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Deep Learning Image Processing Technique for Early Detection of Alzheimer's Disease

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Abstract

Alzheimer's disease is the progressive disease that razes memory and other imperative mental functions and is the cause of 60-70% of dementia cases. No medications end or return its progression, though some may temporarily improve symptoms. Since the cause for most Alzheimer's cases is still mostly unknown, the development of reliable strategies to set up a targeted prognosis at the earliest degree is critical to enhancing prognosis of the disorder, and setting up appropriate care and treatment. Artificial Neural Network (ANN) and Deep Neural Network (DNN) image processing techniques is applied and compared for extraction of features based on the parameters such as cortex thickness, hippocampus shape and corpus callosum by developing an algorithm. In our study, the accuracy of Artificial Neural Network and Deep Learning Neural Networks are compared for normal and abnormal disease diagnosis.

Keywords: *Alzheimer's disease, Deep Neural Network, hippocampus, corpus callosum, cortex thickness*

1. Introduction

Alzheimer's disease became a primary public health problem of increasing importance as life expectancy of health of the population increases, many researchers worked on to diagnosis the Alzheimer's disease based on many factors. Alzheimer disease is one of the most essential causes of disability and is a progressive neurodegenerative disorder displaying sluggish deterioration in cognition, characteristic and behavior [1]. Due to the socioeconomic importance of the disease in occidental International locations there is sturdy worldwide attempt awareness in Alzheimer's disease. This sort of degenerative issue gives psychological and behavioral impedance that meddles with day by day lifestyle of the individual as well as its social community, enforcing an increased affordable and mental cost.

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Greater than 55 ailments are associated with the improvement of dementia and Alzheimer's disease is the most regularly occurring form despite the fact that studies has found out a fantastic deal about Alzheimer disorder, excluding certain inherited types of the ailment, the causes of Alzheimer ailment continue to be unknown. Early diagnosis is essential to mitigate its effects. The diagnosis can be completed after the exclusion of other kinds of dementia but a definitive diagnosis can best be made after a post-Morten take a look at of the brain tissue. Ante-mortem approaches for diagnosis are under progress, but they require neuro pathologic authentication of the distinctive amyloid plaques and neuro fibrillary tangles. There is a sturdy attempt aimed to the evaluation of medical imaging biomarkers identifying the disease at various stages [2]. Besides, the pharmaceutical organizations have effectively prestigious that imaging strategies particularly MRI and Positron Emission Tomography (PET) give surrogate information relating to the pattern and rate of neuro degeneration, where the effects of treatments which slow the progression of neuro degeneration can be monitored [3].

There is a demanding insight that the care of older human beings with disabilities makes huge load on their careers. Terms like dementia and Alzheimer's ailment are actually higher understood. However, this changed into not the case when the Alzheimer's and related disorders Society of India (ARDSI) initiated attention programs in 1992.Dementia vestiges a large concealed hassle in India specially in the ones elements of India where paucity and illiteracy levels are elevated.

One of the hallmarks of Alzheimer's disease is the buildup of amyloid plaques among nerve cells in the brain [4]. To diagnosis the Alzheimer disease it is required to know the internal structures hidden in the brain which can be obtained through various types of scanning techniques existed [5]. These scanning techniques in the medical field include are Angiography and MRI Angiography (MRA), Computed Tomography(CT), Dynamic CT or Dynamic MRI, Flow sensitive MRI (FSMRI), functional MRI (fMRI), Magnetic Resonance Imaging (MRI), Magnetic Resonance Spectroscopy (MRS), Magneto Encephalography (ME), Positron Emission Tomography (PET), Single Photon Emission Computerized Tomography (SPECT), *etc*., Structural MRI is a chief imaging biomarker in AD as the cerebral atrophy is shown to closely links with cognitive symptoms. In familiar with this, several techniques were developed for quantifying the disease associated atrophy from MRI over the past few decades. Exceptional attempts were devoted to separate AD related adjustments from ordinary getting older for early detection and prediction.

