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An Intelligent EOG System using Fractal Features and Neural Networks

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Abstract: The Electrographic signal is measured by moving the eyes from left to right or up and down which create an electrical deflection. EOG signal with the help of eye movement for Parkinson's patients and voluntary movements are examinedinterms of accuracy, object detection and latency. . In this paper, the EOG data was obtained from five participants and the respective data was preprocessed and box counting feature extraction techniques were used to extract the features. The extracted features were then fed into feed forward neural network. From results, it can be observed that subject 3 performs the functional activity with maximum mean accuracy for all the tasks (down, up, left and right) 90% and also can be observed that subject 1 performs the functional activity with minimum mean accuracy for all the tasks (down, up, left and right) 83.25%.

Keywords: *EOG, Neural network, Fractal features*

I. INTRODUCTION

EOG is the techniques used for recording are simple and cheap and done with minimal discomfort. The readings of the EOG can be measured even when the eye is closed. The EOG can be utilized as an aid to detect the neurological disorder. The EOG can be operated in modeling ophthalmic instruments which is capable of accompanying in disease. Further, this article discuss about different reviews and methods of EOG [1]. PanosM.Pandalos et.al, proposes the amplification orientation of electric dipole for patient who affected neuro generative disease. It can be measured by surface electrodes on the skin around the eyes then the severity of disease and abnormality of Arousal Ocular is clearly identified [2]. Rune Frandson et.al, test the neuro generative patientsto evaluate the potential of sleep using a topic modeling and unsupervised learning approach. This concluded the amount of N3 and ability to maintain NREM & REM sleep have equal potential as PD biomarkers. Sue Lord,et.al [3], suggests the detection of Saccades within raw mobile EOG datasets. The EOG signal measured during static and dynamic task using wireless electrodes of EOG and an algorithm developed to detect saccades in EOG data. AdasGelzin et.al, [4] suggestsrecording the signals from neuro generative patients disease through acoustic cardioid and smart phone electrodes. Thus the rate of performance was better in AC than SP microphones.

The electromagnetic peak detection are contributed torecord the Ocular movements and motor behaviors of motor disabilities patients who affected from Parkinson's disease [6-8].

A.C.Downing,et.al, analyze the eye movements of patients who affected by Parkinson's disease. Then the overall tracking time lag for each condition was determined. K.A. Flowers et.al, examine the subjects which performed through sensory monitoring systems, muscle contractions, sensory monitoring systems, accuracy and oscilloscope. Then the ability of patients with two kinds of movement disorder to make simple voluntary movements is examined [9].

II. DATA COLLECTION

In this study, the EOG signal was collected from Biopac MP36R data processing unit. It consists of 5 subjects within the age 26 and 32 and the sampling rate is adjust 80Hz for both channels as shown in below Table 1.

Table 1: Data description

Subject	Age	Gender	Vision
1	26	Male	Glass
2	28	Male	Normal
3	30	Female	Glass
4	31	Female	Glass
5	32	Male	Normal

From the table 1, it shows that EOG data has collected from three male and two male subjects. The mean ages of the subjects are 30.

III. FEATURE EXTRACTION

Box-counting method employs the self similarity property to compute the FD values and it is the most commonly employed method used to compute the FD values [10-11].

To extract the fractal features, the following algorithm is employed:

Step 1: Using EOG protocol, EOG signals are recorded.

Step 2: For each trial, the recorded EOG signals consist of 10 frames (800 samples) such that each frame has 80 samples.

Step 3: For step sizes k = 1, 2, 3,...,4, $\log_2(L\text{-}1)$, compute the total number of boxed required to cover the EOG signals using Equation

Step 4: Apply the least squared fitting line to the log-log plot of $N(r)$ versus $1/r$ using Equation (1). The slope of the straight line is taken as an estimate of the box-counting fractal dimension.

Step 5: Repeat steps 2 to 4 for all the EOG signals recorded while performing the trails

Step 6: Afractal feature dataset features along with its associated target values are formulated, and this dataset is named as EOGbox-counting fractal feature.

IV. CLASSIFICATION

In multilayer neural networks, the information processing takes place only in the fed forward path, i.e. through the input layer, the output layer and the hidden layer. A MFNN is said to be static neural network model because it is characterized by non-linear equations that are memory less. In general, a single neuron computes the weighted input values and obtains output values through a non-linear activation function with a threshold. It is mainly used for accurate classification of input data into various classes were these are obtained by pre-trained model. Generally, the FNN architecture consists of multilayer neural network for specific application as shown in the Fig. 1.

