Early Stage Alzheimer's Disease Detection Using Machine Learning

Ms. P. Ilakiya[1], A.P. Srinivasha[2], R. Sino[3]
[1, 2, 3] Dept of Computer Science & Engineering
[1, 2, 3] Sri Krishna College of Technology, Coimbatore, Tamil Nadu, India

Abstract- *Alzheimer's disease, a form of dementia that primarily affects older adults, is a major public health concern worldwide. The use of machine learning to identify metabolic disorders such as Alzheimer's and diabetes is a rapidly growing area of research. Early detection of Alzheimer's is critical for effective treatment, as interventions provided at this stage are less damaging and more effective than those administered at later stages. Despite the availability of large amounts of clinical data, traditional decision-making methods rely heavily on the experience and intuition of physicians rather than data-driven analysis. In this project, we propose an innovative approach to Alzheimer's disease detection using machine learning algorithms such as Decision Tree and Naive Bayes. Patients can register on the website, input their medical information, and receive an assessment of their Alzheimer's risk through the decision tree algorithm. If the results indicate the presence of Alzheimer's disease symptoms, patients can promptly schedule a doctor's appointment. Physicians can register and log into the website to accept appointments and update patients' medical records with relevant treatment information. By incorporating machine learning algorithms into clinical decision-making processes, this approach has the potential to improve the accuracy and efficiency of Alzheimer's disease detection and treatment.*

Keywords- Alzheimer's Disease, Decision Tree, Naïve Bayes Algorithm, Machine Learning.

I. INTRODUCTION

Alzheimer's disease is a neurologic disorder that causes the brain to shrink and cells to die, leading to the most common form of dementia. The gradual development of Alzheimer's disease symptoms over many years affects several brain functions and begins with minor memory problems. In today's world, Alzheimer's disease is a significant threat to the healthcare industry due to its high frequency. The diagnosis of Alzheimer's disease can be costly and time-consuming through physical and neurological examination. Early detection is challenging, as most symptoms are not observable, but early prediction is recommended to slow down disease progression. Currently, diagnosis is made by calculating the MSME score and manually studying MRI scans of thousands of brain tissue slides, which is a lengthy and costly process. However, machine learning models can be applied to accelerate diagnosis and reduce costs. Intelligence scientists have recently investigated advanced technologies to improve the precision and quality of Alzheimer's detection. Several successful machine learning models have been applied for early detection of the disease.

II. RELATED WORK

In their recent work [1], Maria Teresa Angelillo and Fabrizio Balducci have introduced a novel technique for the automated detection of Alzheimer's disease using the attentional matrices test (AMT) to assess selective attention. The original AMT involves three matrices of increasing complexity, with the test taker required to identify and mark specific digits. In this proposal, the AMT was adapted for use on a digitizing tablet with an electronic pen, allowing for the acquisition of additional measures beyond those obtained with the traditional paper-based test. These measures can then be utilized as input for machine learning algorithms to automate disease detection. By analysing dynamic handwriting data, this approach provides a more comprehensive evaluation of the patient's visual search and motor planning abilities compared to traditional methods.

In their recent publication [2], Francesco Da Ros and Stenio Magalhaes et al. have highlighted the issue of chromatic dispersion, which is a major obstacle in increasing the transmission distance-rate product for short-reach communication systems that use intensity modulation and direct detection. Although optical dispersion-compensation techniques are available, they are not preferred due to their significant impact on the link loss budget. Digital techniques, on the other hand, tend to be power-intensive and introduce latency. To address this problem, the authors compare various digital, optical, and hybrid approaches for equalization and dispersion compensation in short-reach optical transmission links. Additionally, they propose a novel hybrid method that combines reservoir computing with a simple signal pre-conditioning stage in the optical domain. The optical pre-

processing technique involves using an arrayed waveguide grating to divide the received signal into narrow sub-bands.

According to Aakansha's study [3], in today's world, computer and information security pose a significant challenge. Maintaining the security of systems and information requires both authentication and authorization to ensure that only authorized users have access. While passwords are a popular and straightforward authentication method, textual passwords are vulnerable to a variety of attacks. In response to these vulnerabilities, graphical password techniques have been introduced, which use images or pictures instead of text as passwords. However, because of their graphic nature, most graphical password techniques are vulnerable to shoulder-surfing attacks.

