for accurate and fast feature extraction.

6. REFERENCES

[1] Nugent, C.D., et.al, "Electrocardiogram 2: Classification" Automedical 17, pp. 281–306, 1999.
[2] Russell, S., and Norvig, P., "Artificial Intelligence - A Modern Approach", 2nd edn. Prentice Hall, 2003.
[3] Ouelli, Abdelhaq,et.al, "Multivariate autoregressive modeling for cardiac arrhythmia classification using multilayer perceptron neural networks", Multimedia Computing and Systems (ICMCS), International Conference, IEEE, 2014.
[4] J. G. Proakis and M. D. G., "Digital Signal Processing: Principles, Algorithms, and Applications", Prentice-Hall, 1999.
[5] Odinaka, Ikenna, et al., "Cardiovascular Biometrics: Combining Mechanical and Electrical Signals", Information Forensics and Security, IEEE Transaction, Vol. 10, pp.16-27, 2015.
[6] Sornmo, et.al, "Electrocardiogram (ECG) Signal processing", WileyEncyclopedia of Biomedical Engineering, pp. 435-439, 2006.
[7] Sameni, et.al, "A review of fetal ECG signal processing; issues and promising directions", Open pacing, electrophysiology & therapy journal, Vol.3, pp.4-20, 2010.
[8] Chan, Matthias, "Filtering and Signal-Averaging Algorithms for Raw ECG Signals", ESE, Vol. 482, pp. 1-16, 2010.
[9] C.S.E.W. Party., "Recommendations for measurement standards in quantitative electrocardiography", Eur. Heart J, Vol. 6, pp. 815-825, 1985.
[10] H. Tulsani and R. Gupta, "Wavelet based optimized polynomial threshold function for ECG signal denoising," *2nd International Conference on Computing for Sustainable Global Development (INDIACom)*, New Delhi, 2015, pp. 1563-1566.
[11] C. R. Meyer and H. N. Keiser, "Electrocardiogram baseline noise estimation and removal using cubic splines and state-space computation techniques", Comput. Biomed. Res., vol. 10, pp. 459-470, 1977.
[12] Islam, M. K., et al., "Study and Analysis of ECG Signal Using MATLAB & LABVIEW as Effective Tools", International Journal of Computer and Electrical Engineering, Vol.4, No.3, pp. 404-408, 2012.
[13] S. Dasgupta, S. Das, A. Abraham, and A. Biswas, "Adaptive Computational Chemotaxis in Bacterial Foraging Optimization: An Analysis," in *IEEE Transactions on Evolutionary Computation*, vol. 13, no. 4, pp. 919-941, Aug. 2009.
[14] S. Das, S. Dasgupta, A. Biswas, A. Abraham and A. Konar, "On Stability of the Chemotactic Dynamics in Bacterial-Foraging Optimization Algorithm," in *IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans*, vol. 39, no. 3, pp. 670-679, May 2009.
[15] A. Desmal and H. Bağcı, "Nonlinear microwave imaging using Levenberg-Marquardt method with iterative shrinkage thresholding," *2014 USNC-URSI Radio Science Meeting (Joint with AP-S Symposium)*, Memphis, TN, 2014, pp. 252-252.

[16] A. R. Hafiz, M. F. Amin and K. Murase, "Using complex-valued Levenberg-Marquardt algorithm for learning and recognizing various hand gestures," *The 2012 International Joint Conference on Neural Networks (IJCNN)*, Brisbane, QLD, 2012, pp. 1-5.
[17] Dhage, Neha, and Swati Madhe, "An automated methodology for FECG extraction and Fetal Heart Rate monitoring using Independent Component Analysis", Advanced Communication Control and Computing Technologies (ICACCCT), 2o14 International Conference on. IEEE, 2014.
[18] Gaikwad, KaustubhManik, and Mahesh ShrikantChavan, "Removal of high frequency noise from ECG signal using digital IIR butterworth filter", Wireless Computing and Networking (GCWCN), 2014 IEEE Global Conference on. IEEE, 2014.
[19] Odinaka, Ikenna, et al, "Cardiovascular Biometrics: Combining Mechanical and Electrical Signal", Information Forensics and Security, IEEE Transaction, Vol. 10, pp.16-27, 2015.
[20] Vafaie, M. H., M. Ataei, and Hamid R. Koofigar. "Heart diseases prediction based on ECG signals' classification using a genetic-fuzzy system and dynamical model of ECG signals." Biomedical Signal Processing and Control 14 (2014): 291-296.
[21] Shen, Yanting, Yang Yang, Sarah Parish, Zhengming Chen, Robert Clarke, and David A. Clifton. "Risk prediction for cardiovascular disease using ECG data in the China kadooriebiobank." In Engineering in Medicine and Biology Society (EMBC), 2016 IEEE 38th Annual International Conference of the, pp. 2419-2422. IEEE, 2016.

