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
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Aspects	**Paper # 1**
Title / Question (What is the problem statement?)	Auto-Detection of Alzheimer's Disease Using Deep Convolutional Neural Network
Objectives / Goal (What is looking for?)	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 (How to find the solution?)	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 (What program/software is used for design, coding, and simulation?)	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)
Test / Experiment How to test and characterize the design/prototype?	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 (What parameters are determined?)	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 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 (What was the final result?)	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 (List the methodological obstacles if authors mentioned in the article)	The Challenges in this paper, Selecting data from different stages of ADNI, AD/MCI detection using DCNN, MRI data collection, and data processing.
Terminology (List the common basic words frequently used in this research field)	Deep Learning; Alzheimer's Disease; MRI; Early Diagnose;
Review Judgment (Briefly compare the objectives and results of all the articles you reviewed)	From this article, we got to know about AD/MCI detection using DCNN. The convolutional neural network framework implemented here offers much more accuracy and the results show that the DCNN outperforms existing methods.

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 paper, In order to achieve the best result, They tried several activation functions. Finally, the Relu activation function was adopted. 3 classes of tasks including AD versus NC, AD versus MCI, and MCI versus NC are considered. Each task was repeated 10 times in order to check the robustness of the performance. From this work, we got an overview of how to gain the utmost accuracy.

Aspects	Paper # 2
Title / Question (What is the problem statement?)	Early Diagnosis of Alzheimer' Disease with Deep Learning
Objectives / Goal (What is looking for?)	Diagnosis of AD and MCI based on deep learning architecture. To overcome the bottleneck and aid the diagnosis of AD and its prodromal stage, Mild Cognitive Impairment (MCI). Analyzing multiple classes in one setting, and requires less labeled training samples and minimal domain prior knowledge.A significant performance gain on the classification of all diagnoses, groups achievement in these experiments.
Methodology/Theory (How to find the solution?)	Extracted the grey matter volumes from MRI and CMRGlc patterns from PET. The features were further selected with Elastic Net before each classification task.To support the sigmoidal decoder, all the features are normalized to zero-mean and between 0 and 1.
Software Tools (What program/software is used for design, coding, and simulation?)	ADNI database,Elastic Net,MATLAB 2013a,LIBSVM library,
Test / Experiment How to test and characterize the design/prototype?	Extracted the grey matter volumes from MRI and CMRGlc patterns from PET. The features were further selected with Elastic Net before each classification task.To support the sigmoidal decoder, all the features are normalized to zero-mean and between 0 and 1.

	Implemented the deep learning framework described in this paper on Matlab 2013a. A random search in a log domain was applied to choose the hyper-parameters. Used single-kernel SVM (SK-SVM) and multi-kernel SVM (MK-SVM) were chosen to compare with the proposed method.
Simulation/Test Data (What parameters are determined?)	Used the neuroimaging data obtained from Alzheimer's disease Neuroimaging Initiative (ADNI) database.Recruited the MRI images of 311 subjects from the ADNI baseline cohort, including 65 AD subjects, 67 cMCI subjects, 102 ncMCI subjects and 77 normal control subjects.All the MRI images are nonlinearly registered to the ICBM_152 template and further segmented into 83 functional regions.
Result / Conclusion (What was the final result?)	The deep learning method produced a better overall accuracy (87.76%) in binary.
Obstacles/Challenges (List the methodological obstacles if authors mentioned in the article)	neuroimaging data processing,
Terminology (List the common basic words frequently used in this research field)	Alzheimer's disease, neuroimaging, classification
Review Judgment (Briefly compare the objectives and results of all the articles you reviewed)	From this article, we got to know how to diagnose AD and MCI based on deep learning architecture.To overcome the bottleneck and how to aid diagnosis of AD.
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)	The SVM method conducts AD diagnosis as a multi-class classification task, with minimal prior knowledge dependency in the model optimization. The proposed method also performs dimensionality reduction and data fusion at the same time to reserve the synergy between data modalities.

Aspects	Paper # 3
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?)	FMRIB Software Library v5.0, LeNet-5,convolutional neural network (CNN),
Test / Experiment How to test and characterize the design/prototype?	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.Classified AD data from normal control data using CNN deep learning architecture (LeNet), which was trained and tested with a massive number of images. First, anatomical scans were performed with a 3D MP-RAGE sequence (TR=2s, TE=2.63 ms, FOV=25.6 cm, 256 x 256 matrix, 160 slices of 1mm thickness). Next, functional scans were obtained with an EPI sequence (150 volumes, TR=2 s, TE=30 ms, flip angle=70, FOV=20 cm, 64 x 64 matrix, 30 axial slices of 5mm thickness, no gap).
Simulation/Test Data (What parameters are determined?)	In 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.

