

Study of Alzheimer Disease Prediction Using Various Classifiers

¹B. Hemalatha, ²Dr. M. Renukadevi.

¹Research Scholar, Department of Computer Science, Sri Krishna College of Arts and Science, Coimbatore.
bharathihema17@gmail.com.

²Associate Professor, Department of Application, Sri Krishna College of Arts and Science, Coimbatore.
renuga.srk@gmail.com.

Abstract - Alzheimer's disease (AD) is a chronic, lifelong neurological condition that causes memory and thought ability loss. The disorder has no known cure and is almost always fatal. The disease's progression takes a specific path for each person, making prediction extremely difficult. Much of the time, the signs are misdiagnosed as conditions associated with old age. Early Alzheimer's disease diagnosis is critical because it allows dementia patients and their families to better plan for the disease's progression. It also allows patients to take advantage of available medications that can alleviate some of the side effects of dementia and improve their quality of life by making the disease easier to handle. There are several Neuroimaging instruments and examinations available to examine the brain. Magnetic resonance imaging (MRI), functional magnetic resonance imaging (fMRI), and positron emission tomography (PET) scans are some of the most commonly used brain imaging instruments. Using Neuroimaging info, machine learning methods assisted computer scientists in classifying and distinguishing various stages of Alzheimer's disease. However, distinguishing between Alzheimer's phases is difficult. The majority of previous works categorized Neuroimaging data into binary or three groups. For classification, various machine learning approaches have been used, including traditional methods such as the general linear model (GLM) and multi-voxel methods such as support vector machines (SVMs).

Keywords: - Alzheimer's disease (AD), Classification, Machine Learning (ML), positron emission tomography (PET), magnetic resonance imaging (MRI) and Neural Network (NN).

1. INTRODUCTION

Alzheimer's disease (AHLZ-high-merz) is a brain disorder that causes memory, vision, and behavior problems. It does not occur naturally as part of the aging process. Alzheimer's disease (AD) is the leading cause of dementia and a neurodegenerative disease. Mild Cognitive Impairment (MCI) is an early stage of Alzheimer's disease (AD) in which patients show cognitive impairments that are not anticipated for their age and education but do not require significant intervention in their daily activities. AD is an irreversible, progressive brain disorder that gradually deteriorates memory and cognitive skills, as well as the ability to perform even the most basic tasks. It is the leading cause of dementia in older people. While dementia becomes more prevalent as people age, it is not a natural part of the aging process. [1].

AD worsens over time. Though symptoms can vary greatly, many people suffer from forgetfulness severe enough to interfere with their ability to function at home, at work, or to pursue hobbies. The disease may cause an individual to become confused, become disoriented, become disoriented in familiar locations, misplace objects, or have trouble communicating. [2].

AD is the sixth leading motive of demise inside the United States, in keeping with the Alzheimer's Foundation [3]. People aged sixty five and up are much more likely to expand AD [4]. This seems to be the case in Morocco as properly, emphasizing the need for a programmatic technique in Moroccan fitness institutes to help within the early detection of AD. The disorder diagnosis process may be viewed as a choice-making system in which a medical practitioner makes a diagnosis based totally on medical data in a new case. To make this decision-making procedure fee-effective, brief, speedy, accurate, and usable, medical facts processing must be automatic.

Images are the most widely used clinical proof for Alzheimer's disorder diagnosis, due to the enormous growth of biomedical picture processing as a big research field gaining know-how from more than a few disciplines together with carried out mathematics and laptop sciences. Images include magnetic resonance imaging (MRI), Positron-emission tomography (PET), and X-rays. For the functions of our studies, we use MRI pics. As a end result of the rapid development of high-tech techniques and the usage of multiple imaging modalities, new problems stand up. The essential challenge is to procedure and interprets MRI images in order that notable data for Alzheimer's ailment analysis may be produced. [10].

