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ECG SIGNAL ANALYSIS AND PREDICTION OF HEART ATTACK WITH THE HELP OF OPTIMIZED NEURAL NETWORK USING GENETIC ALGORITHM

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ABSTRACT

Heart Attacks are the major cause of death in the world today, particularly in India. The need to predict this is a major necessity for improving the countries healthcare sector. Accurate and precise prediction of the heart disease mainly depends on Electrocardiogram (ECG) data. Heart disease is a major life threatening disease that cause to death and it has a serious long term disability. The time taken to recover from heart disease depends on patient's severity. Heart disease diagnosis is complex task which requires much experience and knowledge. Nowadays, health care industry contain huge amount of health care data, which contain hidden information. Advanced data mining techniques along with computer generated information are used for appropriate results. Neural Network is widely used tool for predicting heart attack. A Heart Attack Prediction System we are proposing with the help of Neural Network and Genetic Algorithm. This system calculates the number of hidden nodes for neural network which train the network with proper selection of neural network architecture and uses the global optimization of genetic algorithm for initialization of neural network.

Keywords*: **ECG (Electrocardiogram), Neural Network, Genetic Algorithm.***

I. INTRODUCTION

The electrocardiogram (ECG) is the most important bio signal used by cardiologists for diagnostic purposes. The ECG signal provides key information about the electrical activity of the heart. The heart signals are taken from ECG, which is known as Electrocardiography. That the heart signals are picked by using electrodes in arms, leg, chest of our body. By using this signal heart disorder can be find out. Depend on the shape of the ECG waveform, find out the cardiac health. ECG signal readings and their analysis are carried out from signal processing. Today signal processing plays a major role in ECG signal analysis and interpretation. The aim of ECG signal processing is diverse and comprises the Improvement of measurement accuracy and reproducibility (when compared with manual measurements) and by taking out the information is not readily available from the signal through visual assessment. ECG is composite from 5 waves - P, Q, R, S and T. This signal could be measured by electrodes from human body in typical engagement [2].

Heart Attacks are the major cause of death in the world today, particularly in India. The need to predict this is a major necessity for improving the countries healthcare sector. Accurate and precise prediction of the heart attack mainly depends on Electrocardiogram (ECG) data. Neural Network is widely used tool for predicting heart diseases diagnosis.

A Heart Disease Prediction System is developed using Neural Network and Genetic Algorithm. This system calculates the number of hidden nodes for neural network which train the network with proper selection of neural network architecture and uses the global optimization of genetic algorithm for initialization of neural network [1].

In today's world, an optimal and intelligent problem solving approaches are required in every field, regardless of simple or complex problems. Researches and developers are trying to make machines and software's more efficient, intelligent and accurate. This is where the Artificial Intelligence plays its role in developing efficient and optimal solutions. Data mining techniques are used to explore, analyze and extract data using complex algorithms in order to discover unknown patterns in the process of knowledge discovery. Prediction is done with the help of available knowledge or previous values so accuracy in prediction is the main challenge. The artificial neural network (ANN) can use for pattern recognition, classification as well as prediction because it is based on biological neurons, an artificial neural network (ANN) is a self-adaptive trainable process that is able to learn to resolve complex problems based on available knowledge Genetic algorithm is one of most pervasive and advanced developed heuristic search technique in Artificial Intelligence.

II. LITERATURE SURVE

1. The literature review related health monitoring:

This section describes the work that has been done in the area of health monitoring systems. Jubadi et al.[13] has proposed heart rate monitoring alert via SMS. In this an alert system is used to monitor the heart beat rate of a patient. This heart rate measurement is based on the principle of photoplethysmography (PPG) technique. Then this PPG signal was processed using PIC16F87 microcontroller to check the heart beat rate per minute. An alert was given to medical experts or family members via SMS. With the help of this system doctors could monitor & diagnose patient's condition continuously & could suggest them precautions if any. Saravanan designed remote patient monitoring system using computer communication networks through Bluetooth, WiFi, Internet Android Mobile. ECG, EMG, Pulse, BP, arterial oxygen saturation, blood glucose concentration & temperature signals were monitored. They had designed android Bluetooth API & constructed a simple peer-to-peer messaging system to work between two paired Bluetooth. The monitoring section receives data via Bluetooth, Wi-Fi & Internet. This system was mainly designed to send data to the doctor.

