Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 3159-0040
Vol. 3 Issue 2, February - 2016

Detection of Airway Obstruction Test Using Neural Network

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***Abstract*—in this paper detection of airway obstruction with Artificial Neural Network (ANN) is presented. For this study, 3 types of spirometric data (Forced expiratory volume in 1 second (FEV1), Forced Vital Capacity (FVC) and FEV1/FVC data) were obtained LungXplorer database. Accuracy of classification of ANN is 88.1%. This result helps clinical decisions for decision makers in health care organizations. Also predict accuracy of ANN is acceptable for obstruction and normal cases.**

Keywords— Flow–volume spirometry ; Pulmonary abnormality;Spirometric patterns . Artificial Neural Network (ANN) . Classification accuracy

I. INTRODUCTION

Pulmonary function tests (PFT) is a physiological test, which determines how a person's breathing air according to time that measure lung function numerically. Pulmonary function tests are done with an equipment that is called spirometry. Spirometry device is used usually for controlling respiratory function. Therefore accurate results of spirometry device are important for different types of lung abnormalities. [1]. Obstructive and restrictive are two major abnormalities of respiratory function. Many factors of obstructive are emphysema such as airflow obstruction of the peripheral airways and mucus hypersecretion. Spirometry predicted values are depends on sex, age and height. Forced expiratory volume in 1 second (FEV1), Forced Vital Capacity (FVC) and FEV1/FVC parameters are measured with spirometry. The evaluation of pulmonary function tests is based on comparison value of the measured values obtained from healthy sources (expected value / predicted value). Expected values were derived from "normal" or "healthy" individuals in studies that have same anthropometric (age, gender, height) and the ethnic characteristics. Evaluation of patient's PFT appropriate maneuver is started firstly assesment as a classical spirometry testing. Firstly, It should be consulted forcibly exhaled in the first second . This time should not be less than six seconds. This time as shown volume-time graph or FET (forced exhalation time) in tests. The results of the short-term maneuver than six seconds is not healthy. The second step is to examine the flow volume curve. This curve give ideas about adaptation to patient testing, and type of probable pathology as well. Then, respectively, FEV1 / FVC ratio and FVC value are categorized according to the FVC value that can be redirected to possible pathology diagnosis. If FEV1 / FVC ratio decreased and FVC value normal, this means that obstructive disorder. If FEV1 / FVC ratio value normal and FVC value decreased, this means that restrictive disorder. If FEV1 / FVC ratio value and FVC value decreased this means mixed type. It has obstructive and restrictive disorders. [2] [3].

TABLE 1. Changes in pulmonary function parameters in the differentiation of types of obstructive, restrictive and mix type pathology.

	Obstructive	Restrictive	Mix
FEV_1	Decreased	Decreased	Decreased
FVC	Normal	Decreased	Decreased
FEV_1 /FVC	Decreased	Normal or Increased	Decreased

In ANN signal, image and data have been used for estimation and classification successfully [4]. ANN is flexible in modelling and it has high accuracy of prediction. Therefore, for different medical diagnosis and classification method ANN have been used such as radiology, ophthalmology, oncology, neurology and in respiratory measurements. [5–7]. Simplest mean of (ANNs) is modelling as the human brain. ANN are the building blocks of neurons. There are approximately 100 billion neurons in the human brain. Within the multilayer neural network has neurons arranged similarly to human brain. Each neuron is connected to other neurons by certain coefficients. During the training, distributed network connection is used for learning information.

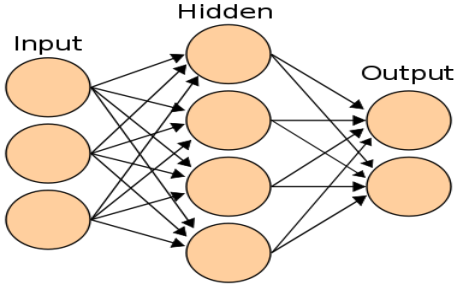

Fig. 1. *Neural network layers*

ANN consists of three layers including input layer, hidden layer and output layer. In order to carry the detection procedure the neural network needs to be trained from input layer to output layer (1).ANN has interesting properties such as storing the entire network information, ability to work with incomplete information, having error tolerance, having distributed memory, gradual deterioration, ability to machine learning, parallel processing capability, parallel processing capability [8,9]. These properties give high accuracy of prediction.

