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PREDICTIVE ANALYSIS MODEL FOR EARLY DETECTION OF ALZHEIMER'S DISEASE USING CLINICAL AND COGNITIVE DATA

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Abstract: Alzheimer's disease is a progressive neurological disorder that impairs memory, cognitive functions, and daily activities, making early detection essential for effective treatment and management. This paper presents a predictive analysis model for the early detection of Alzheimer's disease using clinical and cognitive data. The proposed system employs machine learning techniques to analyze input parameters such as age, body mass index, Mini-Mental State Examination (MMSE) score, memory score, physical activity, sleep quality, and family history. A classification-based approach is used to categorize individuals into four stages: No Alzheimer's, Cognitively Normal, Mild Cognitive Impairment, and Alzheimer's Disease. The model is trained and evaluated on a structured dataset, and its performance is assessed using standard metrics including accuracy, precision, recall, and F1-score. In addition, a user-friendly interface is developed to facilitate real-time prediction and improve accessibility. Experimental results demonstrate that the proposed model achieves high accuracy and reliability in early-stage detection. The system can assist healthcare professionals in decision-making and contribute to improved awareness and timely intervention. The study highlights the potential of machine learning techniques in enhancing traditional diagnostic processes and provides a scalable approach for early Alzheimer's disease prediction.

1. INTRODUCTION

Alzheimer's disease is a progressive neurodegenerative disorder that affects memory, cognitive abilities, and daily functioning. It is one of the most common causes of dementia among the elderly, making early detection essential for effective treatment and management. Traditional diagnostic methods, including clinical assessments and neuroimaging, are often time-consuming, costly, and require expert intervention.

With the advancement of machine learning in healthcare, data-driven approaches have emerged as efficient alternatives for early disease prediction. Machine learning models can analyze clinical and cognitive data to identify patterns associated with Alzheimer's disease. In this work, a predictive analysis model is proposed using features such as age, body mass index, Mini-Mental State Examination (MMSE) score, memory score, physical activity, sleep quality, and family history.

The proposed system employs a classification-based approach to categorize individuals into different stages, including No Alzheimer's, Cognitively Normal, Mild Cognitive Impairment, and Alzheimer's Disease. The model is evaluated using standard performance metrics such as accuracy, precision, recall, and F1-score. The results demonstrate that the system provides reliable predictions, supporting early diagnosis and assisting healthcare professionals in decision-making.

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2. LITERATURE SURVEY

Recent advancements in machine learning and data analytics have significantly contributed to the early detection of Alzheimer's disease. Several studies have explored the use of clinical, cognitive, and imaging data to improve prediction accuracy. Researchers have applied various machine learning algorithms such as Support Vector Machines (SVM), Decision Trees, Random Forest, and Neural Networks to classify different stages of Alzheimer's disease.

Many existing works focus on neuroimaging techniques like MRI and PET scans for diagnosis. While these approaches provide high accuracy, they are often expensive and require specialized medical infrastructure. To overcome these limitations, recent studies have shifted towards using clinical and cognitive data, which are more accessible and cost-effective. Features such as age, cognitive test scores, and lifestyle factors have shown promising results in early-stage detection.

In addition, hybrid models combining multiple algorithms and feature selection techniques have been proposed to enhance performance. Ensemble learning methods, particularly Random Forest and Gradient Boosting, have demonstrated improved classification accuracy due to their ability to handle complex data patterns. Some studies have also incorporated deep learning models; however, these require large datasets and higher computational resources.

Despite these advancements, challenges still exist in achieving consistent accuracy across different datasets and ensuring model generalization. Many models suffer from overfitting and lack interpretability, which limits their practical application in clinical settings. Therefore, there is a need for a reliable and scalable system that utilizes easily available data while maintaining high prediction performance.
The proposed work addresses these challenges by developing a machine learning-based predictive model using clinical and cognitive parameters. Unlike imaging-based approaches, this system focuses on accessible data and aims to provide an efficient, cost-effective, and user-friendly solution for early Alzheimer's disease detection.

3. PROPOSED SYSTEM

In this project, we developed a predictive analysis system for the early detection of Alzheimer's disease using clinical and cognitive data. The system is designed to take structured patient information as input and provide an accurate prediction of the disease stage along with meaningful insights. The entire process is implemented using a machine learning pipeline that analyzes multiple health-related parameters.

The user provides input features such as age, body mass index (BMI), Mini-Mental State Examination (MMSE) score, memory score, physical activity level, sleep quality, and family history through a simple interface. These features are important indicators of cognitive health and are widely used in medical diagnosis.

