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Cardio Vascular Disease Classification Ensemble Optimization using Genetic Algorithm and Neural Network

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Abstract

Objective: To develop a new technique for the detection of heart disease and to build the detection system based on fuzzy logic algorithm for extraction of features by applying neural network classifier of heart disease. **Methods/Statistical analysis:** The disease dataset is classified by using Fuzzy logic, genetic algorithm and training is done by neural network by the extracting features. The image is tested on the basis of features of dataset and the extracted images. **Findings:** The accuracy is improved up to 99.97%. The error rate is reduced, it is .987 %. **Application/Improvements:** This paper presented the ECG signal modeling along with classification of diseases using fuzzy logic, Genetic Algorithm and Neural Network with improved accuracy and less error rate.

Keywords: Accuracy, Error Rate, Fuzzy Logic, Genetic Algorithm, Heart Disease, Neural Network

1. Introduction

The electrocardiogram is a demonstration of body surface potentials generated by the electrical action of the heart. The recording and analysis of the ECG has a very long impact in the past and is a significant portion of the clinical valuation of an individual's cardiac status and general health[1-3]. ECG can also be used to conclude heart rate by scheming the time between consecutive QRS complexes. It is significant to be able to compute the heart rate between every beat as it makes it to look at the beat to beat inconsistency in heart rate. Decrease heart rate unevenness is therefore used as a quantifiable indication of reduced vagal activity. The additional, reduced heart rate inconsistency has been shown to expect sudden death in patients with myocardial infarction[4].

Signal processing is immense popular systems for ECG analysis. The goal of ECG processing is to give the flawlessness of precision, reproducibility and the expulsion of data not accessible from the signals only [5]. As a rule, the ECG is recorded during debilitating conditions such that the signal is raided by various sorts of clamors; now and again start from another physiological procedure of the body. Consequently, clamor diminishment speaks to another huge motivation behind ECG signal handling [6,7]. Electrocardiographic signs might be recorded on a long timescale for the reason to recognize unpredictably happening battling in the heart beat. Transmission of signs crosswise over open beneficiary systems is another solicitation in which substantial measure of information are embroiled. For both areas, information pressure is a critical operation and speaks to another motivation behind ECG signal handling. Basic algorithm of ECG signals is shown in Figure 1.

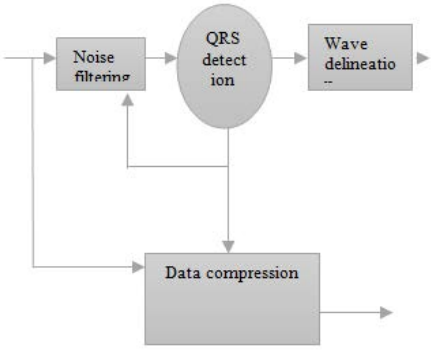

Figure 1. Basic algorithm of ECG signal.

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Signal processing has added to another comprehension of the ECG and its dynamic properties as expressed by change in musicality and beat morphology. For instance, techniques have been produced that recognize motions associated with the cardiovascular framework and reflected by unobtrusive variety in heart rate. The disclosure of low level changes in T wave sufficiency is an extra case of oscillatory execution that has been set up as a pointer of expanded danger for sudden life undermining arrhythmias. Neither of these two oscillatory sign properties can be evident by the bare eye from a run of the mill ECG printout.

A wide range of ECG examination, whether it takes resting ECG investigation, stress testing, wandering screen or thought care observing are the fundamental set of calculations that express the sign regarding unique sorts of clamor and relics [7]. In spite of the fact that these algorithms are consistently actualized to work in consecutive request as created by the QRS indicator are some of the time consolidated into alternate calculations to enhance execution [8].

Table 1 shows the standard ECG data that defines different waves, namely, P wave, R wave, Q wave and T wave, on the basis of amplitude and duration time.