II. METHODOLOGY

In our proposed study data is obtained from 400 persons (Normal=140, Obstructive=100, Testing=160) between 16 and 80 ages ranges at LungXplorer database [10]. All data is obtained precise measurement of laboratory portable spirometry with high accuracy and stability .Hankinson reference values were used for patients <80 years old. [11]. 3 types of spirometric data (Forced expiratory volume in 1 second (FEV1), Forced Vital Capacity (FVC) and FEV1/FVC data) were collected and used for study.

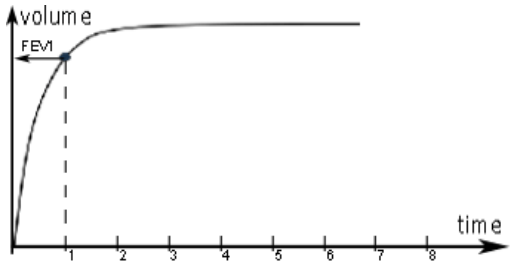

Fig. 2. *Curve of Flow–volume for normal subject*

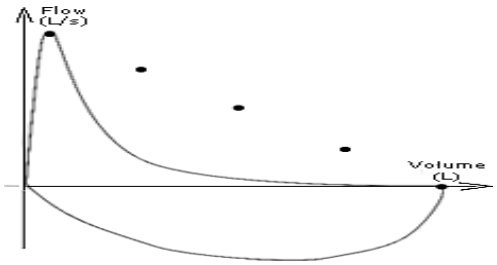

Fig. 3. *Curve of Flow–volume for obstructive subject*

The data used is obtained between 16 and 80 ages ranges from 400 patients at Firat University research hospital under standard recording protocol. The measurement of volume V(t) and the flow rate of air Q(t) dependency formula is given below, The electronic integration of the airflow Q(t) allows us to obtain the volume V(t) [12].

$$V(t)=\int Q(t)dt$$

Standard deviation, standard error and mean value were calculated. In this proposed work sigmoid transfer function was used. Data were normalized between 0 and 1 then it is used for training the network. This work has been implemented in a laptop which has Intel Core i7 4510U processor, 4 GB of RAM and Windows 10 operating system. Application code is written in MATLAB R2015a program. The proposed study is evaluated according to confusion matrix. Confusion matrix parameter as given below;

Accuracy = (True Positive+ True Negative)/ (True Positive+ True Negative + False Positive + False Negative)
Sensitivity = True Positive/ (True Positive+ False Negative)
Specificity = True Negative+ (True Negative+ False Positive)
According given above, if a normal data classified as obstructive, it is False Positive (FP), if a obstructive data classified as normal, it is False Negative (FN), if a obstructive data classified as restrictive, it is True Negative (TN), if a normal data classified as normal, it is True Negative (TP),

TABLE 3 MATHEMATICAL STATISTICS OF ANN

Input	Parameter	Normal(105)			Obstruction(55)		
		Mean	Standard Deviation	Standard Error	Mean	Standard Deviation	Standard Error
1	FVC	3,47805±0,68		0,118	2,2862±0,82		0,09
2	FEV_1	2,9557±0,52		0,09	1,8632±0,48		0,072
3	FEV_1/FVC	0,85±0,07		0,84	0,75±0,02		0,65

III. RESULTS AND DISCUSSION

The features of spirometric patterns (FEV1, FVC and FEV1/FVC ratio) were used as the inputs of the ANN. The mathematical analysis of ANN parameters is given above Table3. This shown that FEV1, FVC and FEV1/FVC ratio was found that there are significant changes between normal and obstructive examples. Table 4 show that Performance observation of proposed method. Total 3 input were given to the ANN. The output performed as 0 or 1, which means obstructive or normal respectively. Confusion matrix is

used to show the validity of test accuracy. According to test result are accuracy (88, 1%), sensivity (89, 9%) and specificity (85, 2%).

