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Spirometry Data Analysis and Classification Using Artificial Neural Network: An Approach

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***Abstract*--In this paper, the acquisition of Spirometry data such as Forced Expiratory Volume in 1 second (FEV1), Force Vital Capacity (FVC) and Small Vital Capacity was carried out using Spirometer.At present numbers of lung diseases are major threat to the human health due to air pollution, smoking and other infections. The various Artificial Neural Network methods for the classification of Spirometry data are Back Propagation Network (BPN), Radial Basis Function (RBF) and Multilayer Perceptron Neural Network (MLPNN). The aim of the present study is to acquire parameter such as FVC, FEV1 and SVC data and use unsupervised Artificial Neural Network for classification of the Spirometer data into Normal, Obstructive and Restrictive dataset.**

Keywords - Spirometry, Obstructive, Neural Network, Multi Layer Perceptron Neural Network, Force Expiratory Volume in 1 second, Back Propagation Network, Restrictive.

I. INTRODUCTION

Nowadays respiratory diseases are one of the most serious problems for the human health. Respiratory diseases are curable from early detection. Respiratory diseases are mostly caused due to factors such as air pollution, smoking and various infections. Respiratory function is commonly access by the standard Spirometry pulmonary function test. There are two main type of lung diseases found with lung function test such as Obstructive and Restrictive [1]. In Obstructive lung condition the airways are narrow normally causing an increasing in the time taken to empty lung [2][3]. Spirometer device measures the volume of air inhaled or exhaled as a function of time during the breathing. It is the most important tool in the diagnosis of airway obstruction disease [4].

Spirometer test depends on some factor such as age, height, weight, gender, and location i.e. in which location the subject are living for example the people living in hilly areas have more breathing capacity as compare to other people. The Spirometer also used to classify the respiratory disease from cardiac disease [5].
Obstructive and restrictive pattern have four different levels as categories as follows [6].

1. Mild
2. Moderate
3. Severely Moderate
4. Severe

II. RELATED WORK

An Artificial Neural Network is mathematical or computational model that inspired by the structural or functional aspect of biological neural network and it is interconnection of Artificial Neuron [7]. The Self-Organizing Map is an unsupervised neural network that uses a competitive (winner-take-all) learning strategy The Self-Organizing Map algorithm belongs to the field of Artificial Neural Networks and Neural Computation. More broadly it belongs to the field of Computational Intelligence [8, 9].

Normally ANN used for complex relationship between input data and output data to find pattern. The input layer is use to take input values from datasets that produces changes in the activation state of output layer [10]

In 2008 Sujatha C. Matructinoharan1, Mahesh Veezhinathan carried out the study to detect obstructive respiratory abnormalities using back propagation function artificial network in which they showed that proposed method.

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This method is useful to classify the Spirometry data into normal and obstructive datasets to that study they collected the 150 (50 normal, 25 restrictive,25 obstructive,50 validation) sample were taken. The age, gender and race were identified before test. The accuracy, sensitivity and specificity of that algorithm were also calculated. Accuracy is the representation of classifier performance in global sense. Sensitivity and specificity are the proportions of abnormal data classified as abnormal, normal data classified as Normal respectively [10].

In 2008 Mahdi Jan Baemani, Amirsham Monadjemi and Payman mollem used the Multilayer Perceptron Neuaral Network (MLPNN) for detection of normal and restrictive pattern of pulmonary disease. In that study they took all three patterns of respiratory abnormalities into consideration. For the classification they used recuurent neural network. The accuracy, sensitivity and specificity of that algorithm were also calculated [11].

Anandan K worked on the diagnostic of relevance of Spirometric pulmonary function test using Neural Networks and Principal Component Analysis [PCA]. Principal Component Analysis was performed on the data sets with measured and predicted values. PCA transforms the input space into a new lower dimensional space. High accuracy was measured of PCA and ANN [12].

Kavitha A. worked on the classification and prediction of Spirometry data using Support Vector Regression Algorithm. In this, they classify Spirometry data into normal and abnormal using Regression Algorithm and accuracy was measured [13].

III. Proposed Method

There are different steps in which project will be implemented and various methodology are used in implementation Breeze software is use to connect Spirometer device with PC and Statistica data miner software is also use for data analysis. Spirometry data of 150 adult volunteers (90 Normal, 30Restrictive, 30 Obstructive) are use in this study. The data is divided to training and test sets. The age, gender, and race of patients are identified and use for obtaining dataset of FVC, FEV1.

A. Data Acquisition

Data collection is the most important step to implement any Artificial Neural network technique and for this purpose provides use the Spirometer device.

Spirometer device provide different parameter like FVC, FEV1, SVC and MVV. Following are the some sample of Spirometer data.

