EARLY DETECTION OF ALZHEIMER'S DISEASE USING NEUROIMAGING

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Certification

This is to certify that **Muhammad Sufyan (2020-BSCS-029), Syed Huzaifa Ali (2020-BSCS-030) , Abdul Rafay (2020-BSCS-031)** and **M.Hamza Jamil (2020-BSCS-042)** have successfully completed the final project **Early Detection of Alzheimer Using Neuroimaging,** at the **Sir Syed University of Engineering & Technology,** to fulfill the partial requirement of the degree **Bachelor of Science in Computer Science.**

External Examiner

Project Supervisor
Ms. Rabiya Tahir
(Senior Lecturer)

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Department of Computer Science, Sir Syed University of Engineering & Technology.

Project Title (mention project title here)

Sustainable Development Goals

(Please tick the relevant SDG(s) linked with FYDP)

SDG No	Description of SDG	SDG No	Description of SDG
SDG 1	No Poverty	SDG 9	Industry, Innovation, and Infrastructure
SDG 2	Zero Hunger	SDG 10	Reduced Inequalities
SDG 3✓	Good Health and Well Being	SDG 11	Sustainable Cities and Communities
SDG 4	Quality Education	SDG 12	Responsible Consumption and Production
SDG 5	Gender Equality	SDG 13	Climate Change
SDG 6	Clean Water and Sanitation	SDG 14	Life Below Water
SDG 7	Affordable and Clean Energy	SDG 15	Life on Land
SDG 8	Decent Work and Economic Growth	SDG 16	Peace, Justice and Strong Institutions
		SDG 17	Partnerships for the Goals

Range of Complex Problem Solving			
	Attribute	**Complex Problem**	
1	Range of conflicting requirements	Involve wide-ranging or conflicting technical, engineering and other issues.	
2	Depth of analysis required	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	
3	Depth of knowledge required	Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach.	
4	Familiarity of issues	Involve infrequently encountered issues	
5	Extent of applicable codes	Are outside problems encompassed by standards and codes of practice for professional engineering.	
6	Extent of stakeholder involvement and level of conflicting requirements	Involve diverse groups of stakeholders with widely varying needs.	
7	Consequences	Have significant consequences in a range of contexts.	
8	Interdependence	Are high level problems including many component parts or sub-problems	
Range of Complex Problem Activities			
	Attribute	**Complex Activities**	
1	Range of resources	Involve the use of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies).	
2	Level of interaction	Require resolution of significant problems arising from interactions between wide ranging and conflicting technical, engineering or other issues.	
3	Innovation	Involve creative use of engineering principles and research-based knowledge in novel ways.	
4	Consequences to society and the environment	Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation.	
5	Familiarity	Can extend beyond previous experiences by applying principles-based approaches.	

Abstract

Alzheimer's disease (AD) is a neurological ailment that causes behavioral abnormalities, cognitive impairment, and gradual memory loss. More than 5 million people are impacted by it, which is the sixth greatest cause of mortality in the country. For AD to be treated and managed effectively, early detection is essential. The present diagnostic techniques, however, are frequently intrusive, expensive, and ineffective. In this research, a brand-new computer-based approach to utilize neuroimaging for AD early diagnosis is proposed. The suggested method analyses brain imaging data using a hybrid pre-trained convolutional neural network (CNN) model. A dataset of brain MRI scans from AD patients, those with amnestic mild cognitive impairment (MCI), and cognitively healthy controls is used to train the model. The model has a 97% accuracy rate in predicting the chance of developing AD. The early detection of AD could be completely changed by the suggested method. Large populations can be screened for AD using this non-invasive, economical, and precise computer technique. The earlier AD is identified, the earlier it can be treated and managed, which can improve patient outcomes and lessen the financial impact the disease has on society. This innovative computer method represents a significant contribution to the field of AD diagnosis and is a valuable addition to existing research in the thesis.

Undertaking

I certify that the project **Early Detection of Alzheimer Using Neuroimaging** is our own work. The work has not, in whole or in part, been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged/ referred.

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We truly acknowledge the cooperation and help make by [**Name of Acknowledger], Designation** of **[Address of Organization].** He has been a constant source of guidance throughout the course of this project. We would also like to thank [**Name of Acknowledger**] from [**Designation]**, [**Address of Organization]** for his help and guidance throughout this project.

