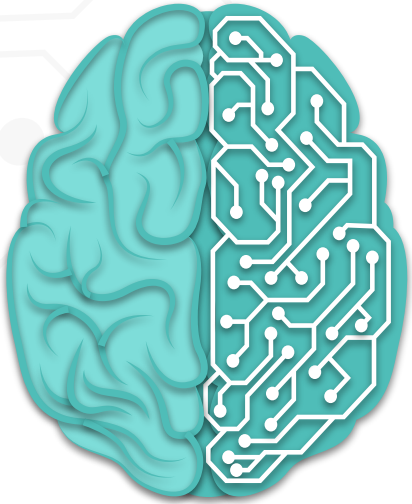


Single Deep CNN Features to Detect Neurodegenerative Diseases and Context Behind the Detection: Alzheimer's, Parkinson's, Dementia

BUBT
BANGLADESH UNIVERSITY OF BUSINESS AND TECHNOLOGY
Committed to Academic Excellence

Capstone Project (CSE 498)

Supervised by
Milon Biswas Assistant Professor Department of CSE Bangladesh university of Business and Technology (BUBT)

Submitted by	
Mohammad Sabbir Ahmed	17183103004
Syeda Nowshin Ibnat	17183103020
Rakibul Ahasan	17183103022
Sheikh Abu Hanif	17183103043
Nusrat Jahan Anka	17183103008
Intake: 39(1), Dept. of CSE, BUBT	

Presented Date: 21-11-2021

Contents

Introduction

Neurodegenerative diseases occur when nerve cells in the brain or peripheral nervous system lose function over time and ultimately die. Alzheimer's disease, Parkinson's disease, and dementia are most common examples of degenerative neurodegenerative disease. Through our work we are willing to detect these three diseases at a time by a DL model.

Problem Statement

Identifying neurodegenerative diseases with proper explanation using one model is quite challenging.

Problem Background

- The present neurodegenerative diseases detection system only detects one disease.
- Identifying neurodegenerative diseases and behind the reason of appearing is a deadly problem that needs to be solved.
- Due to the similarities in disease phenotypes, accurate detection of neurodegenerative diseases, including the context behind the detection is problematic.

Motivation

Detect the disease in early stage.

Detect three disease at a time.

To reduce wasting time & cost.

Objectives

- Identifying present difficulty to work with neuroimaging data.
- Build a new DL model to detect three Neurodegenerative Diseases named Alzheimer's, Parkinson's and Dementia.
- Get decent accuracy using a suitable MRI dataset.
- Use XAI to know the context behind the detection.
- Comparing the existing architectures with the proposed one for neurodegenerative diseases detection.

Literature Review

Title / Question	Convolutional neural networks for classification of Alzheimer's disease: Overview and reproducible evaluation.
Objectives/ Goal	They found 3 problems and their goal is to solve these problems: 1. The classification performance is difficult to compare across studies due to variations in components such as participant selection, image preprocessing, or validation procedure. 2. These studies are hardly reproducible because their frameworks are not publicly accessible and because implementation details are lacking.

Literature Review cont.

Methodology/ Theory	They proposed a solution: 1. Performed a systematic literature Review. To do so, they Identified four main types of approaches: i) 2D slice-level, ii) 3D patch-level, iii) ROI-based and iv) 3D subject-level CNN 2. Their second contribution is the extension of an open-source framework for the classification of AD using CNN and T1-weighted MRI. The framework comprises previously developed tools to automatically convert ADNI, AIBL, and OASIS data into the BIDS standard, and a modular set of image preprocessing procedures, classification architectures, and evaluation procedures dedicated to deep learning. 3. Finally, they used this framework to rigorously compare different CNN architectures.

Literature Review cont.

Test / Experiment	Experiments are conducted using ADNI dataset.
Simulation/ Test Data	A total of 9540 images were used for training the network and 4193 images for testing.
Result / Conclusion	Model accuracy is 98.57% and the validation accuracy is 87.72%.
Obstacles/ Challenges	Fails to interpret the reasoning behind the result obtained.

Literature Review cont.

