Features Analysis of EEG Signals using Neural Network as Classifier for Diseases Diagnoses and Function Operation

Mazher B Tayel
Electronics and Communication Engineering
Faculty of Engineering Alexandria University
Alexandria , Egypt

A. A. A. Nasser
Electronics and Communication Engineering
Arab Academy for Science, Technology, and Maritime Transports, Alexandria, Egypt
Alexandria , Egypt

Ahmed Fouad Gaber Kishk
Electronics and Communication Engineering
Faculty of Engineering Alexandria University
Alexandria , Egypt

***Abstract*—Image processing and neural network in today's world grabs massive attentions as it leads to possibilities of broaden application in many fields of high technology. Here will discuss the use of both in the field of biomedical engineering. "A brain computer interface is a communication system that does not depend on the brains normal output pathways of peripheral nerves and muscles" [1]. Brain Computer Interface (BCI) allow disabled people or people who have brain injury or brain diseases to monitor the brain activity. Faster computers and better EEG devices offered new possibilities. There are two main approaches in BCI, the first approach is called operant conditioning approach and the second is of our important is called pattern recognition approach. In the case of pattern recognition approach we will record the EEG wave as a graphs after amplification and filtering and use image processing technique to extract features from these data and then use neural network techniques to make classification and training on these data and then perform test on the system.**

Keywords—Brain Computer Interface (BCI), electroencephalograph (EEG), Magnetic Resonance Imaging (FMRI), Positron Emission Tomography (PET), Single Photon Emission Computer Tomography (SPECT), image processing, histogram neural network.

I. INTRODUCTION

Brain Computer Interface (BCI) is a communication system, which enables the user to control special computer applications by using only thoughts. Different research groups have examined and used different methods to do this. Almost all of them are based on electroencephalography (EEG) recorded from the scalp. The EEG is measured and sampled while the user imagines different things (e.g. moving the left or the right hand). Today there exists various techniques to do this. These include, for example, functional Magnetic Resonance Imaging (FMRI)[2], magnetoencephalography (MEG)[3]. Positron Emission Tomography (PET), Single Photon Emission Computer Tomography (SPECT)[4], optical brain imaging, single neuron recording (with micro- electrodes) and electroencephalography (EEG)[5]. Here we will use image processing and neural network to classify the EEG data and make data base of different EEG wave then make test on these data bases. There are two main approaches in BCI, the first approach is called operant conditioning approach and the second is of our important is called pattern recognition approach. In the case of pattern recognition approach we will record the EEG wave as a graphs after amplification and filtering and use image processing technique to extract features from these data and then use neural network techniques to make classification and training on these data and then perform test on the system. See fig.1 Electroencephalography (EEG) is a method used in measuring the electrical activity of the brain. This activity is generated by billions of nerve cells, called neurons. Each neuron is connected to thousands of other neurons. Some of the connections are excitatory while others are inhibitory. The signals from other neurons sum up in the receiving neuron. Normal people's brain waves show different rhythmic activity are shown in TABLE 1.

A typical BCI device consists of several components. These include electrode cap, EEG amplifiers, computer and subject's screen. A critical issue is how the user's commands, i.e., the changes in the EEG, are converted to actions on the feedback screen or the application. This process can be divided into five stages:

1) Measurement of EEG.
2) Preprocessing.
3) Feature extraction.
4) Classification.
5) Device control.

II. DATA COLLECTION AND IMAGE PROCESSING AND NEURAL NETWORK

A. Data collection

In this case we will record the EEG data in form of graphs and collect them for the purpose feature extraction and classifying and training.