We are also thankful to our friends and families whose silent support led us to complete our project.

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Chapter 1

1.1 Introduction :

Alzheimer's disease (AD), a progressive neurodegenerative disorder affecting over 5 million people globally, poses a significant health challenge. Timely detection is crucial, with the number of cases expected to triple by 2050. Deep learning, a subset of artificial intelligence, has shown promise in early AD detection. This review focuses on H. Guo and Y. Zhang's groundbreaking work in 2020, highlighting deep learning's potential to advance Alzheimer's diagnosis. Early detection allows for interventions to slow progression, delaying cognitive decline and enabling better planning for patients and families. Current diagnostic methods, such as the cerebrospinal fluid test, are often invasive and ineffective, emphasizing the need for more accurate and accessible approaches in addressing this urgent public health concern.

1.2 Statement of the problem

Alzheimer's disease is a neurodegenerative disorder that leads to memory loss, cognitive decline, and behavioral changes, affecting millions of people worldwide. Early detection of Alzheimer's disease is crucial as it allows for appropriate interventions that can slow down disease progression and improve patient outcomes.

1.3 Goal/Aim

This project aims to develop a model for the early detection of Alzheimer's disease using neuroimaging. The proposed model will analyze AD, EMCI, CN, MCI, and LMCI scans respectively to predict the likelihood of developing Alzheimer's disease.

1.4 Motivation

The motivation for our project on early detection of Alzheimer's disease arises from the urgent global health challenge presented by the escalating prevalence of this neurodegenerative disorder. With over 5 million affected individuals worldwide and projections of a tripling by 2050, there is a critical need for effective interventions. Early detection is key for improved patient outcomes and quality of life. Our project leverages deep learning, a subset of artificial intelligence, to overcome current diagnostic limitations, aiming

to provide a more accurate and timely means of identifying Alzheimer's in its early stages. This endeavor seeks to make a positive impact on affected individuals and their families by facilitating early intervention.

1.5 Assumption and Dependencies

For the early detection of Alzheimer's, we assume that certain data patterns, recognized by deep learning, can reliably indicate the disease's early stages. We depend on having access to diverse datasets for training, which means working closely with healthcare institutions. Success also relies on better computer capabilities to handle complex data efficiently. Ethical handling of patient information and collaboration with medical experts are crucial for the project. We also assume that the patterns we find are the same for different groups of people.

1.6 Methods

The specific methods employed in a project on the early detection of Alzheimer's disease can vary, but they often involve the application of deep learning techniques to analyze complex datasets. Deep learning models, such as neural networks, may be trained on diverse sets of data, including brain imaging, genetic information, and clinical records. These models aim to identify patterns or biomarkers associated with early-stage Alzheimer's. Additionally, the methods include the development of algorithms for processing and interpreting the collected information, with a focus on accuracy, sensitivity, and specificity in detecting early signs of the disease. The overall goal is to leverage advanced technologies to enhance the accuracy and efficiency of Alzheimer's detection at an early stage.

1.7 Report Overview

The report on the early detection of Alzheimer's disease provides a comprehensive overview of a project aimed at leveraging advanced technologies, particularly deep learning, to enhance the identification of early-stage Alzheimer's. The report begins by addressing the motivation behind the project, emphasizing the urgent global health challenge posed by the increasing prevalence of Alzheimer's and the potential benefits of early detection. It outlines assumptions and dependencies, including the reliance on diverse datasets, advancements in computing capabilities, and ethical considerations in handling patient information.

The methods section details the approach taken, emphasizing the application of deep learning techniques such as neural networks to analyze complex datasets, including brain imaging, genetic information, and clinical records. Collaboration with healthcare institutions is highlighted for accessing relevant patient data and validating findings. The report underscores the project's goal of developing accurate and efficient algorithms for identifying patterns or biomarkers associated with early-stage Alzheimer's.

The report also touches on the significance of early detection, emphasizing potential positive impacts on patient outcomes, quality of life, and the burden on healthcare systems. It concludes by outlining the ongoing nature of the project and its contribution to the broader exploration of technological applications in addressing the challenges of Alzheimer's detection.