Table 1. Standard ECG Data

Amplitude	Amplitude	Duration Time	Duration time
P wave	0.25 Mv	P-R interval	0.12 to 0.20 sec
R wave	1.60Mv	Q-T interval	0.35 to 0.44 sec
Q wave	25% of R wave	S-T interval	0.05 to 0.15 sec
T wave	0.1 to 0.5mV	P wave interval	0.11 sec
		QRS complex	0.09sec
		PR segment	0.06 to 0.10 sec
		ST segment	-0.10 to 0.15 sec
		T wave	Varies

In this proposed framework, the benefits of GA and neural networks are joined to anticipate the danger of cardiovascular disease. In numerous applications, learning that depicts craved framework conduct is contained in datasets. At the point when datasets contain learning about the framework to be composed, a neural system guarantees an answer since it can prepare itself from the datasets. Neural systems are versatile models for information examination especially appropriate for taking care of nonlinear capacities. By consolidating

Table 2. Comparison of Techniques

Author	Technique/ Method	Advantages	Results
Kaustubh Manik Gaikwad, 2014 [8]	Butter worth Approximations	The consequences of before filtration and after filtration are depicting in the paper	Noise removal
Neha Dhage, 2014 [9]	Threshold free detection technique	Normal maximum and minimum heart rate.	Accuracy = good
S. Vishnu Gopeka, 2014 [10]	Hence Multiscale Mathematical Morphology	Noise reduction.	Noise reduction.
Abdelhaq Ouelli, 2014 [11]	neural networks	The performance of the networks for speed of convergence and accuracy classifications are evaluated for various ECG data types.	Accuracy = good
M. K. Islam, 2012 [12]	MATLAB functions	detection of any abnormalities in ECG	Great accuracy and ease.
Qian Zheng, 2014 [13]	Multi-Resolution Support Vector Machine algorithm	Consequences show that the algorithm can productively extract original QRS complex waves and T waves regardless of noise magnitude and distinguish the ST segment morphological anomalies.	Average T wave appreciation accuracy rate of 97.5% and ST irregularity detection accuracy rate of 93%.
Menta Srinivasulu, 2014 [14]	FIR and IIR.FIR filters	Noise removal using FIR digital filter is better alternative in assessment with IIR digital filter.	Noise reduction.

the enhancement strategy of hereditary calculation with the learning force of neural system, a model with better prescient exactness can be determined. Further to improve the outcome the fuzzy logic has been used.

2. A Glance of Existing Techniques

ECGs are analyzed by the doctors. The comprehension may differ by doctor to medicinal specialist. Thus, this work is about the consistency in the investigation of the ECG signals with the goal that they should be analyzed and deciphered precisely independent of the doctor. This would make an early activity expected for the issues and numerous lives may be spared. Numerous works have been done already. However, this work presents Electrocardiogram (ECG) orders to analyze patient's condition is fundamental.

Table 2 shows the comparison of the techniques previously proposed by different authors.[9-14]

3. Proposed Work

Proposed system has been developed to classify the heart disease using neural network, fuzzy logic and genetic algorithm. The subsequent steps demonstrate the variety of phases that need to be accomplished:

Step-1: Upload given dataset for 30 samples.

Step-2: Feature extraction using GA.

Step-3: Optimize Fitness Function based on fuzzy logic and get fuzzification of dataset.

Step-4: Implement neural network for classification purpose. It has basically two steps:

- Training phase and
- Testing Phase

Step-5: Diseases Classification

Step-6: Calculate performance metrics like Accuracy and error rate.

3.1 Dataset Acquisition

Data set acquisition is the first step of our proposed technique. Dataset in the form of .mat file has been taken[15-17].

3.1.1 Feature Extraction

Feature reduction has been done using GA on separated signal dataset then feature count and feature values are plotted. After that Fitness function will be optimized as below:

$$Fs = seperated_{signal(1,ii)};$$

$$Ft = mean(seperated_{signal});$$

$$FitnessFunction = @(e)fitness_{fn(e,Fs,Ft)};$$

$$numberOfVariables = 1;$$

$$[xfval] = ga(FitnessFunction, numberOfVariables, options);$$

$$reduced_{index} = round(x);$$

$$if reduced_{index} == 1$$

$$GareducedFeatures(j,p) = Fs;$$

$$p = p + 1;$$

3.1.1.1 Classification

Then classification of trained data will be done using NN. Neural network is a network of "neuron like" units entitled as nodes.

