*A Progress Report*

*on*

Alzheimer’s Detection Using Deep Learning

*carried out as part of the course CSE CS3270 Submitted by*

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***VI-CSE***

*in partial fulfilment for the award of the degree*

*of*

**BACHELOR OF TECHNOLOGY**

In

**Computer Science and Engineering**

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**Department of Computer Science and Engineering,**

**School of Computer Science and Engineering,**

**Manipal University Jaipur,**

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**CERTIFICATE**

This is to certify that the project entitled “***Alzheimer’s Detection Using Deep Learning***" is a bonafide work carried out as ***Minor Project (Course Code: CS3270)***  in partial fulfilment for the award of the degree of Bachelor of Technology in Computer Science and Engineering, under my guidance by ***(Shreyansh Rai )*** bearing registration number(***209302258***), during the academic semester *VI of year 2022-23.*

**Place:** Manipal University Jaipur, Jaipur

**Signature of the project guide:**

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* 1. **Introduction :**

Alzheimer's disease (AD) is a progressive and irreversible neurological disorder that affects millions of people worldwide, particularly in the aging population. Early and accurate diagnosis of AD is crucial for effective treatment and management of the disease. Magnetic resonance imaging (MRI) has been shown to be a valuable tool for the detection and monitoring of AD, as it can detect structural changes in the brain that are associated with the disease. However, manual interpretation of MRI images can be time-consuming and subjective, and there is a need for automated and accurate methods for AD diagnosis. Deep learning-based MRI image classification is emerging as a promising approach for AD detection, leveraging the power of artificial intelligence to analyse and interpret large amounts of imaging data. In this study, we propose a custom-built convolutional neural network (CNN) architecture for MRI image classification to detect AD, and evaluate its performance on a large dataset of MRI images with four classes. Our results demonstrate the potential of deep learning-based MRI image classification for accurate and efficient AD diagnosis.

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   * 1. **Motivation** :

The motivation behind the proposed study is to improve the early detection and accurate diagnosis of Alzheimer's disease (AD), which is a pressing public health issue that affects millions of people worldwide. Current diagnostic methods for AD rely on a combination of clinical assessment and imaging tests, such as MRI. While MRI has shown great promise for detecting structural changes in the brain associated with AD, it requires specialized expertise and can be time-consuming and costly. Deep learning-based MRI image classification offers a powerful and efficient approach to automate the diagnosis process and enhance the accuracy of AD detection. The development of a custom-built convolutional neural network (CNN) architecture for MRI image classification to detect AD has the potential to improve patient outcomes, by enabling earlier diagnosis and intervention. Additionally, such a model could help to reduce the burden on healthcare systems and resources, and facilitate access to accurate and timely AD diagnosis for individuals and communities around the world.

* 1. **Literature Review**

**2.1 Overview:**

Alzheimer's disease (AD) is a chronic and progressive neurodegenerative disorder that affects millions of people worldwide. Magnetic resonance imaging (MRI) has been shown to be a valuable tool for detecting and monitoring AD, as it can detect structural changes in the brain that are associated with the disease. However, manual interpretation of MRI images is time-consuming and subject to inter-observer variability. Therefore, there is a growing interest in developing automated and accurate methods for AD diagnosis, and deep learning-based MRI image classification is emerging as a promising approach.

Several studies have proposed deep learning models for MRI image classification to detect AD. For example, Liu et al. (2020) proposed a deep learning-based model that combines convolutional neural networks (CNNs) and recurrent neural networks (RNNs) for AD detection using MRI images. Their model achieved an accuracy of 94.6% on the ADNI dataset.

Zhang et al. (2019) proposed a novel method based on a deep convolutional neural network (DCNN) for AD diagnosis using multi-modal MRI images, achieving an accuracy of 96.4%. In another study, Yang et al. (2019) developed a model based on a residual network (ResNet) for AD detection, achieving an accuracy of 93.0%.

In addition to CNN-based models, other deep learning techniques have also been applied for AD detection using MRI images, such as autoencoders and transfer learning. For example, Gao et al. (2019) proposed a model based on a variational autoencoder (VAE) for AD detection using multi-modal MRI images.

**2.2 The outcome of the literature review :**

The outcome of the literature review suggests that MRI image classification using deep learning is a promising approach for detecting Alzheimer's disease. Several studies have demonstrated that convolutional neural networks (CNNs) can accurately classify MRI images for AD diagnosis, with transfer learning being a popular technique for improving performance with limited training data. However, there are still challenges to overcome, such as data imbalance and the interpretability of the model's decision-making process. Data imbalance can lead to biased models and poor generalization to new data, while interpretability is essential for building trust in the model and understanding its decision-making process.

Overall, the literature review highlights the potential of deep learning-based MRI image classification for AD detection, but also underscores the need for further research to develop robust and accurate models that can handle data imbalance and improve interpretability. Such models have the potential to improve patient outcomes by enabling early and accurate diagnosis of AD, leading to earlier interventions and better disease management.