Title / Question	Deep Learning-Based Alzheimer Disease Detection.
Objectives / Goal	The objective of this work is to present a framework based on deep convolutional neural networks for Alzheimer's disease detection in terms of accuracy.
Methodology/ Theory	The proposed methodology consists of two steps- preprocessing and network training. 1) For preprocessing, MRI samples were converted into JPEG slices in the MATLAB tool. 2) For network training, the architecture consists of three sets of convolutional and max-pooling layers.
Software Tools	Anaconda, Keras,Tensor- flow

Literature Review cont.

Test/ Experiment	When downloading data from the ADNI database, NII has selected the format data. In order to obtain the data with the same parameters to avoid many other problems in processing procedure, the pre-processed data were preferred here. The steps of pre-processing include gradient unwarping and a nonparametric non-uniformed bias correction (N3) algorithm, both can be done with Grinder Pipeline. The structural MR images were obtained from 3.0 tesla SIEMENS scanners.
Simulation/ Test Data	http://adni.loni.usc.edu/ Data has been selected from different phases of ADNI.In the first group 785 normal controllers, 542 MCI patients, and 336 AD

Literature Review cont.

Title/ Question	Auto-Detection of Alzheimer's Disease Using Deep Convolutional Neural Network
Objectives/Goal	The objective of this work is to present a DCNN for diagnosing the diseases of AD/MCI and Achieve a high level of accuracy.
Methodology/Theory	For this work, Firstly, the structural MRIs are pre-processed in a strict pipeline.Then, instead of parcellating regions of interest, Each volume is re-sliced and resliced images put into a DCNN directly.Finally, four stages of Alzheimer's are identified.
Software Tools	Adni database, grinder pipeline(data processing framework), FSL-BET toolbox(brain extraction),3.0 tesla SIEMENS scanners,SPM toolbox (segmented brain into GM, WM, and CSF)

Literature Review cont.

	patients from ADNI1 and ADNI-GO were picked. In the second group, 1106 normal controllers, 1583 early mild cognitive impairment (EMCI), 1304 late mild cognitive impairment (LMCI), and 336 NC were picked. The age of all the subjects ranges from 60 to 85 years old.There is no noticeable difference between these three groups in terms of gender and age.
Result/ Conclusion	The accuracy of classifying NC with AD is 95.45%, the accuracy of classifying NC with MCI is 95.39% and the accuracy of classifying NC with AD is 93.97%.The convolutional neural network framework implemented here offers much more accuracy.The results show that the DCNN outperforms existing methods. AD patients are much smaller than the groups of EMCI, LMCI, and normal controllers.
Obstacles/ Challenges	The Challenges in this paper, Selecting data from different stages of ADNI, AD/MCI detection using DCNN, MRI data collection, and data processing.

Literature Review cont.

Title / Question	Automatic Alzheimer's Disease Recognition from MRI Data Using Deep Learning Method.
Objectives / Goal	1. To get the highest accuracy. 2. Resulting in an accurate recognition.
Methodology/Theory	convolutional neural network (CNN) with deep learning
Software Tools	Tensorflow, google collab etc.
Test / Experiment	Testing CNN is being proposed to extract seven middle cross-sections as patches. Since not all patches are abnormal in AD cases, only when all seven patches were classified as NC, here, considered the data as NC.

Literature Review cont.

Simulation/Test Data	The MRI data acquired from Alzheimer's Disease Neuroimaging Initiative (ADNI) database
Result / Conclusion	This paper achieved sensitivity at a patch level is 0.69 and specificity is 0.98. When using the AD detection rule which was mentioned in the testing section, the case level sensitivity is 1 and specificity is 0.93.
Obstacles/Challenges	In the structure, every one of the three groups is made up of three layers, including a convolutional layer, a pooling layer, and a normalization layer which was really challenging.