3.1.1.2 Training Using NN

The training process includes the conjugating the neural network then train them about data features. Training procedure benefits in creation of information base. Later it is used in matching and decision level.

3.1.1.3 Testing using NN

The testing phase include the retrieving the trained dataset. The trained network system is displayed by means of trained features. The network, acting as selectively recovers top-matched, a classifier, related, alike data values as per that of dataset from the database and are presented to user.

a) Algorithm for Training Phase

setup NN and also prepare the subsequent factors as: number$_{of_{layers}}$; epochs;

learning$_{rate}$; permissible$_{error}$;

input: network, training set

do

foreach image in training set

fuse the removed characteristics hooked on

to a single characteristics matrix;

untila solitary characteristic of vector

matrix is made;

do

train the given network regarding class

labels as well as feature vectors;

untilending criterion epochs = 2000 is fulfilled

output: a trained neural network.

b) Algorithm for Testing Phase:

input: dataet.

load the input dataset;

extract its reduced features;

load the fused features database;

output: set of similar data values if present;

if not, display then also.

4. Results and Discussion

The whole simulation is done in MATLAB 2010 a environment to classify the data samples having disease or not. Table 3 and Figure 2 describes the obtained values of accuracy and error rate for 30 samples in the dataset of heart diseases.

Table 3. Parameter Evaluation

Sample No.	Accuracy (%)	Error rate (%)
1.	99.197	.807
2.	99.237	.987
3.	99.567	.867
4.	99.347	.907
5.	99.237	.667
6.	99.157	.907
7.	99.167	.667
8.	99.127	.447
9.	99.567	.787
10.	99.777	.447
11.	99.837	.337
12.	99.327	.997
13.	99.897	.777
14.	99.107	.877
15.	99.297	.907
16.	99.597	.770
17.	99.497	.987
18.	99.947	.607
19.	99.277	.677
20.	99.657	.887
21.	99.407	.547
22.	99.307	.657
23.	99.567	.447
24.	99.477	.987
25.	99.107	.767
26.	99.237	.757
27.	99.217	.877
28.	99.117	.657
29.	99.107	.987
30.	99.157	.777

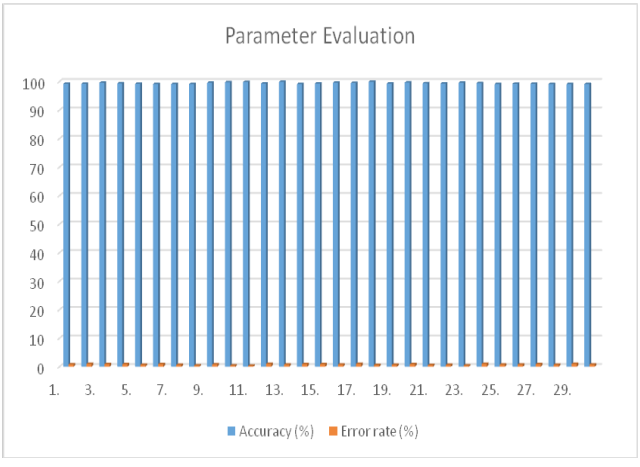

Figure 2. Parameter Evaluation.

5. Conclusion and Future Scope

This paper presented the heart disease prediction system by utilizing Fuzzy logic for feature extraction, GA for feature reduction and NN for classification. Simulation results shows that the obtained values of error rate and accuracy for proposed tested image has been found out to be error rate .987 %and accuracy = 99.97% that are satisfactory results. Future scope lies in the use of other classifiers like SVM that has multidimensional data and use of feature reduction algorithms genetic algorithm, so that accuracy rate can be enhanced. SVMs deliver a unique solution, since the optimality problem is convex. This is an advantage compared to Neural Networks, which have multiple solutions associated with local minima and for this reason may not be robust over different samples.

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