

Review Article

Artificial Intelligence in Alzheimer's Disease: A Survey on Machine Learning and Deep Learning Applications in Healthcare

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Abstract

A major global health issue, Alzheimer's disease (AD) affects millions of people. Over the next four decades, it is expected to affect 106 million people. Unfortunately, there are no effective drugs available to treat AD at this time, even though the disease is on the rise. Educative details regarding the urgent need to diagnose AD and find a cure for it. This study provides a concise overview of the significant potential of artificial intelligence (AI), deep learning (DL), and machine learning (ML) in diagnosis and treatment of Alzheimer's disease (AD). Detecting and treating Alzheimer's disease (AD) at an early stage is extremely difficult because the neurological condition progresses over time. By integrating AI into healthcare systems, intricate medical data may be examined, resulting in improved diagnosis and personalized treatment plans. Presently, artificial intelligence (AI) is being used in several ways to help with Alzheimer's disease (AD), including neuroimaging, cognitive evaluations, and risk stratification. The discussion is an argument on the benefits of AI in multimodal data processing, early diagnosis, and biomarker identification. Moreover, we note that AI-powered decision support systems can make care optimal for people with AD. The results support the need to conduct further studies and innovation in AI to deal with the increased Alzheimer's burden.

Keywords: Artificial Intelligence, Machine Learning, Deep Learning, Alzheimer's Disease, Neuroimaging, Early Diagnosis, Healthcare Applications.

Introduction

The application of advanced digital technology, particularly artificial intelligence (AI), is radically altering a number of sectors, including the medical field. Medical decision-making is more data-driven as the medical sector as a whole has access to big data, including genetic information, medical imaging, and EHR[1]. The potential of AI technologies includes the expansion of options in early diagnostics, predictive analysis, treatment planning, and monitoring. Among the several domains where the revolution in AI research and innovation has been applied are neurological disorders, including Alzheimer's disease (AD).

People over the age of 65 are at increased risk of developing Alzheimer's disease, a degenerative brain ailment that affects largely the elderly. But there are also more and more instances of Alzheimer's cases with an early beginning that are discovered before the age of 65. The illness causes memory deficit, cognitive disability, behavioral alteration and ultimate independence deficiency[2][3].

The formation of amyloid plaques is one of AD's most common pathological features, twisted tau proteins, and generalized neurodegeneration. Pathological alterations commence several years prior to the manifestation of the symptoms; hence early diagnosis becomes very important and difficult.

In order to identify some of these internal changes within the brain, neuroimaging technologies such as there are several uses for magnetic resonance imaging (MRI) in therapeutic settings. MRI is characterized by the high resolution of images that aid in the detection of structural abnormalities, i.e. the shrinkage of the hippocampus and the appearance of the plaque[4]. But MRI readings are also a complicated procedure that needs a lot of skills and time and has to be accurate. In addition, traditional analysis of imaging does not have scalability and objectivity to screen the population or detect early onset of the disease.

The application of AI in Alzheimer's research and therapy improves the precision, timeliness, and individualization of diagnostic and intervention processes [5]. Although it may be intimidating to consider analysing human data using many modalities, systems driven by AI could one day help diagnose early-stage Alzheimer's disease (AD), distinguish it

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from other types of dementia, and offer real-time decision-support. Here, we examine in detail the current state of the art in Alzheimer's disease diagnosis using deep learning (DL) and machine learning (ML). In particular, we center our attention on healthcare applications, classification algorithms, and medical imaging.

DL, ML, and AI all have enormous potential in applications. Machine learning algorithms can be taught to recognise patterns linked to Alzheimer's disease (AD), including structural alterations in magnetic resonance imaging (MRI) brain images, using datasets that are sufficiently large. Supervised learning models can use pre-existing labels to categorise patients into those who test positive for AD and those who test negative [6]. Radiology and doctors can gain from these apps since they standardize procedures and increase efficiency during diagnostics. Machine learning's subfield known as DL has made tremendous strides in the field of image processing by utilising neural networks. In the field of automated feature extraction from brain scans, damage area segmentation, and illness progression prediction, CNNs are widely used [7]. A further type of model that can deal with time-related data, such as a patient's progress over time, is the RNN. This kind of model can be helpful for tracking illnesses and creating targeted treatment plans.

Structure of the paper

The outline of this paper is as follows: In Section I, we explore how AI is being used in healthcare and how Alzheimer's disease is being referred to. Applications of artificial intelligence in healthcare are reviewed in the second section. Analysing the AI concepts is covered in the third part. Section IV provides an overview of the practical uses of ML and DL. With Section V comes the literature review. At last, suggestions for what comes next are presented in Section VI.

