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Visualization of EEG Data to Detect ADHD in Children and Adults

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Abstract- ADHD or Attention Deficit Hyperactivity disorder is a mental illness or a mental disorder, which makes it very hard for the affected individuals to focus and to pay attention. Analysis of EEG signals can be used as a method of diagnosis for tumours other brain disorders.

In this work attempt has been made to detect ADHD syndrome by visualising the region of brain that shows abnormality or excessive alpha waves. Data of several ADHD and normal subjects of different age groups were collected and analysed. The segmented data particularly in the Alpha region is then subjected to extract the energy that corresponds to it as Alpha waves will occur when our brains shift into a relaxed and disengaged state and Excessive frontal Alpha activity is proved to be often associated with ADHD and depression. Finally, 3-D plotting of the EEG signals will be done for the ease of visualization and the doctor can use the image which is generated to distinguish between normal and ADHD affected subjects by analysing the image produced.

Keywords:- *EEG Data, Visualization, ADHD, Alpha wave, Electroencephalogram (EEG), Human Scalp.*

I. INTRODUCTION

It has been estimated with sufficient research that about 9% of all kids have this ADHD (Attention Deficit Hyperactivity Disorder) disorder. It is hard for the affected subject to pay attention or focus. For subjects with ADHD, levels of hyperactivity, inattention, and impulsive behaviours are more than an average child of the same age group. Attention Deficit Hyperactivity Disorder can make it hard for a child to do well in school or behave well in the community orat home. In many cases this mental disorder goes totally undiagnosed. Some of the symptoms of ADHD at first may look like normal behaviours for a child, but ADHD makes them much worse over time and the frequency of such behaviours also increase as a result of ADHD.

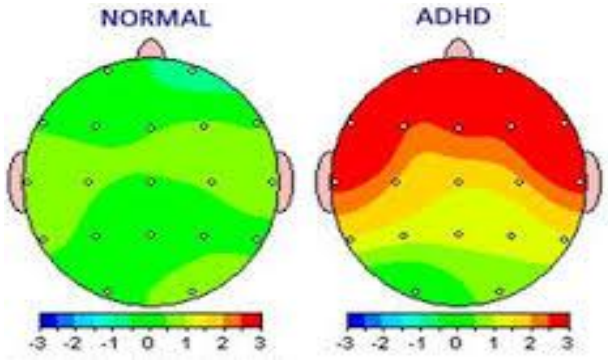

Fig. 1. Difference in Brain Map Pattern
Source: pathways neuropsychology

Treatments include talk therapy, medication, Counselling and Biofeedback which is an is an alternative therapy which is used to treat ADHD. It's also called neurotherapy, EEG biofeedback or neurofeedback. This style or type of treatment has been used effectively since the late 1960s.

I.1 EEG Biofeedback and Response

After the brain wave activity is recorded, the cliniciancan gather information based on the states of the subjects' brains. Symptoms of depression, OCD, anxiety, and a variety of other stressful conditions (ADHD in our case) maybe as a result of states of neurophysiological over-arousal or under-arousal. After the initial information is gathered, EEG Biofeedback, neurobiofeedback, or neurofeedback can be used to track the brain wave activity, and over time use this data to provide visual and auditory feedback to the subject to train the brain to operate more efficiently as their brainwave patterns improve over time and self-regulation occurs gradually.

The electrical activity in the brain is captured by a device known as the electroencephalogram. As we know the brain cells present in the human brain communicate with each other through electrical signals or impulses. An electroencephalogram evaluates these electrical impulses records and tracks the brain wave patterns. With the help of wires, electrodes like small flat metal discs are attached to the scalp. The electrical impulses in the brain are analyzed by the electrodes and the resultant signals or the electrical impulses in the brain are sent to a computer that records these results. Potential problems associated with ADHD or other mental illnesses and disorders can be detected with the help of EEG.