MR images are very rich in information content. With relaxation time constants (T1 and T2) and the proton density, the image pixel value can be considered as a function of parameters. Thus, the change in parameters effect can create same anatomical position MR images differently [6], which can be further processed for production of new maps with respect to blood flow, water diffusion, *etc*. Hence, the technique with superior scientific and diagnostic values can be endowed with the flexibility in data acquisition and the rich contrast mechanisms of MR images.

The MRI scan can obtain different types of images at same cross section. The MRI scan helps to diagnosis the problems such as vessel problems in the head, cause of headaches, check signs and symptoms of recognized or suspected head injury, check symptoms may be caused by brain diseases like Alzheimer's disease.

AD is developed over a period of 2 - 10 years, before the symptoms become visible. Autopsies conducted on AD affected people at diverse a long time recommend that the earliest signs and symptoms are stated at the bottom of the brain in 50s of age. Brain is the crucial and central part of the human nevus system and any abnormality due to a disease can lead to complete failure of human structural function. Alzheimer, an old age disorder of humans over sixty five years causes problems with memory, thinking and behavior. This ailment progresses very slow and its identity in early ranges could be very difficult. It isn't always a selected disorder and the patients may additionally have problems with

communication, concentrated attention, focusing, judgment, memory, reasoning and visual perception. These symptoms appear slowly and gradually will have worse effects [7].

AD early detection is essential so that preventive measures can be undertaken. Current strategies for detecting ad rely on cognitive impairment checking out which regrettably does not defer precise diagnoses until moderate AD is progressed in the patient. Alzheimer's disease being considered one among the extreme diseases that purpose the human death in humans above 60 years antique, many pc-aided prognosis structures is now widely unfold to aid in it [8]. Consequently, an automatic and reliable pc-aided diagnostic system for diagnosing and classifying the brain disease has been proposed. Magnetic Resonance Imaging (MRI) image is taken as input since it has greater range with soft tissue contrast, portrays detailed anatomical features and can show highly sensitive and precise abnormalities within the brain.

Detection of Alzheimer's is very hard in first four degrees. In stage I and stage II, the patient does not experience any memory troubles, whereas in stage III mild cognitive declines can be recognized in some instances. In level IV, some visible adjustments like forgetting latest activities and issues in management of monetary activities are seen within the sufferers. In level V, the sufferers have fairly severe cognitive decline and need assist in acting routine obligations. On this stage the patients have attention troubles. In level VI, they forget about their personal history. In level VII, the patients may have serious issues. At this level, they want extra assist in appearing habitual duties like eating or using the bathroom. They cannot take a seat without aid and feature issue in keeping their heads up. They expand atypical reflexes and even feel difficulty to smile. It's far very crucial to word that Alzheimer's patients may additionally face fatal consequences at the side of non-fatal consequences like stroke, congestive heart failure, and ischemic attacks as a result of aspect effects of their treatment.

Preprocessing is an underlying part in any image processing technique. It relies on the unique technique demand. The Alzheimer's disease diagnosis system contains two main parts one is feature extraction which is based on Digital Image Processing techniques and other is Deep Learning technique. To obtain high accuracy, Multi-Scale DNN based Localization algorithm is used to train the data. The Alzheimer finding and sorting system consists of five modules namely acquire MRI image, MRI pre-processing, segmentation, feature extraction, classification and output respectively.

2. Review of Literature

The Ministry of India released a report that the range of residents over age of 60 jumped 35.5% from 7.6 crore in 2001 to 10.3 crore in 2011. This age organization, which become 7.5% of the populace, is expected to grow dramatically in the coming many years. Alzheimer's disease became a major civic health problem of increasing importance as healthy life expectancy has increased among public. As a rapid change in the life style of human, the Alzheimer's disease cases are increasing a lot compare to the past decade and it also the developing of AD is strongly related with age. Studying how the brain normally changes over time can improve the knowledge of how AD is developed. Diagnosing of AD in an early stage can bring several benefits to the person.