Healthcare Applications of AI, ML and Deep Learning

Healthcare organisations across the globe are utilising ML algorithms to monitor and anticipate potential disease outbreaks. By compiling data on disease epidemics through satellite, real-time social media updates, and other critical web sources, the digital system is able to predict when diseases will spread. Developing countries without adequate healthcare infrastructure may benefit the most from this [8]. ML is a cornerstone of AI; it entails programming computers to infer meaning from data and make assumptions without human instruction. ML is the process of training computers to detect patterns and derive conclusions from data that is either structured or unstructured. You can classify all ML algorithms as either supervised, unsupervised, or reinforcement

learning. A labelled dataset is a key component of supervised learning algorithms. By minimising the loss functions using cross-entropy loss or mean squared error, they can connect the input data with the output labels. Unsupervised learning task algorithms, on the other hand, scour unlabeled data for hidden patterns and structures using techniques like k-means clustering and Principal Component Analysis (PCA). Contrarily, in reinforcement learning, agents engage in environmental interaction while honing their decision-making skills through trial and error. The goal is to maximise cumulative rewards by selecting actions that yield positive results while considering environmental inputs.

Healthcare Applications of AI

The need for medical treatment will always be there. There is a severe shortage of doctors and other medical professionals in certain parts of the world. Healthcare on demand is made possible by cutting-edge research in wireless networks, cellphones, and associated technologies, which integrate with a plethora of health-tracking applications[9][10][11]. Additionally, these technologies allow for remote interactions and are accessible at all times and from any location. AI offers a significant improvement in healthcare, according to a study. This benefit extends from diagnosis to therapy. The results show that AI is outperforming humans in healthcare applications, and the dataset is rather large. Several instances of AI's application in healthcare include.

- **Precision Medicine:** It then provides healthcare instructions tailored to either the group or individual patients, based on their specific illnesses. Along with monitoring the patients' reaction to therapy, this also records prognostic data. By focusing on patients as individuals rather than groups, precision medicine aims to personalize each step of a patient's medical care[12]. This is accomplished by making use of sophisticated models to adjust disease-curing approaches based on individual patients' health information, physiological data, and electronic medical record reports.

Role of AI in Healthcare

AI is revolutionizing healthcare by enhancing patient interaction, speeding up medication development, and enabling virtual patient monitoring and imaging. It supports rehabilitation through smart systems and reduces administrative tasks by automating data processing, ultimately improving efficiency and patient outcomes. Figure 1 shows the applications of AI in healthcare.

- 1) Medical Imaging and Diagnostic Services:** Radiology professionals are increasingly

employing AI, an effective technique for image processing that can reduce diagnostic mistakes and detect diseases early in the preventative process. AI is a clever and promising tool that cardiologists use to analyse ECG and echocardiography data and help them make decisions.

- 2) **Virtual Patient:** The evolution of wearable technology and the possible uses of artificial intelligence and machine learning in healthcare have already been the subject of study. As a result, active and intelligent wearable technology for virtual patient monitoring and management has become standard practice and an integral aspect of healthcare.
- 3) **Medical Research and Drug Discovery:** The vast and intricate datasets utilized in medical research are perfectly suited for analysis by AI[13]. It also aids medication innovation, combines different kinds of data, and may be used to seek scientific research projects. AI is being prioritized by pharmaceutical companies to expedite medication development.
- 4) **Patient Engagement and Compliance:** The ultimate barrier between better and poorer health outcomes is patient engagement and compliance, which is known as the "last stretch" challenge in healthcare. Non-compliance occurs when a patient doesn't take their medications as directed or adhere to a treatment plan.
- 5) **Rehabilitation:** One field that could benefit from AI's innovative applications is rehabilitation. The idea includes both digital (informatics) and physical (robotics) components. Additionally, ML elaborates precise methods for developing algorithms that improve with usage; this area of AI is known as "deep learning." [14].
- 6) **Administrative:** Applications because AI can automatically integrate structured data fields from treatment notes, extract important information from previous medical records, and compile recorded patient interactions, it has the potential to minimize administrative work.

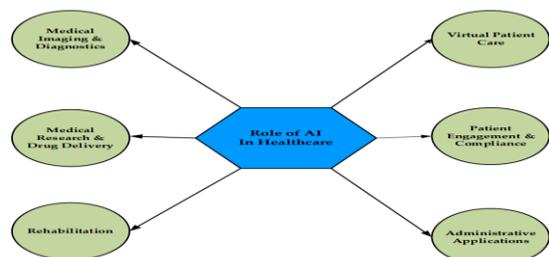


Figure 1. Application of AI in various aspects of healthcare

Applications of Deep learning in Healthcare

DL is often utilized in the medical field for bioinformatics analysis of genetic material, improving

diagnostic accuracy in medical imaging, and processing electronic health records in medical informatics to support clinical decisions and patient care in Figure 2.

