# Analysis of EEG Signals for Diagnosis of Alzheimer Disease

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**Abstract**- Alzheimer's disease is a brain disturbance characterized by a progressive dementia. It is the very costly disease in the today's society & characterized by cognitive decline, cerebral as well as behavioral action disturbance. Because of this, the early stage of the Alzheimer's disease is detected, as it assists the patients & also his relative to take precautionary measures. As electroencephalography are useful tools in the detection of brain cognitive function in normal and aged person caused by the diseases with an excellent time resolution, EEG can be used to bring into conformity with a standard tool for diagnosis of Alzheimer disease. Various monstrosities are found in the EEG signals analysis of the persons those are suffering from Alzheimer disease. Therefore, the Alzheimer Diseases in the early stage is detected. Role of EEG analysis for the diagnosis & clinical research of Alzheimer disease has become more essentials in recent decades. In present, the most crucial task consist the diagnosis of the AD & its early detection in the primary stage. The need is to improve the accuracy for the diagnosis of the EEG signal. In this paper consist of review of previous paper has been put up and some of the problem has been found out during the diagnosing AD from EEG signals.

**Keywords-** Alzheimer's disease (AD), Electroencephalography (EEG) signals.

## I. INTRODUCTION

Alzheimer's disease (AD) is a neuro-degenerative disease, commonly called the form of dementia. Alzheimer's disease is now the third most costly disease after cardiovascular disease and cancer and the sixth leading cause of death. As the world is growing into an era of society, the load and collision caused by AD on relative and the society will be increasingly announced officially. Number of person suffering from AD is supposed to increase in the next decades. It is very difficult to identify the diseases and their effective treatment in neurophysiologic research [1][2]. AD is mainly characterized by the neuronal widespread loss of cells, neurofibrillary tangles, and senile plaques in Hippocampus, entorhinal cortex, neocortex and other brain regions [3].Finding a computational approach for early detection of patients who are to be a Alzheimer's disease patients, but do not exhibit any clinical signs of AD at the time of the test, is thus an important challenge. In the pre-clinical stage of the disease, there are no basically reliable and valid symptoms detected to allow a very early diagnosis. In the mild stage of the disease, memory impairment & loss are noticed. In the moderate stage of dementia, language difficulties become more such as word finding difficulties, paraphasia etc. As the disease's popularity goes high, several symptoms found in the in cognitive abilities such as language, memory and executive functioning [4]. In the final stage called as the severe AD, almost all cognitive functions are severely damaged and executive task including chewing and swallowing are drastically disturbed [5].

Presently, it was estimated that there are 44.4 millions of people suffering from dementia in the world. It was also evaluated that this number will go increasingly till 75.6 million in 2030, and 135.5 million in 2050. It was also noticed that 61% of the people suffering from dementia are from the advanced and progressive countries. The best growth in the elderly population is taking place in United States of America, western countries, India, and their south Asia and [6].

There are basically no proper symptoms for cause of AD. But, some cases are generally accepted for the genetic differences. Some of the hypothesis are used for the understanding the cause of AD. Some of the common hypothesis includes the genetics, cholinergic hypothesis, Amyloid hypothesis, tau hypothesis etc. Another hypothesis is also made that AD is also caused by the age related myelin breakdown in the brain. Air pollution is also one of the contributing factors for the development of the Alzheimer disease. Early diagnosis of the disease also raises the chances of treating the disease at an aborning stage. It allows the patients family to take decision related to finance about the disease, and to make the action for the future needs and care of the patients. [7].

## II. METHOD

Neuro imaging techniques, physiological markers, and genetic analyses are the method those are used for the detection of Alzheimer disease. Out of these methods, Neuro Imaging method very much accepted for defining the Alzheimer disease Various Neuro-imaging methods includes single-photon emission computerized tomography (SPECT), positron emission tomography (PET), and magnetic resonance imaging (MRI) have been successful for recognizing AD at an early stage. The problem found in PET & SPECT are radiation risks and costs which are much expensive, time consuming & inconvenient. So, apart from all these Neuro-imaging methods; EEG is one of the standard methods used for the diagnosis of the Alzheimer disease.

Electroencephalogram (EEG) signals are considered functional. These EEG signals are helping to evaluate disturbances and diagnosis of the diseases, especially when someone considered to exist even after the primary clinical research [8][9]. In recent years a great research has already been conducted to detect the EEG fluctuations occurs in brain [2]. The use of the Electroencephalography is considered as the one of the approach for large screening test the people at risk for Alzheimer's. EEG is no stationary, no repeatable, and can be easily used at house through brain computer interface networks as a expressive medical tool. EEG is also a direct mapping of brain activity that is used clinically to cover the brain functionality. It is shown that non-linear EEG signals

data analysis have shown the unique features to investigate the diagnosis of the neurological diseases such as Alzheimer, Epilepsy & Parkinson's [10][11].

