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A Survey on Classifiers Used in Heart Valve Disease Detection

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Abstract: In this survey paper, Heart sound has a greater requirement for the detection of heart disease. Now a day, recently extensive research has been applied for different feature selection and classification technique. According to this survey paper we deal with the most important feature for the detection of heart disease that is feature evaluation or ranking and feature selection. They are the most important features to the classification problem .In this we study, a lot of possible combinations between each feature search and each feature evaluation algorithms. At classification section we compare four techniques which give 90% & above accuracy as classifier for heart valve disease detection, initially surveys the research that has been conducted concerning the exploitation of heart sound signals for detection of heart conditions. Then, a comparative study is applied to determine the most effective techniques that are capable for the detection of heart valve disease with a high accuracy.

Keywords: ECG-Electrocardiogram , PCG-Phonocardiogram, AS- Aortic Stenosis , AR- Aortic Regurgitation , MS-Mitral Stenosis, MR- Mitral Regurgitation , ANFIS- Adaptive neuro-fuzzy inference system

I. INTRODUCTION

In recent years, with the increasing population in obesity and smoking, the mortality from cardiovascular diseases is gradually on the rise, which has become the "best killer" that threatens human health compared to cancer, AIDS and other diseases, whatever age, identity or location. Electrocardio and cardiechema are two typical means to monitor angiocardiopathy.[1] The cardiac auscultation is well-organized and provides comprehensive and useful information to diagnosis. However, the information from the traditional stethoscope is the basic interpretation of cardiechema, and a well-experienced physician is necessary in this process. So Phonocardiogram compensates for this shortage of traditional auscultation effectively. Cardiechema contains large amounts of information that reflects the cardiovascular disease, causing the cardiac mechanical obstruction, such as valvular defect and cardiac conduction tissue lesions. Some cardiovascular diseases will lead to a heart murmur and cardiechema variation before observing the change of an ECG signal. Thus, the analysis of cardiechema is able to identify some of the cardiovascular system diseases in early. [2]

The diagnosis of diseases like heart valve diseases using data mining tools is an essential requirement in daily life. Most of heart valve diseases have an effect on the heart sound of patients [3]. Classification can be applied to Detect whether the patient's heart sound signal is patient or not and also can detect the type of the heart disease in sick patients [4]. Such an approach could be useful in the diagnosis of heart disease remotely, just by sending a record of the heart signals to a medical back end system that replies automatically by the problem in heart. Also it is considered as a low cost approach rather than the high cost medical examinations. Also A computerized system could provide physicians with suggestions about the diagnostic suggestions about the diseases. Due to the sensitivity of heart diagnosis results, a high classification accuracy and performance are required with the least error percentage. After extracting features from heart sound signals, preprocessing is applied on these features.

The heart valve disease detection pre-processing step:

This reference paper proves that that all the terminals of the process should put into consideration the characteristics of the internal structure of the input data. The most important pre-processing step is the feature reduction of the input data set. Feature selection methods rank and select the most important features, where if only a subset of features with the highest rank are used in classification, high classification accuracy could be achieved. The extracted heart sound data are three different data sets, each of features where they are sliced into six different parts. The first data set is required to classify whether the heart of the patients are normal or not. The second and third data set is required for the detection of the heart valve disease.

The heart valve diseases under investigation in this paper are:
The aortic stenosis AS
The aortic regurgitation AR

The mitral stenosis MS
The mitral regurgitation MR.

This disease classification is performed in two steps:

- The first step is applied on the second data set for determining the type of the systolic murmur which means AS or MR
- The second step is applied on the third dataset of diastolic murmur diseases which means AR or MS.