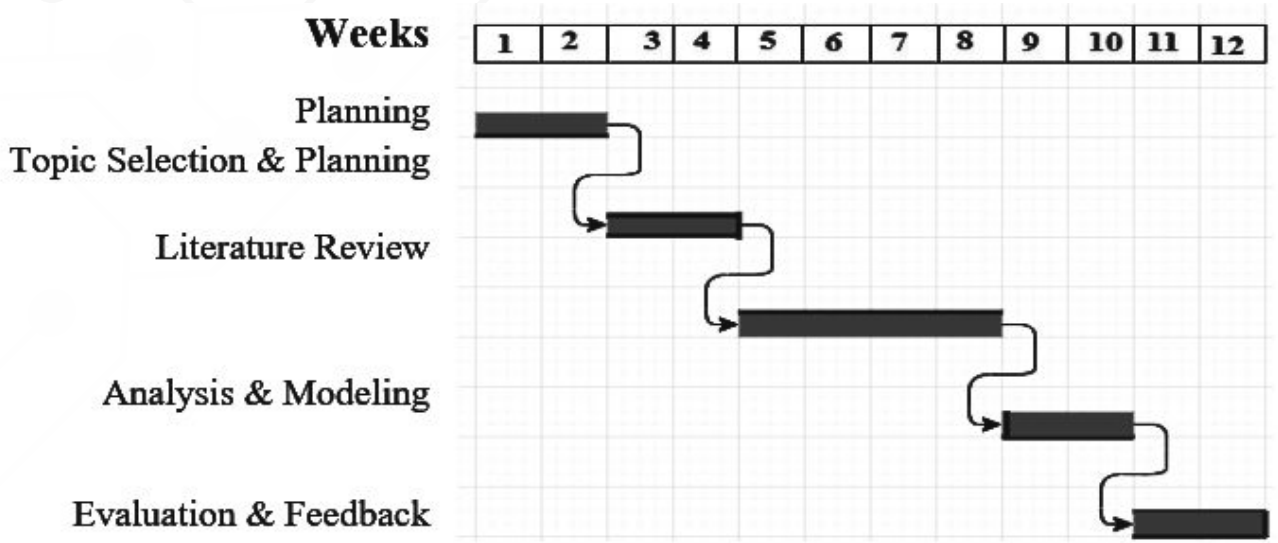
Literature Review cont.

Title/ Question	Deep learning based diagnosis of Parkinson's disease using convolutional neural network.
Objectives/ Goal	The objective of the work is to present a new approach in the field of deep learning models that are able to help the clinicians in the diagnosis of Parkinson's disease and yield an objective and better patient group classification in the near future.
Methodology/Theory	The MR image database, pre-processing of the MR images, CNN AlexNet architecture, Transfer learning applied to the pre-trained AlexNet model and the classification accuracy measures to evaluate the model for given input image dataset
Software Tools	AlexNet, PET, SPECT, PPMI database.
Test / Experiment	MR image dataset used in this work includes the Healthy Control and Parkinson's disease subjects considered from the PPMI database. AlexNet architecture is able to achieve an accuracy of 88.90%.

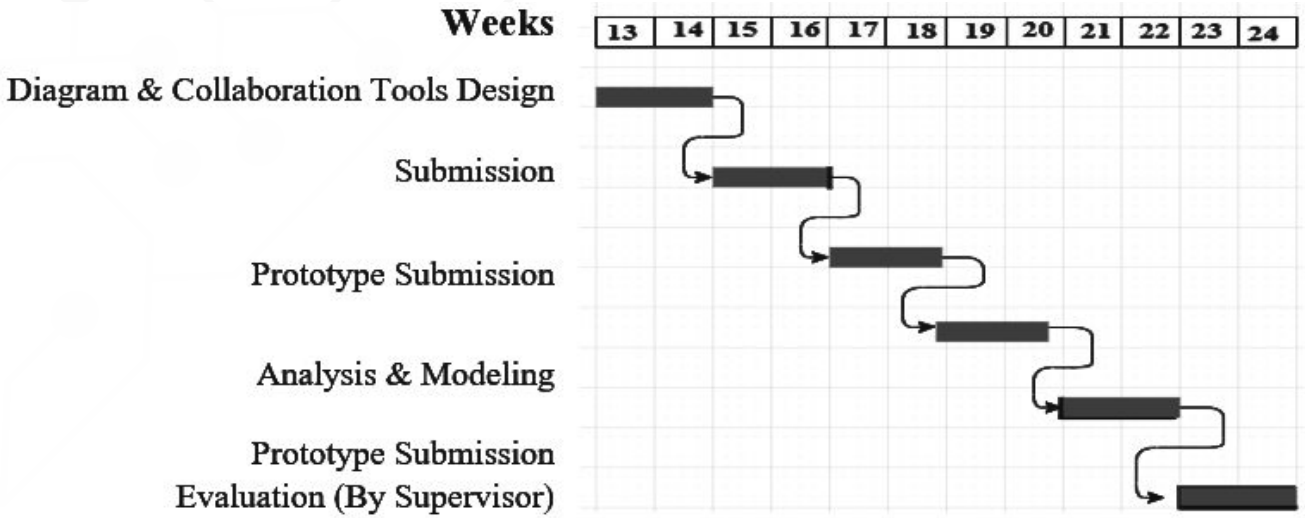
Literature Review cont.

