INTELLIGENCE OF BIOLOGICAL SYSTEMS – 1 [19BIO103]

S1 B. TECH CSE (AIE)

A Project Report

Submitted by
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ABBREIATIONS

- APP - Amyloid Precursor Protein
- PET- Positron Emission Tomography
- AD - Alzheimer's Disease
- AI - Artificial intelligence
- ML - Machine Learning
- MRS - Magnetic Resonance Spectroscopy
- MRI - Magnetic Resonance Imaging
- DTI - Diffusion tensor imaging
- FT - Fiber tractography
- DWI - Diffusion weighted imaging
- CNS - Central Nervous System
- MMSE - mini-mental score examination
- SVM - Support vector machine
- ROI - Regions Of Interest

INTRODUCTION

Alzheimer's disease is a progressive neurologic disorder that causes the brain to shrink (atrophy) and brain cells to die. Alzheimer's disease is the most common cause of dementia — a continuous decline in thinking, behavioural and social skills that affects a person's ability to function independently.

Approximately 5.8 million people in the United States age 65 and older live with Alzheimer's disease. Of those, 80% are 75 years old and older. Out of the approximately 50 million people worldwide with dementia, between 60% and 70% are estimated to have Alzheimer's disease.

The early signs of the disease include forgetting recent events or conversations. As the disease progresses, a person with Alzheimer's disease will develop severe memory impairment and lose the ability to carry out everyday tasks.

Medications may temporarily improve or slow progression of symptoms. These treatments can sometimes help people with Alzheimer's disease maximize function and maintain independence for a time. Different programs and services can help support people with Alzheimer's disease and their caregivers.

There is no treatment that cures Alzheimer's disease or alters the disease process in the brain. In advanced stages of the disease, complications from severe loss of brain function — such as dehydration, malnutrition or infection — result in death

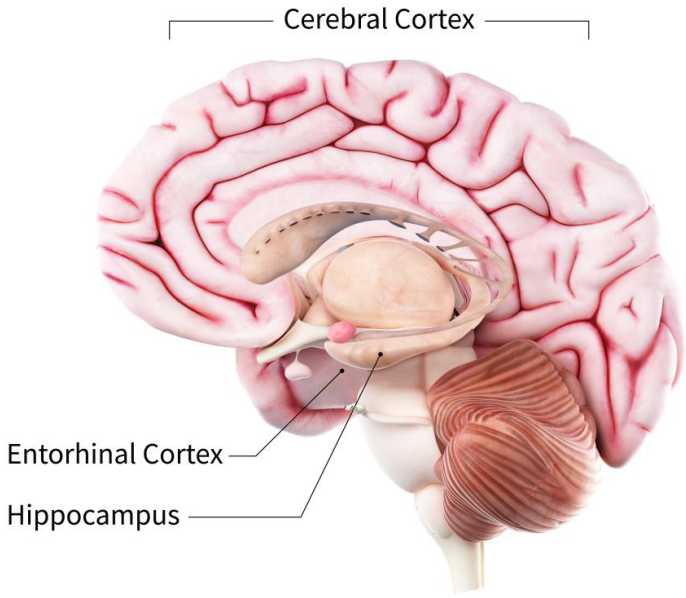
CAUSES OF ALZHEIMER'S DISEASE

The exact causes of Alzheimer's disease aren't fully understood. But at a basic level, brain proteins fail to function normally, which disrupts the work of brain cells (neurons) and triggers a series of toxic events. Neurons are damaged, lose connections to each other and eventually die.

Scientists believe that for most people, Alzheimer's disease is caused by a combination of genetic, lifestyle and environmental factors that affect the brain over time.

- At a basic level, brain proteins fail to function normally, which disrupts the work of brain cells (neurons) and triggers a series of toxic events.
- Neurons are damaged, lose connections to each other and eventually die.
- The damage most often starts in the region of the brain that controls memory, but the process begins years before the first symptoms.
- The loss of neurons spread in a somewhat predictable pattern to other regions of the brains. By the late stage of the disease, the brain has shrunk significantly.
- Scientists believed that Alzheimer's is caused by a combination of genetic, lifestyle and environmental factors that affect the brain over time.