Result / Conclusion (What was the final result?)	The accuracy of testing data reached 96.85%. The rate of accuracy achieved in this work was very high. and confirming that the network architecture was correctly selected.
Obstacles/Challenges (List the methodological obstacles if authors mentioned in the article)	challenges in traditional medical image processing, data processing, Classifying clinical data in the medical conditions
Terminology (List the common basic words frequently used in this research field)	Deep learning; Alzheirmer's Disease; fMRI
Review Judgment (Briefly compare the objectives and results of all the articles you reviewed)	This experiment suggests that the shift and scale-invariant features extracted by CNN followed by deep-learning classification represents the most powerful method of distinguishing clinical data from healthy data in fMRI.This approach also allows for the expansion of the methodology to predict more complicated systems. 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. 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 # 4
Title / Question (What is the problem statement?)	Detection of Parkinson Disease in Brain MRI using Convolutional Neural Network
Objectives / Goal (What is looking for?)	The objective of this work is the Detection of Parkinson's Disease in Brain MRI using a Convolutional Neural Network. This paper presents a Convolutional Neural Network (CNN) based automatic diagnosis system which accurately classifies PD and healthy control (HC).
Methodology/Theory (How to find the solution?)	The proposed system receives MR images as input, which is eventually labeled as PD or HC. The model contains a total number of 8 major layers. Generally, these techniques work on hand-crafted features. CNN is implemented on the NVIDIA GeForce 940MX CUDA-enabled GPU using Keras. All the MRI scans are downloaded in DICOM format.convert images from DICOM to JPEG format by using software package of DICOM-to-JPEG.
Software Tools (What program/software is used for design, coding, and simulation?)	python, keras,Theano - Tensorflow library, MATLAB
Test / Experiment How to test and characterize the design/prototype?	The midbrain slices of 500, T2-weighted MRI are selected and aligned using the image registration technique. The performance of the proposed technique is evaluated using accuracy, sensitivity, specificity and AUC (Area Under Curve). Several experiments are performed with different network settings. Network settings include kernel size, batch size, stride, and padding. During the training of the model, validation and training accuracies are recorded after each epoch. Each time after training the model is tested on the test set. Furthermore, data is divided into training, validation and testing sets with a ratio of 70%, 10%, and 20% respectively.
Simulation/Test Data (What parameters are determined?)	(http://www.ppmiinfo.org)

	The dataset used in this research is obtained from PPMI.The midbrain slices of 500, T2-weighted MRI are selected and aligned using the image registration technique. 22 is collected against each patient's data. The data contains 250 MRI scans of PD while 250 for HC.
Result / Conclusion (What was the final result?)	CNN achieved a better performance from 3% - 9% in terms of accuracy, sensitivity, specificity, and AUC.Each time after training the model, is tested on the test set. In all experiments, the classification accuracy fluctuates between 95 to 98%. The green line shows the validation accuracy while the blue line represents the training accuracy. the training vs validation loss where the x-axis shows the number of epochs and the y-axis shows the loss.
Obstacles/Challenges (List the methodological obstacles if authors mentioned in the article)	The Challenges in this paper, Selecting data from different stages of ADNI, AD/MCI detection using DCNN, MRI data collection, and data processing, limited dataset was a major issue
Terminology (List the common basic words frequently used in this research field)	Parkinson Disease, MRI, Deep Learning, Convolutional Neural Network, CNN
Review Judgment (Briefly compare the objectives and results of all the articles you reviewed)	In the paper, a limited dataset was a major issue., leading the CNN model towards overfitting. The detailed comparison in the result section shows that CNN achieved a better performance from 3% - 9% in terms of accuracy, sensitivity, specificity, and AUC when compared to some existing techniques.
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. We can use this knowledge for our own work. In this paper, the limited dataset was a major issue. For our work, we can use dropout layers in the network for the overfitting problem.

Aspects	Paper # 5
Title / Question (What is the problem statement?)	Early Diagnosis of Parkinson's Disease in brain MRI using Deep Learning Algorithm.
Objectives / Goal (What is looking for?)	Detection of PD is done using deep learning algorithms to discriminate between PD and controlled subjects. Using the Convolutional Neural Network (CNN) and the LeNet-5 architecture, the MRI data of PD subjects was successfully classified from the normal controls.
Methodology/Theory (How to find the solution?)	The dataset was obtained from Parkinson's Progression. Markers Initiative (PPMI). The 3D MRI dataset was in DICOM format and NIFTI format.Afterwards, the images were labelled for the classification of PD vs control data. At the end, the last few slices of each image were discarded as they didn't contain any functional information.
Software Tools (What program/software is used for design, coding, and simulation?)	MRIcro tool (preprocessing of the images) , Python
Test / Experiment How to test and characterize the design/prototype?	The protocol contained T1-weighted (T1w) MRI images based on a scanner by Siemens . The 3D MRI dataset was in DICOM format and NIFTI format. Afterwards, the images were labelled for the classification of PD vs control data.At the end, the last few slices of each image were discarded as they didn't contain any functional information. The dataset containing useful images was then divided into training and testing data, 90% of the images was for training and the remaining 10% for testing.
Simulation/Test Data (What parameters are determined?)	The dataset was obtained from Parkinson's Progression. Markers Initiative (PPMI).The model was trained using a big dataset containing 10,548 images. Loss function was used to measure how accurately the network identified the PD subjects. For this work, 30 PD subjects and 24 elderly controlled subjects (with ages from 60 to 75 years) were picked from the mentioned dataset.
Result / Conclusion (What was the final result?)	97.92% accuracy was achieved using LeNet-5 architecture with batch normalization technique and dropout algorithm. No batch normalization was performed, training accuracy and test accuracy were 96.65% and 97.62% respectively. The model loss was 0.07%.