The second importance of feature selection method is to determine which stage of the heart sound could have the greatest indication to heart valve disease in the case of each murmur type. The four stages of a heart sound are the first heart signal S1, the systolic period, the second heart signal and the diastolic period[5]

The paper is organized as follows: Section I gives an introduction to the heart valve disease , Section II gives a analysis of heart valve diseases into two part that is feature selection and classification techniques ,Section III details the general comparative study of different classifiers used for getting 90% and above accuracy ,The conclusions are drawn in Section IV ,According to the all comparison results, the classification performance of the ANFIS classifier method was best among all the classifiers

II. FEATURE SELECTION AND CLASSIFICATION TECHNIQUES

The analysis of the heart valve diseases contains three phases, the feature selection and evaluation phase, the classification phase, and finally the analysis phase. These three phases are described in detail in this section along with the steps involved and the characteristics feature for each phase.

A. Feature evaluation and selection phase

Data sets may contain irrelevant or redundant features that are considered as misleading to the classification technique applied. These features could lead to what is known as curse of dimensionality problem [6]. The application of feature selection techniques greatly reduces the computational cost and increases the classification accuracy of classifying high dimensional data. The selection of the most important features to the classification problem could be based on two phases, feature evaluation or ranking and feature selection. There are a lot of possible combinations between each feature search and each feature evaluation algorithms [7]. Feature evaluation technique involves the evaluation of each feature according to the target class labels, while feature selection techniques perform the evaluation of subset of feature explicitly via a predictive model, classifier, built from just those features. Feature selection is grouped in two ways according to the attribute evaluation measure: depending on the type (filter or wrapper techniques) or on the way that features are evaluates (individual or subset evaluation) [8], [9]. The used feature selection in this context is the sequential floating selection, filter model, as it leads to the highest classification accuracy. The first requirement in this study to find the feature evaluation techniques that leads to the highest classification accuracy in the current heart sound data sets. The following set of feature evaluation techniques are used here in the experimental work:

- *Consistency subset evaluation:* Evaluates the worth of a subset of attributes by the level of consistency in the class values when the training instances are projected onto the set.
- *Chi Squared Attribute Eval:* Evaluates the worth of an attribute by computing the value of the chi squared statistic with respect to the class attribute.
- *Filtered Subset Eva l:* Class for running an arbitrary subset evaluator on data that has been passed through an arbitrary filter
- *Info Gain Attribute Eval :* Evaluates the worth of an attribute by measuring the information gain with respect to the class
- *Gain Ratio Attribute Eval*: Evaluates the worth of an attribute by measuring the gain ratio with respect to the class.
- *SVM Attribute Eval*: Evaluates the worth of an attribute by using an SVM classifier. Attributes are ranked by the square of the weight assigned by the SVM. Attribute selection for multiclass problems is handled by ranking attributes for each class separately using a one-vs-all method and then “dealing" from the top of each pile to give a final ranking [10].

- *Filtered Attribute Eval*: Class for running an arbitrary attribute evaluator on data that has been passed through an arbitrary filter.

B. Classification phase

This phase includes the training and testing of the classifiers. Every classification technique has its own strong and weak points. Generally, SVMs and neural networks tend to perform much better when dealing with multi dimensions and continuous features [11]. On the other hand, logic-based systems like decision trees tend to perform better when dealing with discrete/categorical features. For neural network models and SVMs, a large sample size is required in order to achieve its maximum prediction accuracy whereas NB may need a relatively small data set. Another problem appears in univariate models like Bayes belief models that assume features are independent [12] where it will be computationally intractable unless an independence assumption (often not true) among features is imposed [13]. The main judge of which machine learning technique to select depends on the nature of the input data set, as selecting inappropriate algorithm may lead to either high processing cost or low classification accuracy.

The classification techniques used in this study is as follows:

1. Back-propagation Network (BPN)

BPN is a feed-forward network with three layers, namely input layer, hidden layer, and output layer, as shown in The number of hidden layers can be more than one, depending on the complexity of the problem. In our study, we used one hidden layer to minimize the computational time and reduce complexity of training.

