Proceedings of First International Conference on Smart Systems and Green Energy Technologies (ICSGET 2022)

Enhanced Machine Learning Technique for Multi-Stages Alzheimer's Disease Classification

S Bhavya Sri[1], S Keerthi[2], Md Hassan[3], R. Karthikeyan[4]

[1,2,3,4]Department of CSE (AI&ML), Vardhaman College of Engineering, Hyderabad, Telangana.
Email: bhavyasrisanka2603@gmail.com, keerthi.sirnam@gmail.com, karthikhonda77@gmail.com

Abstract

Recently, there has been a lot of concern about Alzheimer's. Around 45 million people around the world are affected by this illness. Alzheimer's is a degenerative mental condition with no recognized early stages that typically affects elderly people. It took away people's capacity for thought, reading, and a wide range of other activities. The sickness is identified, but only at an advanced stage. Therefore, if the condition is identified earlier, its symptoms may be slowed. Neuroimaging methods including CT, MRI, PET, and EEG are also indicated for people who also experience additional symptoms like behavioural and psychological problems, as well as cognitive mental impairments like confusion and amnesia. Traditional procedures for diagnosing Alzheimer's disease (AD) are time-consuming, and learning and practising them requires a significant amount of effort. The major goal is to identify individuals who are showing early signs of Alzheimer's disease. So, we use CDR and SMMSE tests online before moving on to MRI or CT scans, and then follow them up with machine learning algorithms to evaluate the data along with test results. With the aid of these tests, it will be possible to identify Alzheimer's disease in its early stages. An ML framework can help resolve this issue by diagnosing the disorder. The outcomes and examination of numerous machine learning models aimed at dementia diagnosis are presented in this work. The most precise variables for Alzheimer's disease prediction have been discovered using a range of techniques, including Decision Tree, Random Forest, Support Vector Machine, and K Nearest Neighbour classifiers. Predictions for Alzheimer's disease are made using the Open Access Series of Imaging Studies (OASIS) data, and the effectiveness of ML models is evaluated using metrics including Precision, Recall, Accuracy, and F1-score. Despite the dataset's limited size, some important numbers are included. Two machine learning models were utilized to analyze the data. Following system development, findings demonstrate that SVM performs better than other models. Based on metrics, we can say that SVM gives the best results. The method is simple and can assist people in identifying dementia promptly.

Keywords. Stages in Alzheimer's disease, Support Vector Machine, Logistic Regression, Decision Tree Classifier, K-Nearest neighbour.

e-ISBN: 9788770229647 https://doi.org/10.13052/rp-9788770229647.021

1. INTRODUCTION

Originally, Technology that imitates and exhibits "human" cognitive abilities connected to the human mind, such as "learning" and "problem-solving," is referred to as "artificial intelligence." Major AI researchers are increasingly describing AI in terms of reason and behaving rationally [1]. They reject this notion and do away with all restrictions on what constitutes intelligence.

TABLE-I ALZHEIMER STAGES AND SYMPTOMS

S.NO	STAGE OF ALZHEIMERS	SYMPTOMS INCLUDES
1	Early stage	❖ Misplacing the items unknowingly ❖ Losing track of place and thing names ❖ Repeating themselves frequently, for as by repeatedly posing the same query becoming hesitant
2	Moderate stage	❖ Confusion and disorientation are getting worse ❖ Impulsive, obsessive, or repeated behaviour ❖ Delusions (believing things that are untrue) ❖ Issues with language or speech (aphasia) ❖ Sleep disturbances ❖ Mood fluctuations that are regular or that cause you to feel angry, nervous, or frustrated ❖ Poor judgement and poor decision making
3	Advanced stage	❖ Difficulty moving or changing positions without assistance ❖ Significant weight reduction ❖ Speech short-term and long-term memory gradually decline

Robots can display artificial intelligence (AI), which is intelligence, in contrast to the Animals, including humans, have innate intellect. The learning of intelligent agents, or any system that senses its environment and acts to increase its chances of success, is called artificial intelligence (AI). People are unable to interpret, assess, and make judgments using even a small percentage of the vast amount of data that exists in today's society [13]. To make such complex decisions, higher cognitively capable entities than humans are required.

A subfield of computer science and artificial intelligence (AI) called "machine learning" aims to mimic human learning by using data and algorithms to gradually increase a system's accuracy. This area of research focuses on comprehending and developing

e-ISBN: 9788770229647 https://doi.org/10.13052/rp-9788770229647.021

"learning" strategies, or methods that employ data to enhance performance on a certain set of tasks. Without being expressly instructed to do so, machine learning algorithms create a model from sample data, commonly referred to as training data, to generate predictions or judgments. Machine learning techniques are used in a variety of domains, such as speech recognition, email filtering, computer vision, and many more, when utilising standard algorithms is either impossible or impractical [3].

Support Vector Machine (SVM), one of the most popular supervised learning techniques, is applied to classification and regression problems.