	Which batch normalization was performed, the training accuracy and test accuracy were 95.44% and 97.92% respectively. The loss was 0.05%.
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)	LeNet-5, Parkinson's disease, Python, Deep Learning, Keras, CNN
Review Judgment (Briefly compare the objectives and results of all the articles you reviewed)	In this research, the chance of curing increases significantly if appropriate steps are taken early and precious time could be saved if the detection process is carried by a computer.The diagnosis of Parkinson's Disease data was successfully performed, with and without batch normalization. 97.92% accuracy was achieved.
Review Outcome (Make a decision how to use/refer the obtained knowledge to prepare a separate and new methodology for your own research project)	For our work, This research may open scope for analysing medical or neuro images.We can use this knowledge for our own work.

Aspects	**Paper # 6**
Title / Question (What is the problem statement?)	Alzheimer's Disease And Dementia Detection From 3D Brain MRI Data Using Deep Convolutional Neural Networks.
Objectives / Goal (What is looking for?)	Alzheimer's Disease And Dementia Detection From 3D Brain MRI Data Using Deep Convolutional Neural Networks Diagnosis. In this paper an alternative approach has been discussed, that is fast, costs less and is more reliable. 3D MRI Images Introduce a Sophisticated Deep Convulsive Neural Network to Detect Alzheimer's Disease and Dementia.
Methodology/Theory (How to find the solution?)	This thesis work has been done using OASIS data. The problem this thesis work is trying to

	solve is a supervised classification problem problem. Clinical Dementia Rating or CDR score is the basis of the classification. The main concern here is the attribute named CDR. If the CDR score is greater than Zero then the person has Alzheimer's disease. And if CDR=0 then-No Alzheimer's disease. So it is now a binary classification problem. Our Xinput is a 3D MRI scan and Y input is whether the person has Alzheimer's disease or not (1 or 0). CDR scores for all subjects are not given. Some have NaN CDR scores. In this thesis NaN CDR score has been replaced by 1. Since Alzheimer's disease mostly affects the Gray matter of the Brain, while image pre-processing white matter and gray matter have been divided from each MRI using. Gray matter has been the main concern.
Software Tools (What program/software is used for design, coding, and simulation?)	Python,OASIS data, Support Vector Machine (SVM)
Test / Experiment How to test and characterize the design/prototype?	The main concern here is the attribute named CDR. If the CDR score is greater than Zero then the person has Alzheimer's disease. And if CDR=0 then-No Alzheimer's disease. So it is now a binary classification problem. Our Xinput is a 3D MRI scan and Y input is whether the person has Alzheimer's disease or not (1 or 0). CDR scores for all subjects are not given. Some have NaN CDR scores. In this thesis, the NaN CDR score has been replaced by 1. Since Alzheimer's disease mostly affects the Gray matter of the Brain, while image pre-processing white matter and gray matter have been divided from each MRI using. Gray matter has been the main concern.
Simulation/Test Data (What parameters are determined?)	This thesis work has been done using OASIS data.The dataset has 416 Subjects cross-sectional brain MRI data and all of them were diagnosed from mild to severe dementia and non dementia.
Result / Conclusion (What was the final result?)	Using Support Vector Machine (SVM) to detect Alzheimer's Disease with the OASIS dataset accuracy level of 80%. Another thesis using v-SVM an alternative formulation of SVM to detect Alzheimer's Disease with the OASIS dataset accuracy level of 92%

Obstacles/Challenges (List the methodological obstacles if authors mentioned in the article)	Most of the modern deep learning models can not represent uncertainty perfectly. So, the Challenge is how well the neural network performs in the case of 3D Neuroimaging data.
Terminology (List the common basic words frequently used in this research field)	Neural Networks, Deep Learning, 3D Brain MRI, Alzheimer's Disease And Dementia, Machine Learning, Big Data, High Dimensional Input.
Review Judgment (Briefly compare the objectives and results of all the articles you reviewed)	From this article, fast, costs less, and more reliable detection of Alzheimer's Disease and Dementia from 3D MRI images.
Review Outcome (Make a decision how to use/refer the obtained knowledge to prepare a separate and new methodology for your own research project)	For our work, we can use the Vector Machine (SVM) technique to detect Alzheimer's Disease with the dataset.We can use this knowledge for our own work.