Table I. Various Method Comparison based on EEG signal

| Sr. No. | Reference | Method | Performance |
|---|---|---|---|
| 1 | 12 | Machine Learning Approach | 86% |
| 2 | 13 | Zero Set Fractal Dimension of EEG Method | 78% |
| 3 | 13 | Zero Crossing Intervals Density | 89% |
| 4 | 14 | standardized low-resolution brain electromagnetic tomography (sLORETA) method | 84.4% |
| 5 | 15 | Nonlinear Analysis of EEG via Tsallis Entropy. | 82% |
| 6 | 16 | Quantitative (qEEG) method for measuring the EEG variability to improve the classification | 88% |
| 7 | 17 | Relative power and complexity measures as features to classify the disease. | 83% |
| 8 | 18 | Integrative EEG biomarkers to predict the diagnosis | 88% |
| 9 | 19 | M3 approach to classify AD. M3 is multi-modal imaging and multi-level characteristics with multi-classifier | 89.4% |
| 10 | 20 | Amplitude Modulation Analysis | 90.6% |

## III. ELECTROENCEPHALOGRAM ANALYSIS

From few years back, several group of research have focused on the capability of electroencephalograms (EEGs) or causes of Alzheimer's disease. Since recording of EEG signals recording systems are less costly, convenient and capable of moving, EEG may implicitly be used as a tool to test a large number of the persons for the probability of suffering AD. Along with this, certain occurrence which is not the normal form are seen in the EEG of the patients suffering from the Alzheimer disease or who are in the first stage called very mild decline impairment. [21][22][23].

Last studies have shown that Alzheimer's disease has been detected based on the EEG signals.EEG signal used for the detection of the AD because of its characteristics. If the subject suffering from Alzheimer's disease, some of the major effects occurred in the EEG signal such as slowing of the EEG, reduction in EEG signals complexity and agitation in EEG synchrony. However these mentioned activities are not always easily detectable. There movements to be a large variable in the subjects those are suffering Alzheimer's disease. As a result, none of the concept permits, now a day, to responsible diagnose Alzheimer's disease at a primary stage. [24][25][26]

*1. Slowing of EEG*

It was observed from the study based on the Alzheimer's disease causes EEG signals to slow down.AD is associated with a decrease of power in alpha, beta and gamma (higher frequencies 8-30Hz signals) with an increase power in delta and theta (low frequencies 0.5–8Hz signals).One has applied Fourier transforms and time-frequency maps such as bump model to measure the change in the spectral power.

*2. Reduced Complexity of EEG Signals:*

Various methods are used for the reducing the complexity of the EEG signals. Several methods have been used for quantifying the EEG signals in very mild decline stage and AD Patients. Different methods such as information theory [16], Tsallis entropy [15], approximate entropy [15], multi-scale entropy, sample entropy & mutual information and Lempel-Ziv complexity [27] are used to quantify EEG complexity.

*3. Agitation of Synchrony Parameters:*

A large number of parameters of synchrony have been employed. In the signal processing biology and physical sciences, these synchrony parameters are measured. From the survey, it is noticed the decreased EEG synchrony in AD patients. The main drawback among all the survey that had been taken in the tables I, it use just one parameter or very less parameters and many of those studies analyze different database of EEG. As a result, it is difficult to compare the various parameters. Various synchrony parameters obtained from the EEG signals are affected by the brain signals. Phase Synchrony, Granger Causality, Magnitude Phase Coherence and Pearson Correlation Coefficient are some of the synchrony parameters used for the diagnosis of the Alzheimer disease.

## III. METHODOLOGY

Electroencephalography (EEG) signal is the recording of electrical activity along the scalp. EEG measures voltage fluctuations resulting from ionic current flows within the neurons of the brain. In our proposed methodology, EEG refers to the recording of the brain's spontaneous electrical activity over a short period of time, usually 20–40 minutes recorded from multiple electrodes placed on the scalp [8]. For the placement of the electrodes; we are using the standard 10 to 20 electrode system. The following figure shows the flow chart of suggested Method.