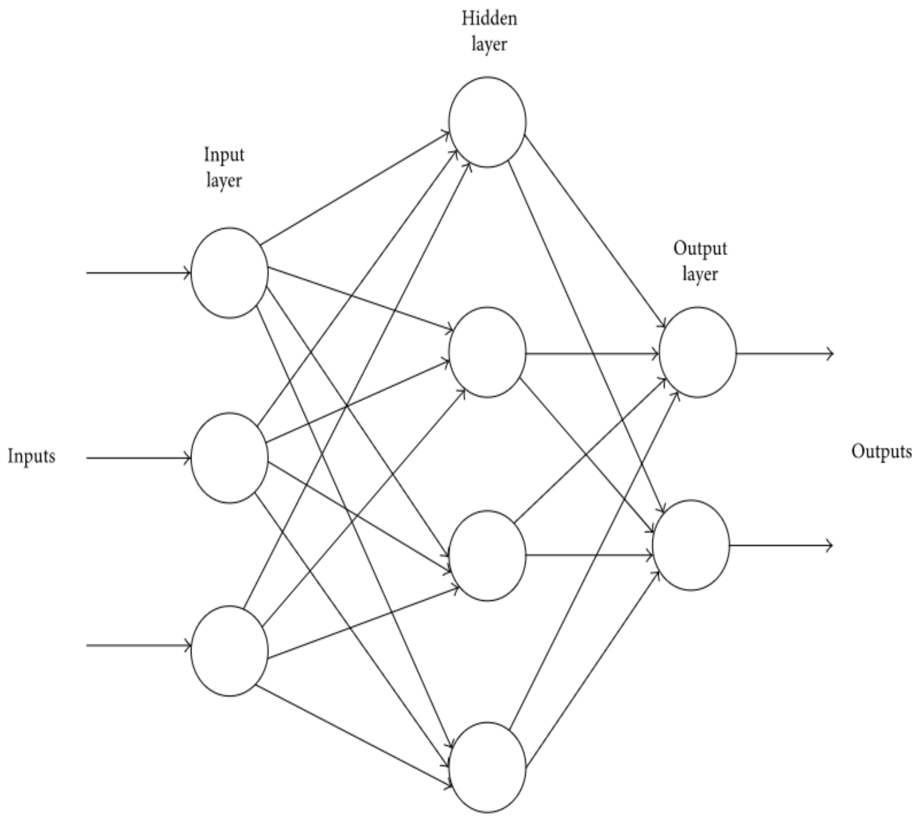

Fig 1. Feed forward Neural network model.

V. RESULTS AND DISCSSUION

In order to develop a generalized neural network model, the training samples are randomly selected from the total samples and a neural network is trained. 40% of dataset has been used for training the neural network and the remaining 60% of dataset has been used to test the performances of the neural network. Box counting fractal features are feed into the feed forward neural network. While developing this model the same spectral band feature is extracted from each channel and fed as input to the network model. The developed neural network model has 5 input neurons and two output neuron. Through simulation the number of hidden neurons is chosen. First, using too many neurons in the hidden layer results in over fitting and using few neurons in the hidden layer results in under fitting. The hidden neurons and output neurons are activated using log sigmoid activation functions. Training is conducted until the average error falls below 0.06 or reaches a maximum epoch limit of 10000.

The classification results of the EOG shown in the Table 2. The graphical representation is shown in the figure 2. From the table 2, It was noted that Box counting fractal feature with 20 order using MFNN has obtained maximum 89% for the subject 3 for the function of down movement. It was also noted that Box counting fractal feature with 20 order using MFNN has obtained maximum 95% for the subject 3 for the function of up movement. It was noted that Box counting fractal feature with 20 order using MFNN has obtained maximum 90% for the subject 2 for the function of left movement. It was also noted that Box counting fractal feature with 20 order using MFNN has obtained maximum 95% for the subject 4 for the function of right movement.

Table 2. Classification accuracy of the EOG system

No. of. Subjects	Classification Accuracy (%)				Overall Accuracy (%)
	Down	**Up**	**Left**	**Right**	
1	70	94	85	84	83.25
2	73	90	90	89	85.5
3	89	95	86	90	90
4	71	90	71	95	81.75
5	80	85	86	85	84
Mean	76.6	90.8	83.6	88.6	84.9

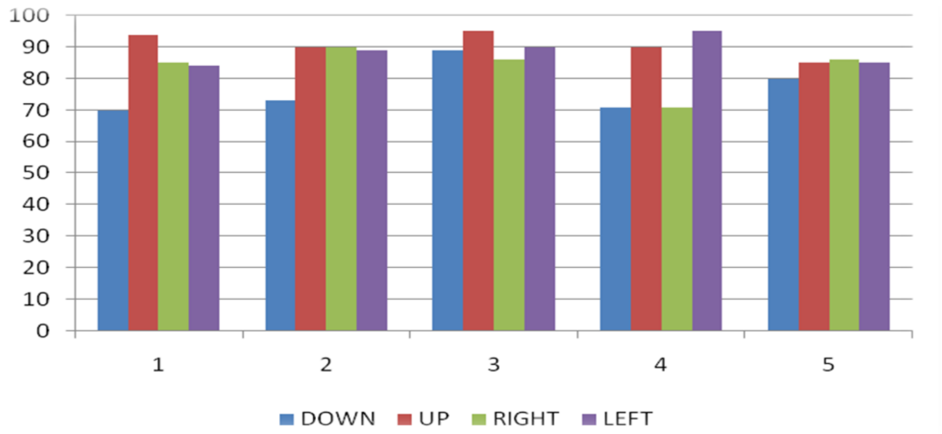

Fig 2. Classification accuracy of EOG system

From the Table 2, It was noted that Box counting fractal feature with 20 order using MFNN has obtained minimum 70% for the subject 1 for the function of down movement. It was also noted that Box counting fractal feature with 20 order using MFNN has obtained minimum 85% for the subject 5 for the function of up movement. It was noted that Box counting fractal feature with 20 order using MFNN has obtained minimum 71% for the subject 4 for the function of left movement. It was also noted that Box counting fractal feature with 20 order using MFNN has obtained minimum 84% for the subject 4 for the function of right movement.

VI. CONCLUSION

The Electrographic signal is measured by moving the eyes from left to right or up and down which create an electrical deflection. EOG signal with the help of eye movement for Parkinson’s patients and voluntary movements are examinedinterms of accuracy, object detection and latency. From results, it can be observed that subject 3 performs the functional activity with maximum mean accuracy for all the tasks (down, up, left and right) 90% and also can be observed that subject 1 performs the functional activity with minimum mean accuracy for all the tasks (down, up, left and right) 83.25%.

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