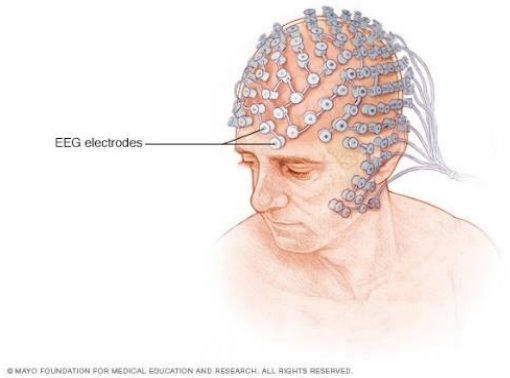

Fig. 2. EEG Electrodes
Source: Mayo Foundation for Medical Education and Research

These electrodes or channels show the activities of the brain where ever they are placed as a result we have the data of the activity of different brain areas.

Anelectroencephalogram has absolutely no risks associated with it. This method is completely painless and safe. The test also causes no discomfort. Additionally, there is no risk of getting an electric shock.

I.2 PRINCIPLES EXISTING IN EEG

The level of consciousness of the subject profoundly influences the EEG signal. The dominant EEG frequency decreases when the person falls asleep. The alpha waves begin to dominate the EEG when the eyes are closed. Rapid eye movement called (REM) sleep, which is one of the stages of sleep where in the person dreams and has rapid active movements of his or her eyes, which is a very evident characteristic in the EEG signal of the patients brain wave patterns. Delta waves are large and slow deflections in the EEG when the subject is in Deep sleep. As expected, a patient with complete cerebral death will have no cerebral activity.

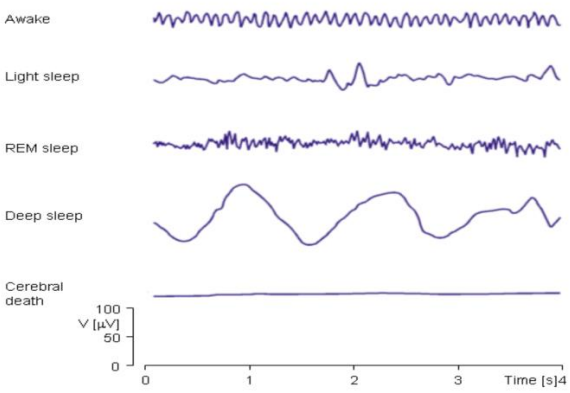

Fig. 3. EEG activity is dependent on the level of consciousness.
Source: Rash Dubey, researchgate

The alpha waves can be measured from a awake person at the occipital region of the persons brain and these waves have a frequency spectrum from 8-13Hz.

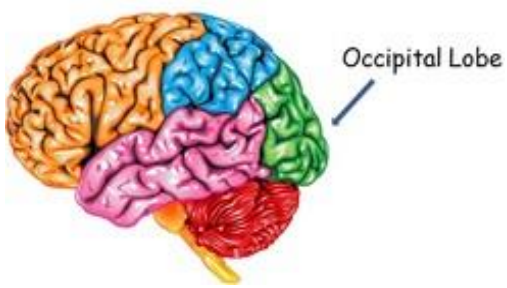

Fig. 4. Location of the Occipital Lobe in the brain
Source: Brain Made Simple

Alpha waves will occur when our brains go into anidle state or relaxed and disengaged state. When a subject has excessive frontal Alpha activity, it is often associated with ADHD.

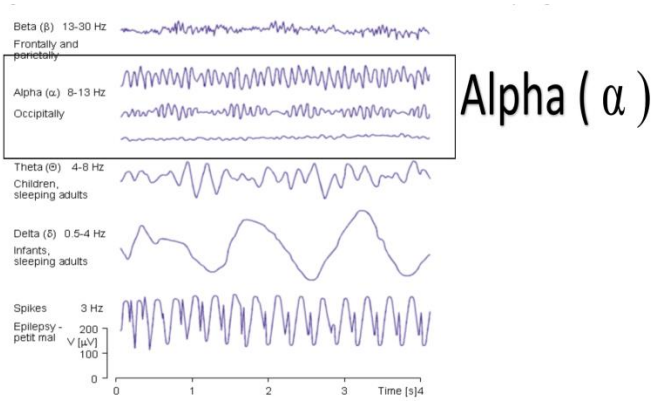

Fig. 5.Examples of EEG waves
Source: Jaakko Malmivuo, researchgate

II. RELATED WORK

Some of the works relating to EEG Data Analysis are briefly explained in this section.

