

Department of Computer Science and Engineering
Bangladesh University of Business and Technology (BUBT)



CSE 498: Literature Review Records

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Capstone Project Title	Single Deep CNN Features to Detect Neurodegenerative Diseases and Context Behind the Detection: Alzheimer's, Parkinson's, Dementia disease.
Supervisor Name & Designation	Milon Biswas, Assistant Professor, Dept. of CSE, BUBT.
Course Teacher's Name & Designation	Dr. M. Firoz Mridha, Chairman & Associate Professor, Dept. of CSE, BUBT.

Aspects	Paper # 1
Title / Question (What is the problem statement?)	Deep learning based diagnosis of Parkinson's disease using convolutional neural network.
Objectives / Goal (What is looking for?)	The objective of the work is to present a new approach in the field of deep learning models are able to help clinicians in the diagnosis of Parkinson's disease and yield an objective and better patient group classification in the near future.
Methodology/Theory (How to find the solution?)	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 (What program/software is used for design, coding, and simulation?)	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.

How to test and characterize the design/prototype?	AlexNet architecture is able to achieve an accuracy of 88.90%.
Simulation/Test Data (What parameters are determined?)	AlexNet has been pre-trained with colour images of size 227 X 227 pixels and process 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 (What was the final result?)	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 (List the methodological obstacles if authors mentioned in the article)	The proposed methodology is not extended on deep fine-tuning of the AlexNet model to obtain improved performance levels.
Terminology (List the common basic words frequently used in this research field)	Parkinson's disease , MRI , Deep learning , Convolutional neural networks, AlexNet.
Review Judgment (Briefly compare the objectives and results of all the articles you reviewed)	An accuracy of 88.90% is achieved for classifying the HC and PD subjects. The PPMI cohort used in this study consists of 182 subjects with 82 Healthy Control and 100 Parkinson's disease subjects.
Review Outcome (Make a decision on how to use/refer to the obtained knowledge to prepare a separate and new methodology for your own research project)	In this work, analysis of T2 weighted MR brain images for discrimination of healthy control and PD subjects is attempted using CNN model.

Aspects	Paper # 2
Title / Question (What is the problem statement?)	Unified deep learning approach for prediction of Parkinson's disease
Objectives / Goal (What is looking for?)	Internal representations of the trained DNNs constitute the extracted knowledge which is used in a transfer learning and domain adaptation manner, so as to create a unified framework for prediction of Parkinson's across different medical environments.
Methodology/Theory (How to find the solution?)	Our approach starts by training a deep neural architecture, such as a convolutional, or convolutional-recurrent network to predict the status (PD, or NPD) of subjects. This is based on analysis of medical images, i.e. DaTscans and/or MRI images, collected in a specific medical centre, or hospital. we consider a CNN part that has a well-known structure, such as ResNet-50, generally composed of convolutional and pooling layers, followed by one, or two fully-connected layers.
Software Tools (What program/software is used for design, coding, and simulation?)	ML, DaTscans, (PPMI) database, SWEDD, Tensorflow.
Test / Experiment How to test and characterize the design/prototype?	The PPMI study includes a cohort of 423 patients with PD, who have been diagnosed for two years or less and do not take PD medications; 196 control subjects, with no PD (NPD). Other categories, such as subjects who have been consented as PD, but whose DaTscans do not reveal dopaminergic deficit (SWEDD), prodromal ones, or subjects with genetic mutations are also followed in the study. As a consequence, the medical image inputs to the DNNs consist of a DaTscan and/or three consecutive MRIs.
Simulation/Test Data (What parameters are determined?)	Parkinson's database has been recently developed [11], based on anonymised data from 75 subjects, 50 subjects with PD and 25 controls, of the Georgios Gennimatas Hospital . It includes at least one DaTscan, in the form of colour image, and many MRIs per subject. In total, it includes 925 DaTscans, 595 of which come from subjects with PD and 330 from controls; and 41528 MRIs, 31147 of which represent PD and 10381 NPD.
Result / Conclusion (What was the final result?)	During the last three years, ML techniques, such as support vector machines (SVMs), logistic regression, random forests (RFs), and decision trees have been used for PD diagnosis. Such methods have been applied based on patient questionnaires [16], reporting an accuracy over 95%.

Obstacles/Challenges (List the methodological obstacles if authors mentioned in the article)	MRI data collection and data processing.
Terminology (List the common basic words frequently used in this research field)	Parkinson, ML, DNN, MRI, deep learning, DaTscans, SVMs, RMs, Tensorflow.
Review Judgment (Briefly compare the objectives and results of all the articles you reviewed)	Use of Tensorflow as an interface for PD diagnosis based on medical imaging has been proposed [22], using a neural network model and providing an accuracy of 97.34%. This work high accuracy then some other models.
Review Outcome (Make a decision on how to use/refer to the obtained knowledge to prepare a separate and new methodology for your own research project)	At first, we extract appropriate internal features, say features v , from the DNN model trained with the data set developed. We also that the proposed approach can improve Parkinson's prediction in cases and environments where some input data types, e.g. DaTscans, are not available and prediction is made only through MRI analysis.

