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Diagnosis of Alzheimer's Disease Using EEG

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Abstract: *A progressive neurologic disorder which causes the brain to contract and brain cells to die is known as Alzheimer's disease. An issue related to this is always there that is to recognise it at its earliest stages. It can be acknowledged once the patient suffers from Mild Cognitive Impairment (MCI) and at that stage it cannot be cured as treatment of AD is not available right now that can alter its effect, they can only hinder its advancement. The base of this research paper are journal articles published on brain signals and diagnosis based on image processing of AD that are published in recent years. The field of magneto encephalogram (MEG) signal processing and electroencephalogram (EEG) are reviewed. The following methods are examined for image analysis: magnetic resonance imaging (MRI), functional MRI, structural MRI and diffusion tensor MRI. Detection and Diagnosis of AD during the early onset of a disease using computer and AI based technologies will influence the future of the treatment of this disease to a greater extent. These technological advancements will serve the doctors by aiding in the process of early diagnosis. In the medical world the earlier we make a diagnosis the better it is for the patient. These will help in creating a well thought and timed treatment of the disease. Hence, reducing its effects and progression.*

Keywords: EEG (Electroencephalogram), AD (Alzheimer's disease), Multiscale entropy (MSE)

I. INTRODUCTION

This disease, the most familiar form of dementia, a continuous reduction in thinking power and interpersonal skills that affects a person's capability to function by itself.

One of the most expensive disease and the sixth prime cause of the end of patient's life.

It influences over 15% of people down the ages of 65, about 50% of people over the age of 80, it is evaluated that the incidence of the disease will triple in the following 55 years. There is no 10 years check out rate of AD

Investigated cure for this disease, it can be delayed with medication. They are divided into four different categories: Medium Cognitive Disorders (MCI), Mild AD, Central AD and severe AD. The initial stage is known as Mild Cognitive Impairment (MCI), complimented by a variety of symptoms such as - frequent memory loss. Further stages of this disease (mild and moderate AD) are distinguished by an expand in dementia.

Early diagnosis uplift the risk of handling the disease at a lower level, (starting to grow or develop) before it becomes severe for the patient. Over the generations, many research teams have begun to investigate the capability for electroencephalograms (EEGs) to detect this disease.

As we know EEG recording systems are cheap and (possibly) motile, EEG can be used as a device to assess a huge amount of people with AD risk that bares permanently in the brain cells.

The medical identification of this disease is tough, and indications are often exacerbated as a common side effect of aging.

Identification is usually made by merging an extensive variety of tests with the expulsion of other causes.

Intelligence question tests such as the Mini Mental State Examinations (MMSE), blood tests, spinal fluid, neurological tests, and augmentation, thinking patterns are the customary identification of this disease. Several modern works look into how to upgrade EEG reactivity to disclose AD.

Prior to EEG signals analysis, they are required to be properly filtered and unwanted information should be removed.

Finding disturbances in EEG symptoms produced by Alzheimer's disease; we will medicate three crucial outcomes in the EEG individually: deceleration of EEG, magnified difficulty of the EEG waves and disturbance in EEG coordination.

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We explore the pros and cons of these computational methods, and address the rest of challenges and open- ended problems.

II. PROBLEM WITH CURRENT EXISTING PROCESS OF DETECTING AD

Presently available testing is restricted, for a patient to receive an identification while seeking for medical attention. Conduct brain scan tests that involves heavy radioactive radiations such as computed tomography (CT), magnetic resonance imaging (MRI), or positron emission tomography (PET), to revoke other possible origin for symptoms. For an AD patient, it is very painful to undergo such heavy radioactive radiation test.

III. APPROACH TO OUR RESEARCH

The aim of our research is to develop a 3D printed headset which have small metal discs (electrodes) attached to head scalp.