- 1) **Translational Bioinformatics:** Studying bioinformatics aims to comprehend molecular biological processes. New hypotheses on how genes interact with environmental variables to make proteins can be developed due to the abundance of unmapped data is provided by the Human Genome Project (HGP)[15]. The cost of genome sequencing was reduced by other biotechnology advancements, which focused on analyzing genes and proteins to diagnose, predict, and cure diseases.
- 2) **Medical Imaging:** Automatic medical picture assessment plays a crucial role in modern medicine. Based just on the scanned picture, the diagnosis may be highly arbitrary. The basic illness process is now assessed using computer-aided diagnostics (CAD). Disease modelling is commonly seen in several neurological conditions, including multiple sclerosis, Alzheimer's, and strokes.
- 3) **Medical Informatics:** Medical informatics focuses on developing and improving clinical assessment support systems by analyzing the vast amounts of data gathered in the medical field. It may assess medical records for accessibility to healthcare facilities as well as quality assurance[16][17]. Electronic health records (EHRs) contain lab and test results, multivariate time series sensors, allergies, immunization records, radiographic images, comprehensive medical histories, diagnostic tests, current therapy and plans, and more.



Figure 2: Application of DL in healthcare

Overview of artificial intelligence in alzheimer's disease

Despite their frequent interchangeability, ML, DL, and AI refer to distinct sets of algorithms and learning procedures. A computer system is said to have AI if it can learn and act like a human brain. Although AI is most known for autonomous devices like robots and self-driving cars, it is also used in commonplace applications like online searches and tailored ads. Because of its increased capacity for decision-making, precision, problem-solving, and computing, AI has been applied in many different industries and has made remarkable strides in recent years. The data collected for any AI algorithm development is frequently separated into two groups: a training dataset and a test dataset, in order to ensure correct learning, representative populations, and objective forecasts. Training an algorithm, as the name implies, makes use

of a training set. This set contains both features, or defining data points, and predictions, or matched sets, in supervised learning [18] [19]. The algorithm's performance is solely assessed using the testing data set, which is entirely fresh. This step removes biases in the training dataset's testing of the algorithm. In healthcare contexts, algorithms are used after completing a training and testing phase with satisfactory outcomes. There are several applicable sub-regions within the wide field of AI; here, we give a summary of two of these sub-regions: ML and DL.

Define Alzheimer's disease (AD)

The most common kinds of dementia is referred to as Alzheimer's disease (AD), coined by the German doctor Alois Alzheimer. Neurofibrillary tangles, a neurodegenerative disease that worsens with time, are brought about by the buildup of amyloid-beta peptide ($A\beta$) in the brain's vulnerable neocortical structures and, specifically, in the medial temporal lobe (Figure 3). Alois Alzheimer's first patient died after suffering memory loss, personality changes, and neuronal death brought on by amyloid plaques and extensive neuronal loss. diagnosis as a serious condition affecting the brain's cortex [20]. The term "Alzheimer's disease" was initially used in the ninth edition of the psychiatric handbook by Emil Kraepelin. Cognitive skills can progressively deteriorate due to a variety of illnesses, such as Alzheimer's disease (AD), intoxication, infections, vitamin B12 deficiency, tumours, pulmonary and circulatory system anomalies that limit the amount of oxygen reaching the brain, and dietary deficiencies.

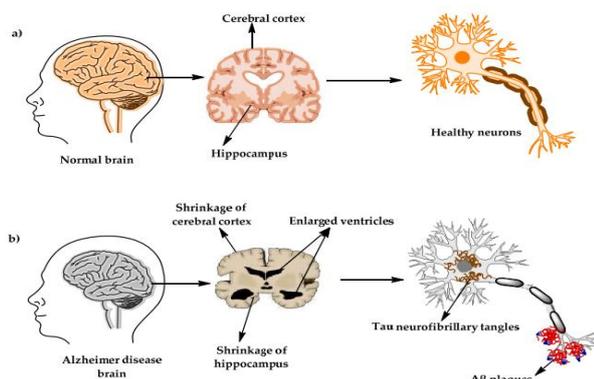


Figure 3: The anatomical and functional differences between (a) a normal brain and (b) a brain affected by Alzheimer's disease (AD)