Table 1
Dataset for FVC, FEV1

ID	Age	Sex	FVC(volume)	FEV1(volume)
01	34	Male	5.06	3.9
02	35	Male	5.2	3.41
03	32	Male	4.9	4.01
04	22	Male	3.5	3.1
05	30	Male	4.8	3.23

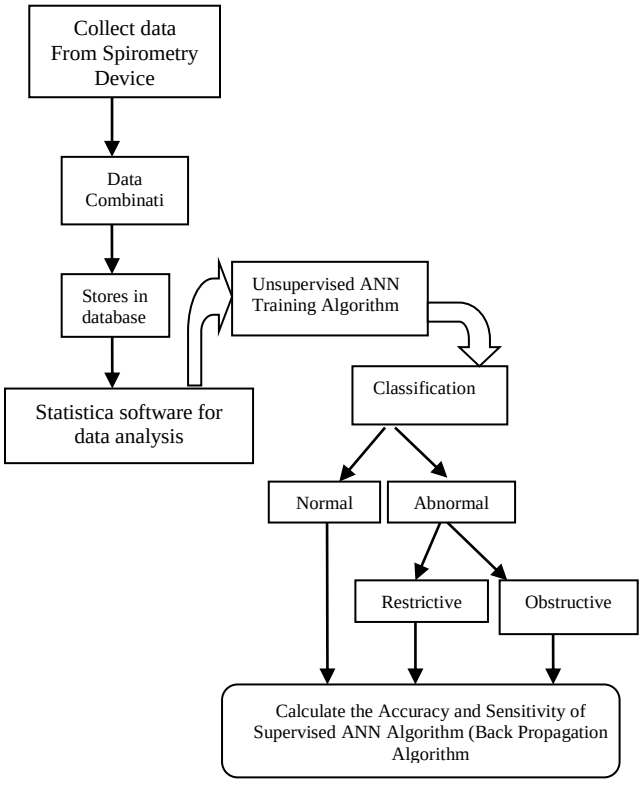

Figure 1. Methodology for Spirometry data classification.

B. Data Preprocessing and Combination

Spirometer device gives the different parameter in different sheet. In that step we collect the data in one database sheets and remove the noise data from the Spirometry data.

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After data preprocessing step the data provides to the Statistica data miner software for data analysis. After data analysis use the self organizing feature map algorithm for data classification.

C. Data Classification

Classification is the process of finding a model that describes and distinguish data classes for the purpose of being able to use the model to classify the class of object whose class is unknown.

The various methods of data classification
1. IF-THEN Rules
2. A decision Tree
3. Artificial Neural Networks

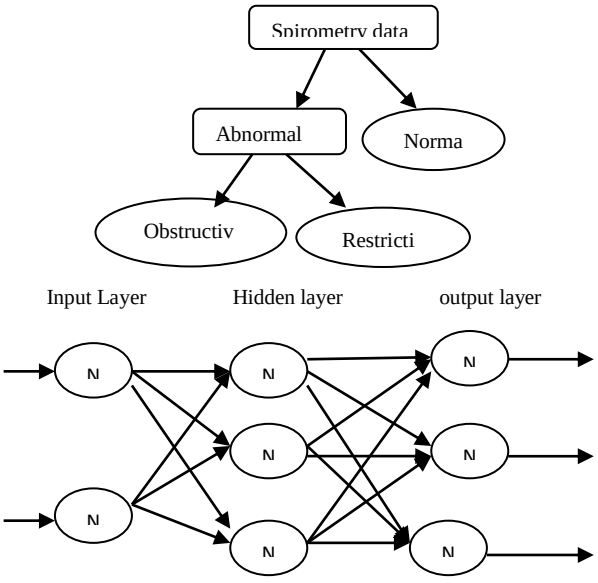

Figure 2. Classification Model

IV. Self Organizing Feature Map (SOM)

For Spirometry data classification use the Self Organizing feature map Algorithm [14]. Self Organizing feature map is used for unsupervised classification and prediction. The Self-Organizing map is comprised of a collection of codebook vectors connected together in a topological arrangement, typically a one dimensional line or a two dimensional grid. The Best Matching Unit (BMU) is the codebook vector from the pool that has the minimum distance to an input vector. A distance measure between input patterns must be defined. For real-valued vectors, this is commonly the Euclidean distance.

$$Dist(x,c) = sum(i=1)^{n} (x\ i - c\ i)^2$$

where n is the number of attributes, x is the input vector and c is a given codebook vector

$$c\ i(t+1) = learn\_rate(t) \backslash times\ (c\ i(t) - x\text{-}i)$$

where c i(t) is the i^{th} attribute of a codebook vector at time t, learn_{rate} is the current learning rate, an x i is the i^{th} attribute of a input vector.[14]

V. Future Scope

In Spirometry data Classification there are various Supervise Artificial Neural Network Algorithms were used. In future the Statistical Data miner and Self Organizing Feature Map Algorithm can be use to predict whether subject is in normal state or abnormal state, it can also be use to implement for more accurate result.

VI. Conclusion

Thus in this paper, the parameters like FEV1, FVC, FEC and MVV are classified according to the test data. Self organizing feature map classification method is easy to implement. Many researchers used different methods for classification methods. Self organizing feature map used two dimensional topological structures for classification. It is well suited for one or more dimensional classes .thus, the proposed method aims at classify and predict Spirometer parameter such as Force Vital Capacity, Force Expiratory Volume in 1second, and Small Vital Capacity into Normal, Obstructive and Restrictive.

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