The paper by Guy McKhann and David Drachman et al. proposes clinical criteria for the diagnosis of Alzheimer's disease based on the onset and progression of cognitive impairment, without any motor, sensory, or coordination deficits. They emphasize the importance of laboratory tests in identifying other potential causes of dementia before confidently diagnosing Alzheimer's disease. Neuropsychological tests are also useful in confirming the diagnosis and assessing the course of the disease and response to therapy. These proposed criteria are meant to serve as a guide and will be updated as more information becomes available.

Poulin and Stéphane P et al., has proposed in this paper that results of the study showed that both the amygdala and hippocampus were significantly reduced in size in very mild and mild AD subjects compared to controls. However, the degree of atrophy in the hippocampus was found to be greater than that of the amygdala. In addition, amygdala atrophy was found to be significantly associated with global cognitive impairment, as measured by the CDR-SB and Mini Mental state examination. These findings suggest that amygdala atrophy may play an important role in the pathophysiology of AD and should be considered as a potential biomarker for early detection and monitoring of the disease.In this study we compared the level of amygdala atrophy to that of the hippocampus in very mild and mild AD subjects in two large samples (Sample 1 n=90; Sample 2 n=174).

III. EXISTING WORK

Early and accurate diagnosis of Alzheimer's disease (AD) is crucial for managing and improving the quality of life of patients. Currently, diagnosis relies heavily on clinical history and physical examination, which can be subjective and prone to errors. Radiological imaging techniques such as magnetic resonance imaging (MRI) and positron emission tomography (PET) scans can provide objective evidence of brain atrophy and abnormalities in glucose metabolism, respectively, which are hallmark features of AD. These imaging techniques can aid in early and accurate diagnosis of AD, but their availability and cost can limit their widespread use. Hence, there is a need for more affordable and accessible diagnostic tools for AD. Research is ongoing to develop reliable biomarkers, such as cerebrospinal fluid (CSF) analysis and blood tests, that can aid in the early detection of AD. These biomarkers can be used in combination with clinical evaluation and imaging techniques to improve the accuracy of AD diagnosis.Thus, the accurate diagnosis especially for the early stages of AD is very important.

3.1 Limitation of existing system

- It is true that the existing system for diagnosing Alzheimer's disease heavily relies on the intuition and experience of the doctor, which can lead to biases, errors, and unnecessary medical costs.
- Misdiagnosis of a serious illness like Alzheimer's disease can have devastating consequences for the patient, their family, and society as a whole. It can lead to delays in treatment and care, worsening of symptoms, and decreased quality of life. Additionally, misdiagnosis can result in unnecessary testing, treatments, and hospitalizations, which not only impact the patient's physical health but also their financial wellbeing.
- Therefore, there is a pressing need for more accurate and reliable diagnostic tools that can aid doctors in making informed decisions and improve the overall quality of healthcare.

IV. PROPOSED WORK

The proposed system sounds promising as it uses data mining techniques to analyse medical profiles and predict the likelihood of a patient developing Alzheimer's disease. By utilizing a web-based questionnaire application, it can be easily accessible to patients and healthcare professionals alike. However, it is important to ensure that the data used in the analysis is accurate and relevant to the disease. Additionally, the system must be regularly updated with new research and findings to ensure that it remains effective in predicting the disease. Overall, the proposed system has the potential to greatly improve the accuracy and efficiency of Alzheimer's disease diagnosis.

The proposed system is a web-based application that allows patients to register and share their health details in

order to detect early stage Alzheimer's disease. The system uses classification technology to construct a predictive model and extract classification rules to improve the diagnosis and prediction of Alzheimer's disease. The system allows doctors to verify test details and update the status of the test and give appointments for treatment. It seems like the system aims to provide a more efficient and accurate way of diagnosing and treating Alzheimer's disease, which could improve the quality of life for patients and reduce healthcare costs.

