

# EEG based detection of Alzheimer disease and monitoring of Alzheimer patient

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**Abstract** - Alzheimer's disease is most common cause of dementia and involves a progressive degeneration of the cerebral cortex. It is a chronic neurodegenerative disease that usually starts slowly and gets worse over time. In Alzheimer disease death of the brain cells causes memory loss and cognitive decline. The early diagnosis of the disease is essential as it helps the patients also his family to take preventive measures. EEG can be used for diagnosis of Alzheimer Disease. In the EEG signals of the patients suffering from Alzheimer disease various abnormalities are found. Hence, the need is to develop the detection of the disease in early stage called as Dementia. Developing tracking and reminder system for Alzheimer patients who suffer from many difficulties such as Memory loss that disrupts daily life, challenges in planning or solving problems, Difficulty completing familiar tasks, Confusion with time and place, problem with words in speaking or writing.

**Key Words:** mild cognitive impairment(MCI), electroencephalogram(EEG), Global System for Module(GSM), Global Positioning System(GPS), Alzheimer's disease(AD), family caregivers(FC), Electronics Geo-Tracking(EGT)

## 1.INTRODUCTION

AD is the most common cause of dementia, and involves a progressive degeneration of the cerebral cortex. There is widespread cortical atrophy. Neurons affected develop surrounding amyloid plaques, neurofibrillary tangles, and produce less acetylcholine. Alzheimer's disease (AD), also known as Alzheimer disease, or just Alzheimer's, accounts for 60% to 70% of cases of dementia[10]. People aged 65 and older constitute the fastest growing population segment in North America, Europe, and Asia. According to the US Census Bureau, the global number of adults over the age of 60 is expected to reach 1.2 billion by the year 2025. In Canada, 50% people is affected due to Alzheimer disease. Early detection of dementia is of great significance because it increases the chances of successfully reversing the cause of dementia. Although no treatment exists, early detection of dementia still provides them and their families with an

opportunity to proactively plan for their future. [5]. It is a chronic neurodegenerative disease that usually starts slowly and gets worse over time. The cause of Alzheimer's disease is poorly understood. About 70% of the risk is believed to be genetic with many genes usually involved. Other risk factors include a history of head injuries, depression, or hypertension.

AD is classified into three stages on the basis of symptoms. Firstly, MCI: symptoms of MCI is short-term memory loss, poor in calculation, frequently forgetting people name, appointments, recent events. Secondly, Moderate: symptoms of moderate is severe memory loss, unable to handle simple tasks, start to depend on others on handling living activities, language problems and cannot communicate clearly with other people, wander around on streets, confused about day and night. Symptoms of last stage is unable to understand or use speech to express simple things, unable to recognize people including his close family members, Difficulties in swallowing and walking, Totally dependent and bedridden. Numerous clinical methods are extensively used for the diagnosis of Alzheimer disease such as neuroimaging techniques[19], physiological markers, and genetic analyses. Neuroimaging is one of the well-accepted methods for definitive diagnosis of dementia. Various Neuro-imaging methods are used for the diagnosis of the Alzheimer disease. Several methods such as 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. But the main problem of PET & SPECT is they impose the radiation risks[9]. Other disadvantages are their 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.

## 2. RELATED WORK

Current detection process starts by general practice physicians referring patients to memory clinics for cognitive assessment after repeated reports of memory problems by the patients themselves, family members, or caregivers[5]. In memory clinics, cognition of patients is assessed using

questionnaires, screening tools, and episodic examinations of cognitive capacity such as the Montreal cognitive assessment [12], the mini-mental state examination (MMSE) [13], and the clinical dementia rating (CDR) [14].

In this paper, Yilmaz Kemal Yuces et. al. (2013) they were proposed a system that are used locating and securing an Alzheimer patients who is outdoor and wandering in state. This system is based on new type of intervention i.e. mobile application with the help of this system patient can be monitor.

ICT (Information Communication) is system act as a communicator between Alzheimer patient and social network i.e. family caregiver (FC). The monitoring system periodically checks whether an Alzheimer patient is in wandering state during he/she is not with the patient. When patient is in wandering state, then this system announces to CNM (Caregiver Network Member) that patient is in wandering state and ask for help and securing the patient. The system starts to direct those CNMs (an ad hoc social network), who would reply its request affirmatively, to the wandering patient by multicasting patients location updates periodically through GSM network until one of them sends a message through Short Messaging Service (SMS) with the text FOUND to signal that patient is found [1]. The tracking device for Alzheimer patient is mobile or smart phone for each FC application server. The tracking device is capable of making receiving calls but not enable voice communication. The middleware is major component in monitoring system. It handle many task such as tracking patients, checking their safety and directing FCs. With the help of GSM can be find location of the patient. The system handle every patient separately [1]. The system is divided into three stages i.e. 1. Safe state 2. Unreachable state 3. Wandering state. The tracking system can calculate the distance between current patient location and home check whether he is personal geofence or not.