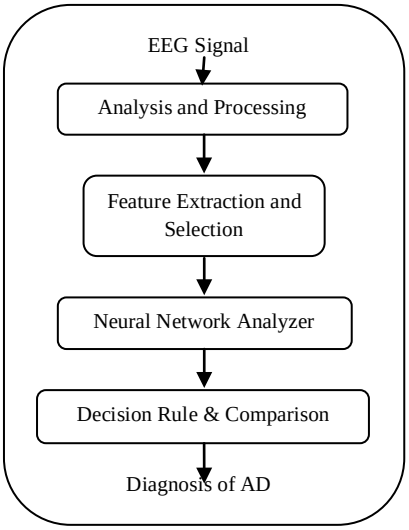

Fig.1 Flow Chart of Suggested Method

1. *Pre-Processing of EEG Signal*

EEG signal need to be processed before the extraction of the parameters from signals.EEG recordings typically consist of electrical activity from the brain as well as several unwanted noise such as interference from electronic equipment, ocular artifacts because of eye movement or blinking, electromyography (EMG) signals developed from the activity of muscle. Those unnecessary components may favor the analysis of the EEG, and may cause to wrong interpretation. So in order to remove this factor, EEG signals preprocess the signals with the help of following Methods

a) Filtering
b) Artifact Suppression
c) Artifact Rejection
d) Adaptive Filtering
e) Regression
f) Blind Source Separation

2. *Feature Selection and Extraction*

In this step, after getting the preprocessed EEG signals, some useful parameters called features are extracted. Usually, a certain range of frequency and relative amplitude of the EEG signal are calculated. Generally features are certain power spectrum and frequency bands those describes the content of EEG signals. Fast Fourier transform, wavelet model, auto regressive model and bump model are the different method to find out the features of EEG signals. It is very important to identify the correct features[45].Some Important features are energy for spectra temporal, spectral power of different bands, phase Synchrony, Bump, Spectral Centroid and spectral Roll-off.

3. *Classifier*

After extracting the features of EEG signals are given to the classifier as input. Classification is the problem of identifying to which of a set of categories a new observation belongs. The classifier is of any type such as linear and complex non linear model of neural network. In this proposed methodology, Principal Component Analysis (PCA), Support Vector Machine (SVM), Amplitude Modulation Analysis and Linear discriminate Analysis can be used for the classification

4. *Decision Rule*

Based on the output of the classifier and compared this output with the some reference dataset. Anyone can detect whether the person is suffering from Alzheimer Disease or in the early stage of the AD.

## IV. DISCUSSION

Alzheimer's is a type of dementia that causes problems with memory, thinking and behavior. Symptoms usually develop slowly and get worse over time, becoming severe enough to interfere with daily tasks. There are the six different stages of Alzheimer Diseases. As per the literature survey mentioned in the table 1, the following point will be discussed for the future purpose.

1. It was observed in one of the reference paper [28] that relative power measured from ratio of theta and gamma is significantly related to degradation of memory in AD patients. Similar type of results have been noticed in other paper [29] for AD patients that relative power of theta and alpha reactivity appear to be related to decreased action in various cognitive domains such as conscious mental activities, speech languages, memory and applied action. Alpha proportion, however, does not appear to match with cognitive decline because of loss in alpha power during the cognitive task as compared to eye closed. From this we can find out the accurate relationship between EEG anomaly and the decline of mental activity and memory in AD patients which remains largely unexplored.

2. As per one of the research group consideration, alteration in the regional cerebral blood flow (rCBF) may suffer the Alzheimer disease. we have to find out the change occur in EEG signal due to alternation of cerebral blood flow (rCBF) simply a similarity was noticed between the mean frequency of EEG power and the regional cerebral blood flow.

3. The number of scientist knew that AD involves the failure of nerve cell, but why this happens is still unknown. There is also one reason of failure of nerve cells that is amyloid plaques (Dense deposits of the protein and cellular material outside and around neurons) that affect the nerve cells. So we have to find out affect of this amyloid plaque on the EEG signal power.

## V. CONCLUSION

At the end of the research, it is expected that we get the high Accuracy of the EEG signal for detection of the Alzheimer disease. By watching the nature of the above signal according to the frequency bands classified we can also detect stage of the Alzheimer disease. In this way, we can use EEG as a measure of diagnosis of Alzheimer disease. Different types of fluctuations are found in the EEG signals after suffering the AD. Slowing of EEG signals, reduced complexity, agitations in synchrony parameters are some of the abnormalities found. Various different features extraction methods as well as classifiers can be used for early detection of the diseases. Thus, EEG can be used as the inexpensive, convenient tool for diagnosis of Alzheimer disease.

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