Purnima et al. [14] proposed health monitoring systems based on GSM &Zigbee technology. In this ECG, temperature & heart beat signals are continuously transmitted & monitored through Zigbee. A Zigbee node was connected to every patient monitoring system. The data are transmitted to the doctors PC via Zigbee as well as GSM technology is used to send data to doctor's mobile.

Singh et al. [15] proposed wireless transmission system which is having a wireless sensor platform along with remote monitoring capability. They have designed sensor nodes for temperature & heart rate. This sensor data are wirelessly transmitted to the controller using RF transmitter & receiver module. This data is also wirelessly transmitted to the remote monitoring station.

Venugopal et al. [16] presented a centralized heart rate monitoring system. The data obtained from sensors of various patients are then transmitted over a WBAN and then this data is transmitted to the main location with the help of Wi-Fi.

Kiran Kumar et al. [17] developed health monitoring system using PSOC mixed signal. They developed data acquisition system to remotely monitor patient's parameters like temperature, heart rate, blood oxygen saturation, blood

pH level & ECG. In this system doctor was able to monitor patient on PC using Zigbee wireless communication technology.

2. The literature review related to different machine learning technique in ECG for classification:

- **Support Vector Machine (SVM):**

SVM is a reliable classification technique, which is based on the statistical learning theory. The SVM originated from the idea of the structural risk minimization Support vector machines are primarily two class classifiers that have been shown to be attractive and more systematic to learning linear or non-linear class boundaries. K. Polat et al. [18]. According to this author he has got 98 percent accuracy and N. Acr et al. [19]. According to this author he has got 94.3 to 96.4 percent accuracy.

- **Fuzzy Set Theory:**

Fuzzy sets are generalization of crisp sets and have greater flexibility to capture faithfully various aspects of incompleteness or imperfection in information. For an ordinary set, an element either belongs to it or not; while for fuzzy sets, an element can partially belong to the multiple sets, with the proviso that the total membership values total one. Since fuzzy sets characterize imprecise properties, they can be effectively used to model vagueness associated with real-life systems. Fuzzy logic is based on the theory of fuzzy sets and approximate reasoning. It is much closer in spirit to human reasoning and natural language than the traditional logical system. W. K. LEI et al.[20]. According to this author he has got 98.1 percent accuracy and U. R. Acharyaa et al.[21]. According to this author he has got 95 to 100 percent accuracy.

- **Artificial Neural Network(ANN):**

ANN has been applied extensively to a wide range of classification problems within the healthcare domain. There are a variety of neural network approaches proposed in the literature that vary in terms of topology and operational mode. Each model can be specified by the following seven major concepts: (1) A set of processing units, (2) An activation function of each neuron, (3) Pattern of connectivity among neurons, that is, network topology, (4) Propagation method of activities of neurons through the network, (5) Rules to update the activities of each node, (6) External environment that feeds information to the network, (7) Learning method to modify the pattern of connectivity. E. Derya et al.[22]. According to this author he used to different models of ANN one was Recurrent Neural Network (RNN) he has got 98.03 percent accuracy and seconnd was Multi Layer Perceptron Neural Network (MPLNN) he has got 90.03 percent accuracy and I. Gler et al.[23]. According to this author he has got 96.94 percent accuracy and S-N. Yu et al.[24]. According to this author he has got 99.65 percent accuracy.

