TEST Engineering & Management

March - April 2020
ISSN: 0193-4120 Page No. 9936 - 9941

Eye Movement Classification System using Spectral Features and Neural Networks

J. Shafiq Mansoor[1],Mrs. T. G. Ramabharathi[2], Devipriya .N[3]
[1]Asst Prof,Dept of ECE ,Karpagam Academy of Higher Education,India
[2]Associate Professor, Dept of ECE Karpagam Institute of Technology,India.
[3]Asst Prof,Dept of ECE, Karpagam College of Engineering, India
shafiqmansoor.j@kahedu.edu.in

Article Info
Volume 83
Page Number: 9936 - 9941
Publication Issue:
March - April 2020

Article History
Article Received: *24 July 2019*
Revised: *12 September 2019*
Accepted: *15 February 2020*
Publication: *11 April 2020*

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 examined interms 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) 80% 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) 71.75%.

Keywords: *Eye movement, spectral, entropy and Neural network*

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.

March - April 2020
ISSN: 0193-4120 Page No. 9936 - 9941

The electromagnetic peak detection are contributed to record 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 [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

A feature extraction algorithm is used to extract the independent spectral entropy features and spectral band combination of entropy features are formulated [10] and stated below:

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

Step 2: For each trial, the recorded EOG signals are decomposed into 10 frames such that each frame has 80 samples with an overlapping of 50 %.

Step 3: The segmented EOG signals are filtered using Chebyshev type 2 filters.

Step 4: The filtered EOG signals are Fourier transformed using Equation (1)

$$Y_i^j = \sum_{n=1}^{N} X_i^j(n)\omega_N^n \quad \text{-------- (1)}$$

Step 5: The spectral entropy feature value is computed using Equation (2).

$$H_i^j = \sum_{m=1}^{N} Y_i^j(m) ln\left(Y_i^j(m)\right)$$

Step 6: Repeat steps 2 to 5 to all the EOG signals recorded while performing 5 EOG subjects for 5 trials. Independent spectral entropy features and spectral band combination of entropy features values are extracted.

Step 7: The independent spectral entropy feature dataset consisting of extracted features for the 5 subjects along with their target vectors are created, and this dataset is named as Independent EOG dataset.

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.

March - April 2020
ISSN: 0193-4120 Page No. 9936 - 9941

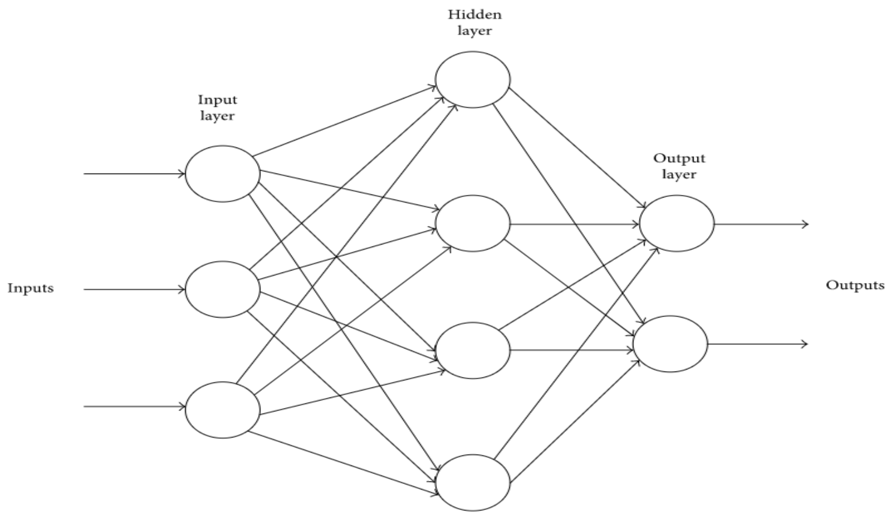

Fig 1. Feed forward Neural network model.

V. RESULTS AND DISCUSSION

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. Spectral entropy 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 tan activation functions. Training is conducted until the mean square error falls below 0.08 or reaches a maximum threshold epoch limit of 2000.

The classification results of the EOG shown in the Table 2. The graphical representation is shown in the figure 2.