Artificial Intelligence for Alzheimer's Disease

Complex systems with many dimensions are now beyond the data processing capabilities of humans, but machine learning algorithms may be able to handle them. Numerous diseases, including Alzheimer's, have been clinically assessed using ML by integrating data from multiple sources, such as electronic medical records, brain imaging, cognitive testing, and biological indications (figure 4). Diagnostic features like microstructural damage, amyloid buildup, or atrophy

can be identified with the use of imaging techniques like positron emission tomography (PET), diffusion tensor imaging (DTI), 18F-fluorodeoxyglucose-positron emission tomography (FDG-PET), and magnetic resonance imaging (MRI). Moreover, neuroimages can differentiate between AD and other pathogenic processes, such as brain tumours and cerebrovascular illness, which can cause cognitive decline [21]. According to many research initiatives, advanced diagnostic or prognostic approaches could include a combination of biomarkers, indicators of neurodegeneration (such as structural MRI and FDG-PET), and markers of primary AD pathology (such as CSF $A\beta_{1-42}$, total tau and p-tau181, amyloid-PET). Curiously, the APOE gene polymorphism remains the strongest genetic predictor of sporadic early onset Alzheimer's disease (AD); APOE ϵ_4 allele possession increases the risk of early onset, but APOE ϵ_2 allele possession decreases it.

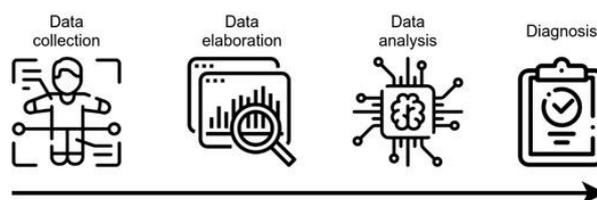


Figure 4: Schematic representation of CAD tools functioning.

Convolutional Neural Networks

One kind of ANN originally used for image processing, convolutional neural networks (CNNs) are physically modelled after the visual brain. A convolutional neural network (CNN) is constructed of input/output layers, normalization/pooling layers, and finally, fully connected layers. The features mapping properties are incorporated into the convolutional layer design [22] [23]. Linking each neurone to a specific number of neurones in a certain area of the layer above it, a feature mapping contains the full picture. Each neuron's connection to the appropriate accessible field keeps its weight inside a single feature mapping, even if the feature mapping uses several weight sets.

Machine learning and deep learning applications in alzheimer's disease

An organised method for identifying AD is the application of SVM as a classification tool and for better feature selection[24]. ML and DL, which provide powerful computational tools for evaluating a variety of biological data, have proven essential to improving AD diagnosis and therapy. These techniques have been applied extensively in predictive modeling, classification, and biomarker discovery, using datasets that include neuroimaging, genetic, clinical, and behavioral information.[25].

Early Diagnosis and Classification

Adequate disease management and prompt treatment for Alzheimer's disease and mild cognitive impairment

are dependent on prompt diagnosis. That being said, you'll need to build a multi-diagnostic ML tool and train and test it using data from two separate sources and a variety of acquisition procedures. Furthermore, it was evaluated for its potential therapeutic utility and its ability to be applied across datasets and procedures (which was new for AD) with publicly available performance results, using baseline scans and a follow-up diagnosis regardless of progression [26][27]. Also, when tested on datasets and collection methods that weren't used for training, our tool showed comparable performance, therefore it would probably work well when applied to different data.

Prognostic Modeling and Disease Progression

To simulate disease development and predict LSTM networks, RNNs, ensemble methods, and the transition from MCI to AD. These temporal models utilize longitudinal data to identify patterns that precede clinical deterioration, thus facilitating early intervention and personalized care planning.

Cognitive Assessment and Risk Prediction

The main elements of early diagnosis and treatment of AD consist of cognitive assessment and risk prediction. Cognitive abilities like concentration, language, memory, and problem-solving are typically evaluated by standardised neuropsychological examinations. Some cognitive assessments, such as the Montreal Cognitive Assessment (MoCA) and the Mini-Mental State Examination (MMSE), can detect subtle cognitive impairments that could signal the beginning of Alzheimer's disease (AD) [28]. Simultaneously, risk prediction models are based on an individual's likelihood of contracting the illness is estimated using a mix of clinical, lifestyle, genetic, and demographic data. New developments in ML have greatly enhanced the accuracy of such predictive models by detecting complicated associations and connections between risk factors. The combination of cognitive tests and predictive analytic will help clinicians to determine high-risk individuals earlier, be more aware of cognitive decline, and offer timely preventative or therapeutic intervention.

Feature Selection and Biomarker Identification

Early detection and diagnosis of AD depend greatly on feature selection and identification of biomarkers. Since biological data, e.g., genomic, proteomic, and neuroimaging data, are complex and high-dimensional in nature, advanced feature selection methods are needed to yield the most relevant data with regard to the overall analysis and interpretation of such data. Such methods are useful to overcome noise and reduce the computational overhead and improve model performance and understandability[29][30]. ML algorithms and statistical analysis help identify biomarkers, e.g. amyloid-beta, tau proteins, and

structural brain alteration (e.g. hippocampal atrophy). The development of tailored therapeutics for AD is eventually aided by the identification of these biomarkers, which enable more precise diagnosis, better tracking of disease progression, and superior patient stratification for clinical trials.