- **Rough Set Theory(RST) and Hidden Markov Model(HMM):**

Rough set theory is a relatively new data-mining technique used in the discovery of patterns within data. The rough sets approach has been successfully applied to deal with vague or imprecise concepts, extract knowledge from data, and to reason about knowledge derived from the data. Hidden Markov model is a statistical model in which the system being modeled is assumed to be a Markov process with unknown parameters, and the challenge is to determine the hidden parameters from the observable parameters. In a regular Markov model, the state is directly visible to the observer, and therefore the state transition probabilities are the only parameters. In a hidden Markov model, the state is not directly visible, but variables influenced by the state are visible. Each state has a probability distribution over the possible

output tokens. Therefore the sequence of tokens generated by an HMM gives some information about the sequence of states. The extracted model parameters can then be used to perform further analysis. Matthew C. Wiggins et al.[25]. According to this author he used RST and he has got 87 percent accuracy and L. Clavier et al.[26]. According to this author he used HMM and he has got 65 percent specificity 70 percent sensitivity.

- **Hybrid Approach:**

Hybrid approaches in the current context employ multiple classifiers which are fused at some level to perform a classification task. Hybrid Systems are computational systems which are based mainly on the integration of different soft -Computing techniques (like Fuzzy Logic, Neuro computing, evolutionary Computing, Probabilistic Computing) but which also allow a traditional symbolic interpretation or interaction with symbolic components (Knowledge Based Systems / Expert Systems) to classify the ECG signals. There are many different possible combinations among the Symbolic systems and Soft-Computing techniques, and also different ways to integrate them. As for example, Neural Networks can be combined with Fuzzy Logic. Y. zbay et al.[27].According to this author Multi Layer Perceptron (MLP) and Fuzzy Clustering Neural Network(FCNN) he has got 98.9 to 99.9 percent accuracy. And R. U. Acharya et al[28]. According to this author ANN and Fuzzy Logic he has got 80 to 85 percent accuracy.

3. The literature review related prediction of heart attack and heart diseases:

This subsection describe about the prediction of heart attack and heart diseases and how much accuracy they have got.

Ravish et al.[1]. According to this author he used ANN technique for heart attack prediction and prevention and he extracted feature like (1) QRS duration, (2) R-R interval, (3) P-R interval (4).Q-T interval, (5) Isoelectric Line (6) Rwave Amplitude (7) P-wave Duration and (8) T-wave duration and he has got 97 to 99 percent accuracy.

J. P. Kelwade et al.[2]. According to this author he also used ANN technique for Prediction of Cardiac Arrhythmia and he extracted feature using R-R interval time series and he has got 97 percent accuracy.

Dimitra Azariadi et al.[5]. According to this author he used SVM technque for ECG Signal Analysis and Arrhythmia Detection and he extracted feature using Discrete-Wavelet- Transform (DWT) and he has got 98.9 percent accuracy.

Medina Hadjem et al.[6]. According to this author he used Baysien Network technique for Prediction of Cardiac Anomalies and he extracted the features using Filtering Undecimated Wavelet Transform (UWT) and he has got 96.1 percent accuracy.

Bhuvaneswari Amma et al.[11]. According to this author she used ANN and GA for Prediction of Cardiovascular Diseases and she extracted the features using normalization and she has got 94.17 percent accuracy.

Nilakshi P. Waghulde et al.[12].According to this author she used ANN and GA for Prediction of Heart Disease and she has got 94.17 percent accuracy.

According to above survey we can say most of the author used ANN technique for prediction or detection and they have got best results.

III. SYSTEM OVERVIEW

From the above literature survey we have concluded that heart activity is very important in health care monitoring system. And it is done through the ECG signals. Different machine learning algorithms were used for predicting the heart diseases as well as heart attack. The all research is done using MATLAB tool.

IV. PROPOSED SYSTEM ARCHITECTURE

- **Raw Data**

ECG normal and abnormal signal dataset for male and female taken from MIT-BIH arrhythmia dataset that is raw ECG data take it for further process.

Data Selection

This includes operations involved the selecting of either normal or abnormal ECG signal data for further process.