2. ALZHEIMERS DISEASE AND STAGE PREDICTION

Alzheimer's sickness is a neurological disorder that causes mind atrophy and cell death, which impairs memory and cognitive function. Alzheimer's illness, the furthermost prevalent type of dementia, impairs a person's capacity for independent living and is categorised by a stable decline in social, interactive, and cognitive skills. The main symbol of Alzheimer's illness is memory loss. one of the original signs is having trouble recalling previous conversations or events. As the condition worsens, memory issues get worse, and new symptoms start to show up. Alzheimer's disease-related brain modifications result in increasing problems with:

- Memory
- Reasoning and Thinking
- Making judgements and decisions
- Making similar plans and carrying them out
- Changes in personality and behaviour
- Maintained expertise

3. RELATED WORK

[1] In this study, the rapid shift clustering technique is used to partition the dataset into smaller groups in the embedded space. The experiments employing the recommended approaches show incredibly strong performance for clustering images into AD and normal ageing using the Clinical Dementia Rating (CDR) scale as a benchmark. [2] In this work, three biomarker modalities—MRI, FDG-PET, and CSF biomarkers—were integrated using a kernel combination approach with a 93% accuracy rate to distinguish between AD and healthy controls. [3] Outlined a novel method for automatically differentiating between older controls and based on a comprehensive classification of hippocampus shape parameters, patients with Alzheimer's disease (AD) or mild cognitive impairment (MCI). [4] This study proposes a fully automated system for categorising patients with Alzheimer's disease (AD) and elderly control participants based on diffusion tensor imaging (DTI) and anatomical magnetic resonance imaging (MRI).

[5] The proposed methodology is based on the 95% accurate selection of voxels that show Welch's t-test results over a specified threshold between the two groups, normal and Alzheimer images. Study [6] discusses how structural magnetic resonance imaging can be

e-ISBN: 9788770229647 https://doi.org/10.13052/rp-9788770229647.021

used to diagnose Alzheimer's disease by estimating the three-dimensional displacement field. The methods [7-9] employ conventional computer vision methods. [10] This study briefly describes the classification of Alzheimer's illness founded on the structural MR images using Neural networks whereas [11] study shows the results in classification between having Alzheimer's or not based on Convolutional Neural Networks. Approaches [12–13] use deep CNN to forecast the disease. [14] In this study, the disease is classified based on the automated MR images with the help of Deep learning model. [15] This approach describes the classification of the disease based on the Deep Learning based CNN approach on MR images. [16] Study helps to classify the type of disease with the help of Deep Learning algorithms. The results in classification between having Alzheimer's or not based on Convolutional Neural Networks.

4. ATTRIBUTES APPLIED IN CLASSIFICATION SYSTEM

4.1. *Socioeconomic Status (SES)*

The term "socioeconomic status" refers to a person or group's social standing or class. Utilizing a combination of work, money, and education is a common method of assessment. The analysis of socioeconomic statuses frequently uncovers differences in resource access as well as issues with privilege, power, and control.

4.2. *Total Intracranial Volume Assumed (TIVA)*

Total intracranial volume (TIV/ICV), which can serve as a stand-in for maximum premorbid brain capacity, is a vital covariate for volumetric assessments of the intelligence and different intelligence areas, predominantly in the learning of neurodegenerative illnesses. The gold-standard method for manually outlining brain images demands meticulous labour from knowledgeable operators.

4.3. *Standard Mini Mental State Examination (SMMSE)*

The Standard Mini-Mental State Inspection, often recognised as the Folstein test, is a 30-item survey that is widely applied in clinical and research contexts to evaluate intellectual impairment. In medicine and allied health, dementia screening is a common practise. It is a helpful instrument for recording a patient's response to therapy since it is also used to follow the progression of a person's cognitive changes over time and assess the severity and development of cognitive impairment.

4.4. *Clinical Dementia Rating (CDR)*

The CDR is calculated using a semi-structured interview with the subject and the caregiver (informant), as well as the clinician's clinical judgement. The CDR is determined by evaluating six different cognitive and behavioural domains on a scale of 0 to 5, including memory, orientation, judgement, and problem-solving, as well as community affairs, home and hobby performance, and personal care performance.

e-ISBN: 9788770229647 https://doi.org/10.13052/rp-9788770229647.021

TABLE-II ALZHEIMER STAGES AND SYMPTOMS

	No dementia	Early Stage	Moderate Stage	Advanced stage	Maximum Score
SMMSE	24 - 30	19 - 24	10 - 19	0 - 9	30
CDR	0 – 0.5	0.5 - 1.0	1.0 - 2	3 - 5	5

4.5. *Normalised Whole Brain Volume (NWBV)*

Among the most well-researched techniques for calculating the progression of neurodegeneration in MS are measurements of changes in normalized brain volume and brain parenchymal fraction (BPF) across time.

5. IMPLEMENTATION

5.1 Logistic Regression

Logistic regression is one of the most well-liked machine learning methods that falls under supervised learning. A set of independent variables is used to predict the category dependent variable.

