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DIAGNOSIS OF ADHD SYNDROME BY COMPARITIVE ANALYSIS OF EEG SIGNALS OF BRAIN

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ABSTRACT : One of the incurable mental disorder, which is estimated to occur in about of all the children (5-15 years, approximately 6.4 million), is Attention Deficit Hyper Active Disorder (ADHD). Electroencephalogram (EEG) is a best method for monitoring, recording and measuring spontaneous voltage fluctuations of the brain that caused due to the ionic current associated with the neurons. Due to having many advantage of using EEG over MRI, PET and MEG in the detection and diagnosis of ADHD, we presented the comparative analysis and distance measure techniques for detection and classification of this disorder in the childhood. In comparative analysis, we compare different parameters of EEG signals of ADHD affected children with normal children. An algorithm is developed to classify the children effectively as normal or affected**.**

Keywords: ADHD, distance measure, comparative analysis, EEG.

1. Introduction

Based on behavior and the energy level we can classify the ADHD affected children as inattentive, hyperactive or impulsive type and combined type. This disorder can be seen in childhood and continue until death. Complete causes for the children are remain unknown. Most of the schools give treatment for the affected children is through meditation, dance and music therapy, multisensory treatment using laser pens, appropriate motor activity, dietary restrictions and many more. All though this may show only few improvements. As per research, boys are more affected by this disorder than girls are. IN most of the cases ADHD is associated with additional problems such as tic disorder, obsessive compulsive disorder(OCD), Oppositional Deficient Disorder(ODD), physiological problems, anxiety, depression, bipolar disorder which are also have no proper detection method other than observation. If periodic detection and treatment is not taken, there may be chance of dramatic increase in this disorder and affected children may severally injure themselves or others.

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2. Classification of ADHD

ADHD are mainly classified into 3types as listed below. Each of the below types shows different symptoms and each need different periodic treatment.

Types	Symptoms	Treatment
1.In attentive.	1. Do not follow instruction and do carless mistakes in all activities and tasks. 2. They feel difficulty in having attention. 3.shows distracted mind. 4. They downed in their own world and always seems to be floating in dreaming. 5. Forget very frequently.	1.Behavioral therapy 2.psycho therapy 3.family therapy 4.social skills training 5.stimulants
2. hyperactivity-impulsive.	1. They do not have control over impulse. 2. Show motor activity. 3. They do not have patience. 4. They are struggling to sit quietly.	1. stimulated drugs. 2. Energy burning exercise. 3. Dietary restrictions.
3.combined.	1. Shows some behavioral as mentioned above.	1.Treatments are given depending on their dominant behavioral activities

Table 1. Shows the various symptoms and treatments for different ADHD types.

3. Causes

1. Exposing to toxic lead. 2. Brain injuries in the early stage. 3. Premature birth. 4. Smoke, alcohol or harmful drug addiction during pregnancy period. 5. Many parents claimed that, after injecting vaccination their child started to show ADHD Symptoms. 6. Chemical imbalance in brain.

4. Methodology

A. Behavioral study

ADHD affected Children shows different behavior than normal children. The behavior of affected children under different situations are understood by keen observation of those children for duration of 1 month and maintained a checklist for each child separately to get clear picture of how they behave when they are instructed to perform different task. In addition, we conducted an interview for both parents and teachers to know their response and characteristics behavior in home and School environment.

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B. Acquisition of EEG data

We selected Seven ADHD affected children and seven Normal children of age 5-15 years, Then we acquired the EEG Signal from both children using a portable EEG Signal. Recording device called Brain tech traveler. It has an inbuilt 16-Bit ADC and 24 channels. Each site has a letter to identify the lobe and a number to identify the right are left hemisphere location.