In this paper, Kam-Yiu Lam et. al. (2015) they introduce SmartMind, an activity tracking and monitoring system to help Alzheimer disease (AD) patient to live independently within their living rooms while providing emergent help and support when necessary [2]. The SmartMind system can monitor and track the Alzheimer patient within their living room. In Smart-Mind, the kinect device is used for activity detection. The kinect device can detect the normal living habit (NLH). With the help of NLH they identify the Alzheimer patients. Another goal of SmartMind is to handle emergence situation such as falling on the floor, SmartMind will immediately generate alert message together with the capture sence to be sent to his relatives so that prompt helps can be provided [2]. In SmartMind, the important activity can be captured by kinect device.

The kinect device can captures the images and 3D posture data of the patients [2]. For capturing the data, two or more kinect devices are installed in living room. If the patient is not enter in their living room for an unexpected long time, then an alert message will be generated to related

people. NCF is one of the sensing device it can installed in their living room. It can capture some activity such as patient picks up the medicines for taking. The main component of SmartMind. It consists of the SmartMind server, the SmartDB server, the Smartweb server, kinect devices, a group of databases and an apps called Smart Reminder in Smartphones [2]. SmartMind Server connects to the Kinect devices through a wireless network it performs analysis to determine the current activity of the activity of the target [2]. The image of the activity can be capture by kinect device and this data can be stored in SmartDB server. Smart Reminder performs four main functions to target (1) people reminder, (2) item reminder (3) Activity reminder (4) mind training games. For identification of current activity of the target they required two things one is his current position and second is current location of the target. The kinect device create the skeleton which consist of 20 joints in body. By checking the coordinates of different joint they can estimate current posture of target [2]. For identification of posture decision tree method is used. The identification of set of activity can be based on three postures such as standing, lying and sitting. The monitoring and tracking Alzheimer patient can be done by developing a healthcare tool called as SmartMind.

In this paper, Ahmad Akl et. al. (2015) they are detect the MCI in older adult population using home based unobtrusive sensing technologies. They are consider 97 subject, 10 were males, two of which had MCI at starting. The remaining were females, 16 out of which had MCI at starting or transitioned to MCI during monitoring. 97 living room like studio apartment is provided to each subject. To detect movement and general activity by location, passive infrared motion sensors [3]. Visitors and absences from the home were tracked through wireless contact switches [3]. Walking speeds were estimated by placing motion sensors [3]. A weekly measure vector  $v$  is basically a vector of values, such as median walking speed and coefficient of variation of walking speed, calculated over a period of one week from the sensing technologies [3]. The measure vector can be converted into features vectors using sliding window. The features vector can be divided into 3 groups, each group having same number of features vectors. The features vector relating to each class i.e. positive negative class. The performance of the machine learning algorithm is evaluated through a threefold cross-validation process that consists of three runs [3]. In each run, two groups are used to train the algorithm and the third group is used to test it [3]. The detection of MCI in older peoples can be possible using area under ROC and precision curve.

In this paper, Y. Hsu et. al. (2014) they developed gait and balance analyzing algorithms to obtain quantitative measurement for AD diagnosis[4]. The gait analyzing algorithm is composed of stride detection and gait cycle decomposition. The balance is measured by sway speed in AP(anterior posterior) and ML(medial-lateral) direction of bodys center of mass(COM)[4]. The decreases Alzheimer patients mobility and increases the risk of falling is happens due to the gait disorder and balance problem in AD. The finding were that AD patients had slower velocity, slower cadence and shorter stride length than HCs(Human Controls)[4]. For recording gait information of elderly and AD patients, many instruments can be developed by many researcher such as videotaping ten consecutive walking patterns of the patients, GAITRite walkway system. For balance analyzing, Berg Balance Scale(BBS), Timed Up and Go Test(TUGT), short physics performance battery(SPPB) these test are used. The traditional method, for measuring gait and balance parameters such as camera, footswitches or electronics mat. they are developed inertial-sensor-based wearable device is composed of a triaxial accelerometer and two gyroscopes. For gait analysis test,71 subjects i.e. participants were referred from the Department of Neurology at National Cheng Kung University Hospital[4], in that 21 AD patients and 50 HC. For balance analysis test, 50 subjects are taken from the same university Hospitals[4], in that 21 AD patients and 29 HC. They used two neuropsychological test such mini mental state examination(MMSE) and cognitive assessment screening instrument(CASI) for evolution of cognitive dysfunction and memory impairment in all subjects.