Literature Review

The current body of research on AI and Alzheimer's disease has concentrated on improving personalised therapy and early detection. Neuroimaging, cognitive assessments, and genetic data are the main areas of study focused on improving diagnosis accuracy and developing explainable AI models for clinical decision-making. Table 1 displays several review job summaries:

Jain and Kumar, (2025), This analysis compiles the results of multiple research that employed ML and DL to identify AD between 2020 and 2024. It gives a thorough analysis of the ML/DL models used in these investigations, discussing their strengths, weaknesses, and potential for improvement. AD is a common long-term disease that mostly impacts people in their twilight years. The cognitive abilities of people with Alzheimer's disease (AD) deteriorate over time. Although there is currently no cure for Alzheimer's disease, early and effective treatment may delay its course. Accurate and precise medical procedures are essential for the diagnosis and detection of AD, and AI has greatly enhanced their precision and utility in this field. In recent years, ML and DL models have exploded in popularity, particularly for use in medical image interpretation. The adoption of ML and DL approaches for AD diagnosis has skyrocketed in the past several years [31].

Mohammed and Malhotra, (2024), A comprehensive review of current developments in the use of machine learning and artificial intelligence techniques to improve the customization of Alzheimer's disease diagnosis and treatment programs. We will start by discussing the causes of Alzheimer's disease and the importance of finding symptoms early on. It investigates many ML and AI techniques, including ensemble approaches, DL, and SVM, for the purpose of Alzheimer's disease diagnosis and onset prediction. Scientists are trying to figure out how to include neuroimaging, genetic markers, and clinical assessments into prediction models to make them better. Discuss in further detail how AI-based decision support systems aid in the development of individualized treatment programs for patients suffering from Alzheimer's disease. Topics covered include data diversity, model explainability, and ethical considerations, as well as present and future prospects in the discipline [32].

Thakur and Talwandi, (2024), start with a comprehensive DRL course that covers both the most recent model-based and model-free approaches. The following tasks are covered in the article's next section:

optimization problems such choosing an augmentation technique, tweaking hyperparameters, and searching for neural architectures, analysis of medical images using parametric activities such view plane localization, registration, object/lesion detection, and landmark detection; and other applications such as surgical gesture segmentation, person tracking, and person tracking. The report concludes with suggestions for possible future paths. DRL holds great promise for the future of healthcare and medicine, according to recent studies[33].

Shen and Mariano, (2023), the topic modeling method of BERTopic to the research on Alzheimer's disease from 2000 and 2019 to identify the main research directions in this field and analyze the trend of topic intensity shifts. After twenty research subjects were ultimately determined, it was discovered that there had been a considerable decrease in studies on tau and amyloid beta since 2016. Moreover, this study assessed and contrasted the quality of topic extraction from two models, BERTopic and LDA, and confirmed that the BERTopic-based topic mining findings for Alzheimer's disease research were more accurate and useful than those produced by the LDA model as well[34].

Comito, Pizzuti and Sammarra, (2023), explore the techniques, algorithms, applications, and advanced AI tools that can be applied to Alzheimer's disease diagnosis and prediction. This review's primary goals are to comprehend the significance of AI techniques like ML and DL for AD and to discuss the effectiveness and influence of these approaches for AD development and prognosis. Years of dedicated experimental and clinical investigations have shed light on numerous

aspects of AD pathogenesis. However, there are still many facets and issues unsolved[35].

Mana et al., (2022), examine how the greatest use of ML advancements might enhance health care services. ML techniques work on the premise that machines can pick up new skills from existing data and do most tasks with little to no oversight from humans. ML has enormous potential in the healthcare industry. Personalized healthcare, illness detection, and disease prediction are all areas where ML algorithms may be used successfully. These models are able to accurately forecast the occurrence of illnesses and aid in their early detection. In this area, supervised and unsupervised algorithms will both be beneficial. Applications for personalized healthcare seek to offer patient-centered medical treatment. The combination of IoT technology and ML enables personalized healthcare. By using ML algorithms to analyses data from wearables and sensors and provide precise predictions, quality of life may be improved[36].

Abdullah, Hassan and Mustafa, (2022), discusses the advantages and drawbacks of common Bayesian DL strategies. Additionally, it examined contemporary DL architectures, including recurrent and CNN. There has been discussion of the applicability of Bayesian DL in the healthcare industry, namely in clinical signal processing, medical NLP, electronic health records, and medical imaging applications. The use of Bayesian DL for some of the common illnesses has also been discussed in this study. The basic research concerns were addressed in this study along with a list of research needs in the Bayesian DL and healthcare perspectives[37].