Simulation/ Test Data	AlexNet has been pre-trained with colour images of size 227 X 227 pixels and processes them in its respective layers, from input to output. The image dataset with 80% of the input data is used for training and the remaining 20% is used for testing.
Result/ Conclusion	The model is trained to learn the low level to high level features and the classification results are validated. An AUC value of 0.9618 is reported from the ROC curve which shows a better discriminative proficiency of the proposed deep learning model
Obstacles/ Challenges	MRI data collection and data processing.

Gantt Chart


Weeks
1
2
3
4
5
6
7
8
9
10
11
12
Planning
Topic Selection & Planning
Literature Review
Analysis & Modeling
Evaluation & Feedback

Gantt Chart Cont.



Problem Analysis

1

The existing approaches can detect one disease at a time.

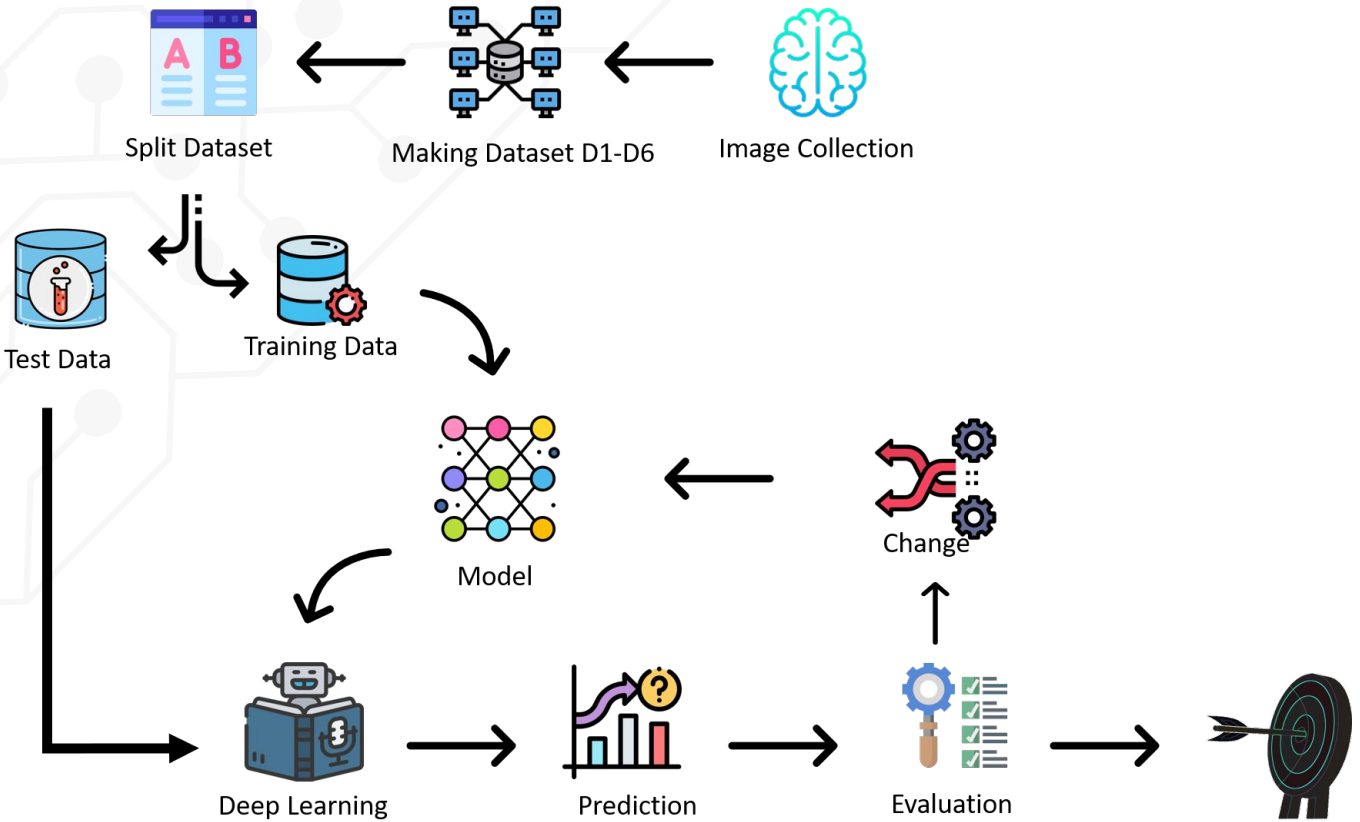
2

Costly and time consuming.