Al Naami *et al.*, [9] proposed a fusion method to distinguish between the normal and (AD) MRIs. Pierrick Coupe *et al.*, [10] proposed the potential use of structural MRI as imaging biomarker for Alzheimer's disease for early detection, especially the use of atrophy of entorhinal cortex (EC) and hippocampus (HC). Therefore, in this study, the capabilities of SNIPE (Scoring by Nonlocal Image Patch Estimator), for the early detection of AD to analyze EC and HC atrophy over the entire ADNI database (834 subjects) were analyzed.

Sima Farhan *et al.*, [11] proposed an automatic image processing primarily based method for the recognition of Alzheimer's disease. Inside the early levels of Alzheimer's ailment brain atrophy may be subtle and spatially distributed over many brain areas, including the entorhinal cortex, the hippocampus, lateral and inferior temporal structures, as well as the anterior and posterior cingulated. Through the most likely causes of AD, we can count genetic, environmental and lifestyle factors [12]. Late onset AD, often developed after age of 60, is related with a gene called Apo lipoprotein (ApoE), which is present in around 25% of world's population [13]. The involvement of free radicals is the most apparent risk factor that accounts for the heterogeneous nature of AD. The likelihood of this contribution is upheld by the way that neurons are amazingly delicate to assaults by damaging free radicals.

The Digital Image Processing refers to dealing with digital images by means of a digital computer. Digital Image Processing has got several advantages in image processing, it allows collection of algorithm to be connected to include information and can evade the issues of noise and signal deformation during processing [14]. Image restoration attempts to reconstruct or recover an image that has been degraded by a degradation phenomenon [15].Image enhancement is to enhance the visual appearance of a image or to give a "better transform representation for future automated image processing" [16].

In this study, image enhancement and restoration for the extraction of MRI image features is used as manual extraction of features is a difficult task and is a time consuming process. In order to extract the features of MRI image automatically, Digital Image Processing techniques are using in the current work. The extracted features are classified using Artificial Neural Network (ANN) and Deep Learning techniques (DLN). An ANN is a mathematical representation of the human neural architecture, reflecting its "learning" and "generalization" abilities. For this reason, ANNs belong to the field of artificial intelligence [17].

A single biological neuron is composed of three major components the cell body (soma), dendrites and axon, which are interconnected [18]. Similar to biological neurons, artificial neurons also has the structure similar to the biological neuron. The computational artificial neuron contains both the input and output neurons. The output neuron y receives the input signals x1, x2, x3…xn through the weighted communication links. Therefore the net input received by the neuron is the sum of the product of the input signals and weights. Neural Network Architectures can be classified into either a single layer or multi-layer Neural Networks based on the number layers present in the network [19]. Deep Learning is a fire new is of Machine Learning studies, which has been introduced with the objective of shifting Machine Learning getting closer towards one its authentic goals.

Though deep architectures theoretically have advantages, the training of Deep Neural Networks is more complicated than the training of shallow ones [20]. Starting from random initializations (of weights and biases) and using conventional supervised learning algorithms, the solutions of deeper networks performed worse than solutions obtained for networks with one or two hidden layers. In 2006, Hinton et al. [21] discovered, that much better generalization results could be obtained, if each layer is pre-trained using an unsupervised learning algorithm, instead of using random initialization. However, in this study a novel region of interest is proposed for automatic extraction of exact features and applying Multi Scale DNN based Localization technique which is able to produce high resolution object detection at low cost for the classification accuracy to diagnosis the disease.

A) Automatic feature extraction of MRI using digital image processing techniques

MRI data is collected based on signs and symptoms then image acquisition procedure is followed. The Artificial neural network technique namely Error Back propagation

neural network is used to train the data. The median filter is used to actualize strategy for smoothing images and to diminish the measure of intensity variation between one pixel and the other pixel of MRI image. The following figure shows the MRI image before and after applying the median filter.