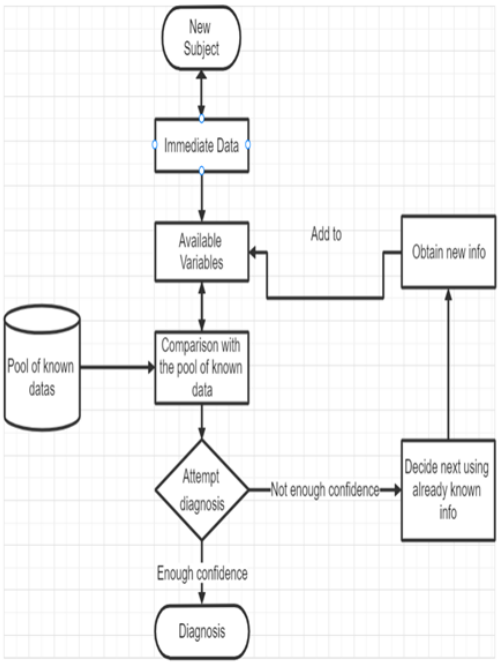


Fig. 1. Block Diagram of Proposed System

4.1 Alzheimer's Disease

The proposed system aims to improve the diagnosis of Alzheimer's disease by using a decision tree algorithm to analyse temporal data and health parameters, which can aid in detecting the disease in its early stages. This can lead to early intervention and treatment, improving the quality of life for the patient. The system also enables doctors to verify test details and update the status of the test, leading to better communication and coordination between doctors and patients.The ultimate goal is to make the diagnosis process easier and more accurate, as well as to facilitate communication between patients and doctors for appointment verification and treatment planning.

Extracting Alzheimer's disease classification rules from the predictive model helps in improving the accuracy of the diagnosis and prediction of Alzheimer's disease. These rules can be used to identify the key features or risk factors associated with Alzheimer's disease, which can aid in the development of more effective treatment strategies. By analysing the patterns in the data, the model can also provide insights into the underlying mechanisms of the disease, which can lead to new discoveries and advancements in the field of Alzheimer's research. Additionally, the predictive model can be updated as new data becomes available, allowing for ongoing improvements in the accuracy of the diagnosis and prediction of Alzheimer's disease. The various modules present in the system are described below

- Data Pre-Processing
- Feature Extraction
- Classification
- Prediction
- Patient Module
- Doctor Module
- Admin Module

4.2 Data Pre-Processing

This contains a reasonable approach to pre-processing the input dataset. Normalization is a common technique used to rescale the data so that it falls within a specific range, which can help improve the performance of machine learning algorithms. Exploratory data analysis is also a crucial step in the data pre-processing phase as it allows you to gain insight into the data and identify any potential issues that need to be addressed before running the algorithms. Good data quality checks are also important as they can help identify any issues with missing or corrupted data that could impact the accuracy of the results.

4.3 Feature Extraction

Feature extraction and selection is an important step in machine learning, where we extract the most relevant and useful information from the input data to improve the model's performance. Bag-of-words is a common method used in text classification where we represent text as a bag of its words, ignoring grammar and word order. N-grams are a variation of bag-of-words that take into account n consecutive words. TF-IDF is a technique used to weigh the importance of each word in a document, based on how frequently it appears in the document and how rare it is across all documents. These techniques help in reducing the dimensionality of the data and improving the model's accuracy by focusing on the most informative features.

4.4 Prediction

Naive Bayes is a probabilistic algorithm that assumes that the presence of a particular feature in a class is independent of the presence of any other feature in the same class. This

assumption simplifies the computations involved in the algorithm and makes it very efficient for large datasets. It takes a patient health record as input from user then model is used for final classification output that is shown to user along with probability of truth.

4.5Patient Module

The patient module is an interactive web-based platform that allows patients to register, log in, and fill out information related to Alzheimer's disease. The platform has three levels of tests that patients can complete to assess the likelihood of having Alzheimer's disease. If the results indicate a high probability of Alzheimer's disease, the information is shared with a doctor for further evaluation and treatment.

In addition to the test results, patients can also book appointments with preferred hospitals and view their appointment status in their login. The platform also provides information related to Alzheimer's disease in both video and text formats, which patients can access from their login.

4.6 Doctor Module

The Doctor module in the proposed system for Alzheimer's disease detection is used to

- Acknowledge appointments made by patients
- Access patients' test-related information
- Share information related to Alzheimer's disease in either text or video format
- Verify patient-related test scenarios

The doctor module is designed to facilitate communication between doctors and patients, and to allow doctors to make informed decisions based on the test-related information available to them.