Chapter 2

2.1 System Architecture Diagram

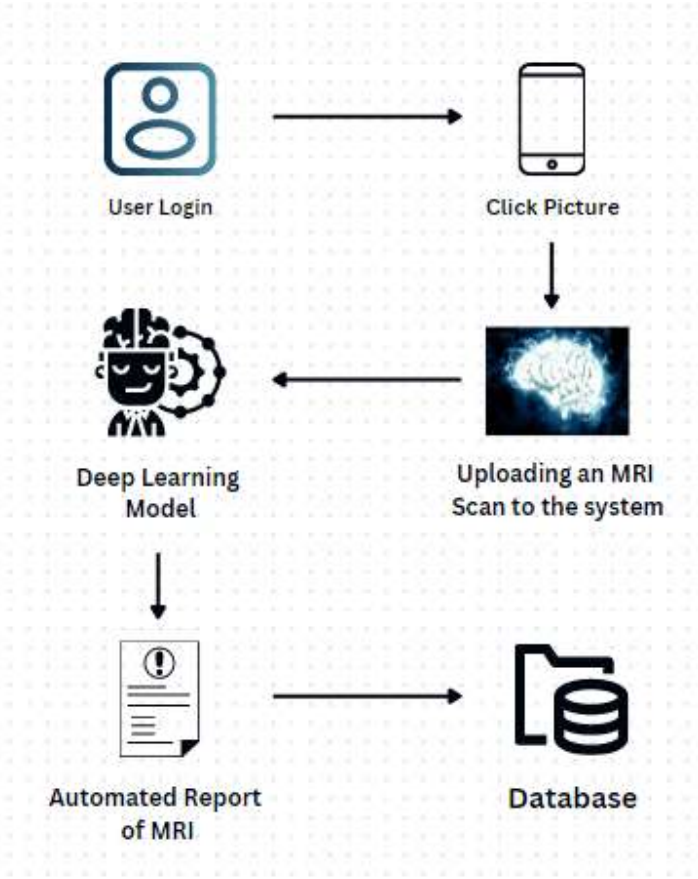

Fig 1) System Architecture.

2.2 Proposed Methodology

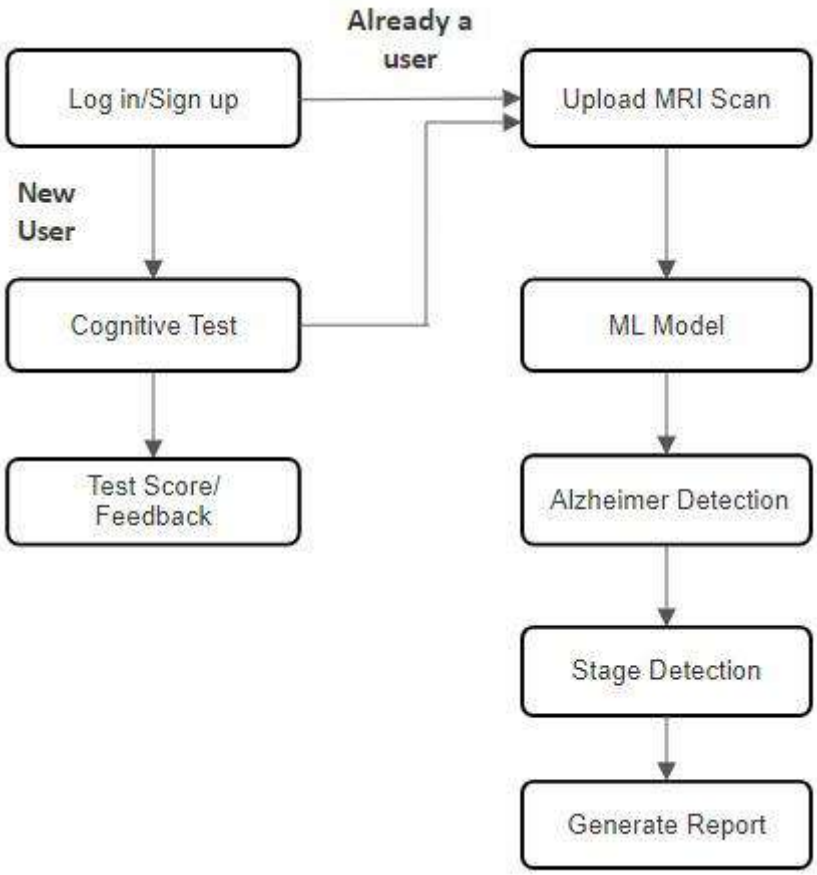

Fig 2) Proposed Methodology

Chapter 3

3.1 Mathematical Equation

Creating a mathematical equation for a project on the early detection of Alzheimer's disease involves various factors and variables. While the exact equation can be complex and dependent on the specific methods employed, a simplified representation might include elements such as:

$$P(t) = f(D, G, C, E)$$

Here,

- $P(t)$ represents the probability of detecting Alzheimer's at time t,
- D stands for the dataset, considering its size and diversity,
- G represents the computing power or the advancement in technology used,
- C accounts for collaboration with healthcare institutions and the quality of clinical data,
- E encompasses ethical considerations and adherence to privacy guidelines.

Chapter 4

4.1 Proposed Solution

This project aims to develop a model for the early detection of Alzheimer's disease using neuroimaging. The proposed model will analyze AD, EMCI, CN, MCI, and LMCI scans respectively to predict the likelihood of developing Alzheimer's disease.

Task	Optimistic Time (O)	Most Likely Time (M)	Pessimistic Time (P)	Expected Time (TE)	Variance (V)
Literature Review	2 weeks	4 weeks	6 weeks	$(O + 4M + P)/6$	$(P - O)/6$
Dataset Acquisition	3 weeks	5 weeks	7 weeks	$(O + 4M + P)/6$	$(P - O)/6$
IRB Approval	2 weeks	3 weeks	4 weeks	$(O + 4M + P)/6$	$(P - O)/6$
Algorithm Development	4 weeks	6 weeks	8 weeks	$(O + 4M + P)/6$	$(P - O)/6$
Model Training	3 weeks	5 weeks	6 weeks	$(O + 4M + P)/6$	$(P - O)/6$
Ethical Approval	2 weeks	3 weeks	4 weeks	$(O + 4M + P)/6$	$(P - O)/6$
Validation Studies	5 weeks	8 weeks	10 weeks	$(O + 4M + P)/6$	$(P - O)/6$
Final Implementation	4 weeks	6 weeks	8 weeks	$(O + 4M + P)/6$	$(P - O)/6$

Fig 3) PERT Table

Chapter 5

5.1 Summary and Future work

Summary:

Early detection of Alzheimer's disease is a critical area of research aiming to identify signs of the neurodegenerative disorder in its initial stages. The project utilizes advanced technologies, particularly deep learning, to analyze diverse datasets, including brain imaging, genetic information, and clinical records. Assumptions include the existence of identifiable patterns indicative of early-stage Alzheimer's, and dependencies involve access to comprehensive datasets, advancements in computing, and collaboration with healthcare institutions. The methods focus on developing accurate algorithms that can recognize biomarkers associated with the disease. The significance lies in the potential to improve patient outcomes, enhance quality of life, and reduce the burden on healthcare systems. The report emphasizes the ongoing nature of the project and its contribution to the broader exploration of technological applications in addressing the challenges of Alzheimer's detection.

Future Work:

Future work in the early detection of Alzheimer's disease will likely involve advancing technology, exploring multimodal approaches combining different types of data, identifying novel biomarkers, conducting large-scale validation studies, investigating remote monitoring and digital biomarkers, addressing ethical and privacy concerns, and focusing on the practical implementation of developed methods in clinical settings. The goal is to enhance the accuracy, accessibility, and effectiveness of early detection methods for Alzheimer's disease.

Chapter 6

6.1 Conclusion & Recommendation

Conclusion:

The project on early detection of Alzheimer's disease, utilizing deep learning and diverse datasets, addresses a critical global health challenge. Assumptions and dependencies underscore its complexity, while methods like biomarker identification demonstrate commitment to technological innovation in healthcare.

Recommendations:

Recommendations for the early detection of Alzheimer's disease project include staying updated on technological advancements, fostering collaboration for diverse datasets, adhering to ethical guidelines for privacy protection, conducting large-scale validation studies, exploring multimodal approaches, engaging in public awareness campaigns, and working towards practical implementation in clinical settings. These measures are essential for enhancing accuracy, promoting inclusivity, ensuring ethical standards, and facilitating real-world applicability of the developed models, ultimately contributing to improved early detection outcomes for individuals at risk of Alzheimer's.