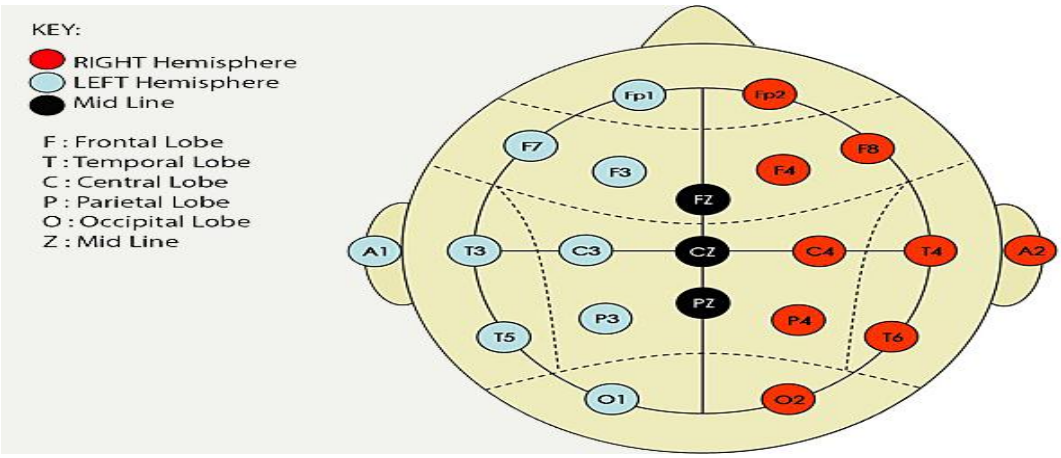

Figure 1. Representation of international standard for 10-20 electrode system.

C. Segmentation of acquired data

Extracted Biomedical signals are non- stationary and are segmented into number of segments for the ease of analysis. Acquired data are segmented manually per timer and activity performed by children. For segmentation purpose children are instructed to perform certain activity namely: (1) eye blinking, (2) left hand movement, (4) right hand movement, (4) leasing. Each of this activity are made to perform by every selected child for a duration of 5 second. For the clear segmentation process an algorithm is developed.

D. Extraction of main features

From the segmented data, different features like amplitude levels, frequency bands of alpha, beta, delta, and theta, energy and power of EEG signals are extracted and recorded. These extracted features of EEG signals may further help us to calculate different parameters.

E. Different parameter calculation

Extracted data are stored as a set and using MATLAB Software, the parameter such as mean, variable, standard deviation, energy, power, and amplitude level is calculated. Then from the value of calculated parameter, we can differentiate the ADHD affected and normal children by specifying the range of all parameter. Respective MATLAB algorithm was implemented for finding the parameters accurately.

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F. Analysis to detect abnormalities

We compare the calculated parameter of ADHD affected and normal children with each other by treating the values associated with normal children as standard. By seeing range of calculated results, we can decide that the ADHD affected children will have value other than the normal.

G. Prediction and indication of probable region of abnormality

Brain is divided into 4 regions to predict the probable region of abnormalities. Having a proper knowledge of segmented data and its corresponding activity and the abnormalities, we can predict the region of brain by considering the position of that electrode. Predicted region are indicated by 3D-plotting performed using MATLAB Software for the ease of identifying the affected part of brain.

H. Classification using distances measure:

Among many different techniques for data mining, we use distance measure technique for the classification purpose. Here both Euclidean distance and Manhattan distance are calculated by developing an algorithm in MATLAB.

1) Euclidean distance:

Euclidean distance is known as L2 norm and it is a distance between two points or two object or two pixels in metric space. Euclidean metric is useful in low dimension; not suitable to work in high dimensions and for categorical variables. The drawback of this distance is that ignores the similarity between attributes. Each attribute is treated as very different from all the attributes.

2) Manhattan distance:

Distance between two points that is horizontal and vertical along the grid lines. The path from bottom left to top right have the same distance. The Manhattan distance is the absolute differences between co-ordinates. In some cases, this metric is preferable to Euclidean distance, because the distance along each axis is not squared so a large difference in one dimension will not dominate the total distance.

5. Results

1). Mean values for left hand movement:

Electrode positions	Normal children	ADHD affected children
FP1	386-406	-5.84-5.84
FP2	42-55	-1.5-256
O1	96-115	-0.69-2.70
O2	96-115	-0.76-265
P3	20-55	-1.5-256
P4	322-366	-2.52-262

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T3	126-239	-3.0-1.33
T4	194-209	-3.42-260

Table 2. showing mean values for left hand movement of both normal and affected children

Normally during the left hand movement, the neuronal activities increase for normal subjects. Hence, it will have more positive values when compared to ADHD subjects. From the above table, we can observe that the mean value is more for normal subjects when compare to the ADHD subjects in FP1 position which is responsible for social judgment.