Table 2. Classification accuracy of the EOG system

No. of. Subjects	**Classification Accuracy (%)**				**Overall Accuracy (%)**
	Down	**Up**	**Left**	**Right**	
1	65	85	75	74	74.75
2	73	80	80	79	78
3	79	86	76	80	80
4	61	80	61	85	71.75
5	80	82	76	75	78.25
Mean	71.6	82.4	73.6	78.6	76.55

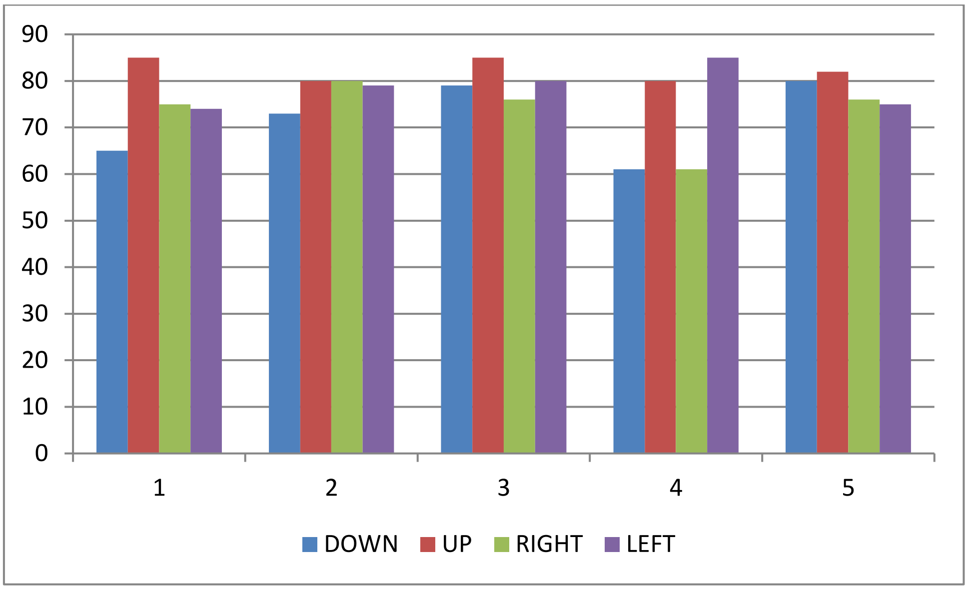

Fig 2. Classification accuracy of EOG system

From the table 2, It was noted that spectral entropy feature using MFNN has obtained maximum 80% for the subject 5 for the function of down movement. It was also noted that spectral entropy feature using MFNN has obtained maximum 86% for the subject 3 for the function of up movement. It was noted that spectral entropy feature using MFNN has obtained maximum 80% for the subject 2 for the function of left movement. It was also noted that spectral entropy feature using MFNN has obtained maximum 85% for the subject 4 for the function of right movement.

From the table 2, It was noted that spectral entropy feature using MFNN has obtained minimum 61% for the subject 5 for the function of down movement. It was also noted that spectral entropy feature using MFNN has obtained minimum 80% for the subject 4 for the function of up movement. It was noted that spectral entropy feature using MFNN has obtained minimum 61% for the subject 4 for the function of left movement. It was also noted that spectral entropy feature using MFNN has obtained minimum 74% for the subject 1 for the function of right movement.

From the table 2, It was noted that spectral entropy feature using MFNN has obtained mean accuracy 71.5% for all the subject 5 for the function of down movement. It was also noted that spectral entropy feature using MFNN has obtained mean accuracy 82.4% for the entire subject 5 for the function of up movement. It was noted that spectral entropy feature using MFNN has obtained mean accuracy 73.5% for the entire subject 5 for the function of left movement. It was also noted that spectral entropy feature using MFNN has obtained mean accuracy 78.6% for the subject 5 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 examined interms 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) 80% 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) 71.75%.

REFERENCES

[1]. PradnyaUdayJambhekar , Sangeetha Prasanna Ram, 'EOG based Study of Eye Movements and its Application in Drowsiness Detection' , International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 6, 2017.

[2]. Panos M Pandalos, Chang-Chia Liu, 'Quantitative analysis on electrooculography (EOG) for neurodegenerative disease', Vol 953 , 2007.

[3]. Stuart, Samuel, Sue Lord, ' A protocol to examine vision and gait in Parkinson's disease: Impact of cognition and response to visual cues', Vol.4,2016.