Initially, the input data is processed to remove inconsistencies and prepare it for analysis. The cleaned data is then passed to the feature processing stage, where relevant attributes are selected to improve prediction accuracy. After preprocessing, the data is fed into machine learning models trained on historical datasets.

The system uses classification algorithms such as Decision Tree, Random Forest, and Support Vector Machine (SVM) to analyze the input data. These models identify hidden patterns and relationships between clinical features and the stages of Alzheimer's disease.

Based on the analysis, the system classifies individuals into four categories: No Alzheimer's, Cognitively Normal, Mild Cognitive Impairment (MCI), and Alzheimer's Disease. The final prediction is generated along with a confidence score that indicates the reliability of the result.

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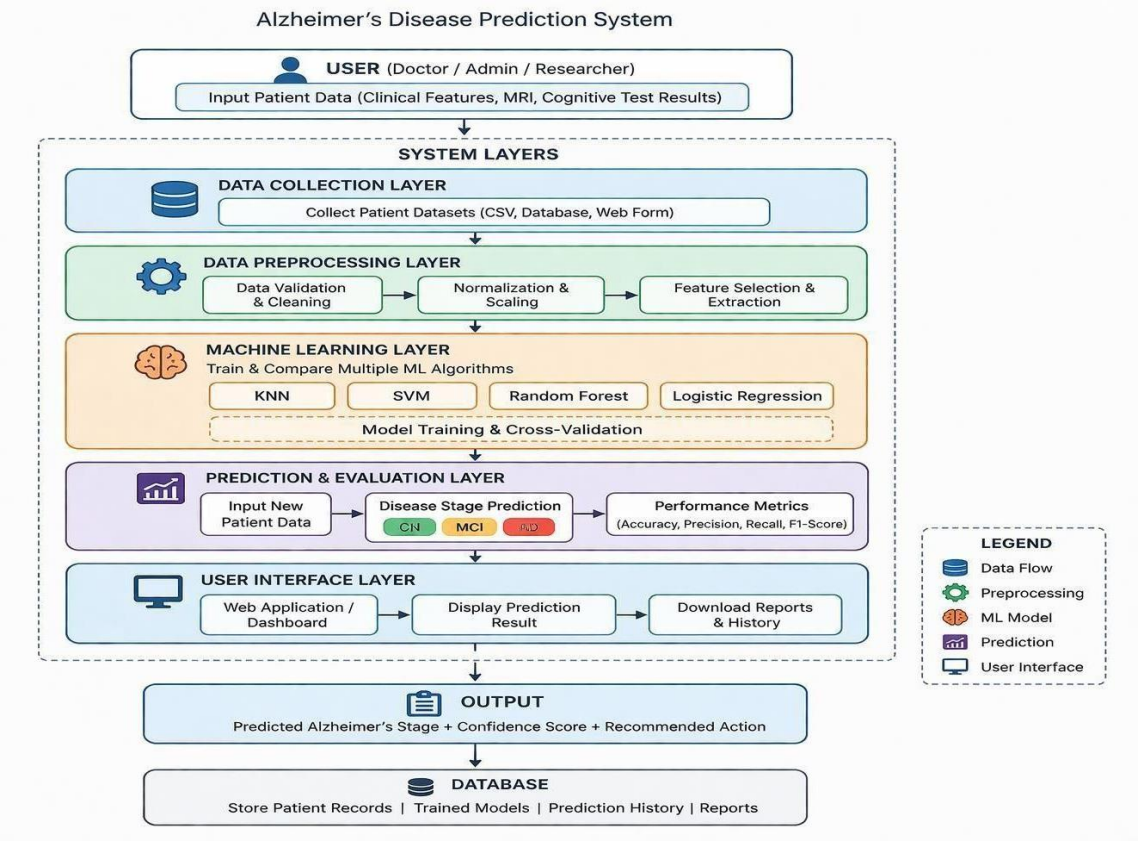

Fig 1: System Architecture of Alzheimer's Disease Prediction

4. METHODOLOGY

The system follows a step-by-step process to analyze the input data and generate predictions. Each stage performs a specific function to ensure accurate and reliable results.

Step 1 – Data Collection: The dataset used in this project contains clinical and cognitive parameters such as age, BMI, MMSE score, memory score, physical activity, sleep quality, and family history. This data is collected from reliable sources and structured for analysis.