The rest of the paper will be structured as follows. In section 2, discuss the different stages of AD and importance of early diagnosis of AD. The various image modalities used for prediction AD prescribed in section 3. In section 4, describe the various classification methods to classify the AD. The methodologies are finally outlined in section 5.

2. STAGES OF ALZHEIMER'S DISEASE

The signs of AD accentuate over the years, even though the rate at which the disorder progresses varies. On common, someone with AD lives four to eight years after prognosis, despite the fact that this could variety from 4 to twenty years depending on other elements. Alzheimer's-related mind changes begin years before the ailment's symptoms seem. This degree, which could close for years, is known as preclinical Alzheimer's disease. [11, 12].

Every person with Alzheimer's disorder has a specific experience with the sickness, however most people of humans observe a comparable course from starting to give up. The specific variety of Alzheimer's levels is alternatively arbitrary. Some clinicians employ a simple 3-section model (early, moderate, and give up), whilst others have found that a granular breakdown is a extra useful resource in information the contamination's progression.

Reisberg, B., et al, 1985 established the most commonly used method for categorizing Alzheimer's disease into seven stages. This mechanism for understanding disease development has been adopted and used by a number of healthcare providers, including the Alzheimer's Association. Here is a breakdown of the seven stages of Alzheimer's disease based on Dr. Resiberg's system:

➤ Stage 1: No Impairment

AD is not detectable at this time, and no memory issues or other dementia signs are visible.

➤ **Stage 2: Very Mild Decline**

Minor memory troubles or misplacing objects across the house may be detected by using the elder, but no longer to the quantity that the memory loss can be without problems outstanding from everyday age-associated memory loss. The man or woman will maintain to perform nicely on memory exams, and the ailment is unlikely to be detected by using own family members or docs.

➤ **Stage 3: Mild Decline**

At this stage, circle of relative's participants and pals of the senior can note cognitive troubles. Memory take a look at performance is affected, and docs can be capable of spot dwindled cognitive ability.

People in stage 3 can struggle in a variety of places, including:

- ✓ Finding the correct word during conversations.
- ✓ Organizing and scheduling.
- ✓ Recalling names of new acquaintances.

People with stage three Alzheimer's disease can often misplace personal belongings, including valuables.

➤ **Stage 4: Moderate Decline**

In stage four of Alzheimer's, the disease's signs are obvious. People in the fourth stage of Alzheimer's disease:

- ✓ Have complexity with easy arithmetic.
- ✓ Have reduced short-term memory (may not recall what they ate for breakfast, for example)
- ✓ lack of ability to manage finance and pay bills
- ✓ May forget particulars about their life histories

➤ **Stage 5: Moderately Severe Decline**

During the fifth stage of Alzheimer's disease, people tend to need assistance in certain daily activities. People in the fifth stage of the disease can suffer from:

- ✓ complexity dressing properly
- ✓ lack of ability to recall easy details about themselves such as their own phone number
- ✓ major confusion

People in stage 5 on the other hand, maintain their functionality. They will normally bathe and use the toilet on their own as well. They often recall family members and some information about their personal backgrounds, especially their childhood and adolescence.

➤ **Stage 6: Severe Decline**

People in the sixth stage of Alzheimer's disease need continuous monitoring and are often in need of clinical treatment. Among the symptoms are:

- ✓ Confusion or lack of knowledge of situation and surroundings
- ✓ lack of ability to distinguish faces except for the neighbouring friends and relatives
- ✓ lack of ability to remember most information of personal history
- ✓ Loss of bladder and bowel control
- ✓ Most important personality changes and potential behavior problems

- ✓ The require for assistance with activities of daily living such as toileting and bathing
- ✓ Wandering

➤ **Stages 7: Very Severe Decline**

AD progresses to the final level at level seven. People in stage seven are on the verge of loss of life due to the fact the circumstance is terminal. People in degree seven of the disease lose their capability to communicate and adapt to their environment. Although they'll nevertheless be able to utter phrases and terms, they have got little information of their condition and want help with all normal sports. People with AD can lose their potential to swallow within the final tiers of the disease.