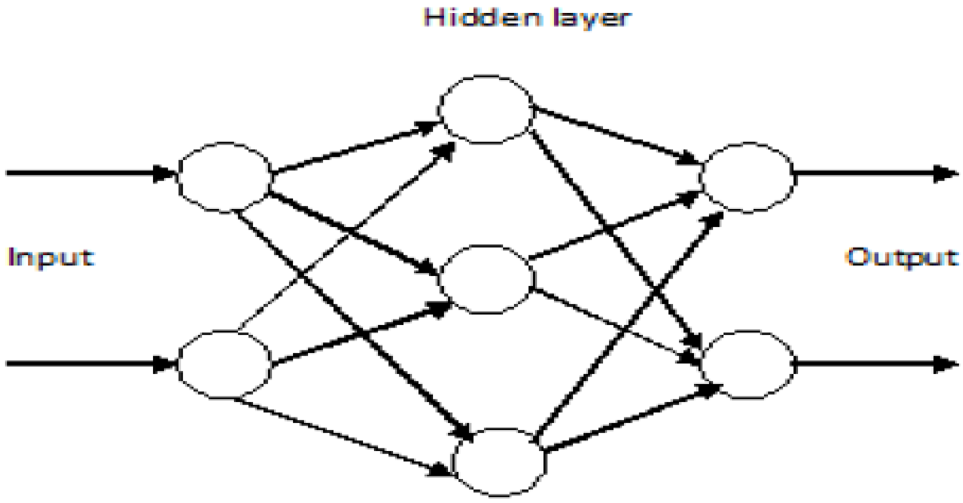

Fig.1. An example of a feed forward neural network

Determining the number of layers and the number of processing elements per layer are important decisions, which are made by the programmer while creating and training the network. Training inputs are applied to the input layer of the network, and the desired outputs are compared at the output layer. The difference between the output of the final layer and the desired output is back-propagated to the previous layer(s). The back-propagated signals are usually modified by the derivative of the transfer function and the connection weights, which are usually, adjusted using the Delta Rule. The minimum mean square error between the actual output layer of the network and the desired output is minimized using the gradient descent algorithm. The performance of a neural network depends on the weights and the transfer function (input-output function) specified for the units.[18]

2. Support Vector Machine (SVM)

Support Vector Machine is a method of machine learning, classification and recognition, which is based on statistical theorems [14]. The classification performance of SVM is superior to traditional classification methods, especially the generalization. Error penalty parameters and the form of kernel function are two key factors of classification performance of SVM. Exchanges can be avoided if we select an appropriate inner product kernel function which makes the classification have better generalization performance and disturbance rejection
Capability. [15]

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3. Radial Basis Function Network (RBF)

It is a three-layer network, namely the input, the output and the hidden layer, where each hidden unit in a hidden layer implements a radial activated function. The main advantages of RBF's over feed-forward networks are its accuracy and shorter computational time. As Venkatesan and Anitha [16] explained, the response of the jth-hidden unit can be mathematically expressed as

$$Zj = \emptyset[\,|\frac{x-\mu j}{\sigma j^{2}}|\,]$$

Where is ∅a strictly positive, radially symmetrical function (kernel) with a unique maximum at its center, µj, and **σ**j is the width of the receptive field. The error between the target and the desired output is minimized using gradient descent algorithm.[18]

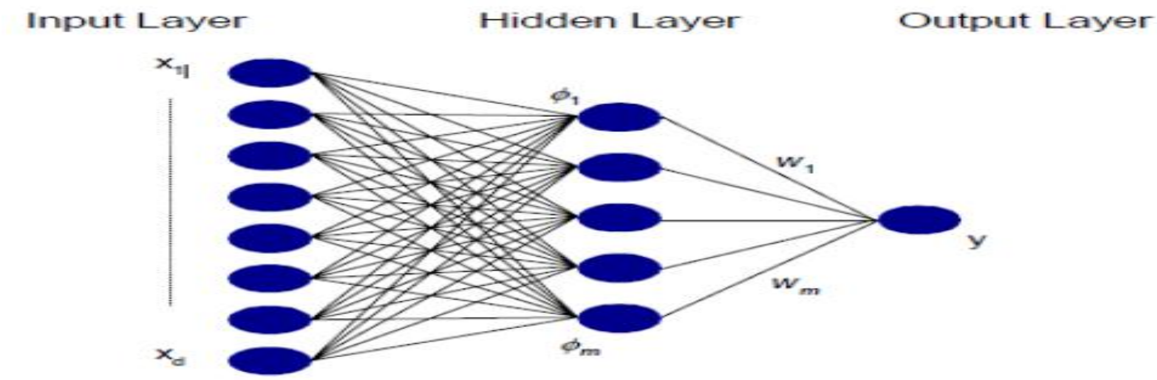

Fig2: RBF network architecture.

