SPECTRAL ANALYSIS BASED DIFFERENTIATION FOR EEG SIGNALS OF CHILDREN WITH AUTISM

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Abstract
Autism and ASD is a related to neuro-developmental issue which is usually present when the child is born. But detection of ASD is not possible till the child is around 1-2 years old. Electroencephalography (EEG) can be used to monitor the brain activities of all human beings. Spectral analysis is used to differentiate between EEG Signal of children with ASD children and normal children.

Keywords: Autism Spectrum Disorder, Electroencephalography, Spectral Analysis.

INTRODUCTION
The symptoms of Autism or ASD is related with children not able to interact properly with others, not able to speak or communicate and not able to express their emotions. Their interest is also found to be restricted[1]. The global statistics show that there is a estimate of around 62/10000 people globally getting affected by Autism[2].

The interconnectivity of brains of human is quite interesting and remarkable. Every neuron in brain is connected to other by a synapt. This is created by various organisation in brain which is not yet completely deciphered by humans. Moreover, the connectivity and organisation changes as the brain develops. The nature of brain can be represented by its intense connectivity locally and its rare connectivity for long-range[3]. From this we can infer that the neuro-development disorder may be a caused due to fault or difference in the connection of brain neurons.

ASD children are affected with lots of difficulties in their skills to speak and communicate, in their way to express their feelings and emotions and in the way they behave with others. Humans have still not decoded the exact defect in the brain connection which leads to such way of life of these affected people. But they are not categorized this under over or less connection of brain. It can be characterized as differently or abnormally connected brain neuron which leads to the problems.

Electroencephalography (EEG) is a screening method for brain which is performed usually without invasion. The purpose of such screening is to read the various variations performed by the brain which can be represented by its activity electrically. This reaction is recorded using conductors and electrodes. The electrical reactions are represented as waves which are usually sinusoidal in shape. They can be classified in 4 types: Beta (13Hz), Alpha (8-13Hz), Theta (4-8Hz), Delta (0.5-4Hz) [4].

EEG is found to detect the functioning and activity of brain and know the exact way in which the brain and its neurons are working. As a result, in our work, we have used EEG to monitor the brain signals of both normal and ASD and differentiate between them.

LITERATURE SURVEY
Asperger and Kanner(1944) were first to explain the children’s problem in interacting with others in a way which other control subjects did. This issue started from the start of their life. This issue can be described as a triad consisting of 3 problems namely communicating with others by them, their difficulty to interact with others socially and behaviour issues.(Wing and Gould, 1979)

Lindsay et al discovered that individuals with ASD would show dysfunctional mirror activity as reflected by mu(μ) wave suppression. 4 activities were used to acquire EEG patterns from the children. They were hand moving, moving hand seeing a video, performing hand movement seeing two bouncing balls and seeing white noise. No suppression was seen in EEG patterns of μ wave in ASD group during observed hand movement condition, suggesting a possible dysfunction in the mirror neuron system. The additional lack of any significant correlation between age and μ wave suppression also suggests that this dysfunction is not something that improves over the lifespan. However, since the sample in this study was solely composed of high-functioning males, the generalizability of the findings to females or lower-functioning individuals is unclear and requires further investigation [6].

A. Sheikhani et al took the values of 17 children with autism and 11 normal children between 6 years to 11 years. QEEG were taken from all of them to show the alpha frequency which showed maximum differentiation of 96.4% in state of relaxed eye – open activity with the help of spectrogram. The autism group showed a distinct decrease in left brain hemisphere criteria value. P is less than 0.01 at F3 and T3 electrodes and p is less than Fp1, F7, C3, Cz and T5. EEG electrodes for 171 pairs of Coherence values show that higher defective values are found in temporal lobes as compared to other lobes where all are taken in μ frequency band [1].

W. Khazaal Shams and A. Wahab Rahman have used Principle Component Analysis (PCA) to implement the autism detection for children. The required patterns were taken from the signals in Time-Frequency domain to reduce data dimension. They have taken Multilayer Perception Neural network (MLP) of the signals which can be helped to compare and differentiate the classifying activity which is done by tasks of opening eyes and movement of hands of autistic children. Around 90-100% accuracy was found in classification patterns of autistic children and 90% accuracy...
was found for normal children while doing opening of eyes task [8].