3. IMAGE MODALITIES OF ALZHEIMER'S DISEASE

The most common type of dementia is AD, which includes the mild cognitive impairment (MCI) phase, which may or may not progress into AD. It is important to correctly classify patients during the MCI stage because this is when AD can or may not grow. As a result, forecasting outcomes is critical during this process. So far, several researchers have concentrated on using a single modality of a biomarker to diagnose AD or MCI. Although recent research indicates that combining one or more biomarkers can provide complementary information for diagnosis, it also improves classification accuracy when distinguishing between different classes [14, 18].

The current Alzheimer's disease diagnosis is based on three psychiatric, neuropsychological, and Neuroimaging tests.

1. Magnetic Resonance Imaging (MRI).
2. Positron Emission Tomography (PET).
3. Computed Tomography (CT).

These imaging modalities revealed characteristic changes in the brains of Alzheimer's disease patients in prodromal and even presymptomatic states.

3.1. Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging (MRI) uses a strong magnetic subject, radio frequency waves, and a display to provide accurate pix of organs, smooth tissues, bone, and actually all other inner frame systems. MRI can diagnose brain abnormalities associated with moderate cognitive impairment (MCI) and predict which MCI patients will broaden Alzheimer's disease in the destiny [15]. In the early stages of Alzheimer's disease, an MRI experiment of the brain is normal. In later stages, MRI will display a lower within the length of various regions of the brain.

Limitations: - Since MRI is very sensitive to head motion, it is possible that it will continue to be troublesome in examining patients with more serious cognitive impairment.

3.2. Positron Emission Tomography (PET)

PET scans are used to decide the concentration of particular molecules inside the mind. PET scans are labeled into many organizations. An amyloid-PET test detects the BuildUp of bizarre amyloid protein inside the mind, which is one of the number one signs of Alzheimer's disorder. PET lets in for the monitoring of different mind features in residing human beings. [16].

Limitations: - PET is relatively costly and, like all PET techniques, is in short supply. It necessitates intravenous access and includes radioactivity exposure, albeit at levels well below significant known danger.

3.3. Computed Tomography (CT)

A CT scan of the brain may be completed to assess the mind for tumours and other abnormalities, fractures, intracranial bleeding, structural defects (e.g., hydrocephalus, illnesses, mind pastime, or different situations), in particular if other styles of assessment (e.g., X-rays or a physical exam) are inconclusive [17].

Limitations: - A CT scan cannot provide accurate details about the brain's structure. Even if a brain scan does not reveal any visible changes, this does not rule out dementia.

4. CLASSIFICATION TECHNIQUES FOR PREDICTION OF AD

AD is categorized as either early-onset or late-onset. The early-onset form's signs and symptoms occur between the thirties and the mid-sixties, while the late-onset form occurs during or after the mid-sixties.

In this study, six different machine learning and data mining algorithms, including K-nearest neighbors (K-NN), decision tree (DT), Naive Bayes (NB), and deep learning, are applied to the ADNI dataset to identify the five stages of Alzheimer's disease. Rapid miner studio, a well-known data mining application, is used in this investigation to implement all of these algorithms.

Xu, L., et al, (2018) considered the main purpose of brain degeneration, and will result in dementia [5]. It is high quality for infected sufferers to be identified with the disease at an early stage so that management tries can begin as soon as possible. The majority of cutting-edge procedures use magnetic resonance imaging to diagnose Alzheimer's sickness (MRI). However, due to the big length of the photographs generated, modern MRI-primarily based techniques are high-priced and time-eating to perform. With this in mind, the modern-day examine predicts AD the usage of a SVM approach primarily based on gene-coding protein collection facts. The frequency of two consecutive amino acids is used to outline the collection records in our proposed device. The proposed method for defining AD has an accuracy of 85.7 percent, as proven with the aid of the experimental effects.