TABLE 4 PERFORMANCE OBSERVATION OF PROPOSED METHODS

Performance Observation		
Parameter	ANN Classification	Clinical Records
TP	89	96
TN	52	64
FP	9	-
FN	10	-

IV. CONCLUSION

A pulmonary function test is an important test for clinical practices [13, 14]. Therefore test result has to be in high accuracy. In medical system high accuracy results is possible only with trustworthy health care system. In this study with using ANN obstructive disorders have been detected [15]. The ANN results give great performance. Total accuracy of ANN was 88,1 % . However, more trained input parameters and data gives more accurate results.

ACKNOWLEDGMENT

I would like to thank to Prof. Dr. Engin Avcı Department of Software Engineering at Firat University for classification of ANN during this research.

REFERENCES

[1] Pierce, R., Spirometer: An essential clinical measurement. Aust. Fam. Physician. 34:535–539, 2005.

[2] Crapo, R. O., Pulmonary-function testing. N. Engl. J. Med.331:25–30, 1994. doi:10.1056/NEJM199407073310107.

[3] Ferguson, G. T., Enright, P. L., Buist, A. S., et al., Office spirometry for lung health assessment in adults: a consensus statement from the National Lung Health Education Program.Chest. 117:1146–1161, 2000. doi:10.1378/chest.117.4.1146.

[4] Jesu, C. J., and Ramakrishnan, S., Assessment and classification of mechanical strength components of human trabecular bone using digital image processing and neural networks. J. Mech. Med. Biol. 7:315–324, 2007.

[5] Übeyli, E. D., Comparison of different classification algorithms in clinical decision-making. Exp. Syst. 24 (1)17–31, 2007. doi:10.1111/j.1468-0394.2007.00418.x.

[6] Übeyli, E. D., Analysis of EEG signals by combining eigenvector methods and multiclass support vector machines. Comput. Biol. Med. 38 (1)14–22, 2008. doi:10.1016/j.compbiomed.2007.07.004.

[7] Übeyli, E. D., Combining neural network models for automated diagnostic systems. J. Med. Syst. 30 (6)483–488, 2006. doi:10.1007/s10916-006-9034-z.

[8] Abboud S., Barnea O., Guber A., Narkiss N., and Bruderman I., Maximum expiratory flow–volume curve: Mathematical model and experimental results. Med. Eng. Phys. 17:332–336, 1995.

[9] Sriraam, N., and Eswaran, C., Context based error modeling for lossless compression of EEG signals using neural networks. J. Med. Syst. 30:439–448, 2006.

[10] Quanjer, P.,2014.LungXplorer software for studying cross-sectional and longitudian spirometric data,http://www.spirxpert.com/download/download6.html. (03.01.2015).

[11] Serhatlioglı,I., Ozyurt, F., Avci, D., Ertam, F., Kacar, E., Spirometric Reference Values with using Artificial Neural Network Classification (JMEST) ISSN: 3159-0040 Vol. 2 Issue 12, December - 2015

[12] Evaluation of Flow–Volume Spirometric Test Using Neural Network Based Prediction and Principal Component Analysis Anandan Kavitha & Manoharan Sujatha & Swaminathan Ramakrishnan

[13] Ulmer, W. T., Lung function—Clinical importance, problems, and new results. J. Physiol. Pharmacol. 54:11–13, 2003.

[14] Enright, P. L., Studnicka, M., and Zielinski, J., Spirometry to detect and manage chronic obstructive pulmonary disease and asthma in primary care settings. Eur. Resp. Monit. 31:1–14, 2005.

[15] Detection of Obstructive Respiratory Abnormality Using Flow–Volume Spirometry and Radial Basis Function Neural Networks Mahesh Veezhinathan & Swaminathan Ramakrishnan