4. Adaptive neuro-fuzzy inference system (ANFIS)

Fuzzy logic and ANN are modeling methods used influentially and effectively in the problems of engineering. The modeling of fuzzy logic method is a rule-based method using the feature of human thinking and decision making. On the other hand, ANN learns the problem by using its ability of learning and comes through successfully for data sets it did not come across before. The method of ANFIS was suggested by Jang [17] in 1993 considering these advantages of ANN and fuzzy logic methods. ANFIS is an integrated form of ANN and fuzzy inference systems. The membership degree of input/output variables is determined in an ANFIS by the use of ANN's ability of learning. A conclusion is reached with the feature of reasoning and decision making of fuzzy logic method.[19]

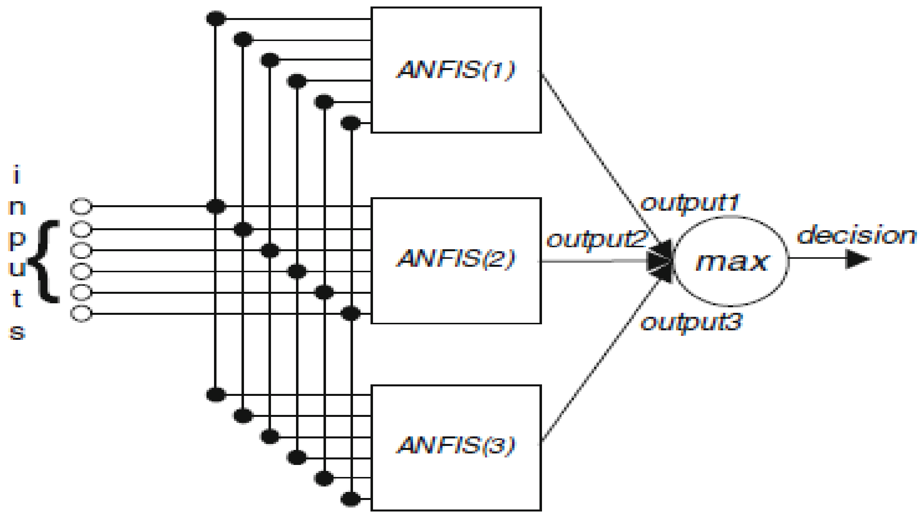

Fig3: Test stage of three ANFIS classifiers

III. Comparison Between Different Classifiers:

S.No	CLASSIFIER	ACCURACY
1	Artificial Neural Networks (ANN) algorithms with Back Propagation Network (BPN) Techniques	90.8%
2	Support Vector Machines (SVM)	95%
3	Artificial Neural Networks (ANN) algorithms with Radial Basis Function(RBF)	98%
4	Adaptive Neuro-Fuzzy Inference System (ANFIS) Classifiers	98.33%

Table 1: Comparative Study of Classifier

IV. CONCLUSION

The prepossessing was performed using Wavelet transform. Four independent feature characteristics related to the PCG signals are extracted. These features are fed as inputs to the classifiers: the traditional back-propagation network algorithm, the radial basis functions network algorithm, Support Vector Machines& Adaptive Neuro-Fuzzy Inference System Classifiers The testing results show that the performance of RBF networks is superior when compared to the traditional BPN networks with 98% accuracy compared with 90.8% for the BPN & the adaptive neuro-fuzzy Inference System classifier gives 98.33%.

According to the all comparison results, the classification performance of the ANFIS classifier method was best among all the classifiers. A comparative study is applied to determine the most effective techniques that are capable for the detection of heart valve disease with a high accuracy.

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Biography

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