[4]. HenrietteKoch, RuneFrandsen, 'Automatic sleep classification using a data-driven topic model reveals latent sleep states', Journal of neuroscience methods, Vol.235, 2014.

[5]. Julie A E Christensen, Miki Nikolic, 'Sleep spindle alterations in patients with Parkinson's disease', 2015.

[6]. O. Rascol, M Clanet, 'Abnormal ocular movement in parkinson'sdisease:Evidence for involvement of dopaminergic systems', Vol.112, 1989.

[7]. Martin, Francisco Javier, Yangüela, David, 'Development of a Computer Writing System Based on EOG', Vol.17, 2019.

[8]. Albert F Fuchs, Dom V. Finocchio, 'Saccadic eye movement deficits in the MPTP monkey model of Parkinson's disease',1986.

[9]. M S Corin, Teresita S Elizan, 'Oculomotor Function in Patients with Parkinson's Disease', Journal of the neurological Sciences 251 Elsevier Publishing Company, Amsterdam - Printed in The Netherlands,1971.

[10]. Dr K A Flowers, A C Downing, 'Predictive control of eye movements in parkinson disease', 1978.

[11]. K A Flowers, 'Ballistic and corrective movements on an aiming task: Intention tremor and parkinsonian movement disorders compared', 1975.

[12]. Nisheena V Iqbal, Kamalraj Subramaniam, Wavelet Packet Entropy Based Control of Myoelectric Prosthesis, Biomedical and Pharmacology Journal, vol11, 375-380, 2018

[13]. Ramkumar, S., SatheshKumar, K., &Emayavaramban, G. (2016). EOG signal classification using neural network for human computer interaction. International Journal of Computer Theory and Applications, 9(24), 223-231.

[14]. Wan, X., Zhang, K., Ramkumar, S., Deny, J., Emayavaramban, G., Ramkumar, M. S., & Hussein, A. F. (2019). A Review on Electroencephalogram Based Brain Computer Interface for Elderly Disabled. IEEE Access, 7, 36380-36387.

[15]. Emayavaramban, G., &Amudha, A. (2016). sEMG Based Classification of Hand Gestures using Artificial Neural Networks. Indian Journal of Science and Technology, 9(35), 1-10.

[16]. Fang, S., Hussein, A. F., Ramkumar, S., Dhanalakshmi, K. S., &Emayavaramban, G. (2019). Prospects of Electrooculography in Human-Computer Interface Based Neural Rehabilitation for Neural Repair Patients. IEEE Access, 7, 25506-25515.

[17]. Emayavaramban, G., &Amudha, A. (2016). Recognition of sEMG for Prosthetic Control using Static and Dynamic Neural Networks. International Journal of Control Theory and Applications, 2(6), 155-165.

[18]. Ramkumar, S., Emayavaramban, G., Kumar, K. S., Navamani, J. M. A., Maheswari, K.,

March - April 2020
ISSN: 0193-4120 Page No. 9936 - 9941

&Priya, P. P. A. (2020). Task Identification System for Elderly Paralyzed Patients Using Electrooculography and Neural Networks. In EAI International Conference on Big Data

[20]. Prediction System using Internet of Things. Indian Journal of Public Health Research & Development, 10(2), 1103-1107.

[21]. G. Emayavaramban, A. Amudha*, Rajendran T., M. Sivaramkumar, K. Balachandar, T. Ramesh. "Identifying User Suitability in sEMG Based Hand Prosthesis Using Neural Networks" in Current Signal Transduction Therapy , (Pubmed& Scopus Indexed) **DOI** : 10.2174/15743624136661806041005 42

[22]. MP Paulraj, SB Yaccob, A Hamid, B Adom, K Subramaniam, CR Hema , EEG based hearing threshold classification using fractal feature and neural network, , 2012 IEEE Student Conference on Research and Development (SCOReD), 38-41,2012

[23]. KamalrajSubramaniam, Nisheena V Iqbal, Classification of fractal features of uterine EMG signal for the prediction of preterm birth, Biomedical and Pharmacology Journal, VOI 11, 369-374, 2018.

Innovation for Sustainable Cognitive Computing (pp. 151-161). Springer, Cham.

[19]. Krishnan, M. S., Ragavi, S., RamKumar, M. S., &Kavitha, D. (2019). Smart Asthma