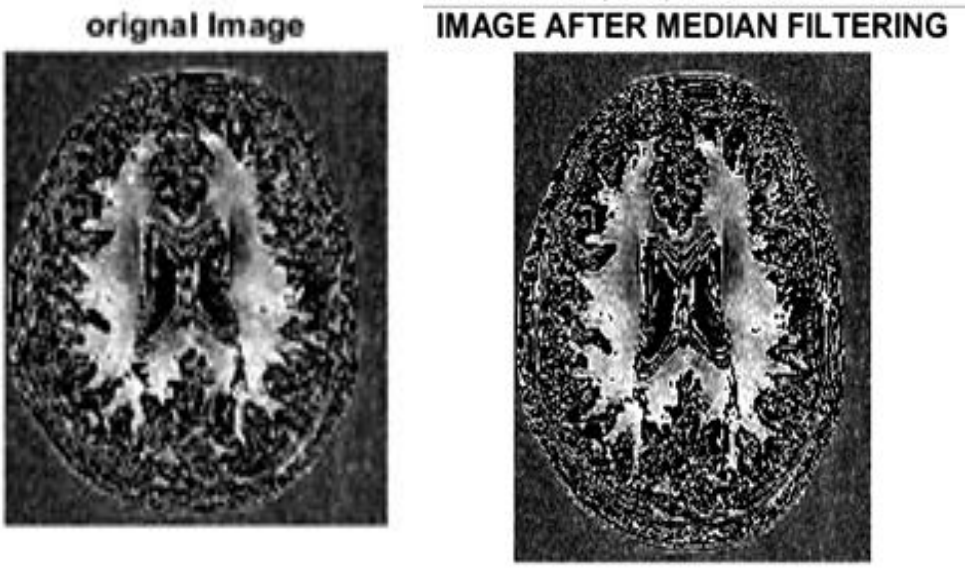
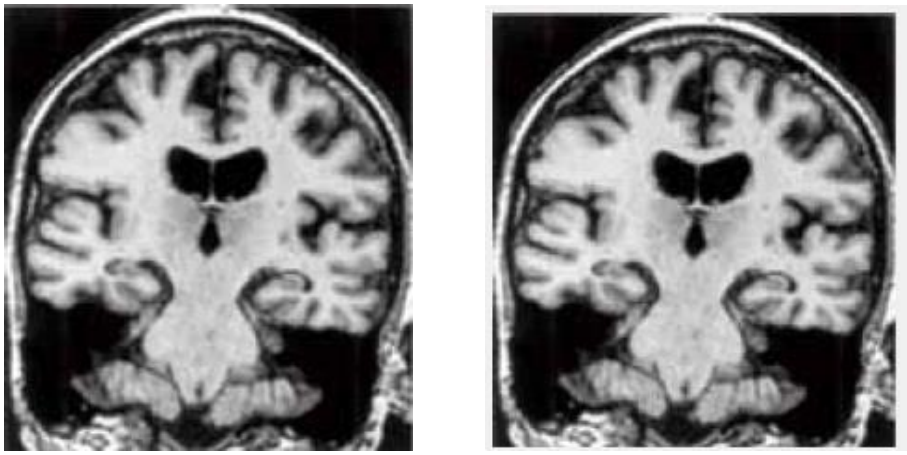


Figure 1. MRI Images after Applying Median Filter

Auto-normalization in image processing software typically normalizes to the full dynamic range of the number system specified in the image file format.



(a) (b)

Figure 2. (a) Original Image (b) Normalized Image

In image object extraction the main emphasis is on extracting each or focused objects from the image. Among all types of object extraction, Region growing technique is used to extract the exact features of the object to diagnosis the Alzheimer's disease based on different regions. Region growing and merging an preliminary set of small regions are iteratively merged according to similarity constraints. It's far started via selecting an arbitrary seed pixel and compared it with neighboring pixels. Region is grown from the seed pixel by using including in neighboring pixels which are similar, increasing the size of the Region.