4.7Admin Module

The Admin module have the following features:

- Manage patient and doctor accounts: Admin can create, update, and delete patient and doctor accounts as needed.
- Manage hospital information: Admin can add, update, and delete hospital information in the system.
- Monitor system activity: Admin can monitor the activity of patients and doctors in the system to ensure proper usage.
- Generate reports: Admin can generate reports on patient and doctor activity, system usage, and other relevant data.

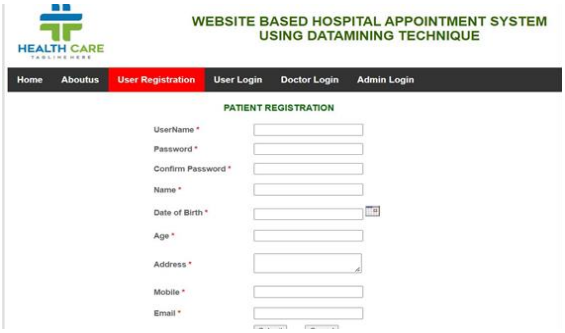
V. EXPERIMENTAL RESULT

Implementation is the stage in the project where the theoretical design in the turned into a working system and is giving confidence on the new system for the user that it will work effectively. It involves careful planning, investigation of the current system and its constraints on implementation, design of methods to achieve the changeover, an evaluation, of change over methods.

The implementation stage involves following Tasks.

- Patient Registration
- Doctor Login
- Admin Login
- Test Report
- Token Booking

PATIENT REGISTRATION FORM

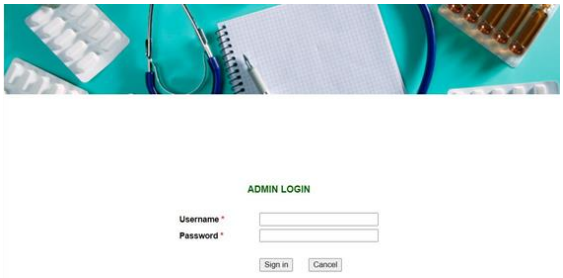


This **Fig 2**, shows the Patient registration form where it asks user's details (name, password, Date of birth, phone number, address and mail Id)

DOCTOR LOGIN

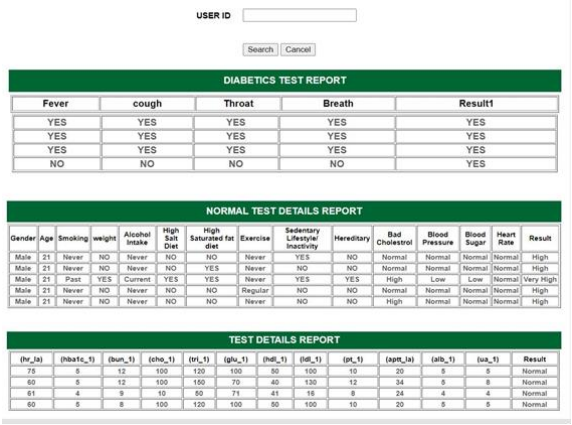
This **Fig 3**, it displays the Doctor login. Doctor needs to login to see the patient details and their test reports.

ADMIN LOGIN



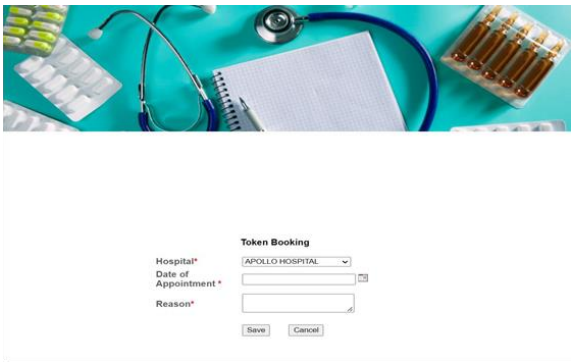
This **Fig 4**, it displays the Admin login where admin can login to add new doctors and change their username and password.

TEST REPORT



This **Fig 5**, it is the test report of the patient. It displays the result whether the patient is having Alzheimer's disease or not using the dataset we provided and the health details of the patient.

TOKEN BOOKING



This **Fig 6**, it shows the token booking portal for the patient. If the patient had confirmed the disease he/she can may book a token for a particular hospital at the available date.