Mohammed J. Alhaddad et al has taken Fisher Linear Discriminant Analysis (FLDA) as an feature for discriminating autism and non-autistic children. Different combinations of pre-processing techniques, average of combinations and features extracted by different processes were used. A accuracy of 88.14% was achieved using Fast Fourier Transform and 0.0404 was the standard deviation [9].

**METHODOLOGY**

24 Channel EEG instrument (RMS 24 BrainView Plus) is the EEG instrument we have used for the study. In the study, ten subjects (6 Autistic and 4 non-Autistic) were recruited. 4 tasks namely relax, flashcards read and spell, video read and spell and video hand movement imitation were chosen for the data acquisition. Since the EEG signals of children are only taken into consideration, paediatric montage is chosen for the study. The paediatric montage consists of electrodes O1, O2, A1, A2 C3, C4, T3, T4, Fp1 and Fp2 according to 10-20 International System. Subjects A1-A6 are children with autism and subjects N1-N4 are non-autistic children.

EEG signals evoked by entire four tasks stated above from ten subjects that are noted. Every recording test lasted for 30 sec. Twelve trials were taken for every operation.

**SPECTRAL ANALYSIS FOR VARIOUS TASKS OF AUTISTIC AND NON-AUTISTIC SUBJECTS**

The spectrums of the raw signals are examined by using Short-Time Fourier Transform (STFT) to display various factors of frequency for each movement. STFT algorithm is used to determine sinusoidal frequency and phase signal content as it alters over narrow time intervals. From the spectral analysis, the frequency components for each task for each channel are inferred. The spectrum for all the sixteen channels for motor tasks for Subject A5 and N2 is shown in table 1.

<table>
<thead>
<tr>
<th>Channels</th>
<th>Autism</th>
<th>Non-autism</th>
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<tbody>
<tr>
<td>C3-a1</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
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<tr>
<td>C3-o1</td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
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<tr>
<td>C4-a2</td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
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<tr>
<td>EEG Channel</td>
<td>Spectral Analysis</td>
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<tr>
<td>C4-o2</td>
<td><img src="image1" alt="Spectral Analysis" /></td>
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<tr>
<td>Fp1-a1</td>
<td><img src="image2" alt="Spectral Analysis" /></td>
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<tr>
<td>Fp1-c3</td>
<td><img src="image3" alt="Spectral Analysis" /></td>
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<tr>
<td>Fp1-t3</td>
<td><img src="image4" alt="Spectral Analysis" /></td>
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<tr>
<td>Fp2-a2</td>
<td><img src="image5" alt="Spectral Analysis" /></td>
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</tbody>
</table>
SPECTRAL ANALYSIS BASED DIFFERENTIATION FOR EEG SIGNALS OF CHILDREN WITH AUTISM

Fp2-c4

Fp2-t4

O1-a1

O2-a2

T3-a1
RESULTS AND DISCUSSION
Spectral Analysis for Various Tasks of Autistic and Non-autistic Subjects
The spectrums of the raw signals are examined by Short-Time Fourier Transform (STFT) to determine frequency components for each movement. From the spectral analysis, the frequency components for each task for each channel are inferred which shows that more frequency range is found in spectrograms of Autistic children as compared to control children in each channel. This emphasizes the fact that more difference of behavior of neurons under each task were found in children with ASD in contrast with non-ASD children.

CONCLUSION
This study was conducted to EEG based Autism diagnosis system which recorded from ten subjects for four different tasks. In this study we used sixteen channel system and obtained classification for Autistic and non-Autistic children for four different tasks. The spectrums of the raw signals are examined by Short-Time Fourier Transform (STFT) to determine frequency components for each movement. From the spectral analysis, the frequency components for each task for each channel are inferred which shows that there is distinct difference between the dominant frequency range as thus EEG signals can be used to differentiate between EEG signals of Autistic and non-autistic children.

REFERENCES