In [1] Analysis is done on resting data during separate three-minute eyes open and eyes closed conditions followed by cognitive ERP tests. The results indicated that malnutritioned lags of fewer than three years would have been detected.

In [2] ERP research. The Oddball paradigm uses navigation images and analyzes the power of the EEG with swLORETA to modify the model generators it can produce to study cortical processing. Visual attention task produced decrease in neural networks. Differentiation of delta-theta in executive function, specifically in visual tasks. Overall, the findings suggest that the first cortical stages of visual processing show the risk of adult ADHD.

In [3] The EEG was recorded during the eye open. Comprehensive and related power viewing analysis. An electrode with 19 electrodes uses a 10-20 system. Children with ADHD showed an increase in the intensity of the slow-moving waves (theta and delta), while adults did not show a difference compared to normal studies.

In [4] EEG compiled while topics do Go / NoGo activity or task. Spatiotemporal BNA analysis was used. The BNA method has shown high discriminatory power between ADHD patients and controls based on active brain connections.

In [5] Brain Computer Interface (BCI) provides the method of communication between the human brain and the computer system. The three machine learning algorithms were implemented and compared Conclusion was that the decision trees algorithm was the most efficient.

III. PROPOSED MODEL AND IMPLEMENTATION

The proposed model aims at improving the speed and accuracy at which a affected subject is recognised and diagnosed thereby profoundly increasing the speed at which the subject can be provided feedback to overcome challenges faced by the Attention Deficit hyperactivity disorder.

Our model is designed to facilitate the use of EEG data with respect to the identification of the brain wave patterns. The choices made during the development of our system reflect the accurate results which were designed to enhance the usability while maintaining functionality and flexibility.

The proposed model is as follows:

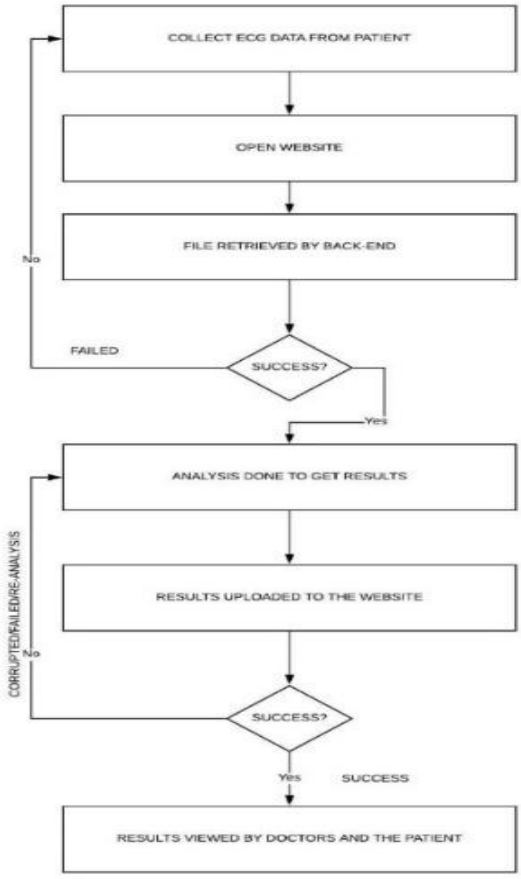

Fig. 6.Flow Chart of the Steps which are done to get the resultant image

Our system begins with the user loading EEGdata.

- We then first convert the data to double-precision to make working with the data easier.
- After that we apply the Fourier conversion to all data, any wave format from time to time can be generated by adding a series of sin waves of frequency, and the appropriate amplitude. FFT looks at complex formats and calculates those frequencies and amplitudes. The result is a new curve that plots amplitude vs frequency.