B. Feature extraction:

In this case we will use the histogram to extract features from the gray scaled graphs. A histogram is a graphical representation of the distribution of data as shown in fig.2. It is an estimate of the probability distribution of a continuous variable and was first introduced by Karl Pearson[5]. Also features are extracted using wavelet transform Neural network is used to be the classifier for BCI in this case. I will use the feed forward network we record data graphs and then divide the data to group, each group contain number of graphs and each group will make a network. The number of networks is given by equation 1. Then the data will be trained according to the neural network parameter, and then we will test the system with input test data that will be classified. When the data is classified and recognized an output will be transmitted from the computer to an external devices for the purpose of control using the arduino as an interface between the computer or the classifier and the external devices. The EEG data is stored for feature extraction and training and testing procedures. The performance of the network is then measured and training will be stopped when the sum squared error between the target data and the actual data is in certain limit. Testing is performed using test data when the test data is classified using neural network a control signal will be output to the arduino circuit for indication or control

C.Classifing the data

In the final stage when the neural network or the classifier classifies the data then we use an the arduino as an interface between the computer or the classifier and an external devices

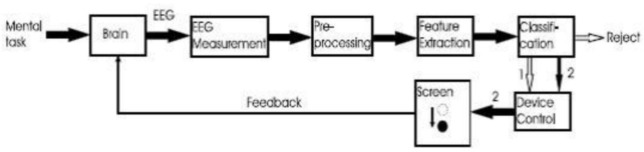

Fig.1 A BCI based on the classification of two mental tasks

TABLE 1: Common EEG frequency ranges

Band	Frequency [Hz]
Delta (δ)	<3.5
Theta (θ)	4-7.5
Alpha (α)	8-13
Beta (β)	>13

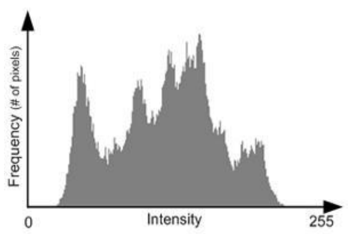

Fig.2 gray scale histogram

D. Arduino and MATLAB M File

Using PDE library of Arduino I/O file that is interfaced with MATLAB, after the processing of image program and the program sends certain number to Arduino, this number identifies the name of the diseases, Using pins 7, 8, 12 and 13 to obtain the number of the diseases, The interface between them will occur via serial port COM 4 using Arduino USB programming cable.

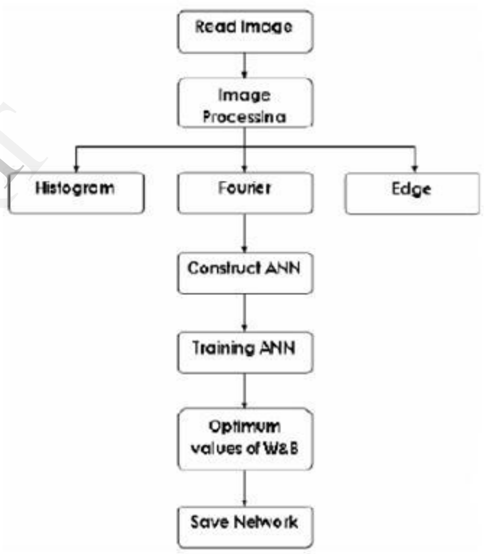

Fig.3 Flowchart to Write Code and Recalling It

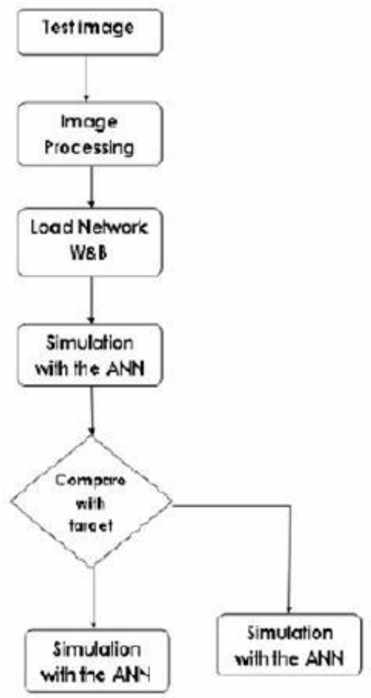

Fig.4 recalling code

$$number\ of\ network = \frac{total\ number\ of\ data\ base}{number\ of\ input\ per\ network} \quad (1)$$

III. RESULTS AND DISCUSSION

The EEG signals are preprocessed using histogram for feature extraction and then classified using ANN as shown in fig.5. And then the performance is measured as shown in fig.6 Experiments are conducted using sigmoid and purelin functions and with optimum weight and bias.