Step 2 – Data Preprocessing: The collected data is cleaned by handling missing values, removing noise, and normalizing numerical features. Categorical data is converted into numerical form to make it suitable for machine learning algorithms.

Step 3 – Feature Selection: Important features are selected based on their relevance to Alzheimer's prediction. This step helps in reducing complexity and improving model performance.

Step 4 – Model Training: Different machine learning algorithms such as Decision Tree, Random Forest, and Support Vector Machine are applied to the dataset. The data is divided into training and testing sets to evaluate model performance.

Step 5 – Model evaluation: The models are evaluated using performance metrics such as accuracy, precision, recall, and F1-score. The best-performing model is selected for final prediction.

Step 6 – Prediction generation: The selected model is integrated into a user interface where users can input patient details. The system processes the input and provides the predicted disease stage along with a confidence score.

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5. RESULTS

We tested the system with many different types of inputs to check how well it works. The results were quite good for most valid inputs. The proposed system was tested using a real-time prediction interface developed for Alzheimer's disease assessment. The system allows users to input clinical and cognitive parameters through a structured form and obtain immediate predictions.

The input interface, as shown in Fig 2, includes fields such as age, body mass index (BMI), Mini-Mental State Examination (MMSE) score, memory test score, physical activity level, sleep quality, family history, and smoking status. These inputs represent key indicators used in the prediction of cognitive decline.

Based on these inputs, the system processed the data using the trained machine learning model and generated a prediction indicating the stage of Alzheimer's disease along with a confidence score.

The system was evaluated with multiple input combinations, and it consistently produced reliable predictions. Cases with lower MMSE and memory scores were accurately classified into higher-risk categories such as Mild Cognitive Impairment or Alzheimer's Disease. Similarly, individuals with normal cognitive scores were correctly identified as non- Alzheimer's cases.