Aspects	Paper # 3
Title / Question (What is the problem statement?)	Classification of MRI images for Alzheimer's disease detection.
Objectives / Goal (What is looking for?)	This paper deals with the important challenge of identification of Alzheimer's disease and the condition prior to dementia which is Mild Cognitive Impairment (MCI), developing intelligent classifiers, which using the information of magnetic resonance imaging, can successfully classify different patients according to their condition.
Methodology/Theory (How to find the solution?)	This paper presents a new methodology for classification of Alzheimer's disease from MR images for medical support. A large database with more than one thousand patients was used. Two different problems are tackled in this work: a first one where a classification method is developed to classify MR images as either normal or with the Alzheimer's disease and a second one for the identification and classification between normal subjects, MCI patients and AD patients.
Software Tools (What program/software is used for design, coding, and simulation?)	MATLAB, SPM5.
Test / Experiment How to test and characterize the design/prototype?	They used ADNI Dataset. ADNI is a multisite longitudinal clinical/imaging/genetic/biospecimen/biomarker study. Its goal is to determine the characteristics of AD as the pathology that evolves from normal aging to mild symptoms, to MCI, to dementia.
Simulation/Test Data (What parameters are determined?)	Once they were normalized and some images with errors were eliminated, 1350 images (443 are from cognitively normal subjects, 448 from MCI subjects and 459 from AD subjects) are left with a size of 15.7 MB each one, which makes a database of normalized MR images with a size of approximately 21 GB.
Result / Conclusion (What was the final result?)	Afterwards and as suggested in previous works [7][8][16], PCA was used to reduce the dimensions of features to a higher degree. Once the principal components and their associated variances were calculated, a number of them that preserves 95% of total variance was kept [16].

Obstacles/Challenges (List the methodological obstacles if authors mentioned in the article)	They identified the identification of Alzheimer's disease and the condition prior to dementia which is Mild Cognitive Impairment (MCI) as a challenge for them.
Terminology (List the common basic words frequently used in this research field)	Support Vector Machine (SVM); Alzheimer's Disease; Mild Cognitive Impairment (MCI); PCA; Wavelets; MRI
Review Judgment (Briefly compare the objectives and results of all the articles you reviewed)	Results show a very high performance in classification results in the NAD problem, higher than 95% for both types of wavelets transformations without the use of PCA feature reduction.
Review Outcome (Make a decision how to use/refer the obtained knowledge to prepare a separate and new methodology for your own research project)	We study on the optimal slices to perform the classification, the use of other dimensionality reduction algorithms which could attain a reduction in time complexity for the problem, and the study on other databases of the same algorithm proposed here.

Aspects	Paper # 4
Title / Question (What is the problem statement?)	Deep Learning-based Pipeline to Recognize Alzheimer's Disease using fMRI Data.
Objectives / Goal (What is looking for?)	Diagnosis of Deep Learning-based Pipeline to Recognize Alzheimer's Disease using fMRI Data. Deploying a convolutional neural network to distinguish an Alzheimer's brain from a normal, healthy brain.
Methodology/Theory (How to find the solution?)	Employ a convolutional neural network to distinguish an Alzheimer's brain from a normal, healthy brain and the most problematic aspect has always been selecting the strongest discriminative features. Using the Convolutional Neural Network (CNN) and the famous architecture LeNet-5, successfully classified functional MRI data of Alzheimer's subjects from normal controls.
Software Tools (What program/software is used for design, coding, and simulation?)	LeNet-5, FMRI Software Library v5.0, Python, OpenCV.
Test / Experiment How to test and characterize the design/prototype?	CNN is a strong feature extractor because of its convolutional layers, which are able to extract high-level features from images. This deep learning method is also a powerful classifier because of its complicated network architecture. The present solution, which is based on fully advanced preprocessing steps followed by CNN classification, improved the accuracy of AD data classification from 84% using Support Vector Machine (SVM) reported in the literature [14] [5] [12] to 96.86%.
Simulation/Test Data (What parameters are determined?)	This work, 28 Alzheimer's disease (AD) patients and 15 normal control (NC) subjects (24 female and 19 male) with a mean age of 74.9 5.7 years were selected from the ADNI1 dataset. The AD subjects' MMSEs were reported to be over 20 by ADNI, and normal participants were healthy, with no reported history of medical or neurological conditions.
Result / Conclusion (What was the final result?)	This paper, we successfully classified AD data from normal control data with 96.86% accuracy using CNN deep learning architecture (LeNet), which was trained and tested with a massive number of images.

Obstacles/Challenges (List the methodological obstacles if authors mentioned in the article)	Deep learning solutions have very few problems, such as high algorithm complexity and expensive infrastructure.
Terminology (List the common basic words frequently used in this research field)	Deep learning; Alzheimer's Disease; fMRI.
Review Judgment (Briefly compare the objectives and results of all the articles you reviewed)	This deep learning solution and the proposed pipeline not only open new avenues in medical image analysis, but also enable researchers and physicians to potentially predict any new data and classified AD data from normal control data with 96.86% accuracy using CNN deep learning architecture (LeNet).
Review Outcome (Make a decision how to use/refer the obtained knowledge to prepare a separate and new methodology for your own research project)	From this work we got an overview of how to gain the utmost accuracy from a model .The importance of classifying this type of medical data lies in its potential to develop a predictive model or system in order to recognize the symptoms of Alzheimer's disease when compared with normal subjects and to estimate the stages of the disease.We can use this knowledge for our own work.