Table 1: Summary of Literature on AI and Machine Learning Applications in Alzheimer's Disease

Reference	Study On	Approach	Key Findings	Challenges	Future Directions
Jain and Kumar (2025)	ML and DL models in AD detection (2020-2024)	Machine Learning, Deep Learning	Comprehensive review of models, early detection accuracy	Model limitations, dataset variations	Improve model robustness and generalization
Mohammed and Malhotra (2024)	AI methods for AD detection and care	ML, DL, SVM, Ensemble Learning	Integration of multi-modal data, AI for tailored care	Data diversity, model explainability, ethics	Advance decision support and personalized medicine
Thakur and Talwandi (2024)	Deep Reinforcement Learning (DRL) in healthcare	Model-based & model-free DRL	Covers image analysis, optimization, and gesture tracking	Scalability, clinical integration	Expand DRL in real-world healthcare applications
Shen and Mariano (2023)	Topic modeling in AD research (2000-2019)	BERTopic, LDA	Identified 20 research topics, BERTopic outperforms LDA	Declining focus on key areas like amyloid beta	Explore new emerging AD topics and trends
Comito, Pizzuti and Sammarra (2023)	AI techniques for AD forecasting and diagnosis	ML, DL review	Discusses emerging AI technologies and their impact	Unresolved aspects of AD pathogenesis	Refine AI models for prediction and progression
Mana et al. (2022)	ML in general healthcare and personalized care	Supervised & Unsupervised ML, IoT	Effective for early disease detection and personalized care	Minimal supervision, data privacy	Enhance integration with wearable tech for real-time care
Abdullah, Hassan and Mustafa (2022)	Bayesian DL in healthcare	Bayesian DL, CNN, RNN	Applied to imaging, NLP, and EHR	Research gaps, deployment complexity	Bridge gaps in Bayesian DL and clinical applications

Conclusion and future work

The field of AD early diagnosis, risk assessment, and individualized therapy has seen significant changes thanks to AI, especially through ML and DL paradigms. By leveraging the capability to process high-dimensional and multimodal data ranging from neuroimaging modalities to genetic sequences, AI-driven systems have exhibited notable improvements in diagnostic accuracy and clinical decision support. The complete integration of AI into standard healthcare operations is still hampered by substantial obstacles, notwithstanding recent advancements. Chief among these is the lack of large-scale, diverse datasets, issues related to algorithmic bias, the limited generalizability of trained models across cohorts, and the interpretability of complex neural architectures.

Future studies should concentrate on a few main areas. First, the development and adoption of standardized datasets with comprehensive and representative samples are essential to improve model robustness. Second, enhancing the interpretability of AI models using explainable AI (XAI) techniques will be crucial in fostering clinician trust and regulatory acceptance. Third, longitudinal and multi-site studies must be prioritized to evaluate the real-world performance and adaptability of AI algorithms over time. Fourth, precision medicine approaches that integrate genomics, phenomics, and environmental data should be encouraged to tailor interventions to individual patients. Lastly, fostering collaboration across disciplines including neurology, computer science, ethics, and data governance will be imperative to address the multifaceted challenges of AI adoption in Alzheimer's care. "