Naganandhini, S., & Shanmugavadivu, P. (2019) awareness the early and correct detection of AD facilitates scientific practitioners to prescribe case-particular scientific treatment manner [6]. Because of its accuracy and velocity, the choice tree technique is one of the most commonplace machine studying algorithms for type/prediction. The proposed paintings describes a singular choice tree-primarily based class technique with highest quality hyper parameter tuning this is best for AD analysis, even inside the early ranges of growth. The output of this newly proposed Decision Tree Classifier with Hyper Parameters Tuning (DTC-HPT) is proven on the Open Access Imaging Studies Series (OASIS) dataset, which includes data from patients at diverse degrees of Alzheimer's sickness. The primary purpose of the DTC-HPT is to perceive the nature of brain abnormality the use of the most critical and probably meaningful records attributes/parameters.

Shree, S. B., & Sheshadri, H. S. (2018) considered the Diagnosis of the disease at the earlier stage is the requirement of the day [7]. AD is one form of dementia, and it influences about 60% of

folks who are demented. Around 35 million people worldwide be afflicted by Alzheimer's ailment, and this parent is projected to double by means of 2030 and greater than triple by means of 2050, totalling 115 million. Diagnosis of this disorder at an early stage could enable patients to stay a greater enjoyable existence for the relaxation of their lives. The authors of this paper collected information from 466 subjects by means of administering neuropsychological tests. The writers use NB to diagnose Alzheimer's disorder the use of neuropsychological tests.

Balamurugan, M., et al, (2017) proposed a unique dimensionality reduction-primarily based KNN Classification Algorithm for comparing and classifying Alzheimer ailment and Mild Cognitive Impairment in datasets [8]. The National Alzheimer's Coordinating Centre (NACC), which has the Researcher's Data Dictionary - Uniform Data Collection (RDD-UDS), presents a dataset for researchers to investigate clinical and statistical data. This research work gives a better precision, sensitivity, and specificity percentage to provide better final results.

Bae, J. B., et al, (2020) built a convolutional neural community (CNN)-based AD type algorithm using MRI scans from AD patients and age/gender-matched cognitively ordinary controls from two ethnically and educationally various populations these people are drawn from the Seoul National University Bundang Hospital (SNUBH) and the Alzheimer's Disease Neuroimaging Initiative (ADNI). We educated CNNs on five subsets of coronal slices of T1-weighted photographs overlaying the medial temporal lobe for every populace. We examined the models on validation subsets from the same population as well as other populations (inside-dataset validation) (between-dataset validation) [9].

5. PERFORMANCE ANALYSIS

This stage is concerned with validating a trained network and comparing the findings to those of other pre-trained networks. A subset of the data is saved for validation, and the classified performance of the approved network is compared to the images in the validation kit. If adequate precision is not obtained, the network's data pre-processing of training options must be changed before the network can perform well. The accuracy of the validity is attained after the training has advanced. [13].

$$ACC = \frac{TP + TN}{TP + TN + FP + FN} \quad \dots \text{Equ(1)}$$

Table 5.1: - Classification Accuracy

S. No	Classification Technique	Accuracy (%)
1.	Xu, L., et al, (2018)	85.7
2.	Naganandhini, S., & Shanmugavadivu, P. (2019)	87.8
3.	Shree, S. B., & Sheshadri, H. S. (2018)	85.3
4.	Balamurugan, M., et al, (2017)	86.7