* + 1. **The problem statement :**

The problem statement for the above topic is the need for an accurate and automated method for Alzheimer's disease (AD) detection using MRI images. Manual interpretation of MRI images is time-consuming, subject to inter-observer variability, and can lead to misdiagnosis. Deep learning-based MRI image classification is an emerging approach for AD detection, but there is a need for robust and accurate models that can handle the data imbalance and improve interpretability of the decision-making process. Therefore, the problem statement is to develop a deep learning model for accurate and automated AD detection using MRI images that can address these challenges and improve patient outcomes.

* + 1. **Research Objectives :**

The research objectives for the above topic are:

1. To develop a deep learning model for accurate and automated detection of Alzheimer's disease using MRI images.
2. To evaluate the performance of the developed model on a large dataset of MRI images with four classes (i.e., mild demented, very mild demented, moderate demented, non-demented).
3. To investigate the impact of various hyperparameters on the performance of the developed model, including the number of layers, learning rate, and batch size.
4. To compare the performance of the developed model with existing deep learning models for MRI image classification in terms of accuracy, precision, recall, and F1-score.
5. To demonstrate the clinical usefulness of the developed model by analyzing its performance on a subset of the dataset and comparing it with expert radiologists' diagnoses.
6. To identify the limitations and potential future directions for improving the performance and interpretability of deep learning-based models for AD detection using MRI images.
   1. **Methodology and Framework**

The methodology and framework for the above topic will involve the following steps:

* + 1. Data Collection: A dataset of 6000 MRI images with four classes (i.e., mild demented, very mild demented, moderate demented, non-demented) will be collected from publicly available sources or clinical repositories.
    2. Data Preprocessing: The collected dataset will be preprocessed, which includes resizing, normalization, and augmentation to increase the diversity of the data and reduce overfitting.
    3. Model Development: A deep learning-based model will be developed using the TensorFlow-Keras framework. The ResNet-50 architecture will be modified and customized to handle the four-class classification problem. The model will include convolutional layers, pooling layers, dropout layers, and fully connected layers. The optimal hyperparameters will be selected through a grid search approach.
    4. Model Evaluation: The performance of the developed model will be evaluated using various metrics such as accuracy, precision, recall, and F1-score. The model will be compared with existing state-of-the-art deep learning models for MRI image classification. The interpretability of the model's decision-making process will be improved using visualization techniques such as saliency maps and Grad-CAM.
    5. Clinical Usefulness Analysis: The developed model will be tested on a subset of the dataset to demonstrate its clinical usefulness. The model's performance will be compared with expert radiologists' diagnoses to assess its accuracy and effectiveness in detecting Alzheimer's disease.
    6. Limitations and Future Directions: The limitations of the developed model will be identified, and potential future directions for improving the performance and interpretability of deep learning-based models for AD detection using MRI images will be discussed.

Overall, the proposed methodology and framework will enable the development of an accurate and automated method for Alzheimer's disease detection using MRI images, which has the potential to improve patient outcomes by enabling early and accurate diagnosis of AD.

* 1. **Work Done :**

**4.1 Overview:**

* + 1. Data Collection: A dataset of 6000 MRI images with four classes (i.e., mild demented, very mild demented, moderate demented, non-demented) will be collected from publicly available sources or clinical repositories.
    2. Data Pre-processing: The collected dataset will be pre-processed, which includes resizing, normalization, and augmentation to increase the diversity of the data and reduce overfitting.
    3. Model Selection : First we selected ResNet50 model for our project as it is the most popular and efficient model for image processing. The results were no promising so we decided to go with Multi-class custom built convolutional neural network (CNN) instead of using a pre-trained Resnet50 model as it does not suit our requirements. Much higher accuracy was achieved. Then we built a VGG-16 pre-trained model and compared it with the custom built model.
    4. Model Evaluation: Validation accuracy of 54% and validation loss of 90% was achieved for pre-trained ResNet50 model. With Custom Built Model we achieved validation accuracy of 99.14% and validation loss of 2.36%.

A picture containing graphical user interface

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Custom Built Model

Chart, line chart, histogram

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VGG16 pre Trained model

And with VGG- 16 pre-trained model we achieved validation accuracy of 65.22% and validation loss of 90%.

4.2 **Individual Contribution of project members :**

First we both read some research papers regarding the topic Alzheimer’s detection using deep learning. We also went through some datasets available online on different platforms like ADNI, Kaggle,etc.

I studied basic structure of a convolutional neural network (CNN) and its different architectures like ResNet, AlexNet, VGG, etc. As our dataset was large so I thought we should use resnet50 model.

So we modified the basic ResNet50 model and decided to go with custom-built CNN and then for further research we also compared our model to VGG-16 pre-trained model.

1. **Conclusion and Future Plan**

The future plan for this research includes further validation and refinement of the model using a larger dataset, including diverse populations, to enhance its generalizability. Additionally, investigating the transferability of the model to other neurodegenerative diseases and implementing a real-time diagnosis system using the model will be explored. The integration of the model into the clinical workflow, including evaluation of its impact on patient outcomes and healthcare resource utilization, will be another area of future investigation. Overall, the developed model shows significant potential for improving the diagnosis of Alzheimer's disease using MRI images, and its future development and deployment have the potential to positively impact patient outcomes and healthcare systems.

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