PARTS AFFECTED



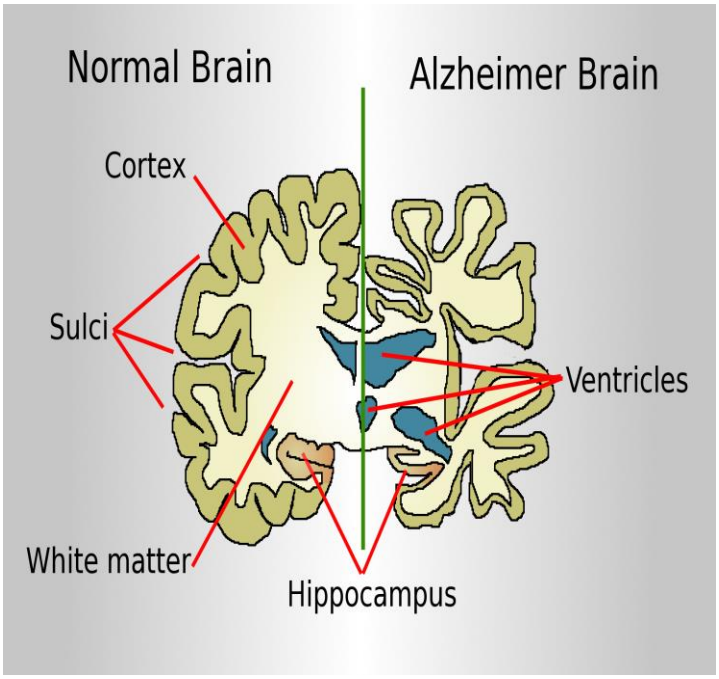
Which part of the brain does the **Alzheimer's** affects?

At first, Alzheimer's disease typically destroys neurons and their connections in parts of the brain involved in memory, including the Entorhinal cortex and hippocampus. It later affects areas in the cerebral cortex responsible for language, reasoning, and social behaviour. Eventually, many other areas of the brain are damaged. Over time, a person with Alzheimer's gradually loses his or her ability to live and function independently. Ultimately, the disease is fatal.

Symptoms

- Memory loss is the key symptom of Alzheimer's disease.
- Early signs include difficulty remembering recent events or conversations.
- As the disease progresses, memory impairments worsen and other symptoms develop.
- At first, a person with Alzheimer's disease may be aware of having difficulty remembering things and organizing thoughts.
- A family member or friend may be more likely to notice how the symptoms worsen.

EFFECTS OF ALZHEIMER'S DISEASE IN BRAIN



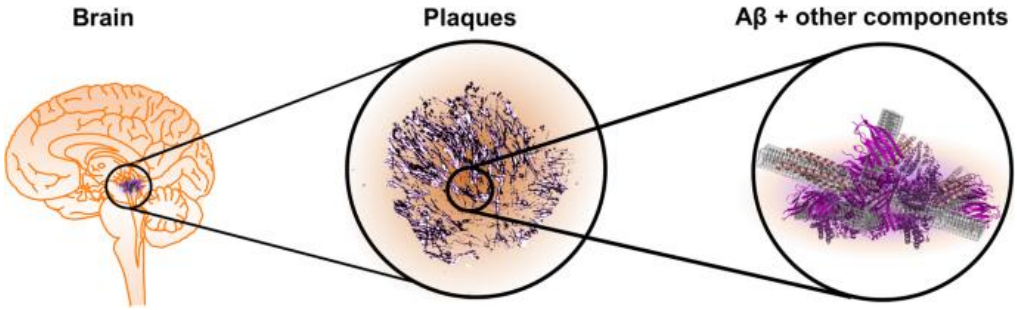
- In many cases, changes in the blood vessels of the brain and in blood flow to the brain may increase the risk of dementia. People with blood vessel blockages in the brain are more likely to develop dementia.