5.	Bae, J. B., et al, (2020)	92.5
----	---------------------------	------

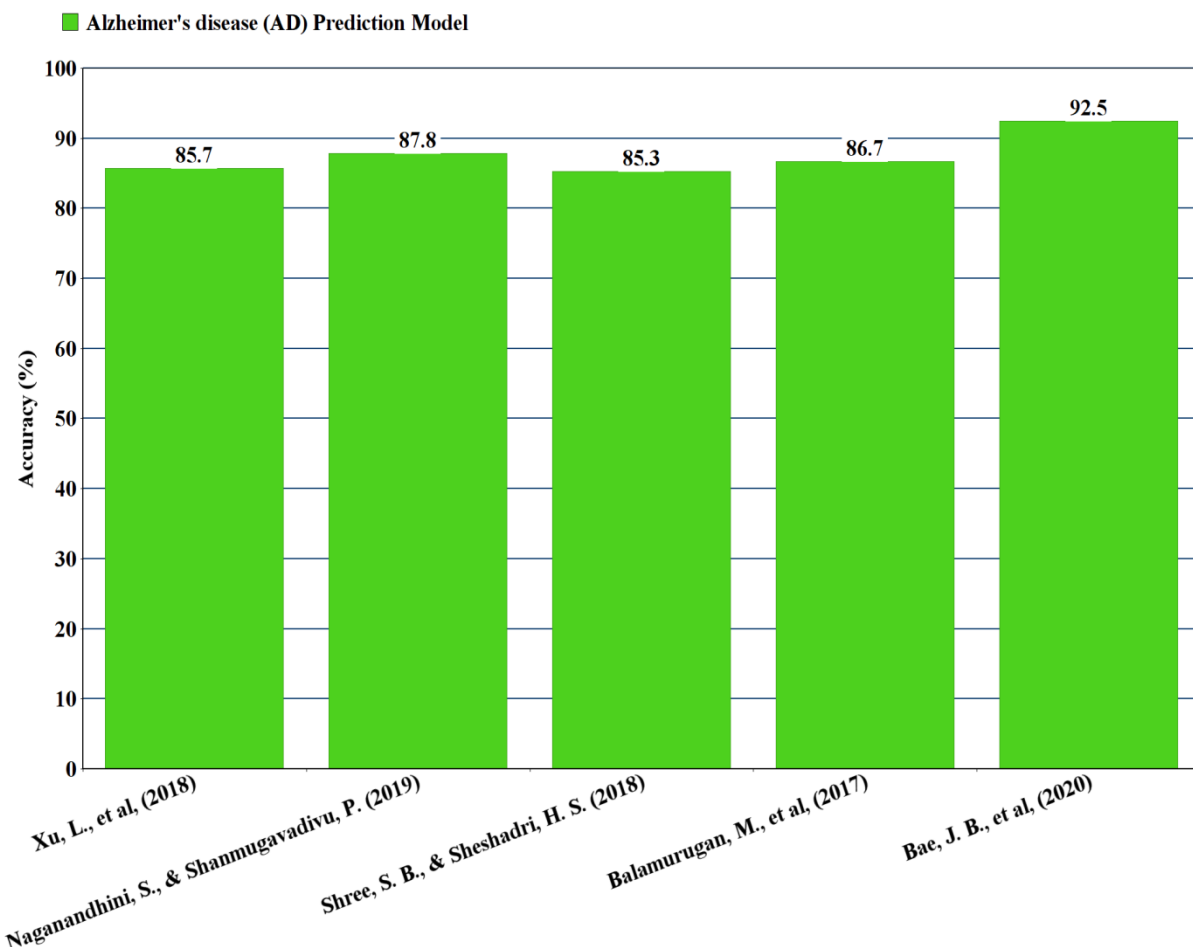


Figure 5.1: - The classification accuracy of the classifiers

6. CONCLUSION

Growing older may be associated with an increased risk of Alzheimer's disease. Machine learning and data mining techniques are extremely useful in medicine and healthcare research for disease detection and diagnosis. The results showed that machine learning and data mining techniques can be used to accurately diagnose Alzheimer's disease in its early stages. The deep learning system known as CNN is the most promising tool for early AD prediction with the highest accuracy rate, according to the accuracy of the AD stages classification accuracy.