3

Accuracy rate wasn’t satisfactory.

Research Methodology



Ethics

We are working on detecting neurodegenerative diseases: Alzheimer's, Parkinson's, Dementia, and the context behind the detection. We got our datasets from Oasis, Kaggle & PPMI. Our collected datasets are open source. From their written description these datasets were approved to show openly.

Impact of Society

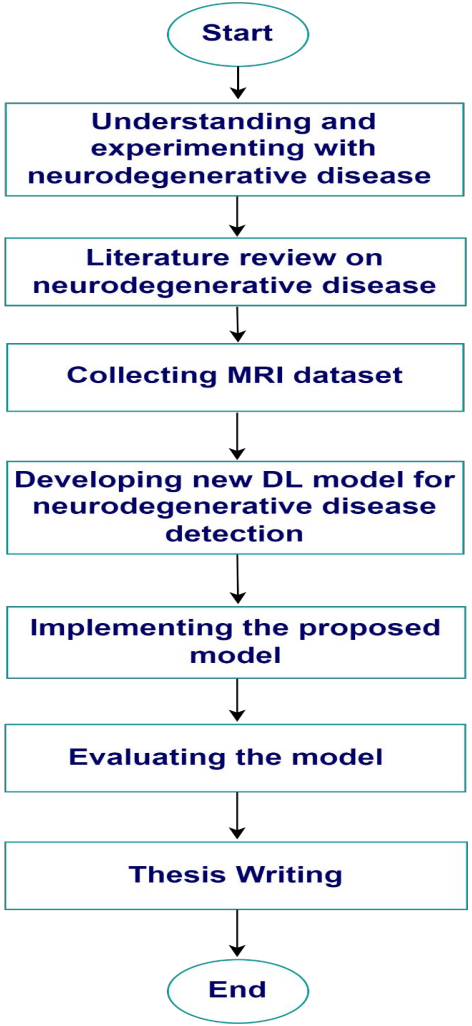
It is essential in order to treat patients at an early stage.

Sustainability

- From previous works obtaining highest result we took inspiration and made a decision of using Deep Learning to get better result.

- Through our proposed approach we are willing to detect three diseases which wasn’t been done yet so with huge hope, we think our work will fulfill the sustainability.

Research Flow



Conclusion

In our society, there are a significant number of senior persons who suffer from neurodegenerative diseases. By this work, we will be able to detect three diseases at a time which will be beneficial for medical professionals.

Reference

[1] J. Wen *et al.*, “Convolutional neural networks for classification of Alzheimer’s disease: Overview and reproducible evaluation,” *Med. Image Anal.*, vol. 63, p. 101694, 2020, doi: 10.1016/j.media.2020.101694.

[2] S. S. Kundaram and K. C. Pathak, *Deep Learning-Based Alzheimer Disease Detection*, vol. 673. Springer Singapore, 2021.

Reference cont.

[3] L. Yue *et al.*, “Auto-detection of alzheimer’s disease using deep convolutional neural networks,” *ICNC-FSKD 2018 - 14th Int. Conf. Nat. Comput. Fuzzy Syst. Knowl. Discov.*, pp. 228–234, 2018, doi: 10.1109/FSKD.2018.8687207.

[4] Suhuai Luo, Xuechen Li, Jiaming Li, “Automatic Alzheimer’s Disease Recognition from MRI Data Using Deep Learning Method”, Journal of Applied Mathematics and Physics, 2017, 5, 1892-1898

Reference cont.

[5] S. Sivaranjani and C. M. Sujatha, “Deep learning based diagnosis of Parkinson’s disease using convolutional neural network,” 2019, [Online]. Available: https://doi.org/10.1007/s11042-019-7469-8.


Thank You