2). Standard deviation values for left hand movement:

Electrode positions	**Normal children**	**ADHD affected children**
FP1	20-112	40-102
FP2	23-121	41-218
O1	18-20	42-54
O2	18-20	46-238
P3	23-121	41-218
P4	22-39	45-221
T3	23-40	33-218
T4	20-31	35-221

Table 3 showing the standard deviation values for left hand movement of both normal and affected children.

From the table, we infer that the standard deviation for the normal subject is lower when compared to the ADHD subject. Standard deviation parameter helps in comparison between normal and ADHD subjects. The amplitude level will be more for ADHD subjects when compared to normal subjects. In the O2 position which is responsible for visual process.

3). Energy:

	Frequency or electrode	Fp1	Fp2	O1	O2	P3	P4	T3	T4
N O R	Delta	11-203	2-313	59-63	181-491	2-636	2-361	5-234	179-436
	Theta	24-721	2-72	45-59	54-141	141-213	104-213	44-451	36-122

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M A L	Alpha	25-122	14-101	34-58	28-319	40-319	67-459	55-263	31-175
	Beta	28-53	20-44	35-46	40-62	49-91	40-42	56-93	41-175
	Gamma	29-50	20-27	22-36	37-48	40-55	35-55	44-46	49-63
A F F E C T E D	Delta	3-402	5-150	32-42	6-300	2-553	3-330	4-150	5-415
	Theta	151-218	134-581	214-576	186-575	258-594	229-425	160-255	140-597
	Alpha	211-603	274-339	364-853	297-495	2-836	335-879	181-337	262-597
	Beta	180-316	107-360	374-421	314-450	236-323	290-558	272-561	275-535
	Gamma	22-27	15-31	15-20	22-30	20-42	25-37	42-36	42-53

Table 4.Showing the standard deviation values for left hand movement of both normal and affected children.

4). Channel spectra and maps:

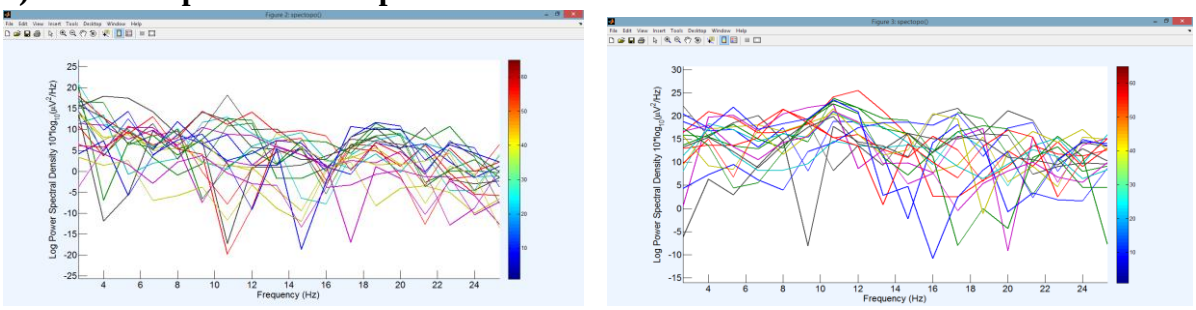

Fig. 2 shows the channel spectra and map for both ADHD and Normal subjects for eye blinking activity. Each colored trace represents the spectrum of the activity of one data channel

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6. Conclusion

This paper classifies the ADHD affected children and normal children based on different analysis conducted over seven affected and seven normal children. Here two methods are incorporated to detect the affected children. First method is through behavioral analysis, which shows the physical and psychological behavior of the children when they exposed to some work. This study provides symptoms, causes and their day-by-day improvement under special training and medication.

Another method that is discussed in this paper detect the ADHD childrenthrough different parameter and signal map analysis. Here calculated results of normal children are treated as standard trained data set whereas results of ADHD affected children are taken as test data set. Every test data set is compared with standard results to detect the affected child. Distance measure algorithm allowed us to classify the children effectively.

7. Future Scope

It supports trainers to see improvement in behavior and academic performance of the ADHD affected children day by day, help doctors in detection of abnormalities, and allow them to start exact treatment. Method implemented here is cost effective when compared to previously. Prediction of probable region of abnormalities is based on the electrode position. This can be further implemented by SVM and neural network algorithm, which are approximated to provide 99% efficiency in classifying the syndrome.

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