- Changes in blood to the brain can further damage the brain, making it even more likely that the brain will struggle to clear toxins, which can lead to harmful effects. This means that Alzheimer's may cause vascular changes in the brain.

- Typical brains metabolize (process) a chemical called amyloid precursor protein (APP).

- In Alzheimer's, APP turns into a protein called beta-amyloid, which the brain does not clear away.
- Instead, the proteins form clumps and tangles that stick between and damage the neurons.
- The clumps of beta-amyloid protein can also destroy connections between the neurons, causing them to die.

ALZHEIMER’S DISEASE-CAUSING PROTEINS



Researchers trying to understand the cause of Alzheimer's disease are focused on the role of two proteins:

- **Plaques.** Beta-amyloid is a fragment of a larger protein. When these fragments cluster together, they appear to have a toxic effect on neurons and to disrupt cell-to-cell communication. These clusters form larger deposits called amyloid plaques, which also include other cellular debris.

- **Tangles.** Tau proteins play a part in a neuron's internal support and transport system to carry nutrients and other essential materials. In Alzheimer's disease, tau proteins change shape and organize themselves into structures called neurofibrillary tangles. The tangles disrupt the transport system and are toxic to cells.

Prevention

Alzheimer's disease is not a preventable condition. However, a number of lifestyle risk factors for Alzheimer's can be modified

- Exercising regularly
- Eating a diet of fresh produce, healthy oils and foods low in saturated fat such as a Mediterranean diet
- Following treatment guidelines to manage high blood pressure, diabetes and high cholesterol
- Asking your doctor for help to quit smoking if you smoke

INVOLVEMENT OF AI IN EARLY DETECTION OF ALZHEIMER'S DISEASE

- The problem is that there is no medicine to stop or slow the growth of illness so it is mandatory to scout the ALZHEIMER'S DISEASE before it spread to many.
- So, there is the light of hope for AI in ALZHEIMER'S DISEASE detection. There are many studies goings onto detect the ALZHEIMER'S DISEASE using ML and AI. Let us focus some more about this section.

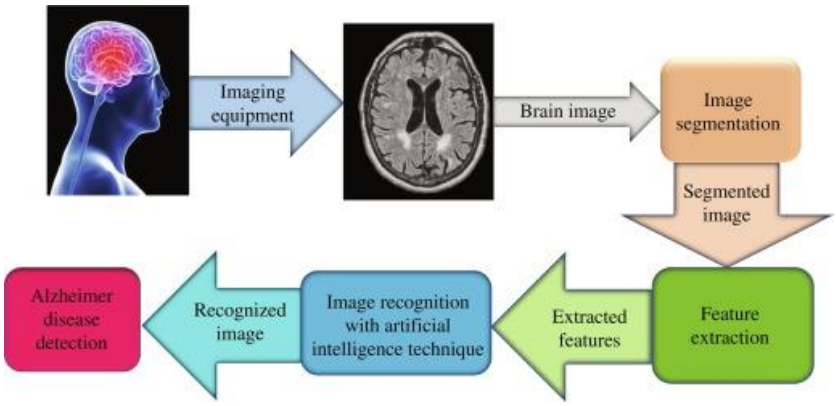


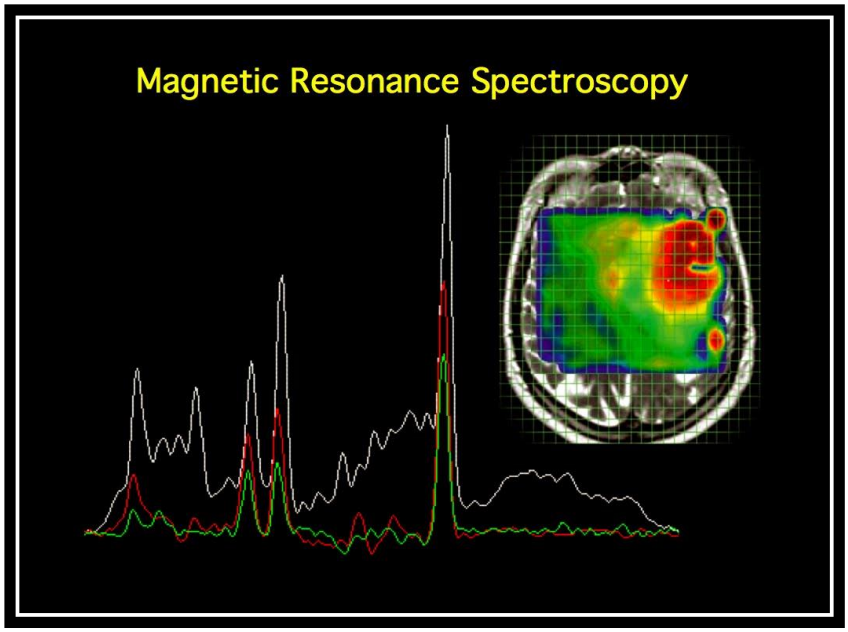
Fig: Artificial Intelligence in Detecting Alzheimer's Disease