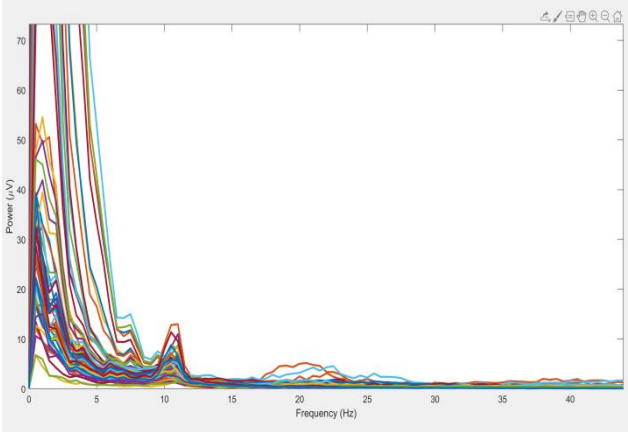

Fig. 7. Amplitude vs Frequency Plot

- Then we average the power from 8-12 Hz ("alpha band") which is the band that we concentrate on for this exercise as we knowas Alpha waves will occur when our brains shift into a relaxed and disengaged state and Excessive frontal Alpha activity is proved to be often associated with ADHD and depressionand this average of powers is used to make a topographical map of the distribution of this power.
- We then quantify this part. That is square it, to get amplitude and better peaks which can be easily viewed and to get a more precise plot when we plot the spectrum data in the next step

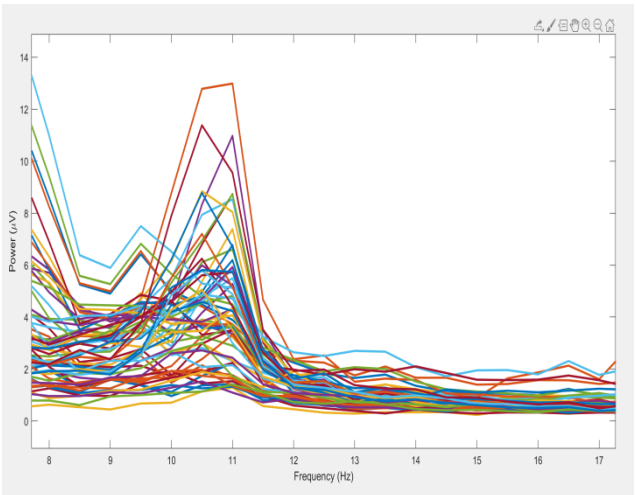

Fig. 8. Quantified Amplitude vs Frequency Plot in the range 8-12 Hz or the Alpha Band

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- Then we plot the spectrum of all channel data on the scalp

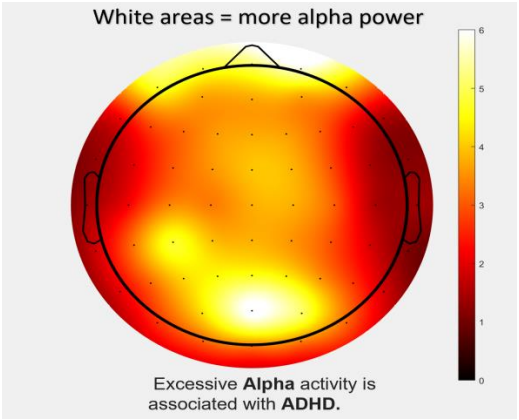

Fig. 9. Resultant Plot on the human Scalp

- Physically analyse the image and draw a conclusion to help and support the medical practitioners.

