Alzheimer Disease Detection and Tracking of Alzheimer Patient

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Abstract— Alzheimer disease is one of the forms of dementia. AD is tremendously increasing disease in the world. There are so many biomarkers detect the Alzheimer disease. From that Electroencephalograph signal is give correct result and performance. In Alzheimer disease, death of brain cells are occurs so there is many causes happened such as memory loss, poor in calculation and recent event happened etc. Early detection of Alzheimer disease is very useful for him and his family. Early detection of Alzheimer patients is very useful for him and his family. In detection, firstly EEG database is filter then noise and artifacts is removed from EEG database using independent component analysis. By wavelet transform four features are extracted and classification is done by support vector machine. In monitoring system, Alzheimer patient is track by using GPS and GSM. With the help of this monitoring system Alzheimer patient is travel anywhere without caregiver.

Keywords— Electroencephalogram (EEG), Global System for Module(GSM), Global Positioning System(GPS), Alzheimer's disease (AD), family caregivers (FC), Mild Cognitive Impairment (MCI), Support Vector Machine(SVM), Independent Component Analysis(ICA).

I. INTRODUCTION

Alzheimer disease (AD) is sixth ranked leading disease that cause of death in United States [2]. AD is chronic neurodegenerative disease that causes death of brain cells due to loss of memory occurred. AD is fastest growing in people aged 65 and older. According to US Census Bureau, the global number of adults over the age of 60 is expected to reach 1.2 billion by year 2025[2]. AD is neurodegenerative type of dementia, the disease start mild and gets progressively worse.

AD is divided into three stages on the basis of their symptoms. The stages are mild, moderate and severe. The symptoms of 1st stage AD is short term memory loss, forgetting people names, appointments and recent event happened, poor in calculation. First stage of AD is also called MCI. Symptoms of second stage of AD is severe memory loss, unable to handle simple task, start to depends on others on handling living activities, language problem and cannot communicate early with others people, wander around on streets and confused about day and night. Lastly symptoms of third stage are unable to understand or use speech to express simple things, unable to recognize people including his close family members, difficulties swallowing and walking and totally dependent and bedridden.

There is no treatment is exists, early detection of AD still provide them and their families with an opportunity to plan for their future. Detection of the AD patient is possible by various methods such as Mini-Mental State Examination (MMSE) [14], Clinical Dementia Rating (CDR) [15], single photon emission computerized tomography (SPECT), and positron emission tomography (PET)[23], and magnetic resonance imaging (MRI) and EEG so on. But the main problem of PET & SPECT is they impose the radiation risks [15]. There are 30-point questionnaires is used in MMSE test to detect MCI patient. Linguistic memory tests, such as word list and narrative recall, are more efficient than MMSE in detecting MCI [3]. MRI is a medical imaging technique used in detection AD patients and it is costly technique.

EEG signals are prone to noise sources and several artifacts such as eye blink, hardware inherent noise and power grid interference [1]. Artifacts have effect on EEG result hence artifacts are removed by ICA algorithm.

The reminder of this paper is organized as fallows. Section II described related work of present study. Section III describes proposed system of detection of AD based on EEG signal and tracking system. Section IV present experimental results. Lastly, Section V present conclusion.

II. RELATED WORK

In this paper, Justin Dauwels et. al. (2010) they proposed to diagnosis of AD patient from EEG recording. In traditional day, diagnosis of AD can be possible using MMSE, CDR, blood test, spinal fluid, neurological examination. Analysis of EEG of MCI and AD patients can be possible on the basis of three factors i.e. slowing of EEG, reduced complexity of EEG signal perturbations in EEG synchrony [16].

In this paper, Van der Hiele K. et.al. (2007) they can investigate relations between EEG measures & performance on test of global cognition, languages & executive functioning [17]. The variation in EEG recording in different stages can detect the AD patient. From the result, theta relative power was increased in AD patients as compared to MCI & control and related to decreased performance in all cognitive domains.

Alpha reactivity was decreased in AD patients.

In this paper, Jaeseung Jeong (2004) they proposed, some changes is occurs in EEG signal of various frequency bands of EEG signal in MCI patients & AD patients. The EEG in AD patients has demonstrated a slowing of dominant posterior rhythm an increase in diffuse slow activity [18]. The complexity of EEG in AD was decreased because the AD patient brain is shrinkages. The functional connectivity in AD brain was decreased.

III. PROPOSED SYSTEM

In this section, the detailing about diagnosis of AD and tracking of AD patients with GPS and GSM is done.

A. Diagnosis of AD Patient:

In this section, the detail about diagnosis of AD patients. The following figure shows that general block of the EEG based AD diagnosis system.