There are some ways to detect the ALZHEIMER'S DISEASE in beginning stage itself.

1. **Positron emission tomography**

- ❖ Positron emission tomography (PET scans) were explored as a technique for helping identify the illness of Alzheimer's before symptoms were acute.
- ❖ It measures the levels of particular chemicals, such as glucose in the brain. The main source of energy for brain cells is glucose.
- ❖ therefore the more productive the cells are the more glucose they consume. As brain cells get sick and die, they utilize less and less glucose until they ultimately stop using it altogether.
- ❖ In this field, They have used machine learning to get more accuracy in the disease detection.
- ❖ Today, Radiologists have been using these scans to attempt to identify Alzheimer's disease by searching for decreased glucose levels throughout the brain, particularly in the frontal and parietal lobes of the brain

2.Magnetic resonance spectroscopy (MRS)



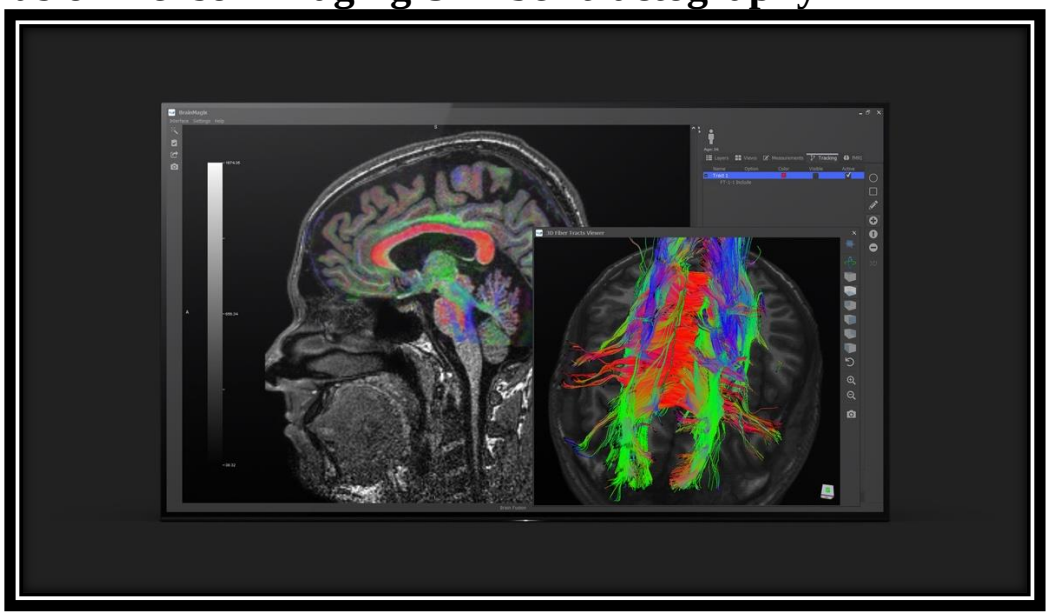
A team led by National Brain Research Centre and Neuroimaging and Neurospectroscopy laboratory is jointly working to develop a model that can map metabolic patterns in various sections of the brain.