3. Region of Interest (ROI) Technique

By approaching the problem of object detection, firstly unique invariant features from images are extracted that are further used for region grouping. Using Harris corner detector, the features are extracted which can be associated with point locations that have massive gradients in all directions at a determined scale [22]. The shape and texture statistics evaluated on local regions are meditated and has been confirmed to be invariant across a considerable range of image deformations and illustration settings. The hired features additionally account for spatial dependencies of intensity levels .Aside from considering about the distributions of color and intensity metrics the hired features additionally.

3.1. Feature Extraction Based on Cortical Thickness

The thickness of the cerebral cortex can provide treasured facts approximately ordinary and abnormal Alzheimer's disease. The MRI image is given as input and median filter is applied, followed by canny edge detection. Later, function is set (truncated length) to extract ROI specific feature and the target location is extracted.

In this chapter image processing techniques are used for feature extractions from the given MRI input image based on the parameters cortical thickness, hippocampus shape and corpus callosum to diagnosis the Alzheimer's disease. The image processing techniques includes image enhancement, normalization, noise removal and filtering. Here the region of interest method is used for object extraction. Finally for this extracted image the lengths are measured based on threshold value. In further chapters the Deep Learning technique is used for classification to diagnosis the Alzheimer's disease at early stage based on the three parameters such as cortical thickness, hippocampus shape and corpus callosum.

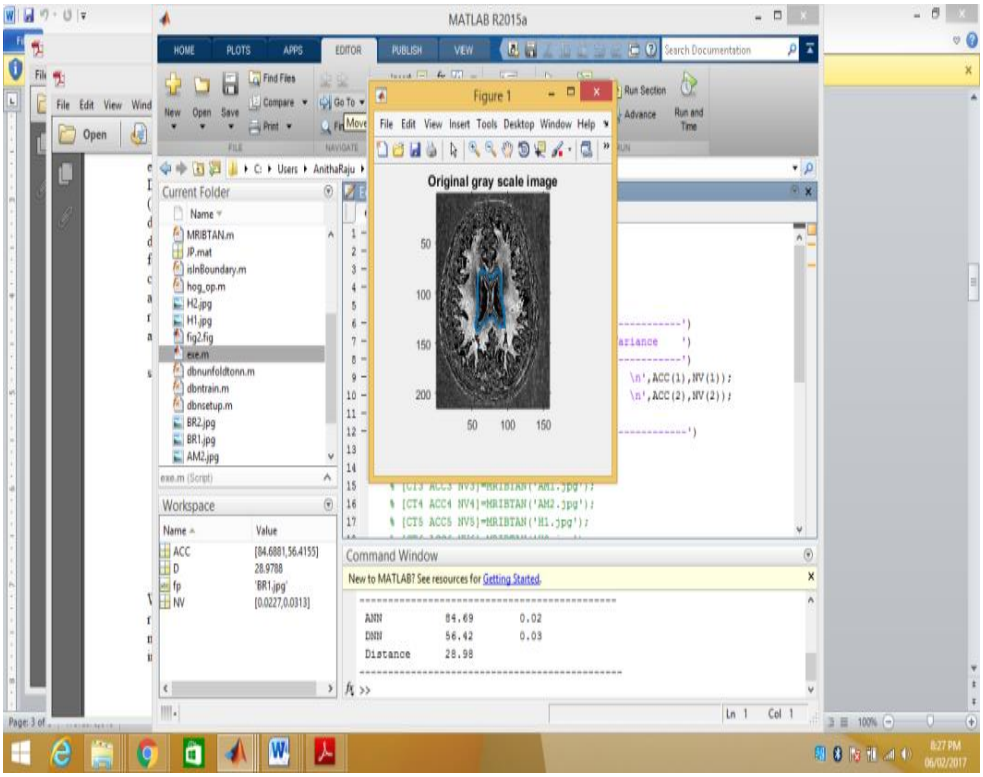


Figure 3. Original Gray Scale Image with Extracted Region

The following diagram shows the feature extraction based on ventricles enlargement for the given input MRI image of healthy individual by applying region of interest method. Then applying the binary mask for the extracted region to crop the image and measure the distance of cropped image based on the threshold value.