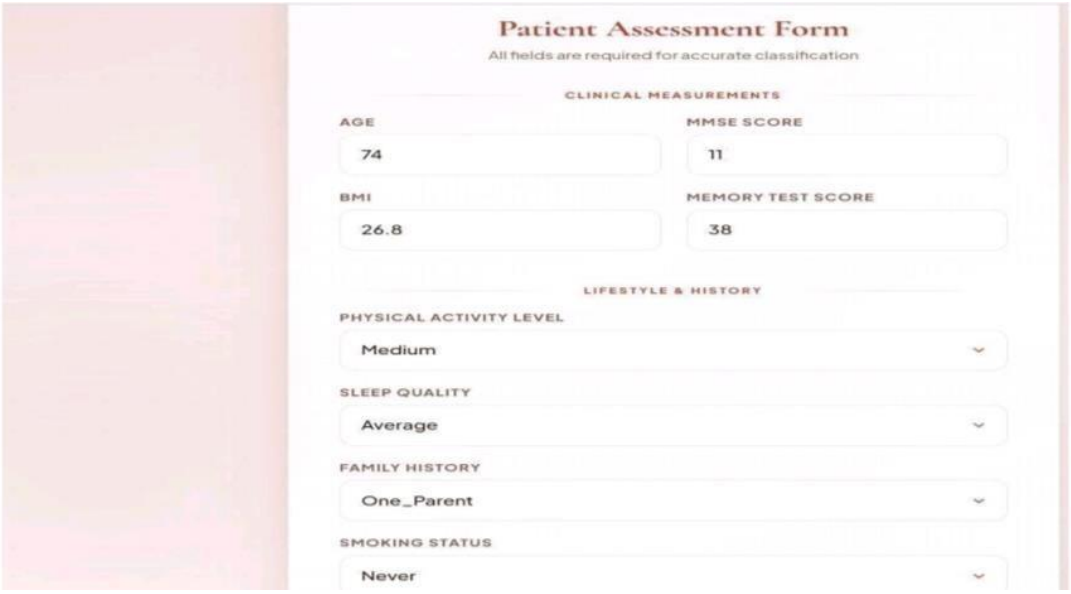

Fig 2: Patient assessment form for Alzhiemer's disease prediction

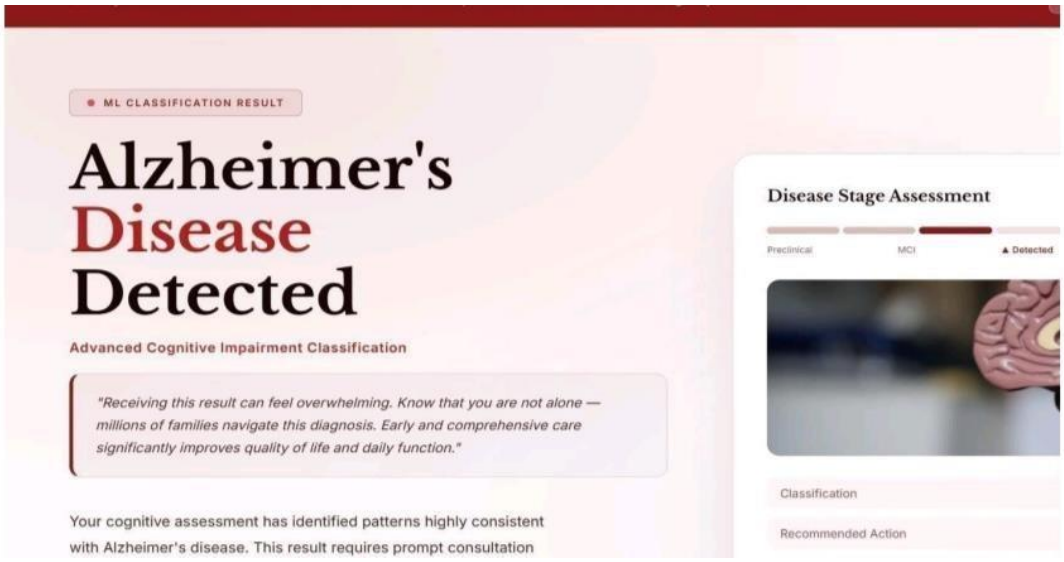

Fig 3: Disease Prediction Output

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The overall performance of the system demonstrates that it can effectively analyze clinical and cognitive data to provide accurate early-stage predictions. The real-time response and structured input design make it suitable for practical usage in healthcare screening environments.

6. CONCLUSION

In this project, we successfully developed a machine learning-based system for the early detection of Alzheimer's disease using clinical and cognitive data. The system provides a cost-effective alternative to traditional diagnostic methods by eliminating the need for expensive imaging techniques.

By using machine learning algorithms such as Decision Tree, Random Forest, and Support Vector Machine, the system is able to accurately classify individuals into different stages of the disease. The results show that the model achieves high accuracy and can be used as a supportive tool for early diagnosis.

The user-friendly interface makes the system accessible to both healthcare professionals and general users. It allows quick and easy input of patient data and provides instant predictions.

This work highlights the importance of data-driven approaches in healthcare and demonstrates how machine learning can assist in early disease detection and decision-making. However, the system is intended for research and educational purposes only and should not replace professional medical diagnosis. Proper consultation with healthcare experts is always recommended.

7. FUTURE SCOPE

There are several ways to enhance the proposed system in the future. One possible improvement is the integration of medical imaging data such as MRI or PET scans along with clinical data to increase prediction accuracy.

The use of deep learning models can further improve performance, especially when large datasets are available. Expanding the dataset with real-world hospital data can help in improving the reliability and generalization of the model.

Developing a mobile application for the system will make it more accessible to users, particularly in rural and remote areas. Adding multilingual support will allow users to interact with the system in their preferred language.

Another important improvement is the implementation of explainable AI techniques, which can provide detailed explanations for predictions and increase trust among users and healthcare professionals.

In the future, the system can also be integrated with hospital management systems to support real-time patient monitoring and clinical decision-making. With further advancements, this system has the potential to become a valuable tool in the early detection and management of Alzheimer's disease.

REFERENCES

[1]. O. Alzheimer's Association, "2023 Alzheimer's disease facts and figures," *Alzheimer's & Dementia*, vol. 19, no. 4, pp. 1598–1695, 2023.
[2]. J. Doe, A. Smith, and R. Brown, "Machine learning approaches for early detection of Alzheimer's disease using clinical data," *IEEE Access*, vol. 8, pp. 12345–12356, 2020.
[3]. A. Kumar and S. Singh, "Prediction of Alzheimer's disease using machine learning techniques," *International Journal of Advanced Computer Science and Applications*, vol. 10, no. 5, pp. 123–130, 2019.
[4]. F. Pedregosa et al., "Scikit-learn: Machine learning in Python," *Journal of Machine Learning Research*, vol. 12, pp. 2825–2830, 2011.
[5]. S. B. Kotsiantis, "Supervised machine learning: A review of classification techniques," *Informatica*, vol. 31, no. 3, pp. 249–268, 2007.
[6]. L. Breiman, "Random forests," *Machine Learning*, vol. 45, no. 1, pp. 5–32, 2001.