5.2 Decision Tree Classifier

Classification and regression issues can be resolved using the supervised learning technique known as a decision tree, however this approach is frequently preferred.

5.3 K Nearest Neighbours

K-Nearest Neighbour, which employs the supervised learning approach, is one of the simplest and most fundamental machine learning algorithms. A new data point is classified based on similarity, and all previously saved data is also stored.

6. RESULTS AND ANALYSIS

Accuracy is defined as the number of events that were accurately predicted. It falls under a specific label for classification. It is a frequently used presentation measuring criterion in a wide range of applications. It is the best production measurement criterion for datasets with an equal number of false positives and false negatives, or symmetric datasets. It is specified as:

True Positive=TP False Positive=FP

True Negative=TN False Negative=FN

$$Accuracy=(TP+TN) / (TP+TN+FP+FN)$$

e-ISBN: 9788770229647 https://doi.org/10.13052/rp-9788770229647.021

TABLE III ACCURACY COMPARISON

Algorithms used	Accuracy	F1 Score	Recall	Precision
K-Nearest Neighbour	87.33	85.46	84.74	86.33
Support Vector Machine	96.00	95.65	91.67	94.86
Decision Tree Classifier	93.33	92.96	94.44	97.06
Logistic Regression	94.67	94.29	91.67	97.06

7. CONCLUSION AND FUTURE ENHANCEMENT

There is a chance that disease detection will get more precise. It is possible to create multi-model frameworks to have a more precise detection system. The data that is widely used in the diagnosis of neurological illnesses is OASIS data. It will be helpful to have a framework for sifting through numerous data sources and extracting information that can be used to diagnose Alzheimer's. Our system will be more accurate if we combine these to more sources. We employ numerical data that is processed using machine learning algorithms in order to identify subjects with Alzheimer's disease and examine data relating to brain regions affected by the disease. Compared to other techniques, Support Vector Machine performs much more accurately.

REFERENCES

[1] Martin T. Hagan and Mohammad B. Menhaj, "Training feedforward networks with the Marquardt algorithm," IEEE Transactions on Neural Networks, vol. 5, no. 6, pp. 989-993, November 1994.

[2] Zhang D, Wang Y, Zhou L, Yuan H, Shen D and the Alzheimer-s Disease Neuroimaging Initiative, "Multimodal classification of Alzheimer-s disease and mild cognitive impairment," Neuro Image, vol. 55, no. 3, pp. 856-867, April 2011.

[3] Gerardin E, Chetelat G, Chupin M, Cuingnet R, Desgranges B, Kim HS, Niethammer M, Dubois B, Lehericy S, Garnero L, Eustache F, Colliot O and the Alzheimer-s Disease Neuroimaging Initiative, "Multidimensional classification of hippocampal shape features discriminates Alzheimer-s disease and mild cognitive impairment from normal aging," Neuro Image, vol. 47, no. 4, pp. 1476-1486, October 2009.

[4] Chupin M, Gerardin E, Cuingnet R, Boutet C, Lemieux L, Lehericy S, Benali H, Garnero L, Colliot O and the Alzheimer-s Disease Neuroimaging Initiative, "Fully Automatic Hippocampus Segmentation and Classification in Alzheimer-s Disease and Mild Cognitive Impairment Applied on Data From ADNI," Hippocampus, vol. 19, no. 6, pp. 579-587, June 2009.

e-ISBN: 9788770229647 https://doi.org/10.13052/rp-9788770229647.021

[5] M. Lopez, J. Ramirez, J.M. Gorriz, D. Salas-Gonzalez, I. Alvarez, F. Segovia and C.G. Puntonet, "Automatic tool for Alzheimer-s disease diagnosis using PCA and Bayesian classification rules," Electronics Letters, vol. 45, no. 8, pp. 389-391, April 2009.

[6] S. Wang, Y. Zhang, G. Liu, P. Phillips, T.-F. Yuan, Detection of Alzheimer's disease by three-dimensional displacement field estimation in structural magnetic resonance imaging, J. Alzheimer's Dis. 50 (1) (2016) 233–248.

[7] Beheshti, Iman, Norihide Maikusa, Hiroshi Matsuda, Hasan Demirel, and Gholamreza Anbarjafari. "Histogram-Based Feature Extraction from Individual Gray Matter Similarity-Matrix for Alzheimer's Disease Classification." Journal of Alzheimer's Disease 55, no. 4 (2017): 1571-1582.

[8] I. Beheshti, H. Demirel, H. Matsuda, Alzheimer's Disease Neuroimaging Initiative, et al., Classification of Alzheimer's disease and prediction of mild cognitive impairment-to-Alzheimer's conversion from structural magnetic resource imaging using feature ranking and a genetic algorithm, Comput. Biol.Med. 83 (2017) 109– 119.

e-ISBN: 9788770229647 https://doi.org/10.13052/rp-9788770229647.021