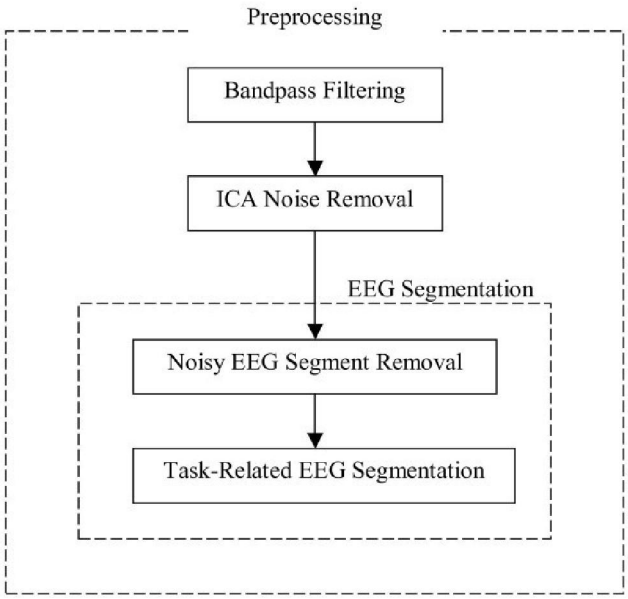
Human brain cells communicate via electrical impulses and are active all the time, even when you're asleep. This activity shows up as wavy lines on an EEG recording. The system's main function is to generate accurate status of the waves which will further help in detecting the disease. Experimental results demonstrate that the system can produce effective results.

IV. SYSTEM WE HAVE RESEARCH ON

A. **Hardware:**
1. Arduino Uno R3
2. SainSmart Colour TFT Display
3. Mini Breadboard
4. Headset printed with help of 3-D technology
5. 9v batteries + (9v to Arduino power adapter cable, for portability)
6. Jumper Wires
7. Sensors
8. Scrap wire / cable from your Junk Box about 12" long

B. **Software:**
1. Arduino IDLE
   Optional: Processing Brain Visualizer.
2. optional (required for the visualizer): controlP5 Processing GUI Libr

V. METHODOLOGY



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At first, we explain needs of pre-processing, and then explain modern techniques in EEG pre-processing. At the end, we take a brief look at the previous EEG analysis in the contexture of the AD diagnosis.

Need for pre-processing

EEG recording usually contains not only electrical impulses from the human brain, but also many undesirable waves.
Disruption from electronic tools, like 55 or 60Hz electrical signals,
Electromyography (EMG) signals produced by muscle function, ocular apparatus, due to eye movement or blinking.
Such undesirable factors may contribute to EEG analysis, and may results to erroneous conclusions. As a result, artifact resistance is a major problem in medical field and analysis of EEG. It is generally believed that EMG activity is restricted to high frequencies (above 20 or 40Hz); therefore, one usually uses a low-level filter in the EEG, for the purpose of removing EMG and other things.

Pre-processing Methods

Here we describe a variety of pre-processing methods to filter out undesirable signals from the EEG.

Filtering

The false 55 or 60Hz electric waves/ signals are usually removed with the help of a band filter, that transmits many unchanged frequencies, but reduces those at a certain level (e.g., 55 or 60Hz) to very low levels. However, other things such as EMG signals and ocular components often affect a large frequency band and their range may vary over time.
As a consequence, these filters often fail to eliminate such waves. One is usually interested in bands of specific frequency in the EEG, like 4-8Hz (theta), 8- 10Hz (alpha 1), 10-12Hz (alpha 2), 12- 30Hz (beta), and 30-100Hz (gamma). Those (frequencies) waves are usually filtered out with the use of a bandpass filter, that allows only those waves which lies in certain range and filtered out those which lies outside that range.

Artifact Reduction

To suppress the waves, subject need to reduce eye movements or blink and remain calm. Nevertheless, this method is difficult: in medical studies, subject may have feel difficulty following those instructions. In addition, reducing blinking or eye movements can disfigure brain function, as it needs focus from the subject.

Artifact Obliteration

Instead, a person often rejects corrupt periods/trials, obtained by visual inspection this method leads to data loss, and therefore, may not work.
In addition, visual inspections are qualitative and time taking
To get rid of those issues, sometimes an objective criterion is used; in particular, one tends to acquire artifacts using the limit: signals above a certain limit are considered false.
Instead of discarding the epoches that are ruined by artifacts, one can try to eliminate them.
We have proposed various approaches to reduce artifacts:

- Separation of the blind source
- Flexible filters, especially Kalman filters.
- Regression

Epilogue

Sometimes EEG recordings contain undesirable signals that may change EEG analysis/results, and may cause incorrect results, therefore it is required to filter out or stop undesired signals before EEG analyzing.
We have discussed various ways to remove artifacts:

- A person may attempt to coerce artifacts by guiding subjects;
- Otherwise, one may reject the tests.

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- One can attempt to filter out objects/artificates with modern signal processing procedures such as blind source separation (BSS) and flexible filtering.