- **Data Preprocessing**

This includes operations applied to the data to prepare it for further analysis. Typical pre-processing operations include data cleaning to filter out noisy data elements, data interpolation to cope with missing values, data normalization to cope with heterogeneous sources, temporal alignment, and data formatting.

- **Feature Extraction**

This includes operations for representing the data appropriately and selecting specific features from this representation. This stage is often called feature extraction and selection.

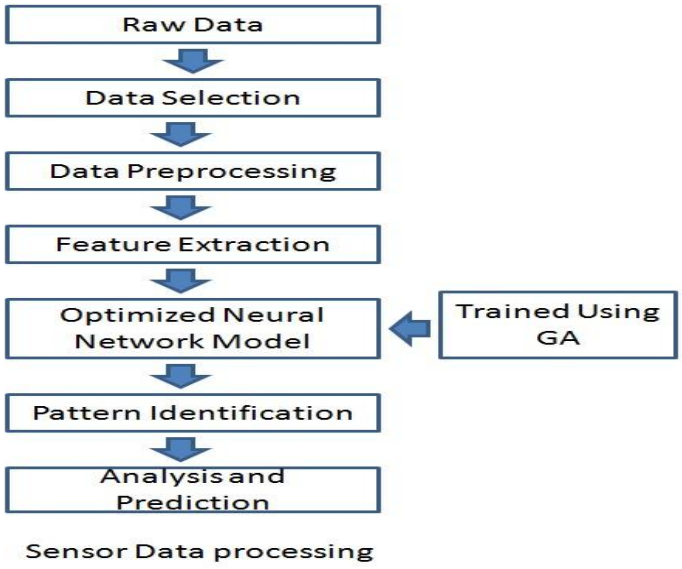

Figure1: Proposed System Architecture

- **Optimized Neural Network Model**

This stage, also called mining applies knowledge discovery algorithms to identify patterns in the data. Modeling problems can be classified into six broad categories: anomaly detection to identify statistically deviant data, association rules to find dependencies and correlations in the data, clustering models to group data elements according to various notions of similarity, classification models to group data elements into predefined classes, regression models to fit mathematical functions to data and summarization models to summarize or compress data into interesting pieces of

information. Here, we are applying Optimized neural network using GA for classification and prediction of heart Attack.

- **Pattern Identification:**

In this stage system identify the pattern of normal ECG dataset as well as abnormal ECG dataset for the analysis and prediction purpose.

- **Analysis and Prediction**:

This stage includes operations for analysis and prediction of the results of the pattern Identification process.

V. METHODOLOGY

Neural Network Optimized by Genetic Algorithm

In the neural network, the hidden neuron can influence the error on the nodes to which their output is connected. It can greatly degrade the generalization capability of the neural network which leads to the significant deviation in prediction result to the problem. To overcome this, an approach is proposed which is able to find minimum number of hidden nodes. The Neural Network Training Problem consists in determining the synaptic weights of a neural network to get the desired output for a set of input vectors. As the Genetic Algorithm is able to find global optimize solution to the problem it can be used for the initialization of neural network weights. Thus, the proposed method with Genetic-Neural approach can be used to design system for the heart disease prediction.