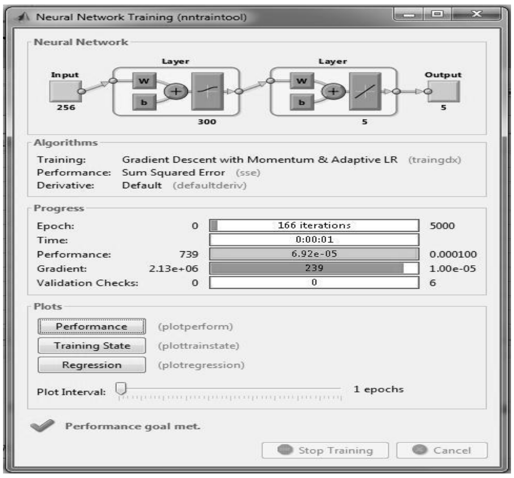

FIG.5 neural network training

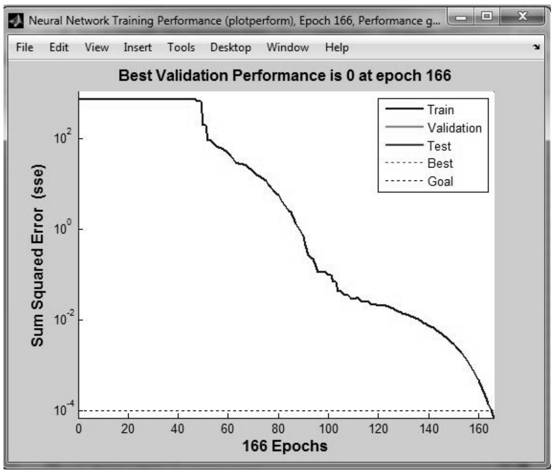

FIG.6 neural network performance

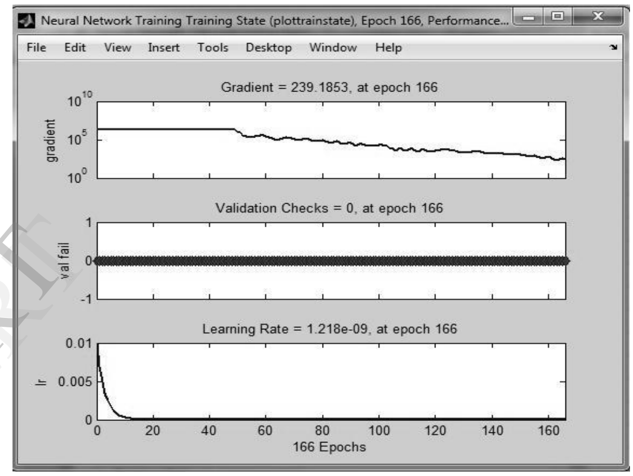

FIG.7 neural network training state

IV. CONCLUSIONS

In this paper, it was proposed to extract features from EEG data by EEG data to gray scale and then perform histogram for features extraction. The preprocessed signal is classified using feed forward neural network using sigmoid and purelin function. Experiments are conducted using EEG data graphs cross validation and different learning rates and momentum. The accuracy obtained is comparable with the results obtained from other researchers in literature. The proposed method is extremely fast in both feature extraction and classification.in my work also I do feature extraction using wavelet transform Further work needs to be done to improve the classification accuracy.

ISSN: 2278-0181
Vol. 3 Issue 8, August - 2014

REFERENCES

[1] G. Eason, B. Noble, and I.N. Sneddon, "On certain integrals of Lipschitz-Hankel type involving products of Bessel functions," Phil. Trans. Roy. Soc. London, vol. A247, pp. 529-551, April 1955. (*references*)

[2] J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68-73.

[3] I.S. Jacobs and C.P. Bean, "Fine particles, thin films and exchange anisotropy," in Magnetism, vol. III, G.T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271-350.

[4] K. Elissa, "Title of paper if known," unpublished.

[5] R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.

[6] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740-741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[7] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.