Artifact filtering methods appear to promote differentiation between AD subjects/ patients and control subjects, with varying stages/levels of the disease/ailment.

We conclude a prime result/ observation: EEG specialists do not always agree on what EEG signal products are offered; like, in a recent study of EEG, EEG specialists agreed on only 75% cases. So, deleting all actions on EEG signals is almost impossible.

The outcomes of EEG analysis can be discriminatory if one (subject) number has significantly higher outcomes than another (subject).

VI. EEG ANALYSIS

The EEG signal indicates brain electrical activity. They are highly organized and may contain practical details and statistics regarding the condition of the brain. However, it is very difficult to get useful information from these signals directly in the time zone just by looking at them.

Compatibility

A research of intrahemispheric, interhemispheric, and distal brain interactions in patients suffering from Alzheimer's disease was performed. They reported a pattern of degeneration of the AD joint, indicating a decrease in cortical connectivity outside certain groups where the increase in conjunctiva could not be caused by the charge.

VII. ENTROPY METHODS

As we know the brain is a non-linear flexible structure the use of entropic methods to study brain functions is suggested. Various entropy methods are used for EEG and MEG data analysis such as:

1. Entropy rate (ApEn)
2. Sample entropy (SampEn)
3. Multiscale entropy (MSE)

When the downgrade values correspond to normal (less common) activity.

Specifically, this falls into a category known as embedding elements that are used to evaluate the complication and inconsistency of time series data. These entropic technique do not require large data sets.

VIII. ENTROPY RATE

ApEn differentiate between the EEGs of AD patients and HCs (non AD population) we use ApEn, the basis of this technology is the data obtained from a series of electrodes following the global 10-20 system.

The steps followed are:-

1. A minimal 5 minute resting time is required before carrying out any tests.
2. The eyes of the patient must be covered so as to reduce all the disturbances of the brain waves caused by the things we see and then think about. This will ensure the higher accuracy even in a small sample size of 10 AD patients and 8 HCs.

It was concluded from the results that HCs had higher levels of ApEn as compared to an AD patient, more specifically P3 & P4. The synopsis of the result of the experiment can thus be reciprocated as - An electrical activity is less severe and more norm in AD patients than in the HCs. The area of the brain with most obvious difference is the Parietal lobe.

Sample Entropy. (2006)

Use of SampEn to differ among AD patients (11) and HCs (11). It was concluded that Samp En is much for simple, fast and reliable than ApEn. The electrodes in the occipital and parietal region, namely O1, O2, P3, and P4 were taken into account and the accuracy was reported 77.27% on all four of them.

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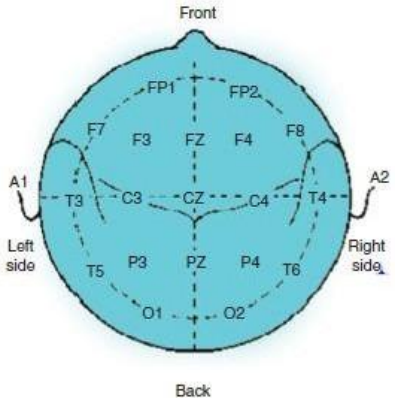

Figure 1 Locations of the EEG electrodes in the international 10–20 system. Used with expressed permission of Brain Master Technologies, Inc.

Multiscale entropy:

To distinguish between HCs and AD patient's EEG, multiscale entropy (MSE) was pre-owned. It is known that the values obtained in an MSE of EEG signals from HCs were higher on the scale than the ones obtained from AD patients, at shorter scale times in the MSE algorithm, while the values were lower than the AD patients at larger time intervals. Based on these values, a discriminatory linear analysis (LDA) was used by us to gain better results by putting into comparison the estimated value of MSE under a specific time frame for each topic.

IX. CONCLUSION

Prognosis of AD is a very problematic clinical step that troubles the medical workers. Due to the fact that EEG is a non-invasive brain imaging technology, easy, inexpensive, and doubtlessly high-speed it appears to be a natural desire as an AD diagnostic mechanism.

Several research strongly confirm the exquisite capacity of EEG to detect AD; similarly, a few research display promising outcome for MCI ("predementia"), the pre-AD level. But, a number of crucial troubles will need to be addressed earlier than EEG can enter into AD treatment practices.

This discipline of studies nonetheless offers many possibilities for stimulating and applicable clinical research. We believe that this evaluation can assist discover essential studies topics, which can also enhance through the years.

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