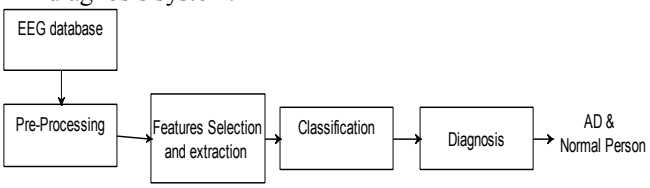

Fig (1): Block Diagram of Classification of AD and Normal Person Based EEG

1) Participant: EEG database was used for this experiment had taken from the Smt. Kashibai Navale Medical Hospital Pune. EEG signal is 19 channel database. Consider 15 participants who were divided into two groups i.e. normal persons and AD patients. AD patients were diagnosed by neurological test such as MMSE (Mini Mental State Examination) and CDR (Clinical Dementia Rating) etc. Participants are in first group i.e. AD patient with CDR scale is less than or equal to 2 and greater than or equal to 0.5 as well as MMSE is less than or equal to 24. In second group i.e. in normal person with CDR scale is less than 0.5 as well as MMSE is greater than 24.

2) EEG database: The recording of EEG signal had done by using RMS (Recorders and Medicare systems Private Limited). EEG machine with 12 bits resolutions and sampling rate of 1024Hz. The electrodes (Referential Montages) are placed according to the International 10-20 systems and impedance is maintained below 10Mohms. EEG signal is converted into .mat file i.e. MATLAB file. The acquisition of EEG signal is possible by using Simulink.

3) Pre-processing: In this stage, the EEG signal is amplified and removed the noises and artifacts from the EEG signal. The low pass filter is used for removing unwanted EEG signal with sampling frequency 50 Hz. To remove noise and artifacts is done by notch filter. The various artifacts especially eye blinking cannot be removed by notch filter. The Independent Component Analysis (ICA) is a blind source separation technique that separates statistically independent (rather uncorrelated) sources or components from their linear mixtures [20].

The concept and algorithms of the ICA techniques are discussed in [20]. ICA gives more enhanced EEG signal. After applying ICA algorithm to EEG signals it gives pure EEG Signal. The EEG signal is divided into two second part for perfect decomposition of EEG signal see in figure (2).

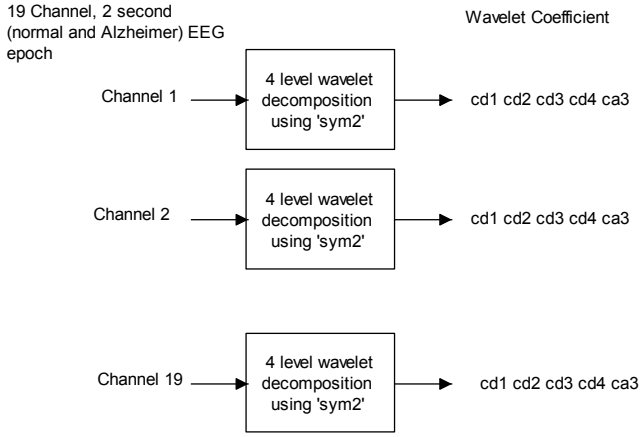

Fig (2): 4-level wavelet decomposition of EEG signal by using 'sym2'

4) Feature Extraction and selection: Feature extraction is based in the reduction of the existing features by applying a transformation to these, obtaining a lower dimensional space which better represents the target concept. In this stage, certain features are extracted from pre-processed and digitized EEG signal by using wavelet transforms and FFT. These features are mean, standard deviation, median, mode, range, skewness,, kurtosis, power spectral density of the EEG signals.

- Mean: Each and every band and sub-band of signal is calculated by mean.

$$mean = \frac{1}{n-1}\sum_{i=1}^{n} x_i \qquad \ldots (1)$$

- Standard Deviation: Root Mean Square (RMS) deviation is also called as standard deviation. It measures the variation of set of EEG signal.

$$SD = \sqrt{\frac{\sum_{i=1}^{n}\left(x_i - x\right)^2}{N-1}} \qquad \ldots (2)$$

Where S- Standard Deviation

x -amplitude of EEG signal

- Mode: The mode is the signal that is repeated more often than any other, so it is the mode.

- Median: Median is the number separating the higher half of a data sample from the lower half. The median of a finite list of numbers can be found by arranging all the observations from lowest value to highest value and picking the middle one which corresponds to interpreting the median as the fully trimmed midrange.

- Skewness: The asymmetry of the probability distribution of a real-valued random variable about its mean is measured by Skewness. The skewness value can be positive or negative, or even undefined [28].

$$skewness = E\left(\frac{x-\mu}{\sigma}\right)^3 \quad \ldots (3)$$

Where, μ - mean of x
σ - standard deviation of x
$E(t)$- the expected value of the quantity t.