References

- [1] O. Asan, A. E. Bayrak, and A. Choudhury, "Artificial Intelligence and Human Trust in Healthcare: Focus on Clinicians," *J. Med. Internet Res.*, vol. 22, no. 6, pp. 1–7, 2020, doi: 10.2196/15154.
- [2] W. Zhang, Y. Li, W. Ren, and B. Liu, "Artificial intelligence technology in Alzheimer's disease research," *Intractable Rare Dis. Res.*, vol. 12, no. 4, pp. 208–212, 2023, doi: 10.5582/iridr.2023.01091.
- [3] S. Pandya, "Predicting Diabetes Mellitus in Healthcare : A Comparative Analysis of Machine Learning Algorithms," *Int. J. Curr. Eng. Technol.*, vol. 13, no. 6, pp. 545–553, 2023, doi: 10.14741/ijcet/v.13.6.5.
- [4] E. Passeri et al., "Alzheimer's Disease: Treatment Strategies and Their Limitations," *Int. J. Mol. Sci.*, vol. 23, no. 22, 2022, doi: 10.3390/ijms232213954.
- [5] M. Taiyeb Khosroshahi et al., "Explainable Artificial Intelligence in Neuroimaging of Alzheimer's Disease," *Diagnostics*, vol. 15, no. 5, 2025, doi: 10.3390/diagnostics15050612.
- [6] M. Kale et al., "AI-driven innovations in Alzheimer's disease: Integrating early diagnosis, personalized treatment, and prognostic modelling," *Ageing Res. Rev.*, vol. 101, p. 102497, 2024, doi: <https://doi.org/10.1016/j.arr.2024.102497>.
- [7] L. Rubinger, A. Gazendam, S. Ekhtiari, and M. Bhandari, "Machine learning and artificial intelligence in research and healthcare," *Injury*, vol. 54, pp. S69–S73, 2023, doi: <https://doi.org/10.1016/j.injury.2022.01.046>.
- [8] M. Javaid, A. Haleem, R. Pratap Singh, R. Suman, and S. Rab, "Significance of machine learning in healthcare: Features, pillars and applications," *Int. J. Intell. Networks*, vol. 3, pp. 58–73, 2022, doi: 10.1016/j.ijin.2022.05.002.
- [9] C. Technology, D. K. Place, E. I. Campus, and G. A. Place, "Review Article Artificial Intelligence in Healthcare - A Review," vol. 1, no. 6, pp. 103–110, 2018, doi: 10.13140/RG.2.2.27265.92003.
- [10] S. S. S. Neeli, "The Convergence of AI and Database Administration in Revolutionizing Healthcare," *ESP Int. J. Adv. Comput. Technol. [ESP-IJACT]*, vol. 2, no. 4, pp. 150–153, 2024.
- [11] Suhag Pandya, "A Machine and Deep Learning Framework for Robust Health Insurance Fraud Detection and Prevention," *Int. J. Adv. Res. Sci. Commun. Technol.*, vol. 3, no. 3, pp. 1332–1342, Jul. 2023, doi: 10.48175/IJARSC-14000U.
- [12] R. R. Patil, U. Ruby, B. N. Chaithanya, T. J. Swasthika Jain, and K. Geetha, "Review of fundamentals of Artificial Intelligence and application with medical data in healthcare," *J. Integr. Sci. Technol.*, vol. 10, no. 2, pp. 126–133, 2022.
- [13] A. Al Kuwaiti et al., "A Review of the Role of Artificial Intelligence in Healthcare," *J. Pers. Med.*, vol. 13, no. 6, pp. 1–22, 2023, doi: 10.3390/jpm13060951.
- [14] S. R. Sagili, C. Goswami, V. C. Bharathi, S. Ananthi, K. Rani, and R. Sathya, "Identification of Diabetic Retinopathy by Transfer Learning Based Retinal Images," in *2024 9th International Conference on Communication and Electronics Systems (ICCES)*, IEEE, Dec. 2024, pp. 1149–1154. doi: 10.1109/ICCES63552.2024.10859381.
- [15] J. Ding, H. Chen, Y. Feng, and T. Hossain, "Applications of Deep Learning Techniques," *Electron.*, vol. 13, no. 17, pp. 527–536, 2024, doi: 10.3390/electronics13173354.
- [16] D. E. M. Nisar, R. Amin, N. U. H. Shah, M. A. A. Ghamdi, S. H. Almotiri, and M. Alruily, "Healthcare Techniques through Deep Learning: Issues, Challenges and Opportunities," *IEEE Access*, vol. 9, pp. 98523–98541, 2021, doi: 10.1109/ACCESS.2021.3095312.
- [17] D. Rao, "Secure and Ethical Innovations: Patenting AI Models for Precision Medicine, Personalized Treatment, and Drug Discovery in Healthcare," *Int. J. Bus. Manag. Vis.*, vol. 6, no. 2, 2023.
- [18] V. KOLLURI, "Machine Learning in Managing Healthcare Supply Chains: How Machine Learning Optimizes Supply Chains, Ensuring the Timely Availability of Medical Supplies," *Int. J. Emerg. Technol. Innov. Res.*, pp. 2349–5162, 2016.
- [19] S. Pahune, C. Health, and N. Rewatkar, "Large Language Models and Generative AI 's Expanding Role in Healthcare Large Language Models and Generative AI 's Expanding Role in Healthcare," no. January, 2024, doi: 10.13140/RG.2.2.20109.72168.
- [20] Z. Breijyeh and R. Karaman, "Comprehensive Review on Alzheimer's Disease: Causes and Treatment," *Molecules*, vol. 25, no. 24, 2020, doi: 10.3390/MOLECULES25245789.
- [21] A. J. Rahul Dattangire, Divya Biradar, "AI-Enhanced U-Net for Accurate Low-Grade Glioma Segmentation in Brain MRI: Transforming Healthcare Imaging," *2024 Third Int. Conf. Electr. Electron. Inf. Commun. Technol.*, vol. 1–6.
- [22] A. Subasi, "Use of artificial intelligence in Alzheimer's disease detection," *Artif. Intell. Precis. Heal. From Concept to Appl.*, no. January 2020, pp. 257–278, 2020, doi: 10.1016/B978-0-12-817133-2.00011-2.