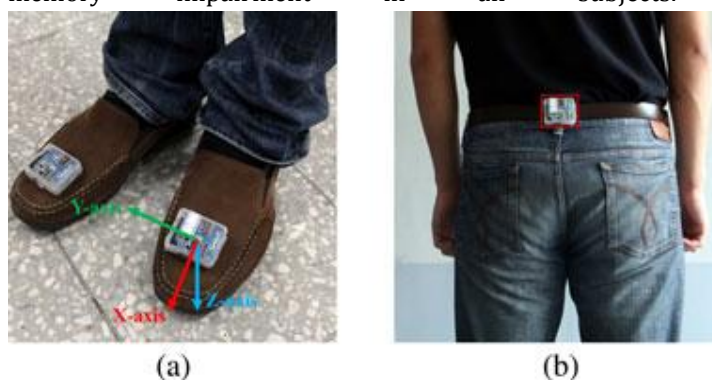


Fig. 1. (a) Feet mounted the inertial-sensor-based wearable devices for gait analysis. (b) Waist mounted the inertial-sensor based wearable device for balance analysis. [4]

For gait analysis, the wearable device can be mounted on feet of the participant or subject see in figure 1(a)[4]. The participant were demanded walk along two straight lines of 40m[4]. The variability in gait during single

and dual task walking can analyze by using inertial sensor based wearable device. For balance analysis, the wearable device can be mounted on waist see in figure 1(b)[4]. for analyzing the balance activity, the subjects were requested to maintain body balance and perform some balance ability tests. In balance ability test, AD patient gives larger sway speed in ML direction compared with HCs. The gait and balance parameter in AD patient can be find out by using inertial sensor based wearable device. In balance ability test, AD patients has a significant larger average sway speed in ML direction compared with the HCs during right food tandem stand.

In this paper, Justin Dauwels et. al.(2010) they proposed to diagnosis of AD patient from EEG recording[15]. 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[15] can be possible on the basis of three factors i.e. slowing of EEG , reduced complexity of EEG signal perturbations in EEG synchrony.

a. Slowing of EEG: In AD, increase of power in low frequencies i.e. delta & theta band(0.5-8Hz) and decrease of power in high frequencies i.e. alpha & beta band (8-30Hz) & gamma band (30-100)[15].

b. Reduced complexity of EEG signal: In AD patient, complexity of EEG signal is reduced. The EEG complexity is approximate entropy, automutual information, sample entropy, multiscale entropy, Lempel-ziv complexity and fractal dimension[15].

c. Perturbation in EEG synchrony: Decreased EEG synchrony MCI & AD patient under resting condition[15]. On the basic of slowing of EEG, reduced complexity of EEG signal & perturbation in EEG synchrony can be classified AD, MCI & normal patient.

In this paper, K. van der Hiele et.al. (2007) they can investigate relations between EEG measures & performance on test of global cognition, languages & executive functioning[16]. Consider 61 participants in which 24-control, 20-MCI & 17- Probable AD[16]. The medical check, physiological, psychological test of all participant is done properly. EEG recording can be taken in different stages. 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 domain[16]. Alpha reactivity was decreased in AD patients[16].

In this paper, Jaeseung Jeong(2004) they proposed, some changes is occurs in various frequency bands of EEG signal in MCI patients & AD patients. The EEG in AD patients have demonstrated a slowing of dominant posterior rhythm an increase in diffuse slow activity[17]. The power spectrum of theta band delta band was increased and alpha & beta bands was decreased in AD patients. The complexity of EEG in AD was decreased because the AD patient brain is shrinkages. The functional connectivity in AD brain was decreased.

In this paper, Francois Vialatte(2005) they can detect AD By BSS bump modeling of EEG signals. In EEG signal of AD patient many artefacts can be added due to the eye blink, machine intervention etc. for detection of AD patients, EEG signal should be artefacts free so for removing the artefacts & filtering of EEG signal can be possible by BSS. Automatic classification of EEG data can be possible by using the bump modeling method.

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