- Kurtosis: The "tailedness" of the probability distribution of a real-valued random variable is measured by Kurtosis.

$$k = E\left(\frac{x-\mu}{\sigma}\right)^4 \quad \ldots (4)$$

- Power Spectral Density: PSD is a measure of signals power intensity in the frequency domain. The PSD is computed from FFT spectrum of a signal. The PSD provides a useful way to characterize the amplitude versus frequency content of a random signal.

5) Classification: As above mention, the total of 404 features has computed. Only 15 features are selected from total features. For classification, we use the support vector machine (SVM) [22] as well as normalized minimum distance (NMD). The principle behind SVM is to find the hyper plane in some for separating data point into two classes. The principle behind NMD is to compute the Euclidian distance in data points. The classification of AD and normal person is based on the result. Support Vector Machine (SVM) [22] gives most accurate result as compared to NMD. Accuracy of SVM is more than NMD classifier. Table I shows that performance comparison of SVM and NMD. Hence supervised SVM learning model is used for the classification.

Table I: Performance comparison of SVM and NMD

System	Accuracy (%)
SVM	95
NMD	35

B. *Tracking System for AD Patient:*
The tracking system for AD patient is designed. They are suffering from memory loss and facing problems in day to day life. These problems can be solved by the system described here.

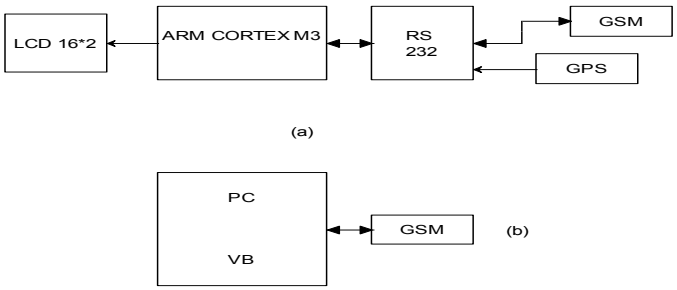

Fig (3): Block Diagram of tracking system: (a) AD patient module (b) caregiver module

Fig (3) shows that tracking system (a) AD patient module (b) caregiver module. Whenever AD patient has travelled outside then GSM in the caregiver initiates and received information from AD patient module. On the Visual Basic, the exact location of the AD patient has been seen. After every 1 minute GSM in AD patient module send message to the caregiver module. The exact coordinates of location and message sending is display on LCD.

The AD patient module has ARM cortex M3 LPC 1768, GPS antenna, power supply, 16*2 LCD display, and GSM and GPS module. The caregiver module has GSM module, PC and RS 232 kit.

Whenever AD patients are wander around a city or anywhere then system is initiate and receive GPS co-ordinate of AD patient where he is wandering from GPS satellite. If receive date is correct then send GPS information to caregiver or otherwise it check co-ordinate again. AD patient module is sending message after every 1 minute for informing caregiver AD patient is in safe zone or not.

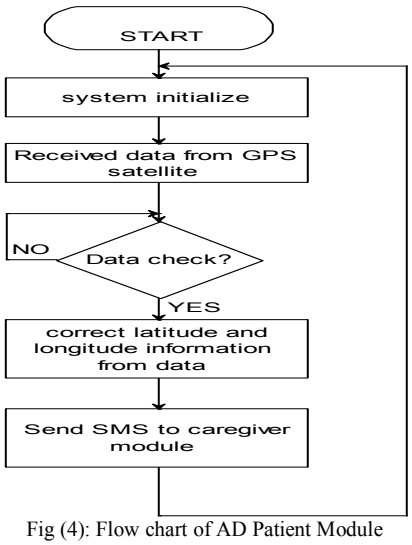

Fig (4): Flow chart of AD Patient Module

IV. Experimental Result

Various features such mean, median, mode, range, standard deviation, skewness, kurtosis, power spectral density and amplitude modulation are extracted from EEG signal by wavelet transform. The 4-level wavelet decomposition of EEG signal is done by using 'sym5'. SVM classifier is used to detect AD patient and normal person. Slowing of EEG signal

in AD patient. The complexity of AD patient is decreased as compared to normal person.

The result of the tracking system is shows the latitude and longitudinal co-ordinates and exact location of AD patient. From tracking system, caregiver is received the position of AD patient using GSM and GSP.

V. CONCLUSION

From above discussion, EEG signal is effectively used for detection of the AD patient. In EEG signal several abnormities are measured such as slowing in EEG signal, complexity of EEG signal is decreases. Several features are extracted by using appropriate extraction tool. Caregiver is received message from AD patient module. The exact position of AD patient is trace by using tracking system. For future work automatic artifacts remove tools are used such as Principal Component Analysis (PCA), Blind Source Separation (BSS) etc are used to make system automatic. In future for monitoring of AD patient, RFID are used for bank transaction without the help of caregiver.EEG signal is important role in detection of AD patient.

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