VI. CONCLUSION

Machine learning methods have shown great potential in improving the accuracy and efficiency of Alzheimer's disease prognosis and prediction. Recent studies have used various types of data, including imaging data, genetic data, and clinical data, to develop predictive models using different machine learning algorithms.Overall, machine learning algorithms have demonstrated better performance in predicting early stages of Alzheimer's disease compared to standard statistical tools. However, it should be noted that clinical diagnosis of Alzheimer's disease is not always 100% accurate, and pathological verification is necessary to confirm the predicted results.

Future research should focus on improving the accuracy and reliability of predictive models by incorporating more diverse and comprehensive data sources, as well as incorporating pathological verification into the evaluation of the models. Additionally, research should continue to explore the use of machine learning in developing personalized treatment plans for Alzheimer's disease patients.

REFERENCES

[1] M. M. T. Angelillo, F. Balducci, D. Impedovo, G. Pirlo, and G. Vessio, ''Attentional pattern classification for automatic dementia detection,''IEEE Access, vol. 7, pp. 57706–57716, 2019.

[2] F. Da Ros, S. M. Ranzini, H. Bülow, and D. Zibar, ''Reservoir-computing based equalization with optical pre-processing for short-reach optical transmission,'' IEEE J. Sel. Topics Quantum Electron., vol. 26, no. 5, pp. 1–12, Sep. 2020.

[3] G. McKhann, D. Drachman, M. Folstein, R. Katzman, D. Price, and E. M. Stadlan, ''Clinical diagnosis of Alzheimer's disease: Report of the NINCDS-ADRDA work group under the auspices of department of health and human services task force on Alzheimer's disease,'' Neurology, vol. 34, no. 7, pp. 939–944, 1984.

[4] S. P. Poulin, R. Dautoff, J. C. Morris, L. F. Barrett, and B. C. Dickerson, ''Amygdala atrophy is prominent in early Alzheimer's disease and relates to symptom severity,'' Psychiatry Res., Neuroimag., vol. 194, no. 1, pp. 7–13, 2011.

[5] X. Hao, Y. Bao, Y. Guo, M. Yu, D. Zhang, S. L. Risacher, A. J. Saykin, X. Yao, and L. Shen, ''Multi-modal neuroimaging feature selection with consistent metric constraint for diagnosis of Alzheimer's disease,'' Med. Image Anal., vol. 60, Feb. 2020, Art. no. 101625.

[6] N. Dessì, E. Pascariello, and B. Pes, ‘‘A comparative analysis of biomarker selection techniques,’’ BioMed Res. Int., vol. 2013, pp. 1–10, Sep. 2013.
[7] M. Gillies, J. Hyam, A. Weiss, C. Antoniades, R. Bogacz, J. Fitzgerald, T. Aziz, M. Whittington, and A. Green, ‘‘The cognitive role of the Globus pallidus interna; insights from disease states,’’ Exp. Brain Res., vol. 235, no. 5, p. 1455, 2017.
[8] C. Patterson, ‘‘The state of the art of dementia research: New frontiers,’’ Alzheimer’s Disease Int., London, U.K., World Alzheimer Rep. 2018, Sep. 2018.
[9] F. D.-L. Coarer, M. Sciamanna, A. Katumba, M. Freiberger, J. Dambre, P. Bienstman, and D. Rontani, ‘‘All-optical reservoir computing on a photonic chip using silicon-based ring resonators,’’ IEEE J. Sel. Topics Quantum Electron., vol. 24, no. 6, pp. 1–8, Nov. 2018.
[10] J. B. Héeroux, H. Numata, N. Kanazawa, and D. Nakano, ‘‘Optoelectronic reservoir computing with VCSEL,’’ in Proc. Int. Joint Conf. Neural Netw. (IJCNN), Rio de Janeiro, Brazil, Jul. 2019.

DECLARATION

Funding/Grants/Financial Support	No, I did not receive
Conflicts of Interest/ Competing to Interest	No conflicts of Interest to the best of our knowledge
Ethical Approval and Consent to Participate	No, the article does no require ethical approval and consent to participate with evidence
Availability of Data and Material / Data Access Statement	Not relevant
Authors Contribution	All author have equal participation in this article