Aspects	Paper # 5
Title / Question (What is the problem statement?)	Computer-Aided Classification of Multi-Types of Dementia via Convolutional Neural Networks.
Objectives / Goal (What is looking for?)	This paper proposes a deep learning- based computeraided diagnosis approach for the early detection of multi-type of dementia.
Methodology/Theory (How to find the solution?)	To show the performance of the proposed CAD algorithm, three conventional CAD methods are implemented for comparison. This architecture initially builds CNN whose first layer takes the preprocessed images as inputs, and then builds logistic regression model to classify all examples of dataset into one of different classes of dementia.
Software Tools (What program/software is used for design, coding, and simulation?)	Python, pandas.
Test / Experiment How to test and characterize the design/prototype?	A classification of dementia was tested on MR images collected from 74 different subjects. These images have been stored in the dataset that has been chosen among many datasets available on the Open Access Series of Imaging Studies (OASIS) for conducting our experiment. All healthy control subjects had a clinical dementia rating (CDR) of 0. On the other hand, subjects diagnosed with dementia had a CDR of at least 0.5.
Simulation/Test Data (What parameters are determined?)	To evaluate the performance of the proposed model when deployed to make prediction on a new unseen data, 7- fold cross validation is performed on 734 MRI images. After getting preprocessed dataset, seven random datasets are produced to repeat training and testing of model in which 60% of MRI images are assigned to the training set while 40% of images are used for testing the algorithm.
Result / Conclusion (What was the final result?)	The proposed algorithm yields a 74.93% accuracy in early diagnosis of multi-type of dementia and outperforms the state of the art CAD methods.
Obstacles/Challenges	The early diagnosis of dementia is a challenging task due to the image quality, noise, and human brain irregularities.

(List the methodological obstacles if authors mentioned in the article)	
Terminology (List the common basic words frequently used in this research field)	Alzheimer's disease; Brain imaging; Computer-Aided Diagnosis; Convolutional Neural Networks; Dementia; Early diagnosis; Magnetic Resonance Imaging;
Review Judgment (Briefly compare the objectives and results of all the articles you reviewed)	This work got less accuracy then some other models.
Review Outcome (Make a decision how to use/refer the obtained knowledge to prepare a separate and new methodology for your own research project)	These investigations about the performance of our model could be improved in the future studies.

Aspects	Paper # 6
Title / Question (What is the problem statement?)	Deep learning based-classification of dementia in magnetic resonance imaging scans .
Objectives / Goal (What is looking for?)	Deep learning is much preferred in image processing applications since it can give fast and important results. This research aims at developing an open source software for deep learning based-classification of dementia in magnetic resonance imaging scans.
Methodology/Theory (How to find the solution?)	https://www.oasis-brains.org/ In this research, Open Access Series of Imaging Studies-2 dataset includes longitudinal MRI scans in non-demented and demented elder individuals. 3 or 4 individual T1-weighted MRI scans achieved from one scan sessions are contained for each subject. The basic architecture of the concept of deep learning is considered as convolutional neural networks (CNNs).
Software Tools (What program/software is used for design, coding, and simulation?)	TensorFlow, Keras, Sklearn, OpenCV, Pandas, NumPy, Matplotlib, and Flask.
Test / Experiment How to test and characterize the design/prototype?	The related individuals are all right-handed and comprise men and women. 72 of the individuals were defined as non-demented during the study. 64 of the subjects were defined as demented at the time of their early visits and ensuing scans were obtained.
Simulation/Test Data (What parameters are determined?)	The image dataset encapsulates 1592 MRI scans for demented and 2032 MRI scans for non-demented .
Result / Conclusion (What was the final result?)	Deep-learning framework is performed with respect to accuracy, sensitivity, specificity, positive and negative predictive values together with 95% confidence interval (CI) levels in training and testing stages. 95% confidence interval values for all the metrics are calculated by our developed software.

Obstacles/Challenges (List the methodological obstacles if authors mentioned in the article)	The early diagnosis of dementia is a challenging task due to the image quality, noise, and human brain irregularities.
Terminology (List the common basic words frequently used in this research field)	Classification, deep-learning, dementia, Keras, magnetic resonance imaging.
Review Judgment (Briefly compare the objectives and results of all the articles you reviewed)	This work got less accuracy than some other models.
Review Outcome (Make a decision how to use/refer the obtained knowledge to prepare a separate and new methodology for your own research project)	In the researches that will be carried out in the following stages, it may be suggested to develop artificial intelligence based-classification models and softwares that can classify the types of dementia (i.e., vascular, Lewy bodies, frontotemporal, Alzheimer, etc.) and non-dementia status.