Core Code of the Analysis

The goal is to compute the power spectrum of each 2-second epoch Separately, then average together. Then, extract the average power from 8-12 Hz (the "alpha band") and make a topographical map of the distribution of this power to get our output image.

```
% Convert to double-precision
EEG.data = double(EEG.data);
chanpowr=(2*abs(fft(EEG.data,[],2)/EEG.pnts)).^2;
% Then average over trials
chanpowr = mean(chanpowr,3);
hz=linspace(0,EEG.srate/2,floor(EEG.pnts/2)+1);
% Plot power spectrum of all channels
figure(15), clf
plot(hz,chanpowr(:,1:length(hz)),'linew',2)
xlabel('Frequency (Hz)'),ylabel('Power (\muV)')
set(gca,'xlim',[0 30],'ylim',[0 50])
%% Now to extract alpha power
alphabounds = [ 8 12 ]';
freqidx = dsearchn(hz',alphabounds);
% extract average power
alphapower=mean(chanpowr(:,freqidx(1):freqidx(2)),2);
% Finally plot
figure(16), clf
topoplotIndie(alphapower,EEG.chanlocs,'numcontour',0);
set(gca,'clim',[0 6])
colorbar%or colourmap hot
```

IV. RESULS

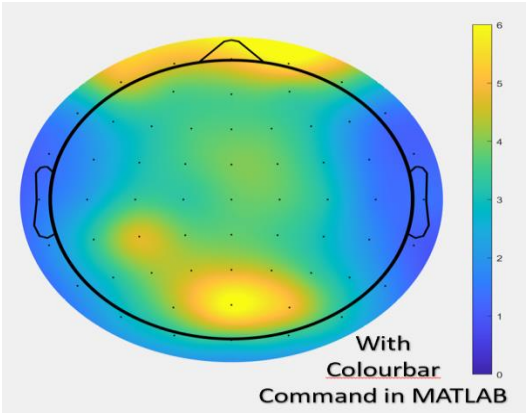

Fig. 10. Example of a ADHD Subject

We obtain the following spectrum at the end of the analysis and this resultant image is the coalesce of all the data and analysis done to the EEG data by my model. This image is viewed by the doctor and the diagnosis is made.

V. CONCLUSION

To get the best performance of this model we have used MATLAB which was provided by Ramaiah Institute of Technology. The open source data available in the Information Science and engineering department of RIT was also used. The EEG method to detect ADHD in children and adults is quite effective and this will help doctors in the medical field to better analyze and understand the nature of this mental illness. I believe this will help the millions of patients out there waiting to be diagnosed with ADHD.This method off EEG detection is nonintrusive, safe and does not involve any medication

FUTURE SCOPE

This project can further be modified to have limitless potential in the future. For example, if the technology improves the data collection and the analysis can be done by the patient itself.An api can be created for the same so that it can embedded into already existing electrical medical equipment so that reduces the rate of error and simplifies the way to use it.

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REFERENCES

[1]. Liechti MD, Valko L, Müller UC, Döhnert M, Drechsler R, Steinhausen HC, et al. The diagnostic value of rest electroencephalogram in dealing with mental disorders / failure throughout life. *Brain Topogr (2013) 26(1):135–51*. doi: 10.1007/s10548-012-0258-6

[2]. Leroy A, Petit G, Zarka D, Cebolla AM, Palmero-Soler E, Strul J, et al. EEG Dynamics and Neural Generators in Implicit Navigational Image Processing in Adults with ADHD. *Neuroscience (2018) 373:92–105. doi: 10.1016/ .neuroscience.2018.01.022*

[3]. Markovska-Simoska S, Pop-Jordanova N. Quantitative EEG in Children and Adults with Attention Deficit Hyperactivity Disorder. *Clin EEG Neurosci (2017) 48(1):20–32.* doi: 10.1177/1550059416643824

[4]. Biederman J, Hammerness P, Sadeh B, Peremen Z, Amit A, Or-Ly H, et al. Diagnostic utility of brain activity flow patterns analysis in attention deficit hyperactivity disorder. *psychol Med (2017) 47(7):1259–70. d*oi: 10.1017/ S0033291716003329

[5]. HS Anupama, NK Cauvery, GM Lingaraju. Real-time EEG based object recognition system using Brain Computer Interface. *2014 International Conference on Contemporary Computing and Informatics (IC3I).*PP 1046-1051