Application of Single Channel Wireless EEG - Detection of Alzheimer's Disease

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***Abstract*— The improvement and quality of the life of the patient is more important in the world. As the person's age is increasing the ability of the persons to get attracted towards the disease also keeps on increasing. Therefore by providing a proper and improved techniques which helps in getting rid from that sort of disorder and could able to prevent them from going to abnormal state. In this paper we discuss about the Alzheimer's disease (AD) which predominantly occurs in the aged people which affects their normalized well-being. The prior detection could help them and provide them with a better treatment of the disease. The spontaneous monitoring of the EEG of the patient and alerting the doctor through wireless module could enhance in providing a better treatment and location of the patient. In this paper we have come up with the different interference reduction technique and power consumption technique that acted as a challenge in the design of continuous monitoring.**

Keywords*— *Alzheimer's disease (AD), EEG, Wireless Module

I. INTRODUCTION

The abnormalities and disorder present in the brain could be identified through continuous monitoring of EEG signal. The Electroencephalogram is a technique which is used in the measure of electrical activity of the brain. As the amplitude of the EEG signal is very small it is very difficult to acquire and process the signal. The frequency of EEG ranges from 0.5-100 Hz, with amplitudes of 1-300 micro volts measured at the surface of the skull [8]. The figure 1 shown below describes the different EEG signal which is measured during various activities.

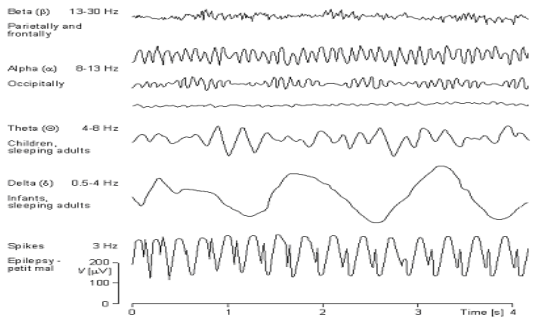

Fig. 1 EEG Signal

Image Courtesy: bem.fi/book/13/13.htm

Alzheimer's disease (AD) is one among the major neurological disorder which results due to the death of brain cells and cause the patient to suffer with memory loss. This is a type of dementia where the disease starts mild and gets progressively worse. The AD increases substantially after the age of 70 and affect around 50% of persons over the age of 85[8]. According to census of 2010 in US nearly 4.7 million people whose age is 65 and older were livings with Alzheimer's disease [9]. The statistical report from the Alzheimer's Association gives a proportion of the population affected just over a tenth of people in the over-65 age group and have the disease in the US. For the patient over-85s, the proportion goes up to about a third [9]. The progression of these diseases can be broadly characterized into four different stages. The first stage is referred as Mild Cognitive Impairment (MCI) which corresponds to a variety of symptoms commonly lead to memory loss which don't alter the routine life. More over 25% of the people affected with the first stage proceeds to AD. The next stages of AD (Mild and Moderate AD) are characterized by increasing cognitive deficits, and decreasing independence, culminating in the patient's complete dependence on caregivers and a complete deterioration of personality (Severe AD) [4]. And other major causes of the AD are that slowing down of the EEG signals. AD is associated with an increase of power in low frequencies (delta and theta band, 0.5–8Hz) and a decrease of power in higher frequencies (alpha and beta, 8–30Hz) [2, 3]. More over increased gamma band power (30–100Hz) has been reported in AD patients compared to healthy age-matched control subjects [2, 3].

There are various genes in our body which is responsible for colour of the eyes and growth of the hair, similarly the genes which is responsible for the late onset Alzheimer's disease is Apo lipoprotein E (APOE). There are three different forms of APOE which include

- APOE e2- this gene is not common and this reduces the risk of AD
- APOE e4- this is more common gene which increases the risk of AD
- APOE e4- this gene is commonly found which does not affect the risk of AD

And more over APOE gene is not only the responsible for AD. There are some other factors which include genetic as well as environmental factors which play a major role in the development of Alzheimer's disease [6].

In this paper we bring about the use of wireless technology which is helpful in examining the elderly people. The early and prior detection of diseases could prevent people from going into trauma condition. This provides a better health for the remote monitoring of the patient. This enables the doctor to monitor the patient continuously. In this method we discuss about the use of reduced interference through the mode of wireless technology and low power consumption for the transmission process of the data.