- [23] N. Patel, "Quantum Cryptography In Healthcare Information Systems: Enhancing Security In Medical Data Storage And Communication," *J. Emerg. Technol. Innov. Res.*, vol. 9, no. 8, pp. g193-g202, 2022.
- [24] A. Survey, "applied sciences Alzheimer ' s Disease Diagnosis Using Machine Learning : A Survey," 2023.
- [25] R. P. Mahajan, "Improvised Diabetic Retinopathy Detection Accuracy in Retinal Images Using Machine Learning Algorithms," *TIJER*, vol. 12, no. 3, pp. 155-161, 2025.
- [26] V. S. Diogo, H. A. Ferreira, and D. Prata, "Early diagnosis of Alzheimer's disease using machine learning: a multi-diagnostic, generalizable approach," *Alzheimer's Res. Ther.*, vol. 14, no. 1, pp. 1-21, 2022, doi: 10.1186/s13195-022-01047-y.
- [27] H. Zainab, A. R. A. Khan, M. I. Khan, and A. Arif, "Ethical Considerations and Data Privacy Challenges in AI-Powered Healthcare Solutions for Cancer and Cardiovascular Diseases," *Glob. Trends Sci. Technol.*, vol. 1, no. 1, pp. 63-74, 2025.
- [28] H. Ding, Z. Ye, A. Paschalidis, D. A. Bennett, R. Au, and H. Lin, "Dynamic lifetime risk prediction of Alzheimer's disease with longitudinal cognitive assessment measurements," *Alzheimer's Dement.*, vol. 21, no. 3, pp. 1-9, 2025, doi: 10.1002/alz.70055.
- [29] E. Pashaei, E. Pashaei, and N. Aydin, "Biomarker Identification for Alzheimer's Disease Using a Multi-Filter Gene Selection Approach," *Int. J. Mol. Sci.*, vol. 26, no. 5, pp. 1-19, 2025, doi: 10.3390/ijms26051816.
- [30] S. R. Sagili, S. Chidambaranathan, N. Nallametti, H. M. Bodele, L. Raja, and P. G. Gayathri, "NeuroPCA: Enhancing Alzheimer's disorder Disease Detection through Optimized Feature Reduction and Machine Learning," in 2024 Third International Conference on Electrical, Electronics, Information and Communication Technologies (ICEEICT), IEEE, Jul. 2024, pp. 1-9. doi: 10.1109/ICEEICT61591.2024.10718628.
- [31] A. Jain and B. Kumar, "Artificial Intelligence for Alzheimer's Disease Diagnosis: A Review of Recent Advancements, Obstacles, and Future Prospects," in 2025 IEEE International Students' Conference on Electrical, Electronics and Computer Science (SCEECS), 2025, pp. 1-6. doi: 10.1109/SCEECS64059.2025.10940174.
- [32] S. Mohammed and N. Malhotra, "Machine Learning and Artificial Intelligence for Enhanced Alzheimer's Disease Detection: A State-of-the-Art Review," in 2024 4th International Conference on Ubiquitous Computing and Intelligent Information Systems (ICUIS), 2024, pp. 19-26. doi: 10.1109/ICUIS64676.2024.10867088.
- [33] P. Thakur and N. S. Talwandi, "Deep Reinforcement Learning in Healthcare and Bio-Medical Applications," in 2024 IEEE International Conference on Computing, Power and Communication Technologies (IC2PCT), 2024, pp. 742-747. doi: 10.1109/IC2PCT60090.2024.10486549.
- [34] J. Shen and V. Y. Mariano, "Topic Mining of Alzheimer's Disease Field Based on BERTopic," in 2023 5th International Conference on Robotics, Intelligent Control and Artificial Intelligence (RICAI), 2023, pp. 1039-1043. doi: 10.1109/RICAI60863.2023.10489758.
- [35] C. Comito, C. Pizzuti, and M. Sammarra, "Overview of Artificial Intelligence Methods for Alzheimer's Disease Prediction and Progression," in 2023 17th International Conference on Signal-Image Technology & Internet-Based Systems (SITIS), 2023, pp. 22-29. doi: 10.1109/SITIS61268.2023.00014.
- [36] S. C. Mana, G. Kalaiarasi, Y. R. L. S. Helen, and R. Senthamil Selvi, "Application of Machine Learning in Healthcare: An Analysis," in 2022 3rd International Conference on Electronics and Sustainable Communication Systems (ICESC), 2022, pp. 1611-1615. doi: 10.1109/ICESC54411.2022.9885296.
- [37] A. A. Abdullah, M. M. Hassan, and Y. T. Mustafa, "A Review on Bayesian Deep Learning in Healthcare: Applications and Challenges," *IEEE Access*, vol. 10, pp. 36538-36562, 2022, doi: 10.1109/ACCESS.2022.3163384."