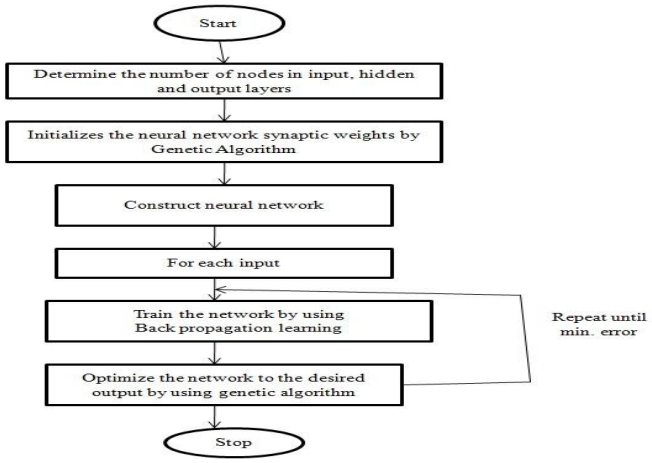

Figure 2: Flowchart of Neural Network Optimization by Genetic Algorithm

VI. DATASET AND RESULTS

We have taken the ECG signal Datasets from the MIT-BIH arrhythmia dataset site. We have taken the normal and abnormal ECG signal dataset for male and female.

We have done the Preprocessing of normal and abnormal ECG signal datasets. Preprocessing done using R programming details are given below.

The low-pass filter was first applied to eliminate the high frequency noise, anything greater than 30Hz. we next applied the filter at a cut-off frequency of 1Hz in order to isolate the slow wave that corresponds to respirations. The images below give the sequence of filtering of normal and abnormal data.

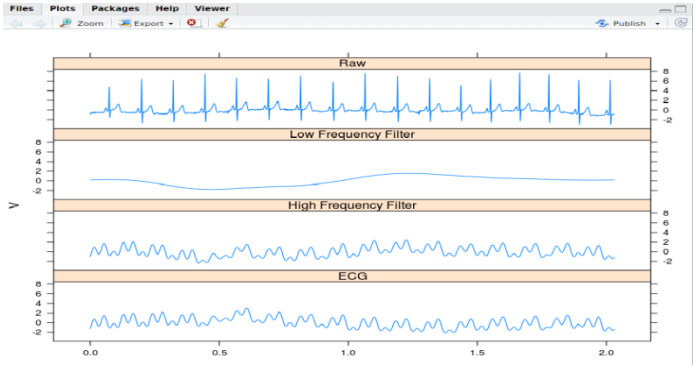

Figure 2: Normal ECG Signal Data preprocessing

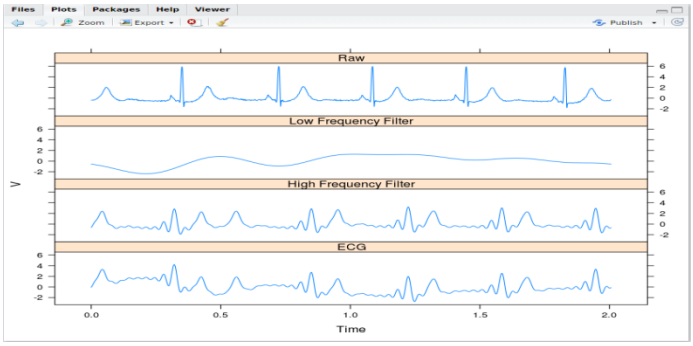

Figure 3. Abnormal ECG Signal Data preprocessing

VII. CONCLUSION AND FUTURE WORK

The ECG is mainly used for diagnosis of heart disease. Genetic Algorithm is used to optimize the initialization of neural network weights. Genetic Neural Network based prediction of heart disease for patient by improving the performance using optimize neural network architecture and predicts whether the patient is suffering from heart disease or not. Also find out possibilities of heart attack based on heart activities. Back propagation is having disadvantage like slow convergence, long training time and local minima. Genetic algorithm is use to solve this problem and gives optimal result as well as get accuracy to predict heart attack.

As the healthcare domain is dynamic and this issue is a challenge to the data mining. It is also a forcing motivation to the data mining applications in healthcare. This dynamism gives way to new horizons and more data mining applications will be employed to discover new patterns and associations. In the view of the subjects examined in this study, future data mining studies seem to take place, not limited but in considerable weight, in distributed data mining applications and text mining algorithms. With the help of data mining algorithms, the classification performance increases. This can be further enhanced and expanded with more prediction algorithm for major life threatening diseases. The further enhancement observes on utilizing different method that provides higher accuracy in feature extraction and classification.

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