To develop the model, scientists are keeping track of all kinds of symptoms such as anatomical atrophy (degeneration of cells), Magnetic Resonance Spectroscopy (MRS) And neuropsychological measures to get sensitive specific characteristics of the disease.

- MRS can be conducted at high magnetic field strengths (typically 11–14 T) on body fluids, cell extracts and tissue samples, with new developments in whole-body magnetic resonance imaging (MRI) allowing clinical MRS at the end of a standard MRI examination, obtaining functional information in addition to anatomical information.

- It has been made legal for research in India.

3. Diffusion Tensor Imaging & Fiber tractography



- **Diffusion tensor imaging (DTI)** is an MRI technique that uses anisotropic diffusion to estimate the axonal (white matter) organization of the brain.
- **Fiber tractography (FT)** is a 3D reconstruction technique to assess neural tracts using data collected by diffusion tensor imaging.
- Diffusion weighted imaging (DWI) is based on the measurement of thermal Brownian motion of water molecules. Within cerebral white matter, water molecules tend to diffuse more freely along the direction of axonal fascicles rather than across them. Such directional dependence of diffusivity is termed anisotropy This direction of maximum diffusivity along the white-matter fibers is projected in the final image.

Clinical applications of DTI & FT

- DTI is synonymous with MRI of the CNS. However, its use for the assessment of highly-organized body systems outside the CNS, where anisotropy can facilitate early detection of pathology, has been gaining favour in recent years.
- The clinical applications include :

1. assessment of the deformation of white matter by tumours - deviation, infiltration, destruction of white matter.

2. delineation of the anatomy of immature brains
3. presurgical planning
4. Alzheimer's disease - detection of early disease
5. early identification of musculoskeletal and peripheral nerve pathology

Support vector machine-based classification of Alzheimer's disease from whole-brain anatomical MRI

- **Purpose**: To present and evaluate a new automated method based on support vector machine (SVM) classification of whole-brain anatomical magnetic resonance imaging to discriminate between patients with Alzheimer's disease (AD) and elderly control subjects.
- **Materials and methods: A s**tudied 16 patients with AD [mean age +/- standard deviation (SD) = 74.1 +/- 5.2 years, mini-mental score examination (MMSE) = 23.1 +/- 2.9] and 22 elderly controls (72.3 +/- 5.0 years, MMSE = 28.5 +/- 1.3). Three-dimensional T1-weighted MR images of each subject were automatically parcellated into regions of interest (ROIs). Based upon the characteristics of Gray matter extracted from each ROI, we used an SVM algorithm to classify the subjects and statistical procedures based on bootstrap resampling to ensure the robustness of the results.
- **Results: I**t has obtained 94.5% mean correct classification for AD and control subjects.
- **Conclusions: T**his method has the potential in distinguishing patients with AD from elderly controls and therefore may help in the early diagnosis of AD.

RESEARCH GAP

- Nanotechnology is expected to have a role in the treatment of Alzheimer's disease and dementia in the future, either to "repair" neurological damage or to facilitate medication administration.
- Although many hurdles still have to be solved, working on nanoparticles and implantable therapies to localize chemotherapy for brain tumours offers up enormous opportunities for novel treatments for individuals with dementia or preferably before dementia begins.
- All of these factors may help to speed up the development of preventative treatments for dementia in future.

This study investigated how artificial intelligence (AI) can be used by caregivers in the care of people suffering from Alzheimer's disease and related dementias. AI is a tool for dealing with many of the perceived difficulties connected with Alzheimer's disease and dementia using contemporary research and business technologies. First of all, technology may be utilized to Address lifestyle variables linked to the risk of dementia development. technology may offer cues and alerts to assist cognitive, social, and exhibit strong as well as everyday tasks. Technology may also make its direct and indirect contribution to the provision of care, lowering family expectations If people are diagnosed with dementia, are equipped with technology (– for example, applications, sensors, smart home systems), we may track their development from the moment of diagnosis, detect developing issues, provide intervention and prevent needless emergency hospitalization and formal positively contribute significantly to the economic expenses of dementia.

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