II. DEVELOPMENT OF THE PROPOSED SYSTEM

The proposed system which include the front end circuit which include analog design as well as digital and back end circuit which is completely digital. The front end which include the surface electrode, instrumentation amplifier, high pass filter, low pass filter, Gain amplifier along with a level shifter and Transmitting module. In the back end circuit which consist of a receiving module and the internet server through which we could contact the medical practitioner and patient relatives. The proposed systems which enable the alert to the doctor through sms also have been provided with the details of the patient location.

A. Front End:

The Acquisition and processing of the bio signal provide a challenging task for the measurements. The presence of electrical noise and 50Hz noise at low level frequencies could be corrupted by impedance imbalance at skin electrode interface and physiological artifacts. The design of the preamplifier in the case of EEG is a challenging task. The Agcl conductive paste or spectra gel is applied on the region where the scalp surface electrode has to be placed which provide the better conduction of the electrode. The EEG signal generated by the cerebral cortex is acquired by the two electrodes and passes through the protection circuit which protects both patient and circuitry. The Driven Right Leg (DRL) has been used for the reduction of common mode noise, 50Hz interference which is unavoidably coupled into the patient as well as the electrodes. The Driven Right Leg has a function which is similar to that of the DC restorator and it act as a feedback circuit in sending the inverse of the common mode voltage back to the patient and which tends to reduce the common-mode noise present at the active electrodes [6].

The signal which is acquired through left and right EEG electrode is given to the instrumentation amplifier AD620 which offers low power, low offset voltage, high input impedance and provide with a high common mode rejection ratio (CMRR). Then it is passed through the high pass which has a cutoff frequency of 0.25Hz and then to the low pass filter which has a cutoff frequency of 95Hz which is used to remove the DC artifacts and noise. After the filtering and removing of DC artifacts and noise then it is passed through the amplifier stage AD 524 to get the original strength of the acquired and processed EEG signal. The acquired EEG signal is transmitted through transmitting module. The front end design is shown in fig. 2

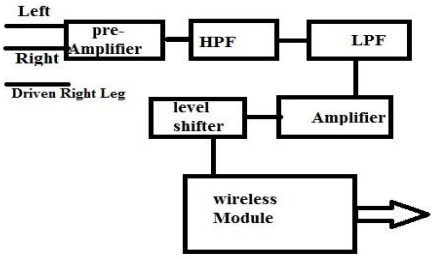

Fig. 2 Front End with transmitting module

III. BACK END

The back end consists of a receiving module. The prototype uses eZ430-RF2500 development tool which contains both MSP430 controller and CC2500 wireless module [5]. The controller consumes few micro amps for the operation and added to that the processing of the instruction is very fast and which include a10-bit Analog to Digital converter (ADC) with maximum sampling rate of 200 kilo samples per second. The wireless module CC2500 is the good suitable low data process protocol which has been used in the low power applications and it also uses 2.4 GHz Industrial, Scientific and Medical (ISM) frequency for transmission purpose [7]. The back end circuit is shown in figure 3

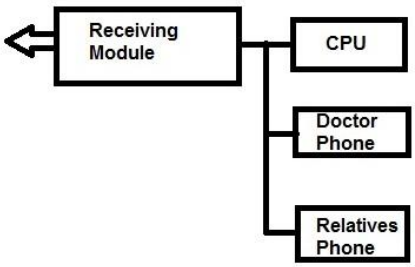

Fig. 3 Back End with Receiving Module

IV. RESULTS AND DISCUSSION:

The proposed method is designed on the printed circuit board with proper grounding at the input leads. The circuit has been simulated before going for the test. The Ag electrode from the EEG amplifier is connected to left and right frontal lobe and reference is given to the right ear of the subject. The obtained signal is transferred and made to display in oscilloscope. Our proposed systems provide the amplification of the signal and transmitted using the module and so that medical practioner could get the proper intimation regarding with the patient during the onset detection of AD. The subject and receiver has been kept apart a distance of 80m for the testing of the proposed system. The work which we have carried with a.single channel could be transferred to the multichannelacquisition system and provide a better and improved quality life of the patient.

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