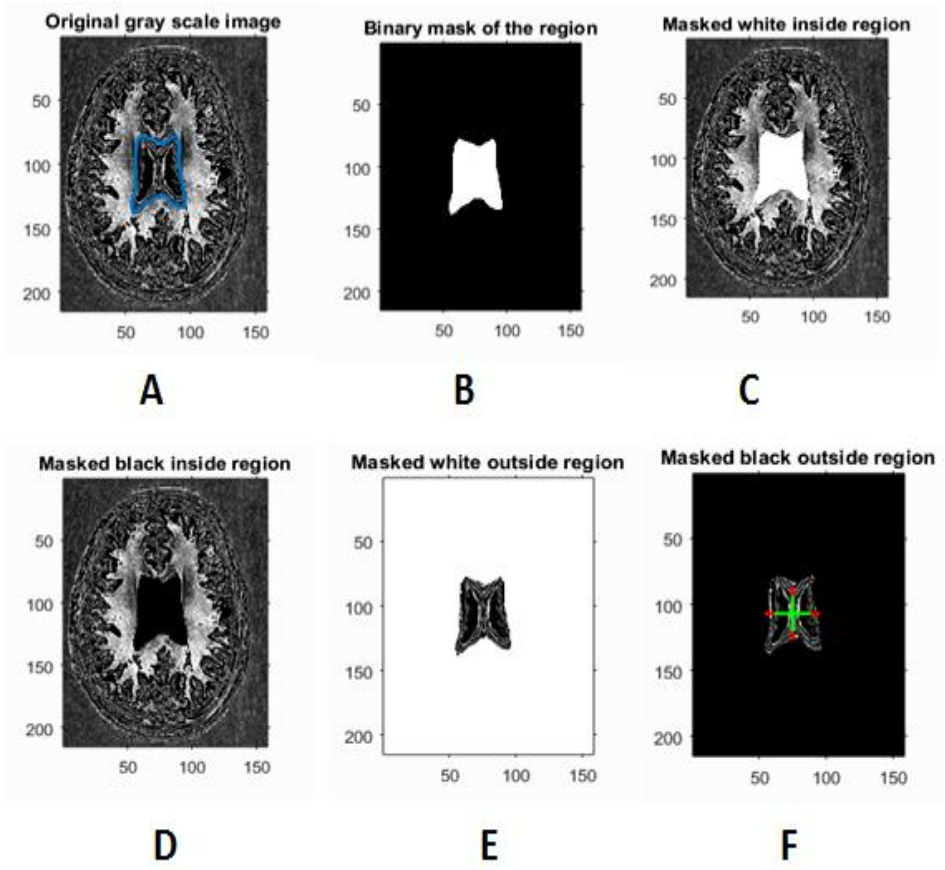


Figure 4. MRI Images of Healthy Individual for the Parameter - Cortical Thickness

A. Feature extraction in MRI image
B. Binary mask for extracted region
C. Masked with white inside the extracted region
D. Masked with black inside the extracted region
E. Masked with white outside regions for cropped image
F. Marked centre using Threshold value to measure the distance

Threshold Values for Extracted Images:

After extracted the exact feature from the given input image various thresholds (numerals depict the threshold gray value) values are applied to calculate the length from the centre of the cropped image. The distance from centre of the image has to be calculated based on total area of extracted object and the threshold value. Using the threshold value 0.03 yielding the correct values of the distance measured from the centre of the image to inner edge of the cropped image.

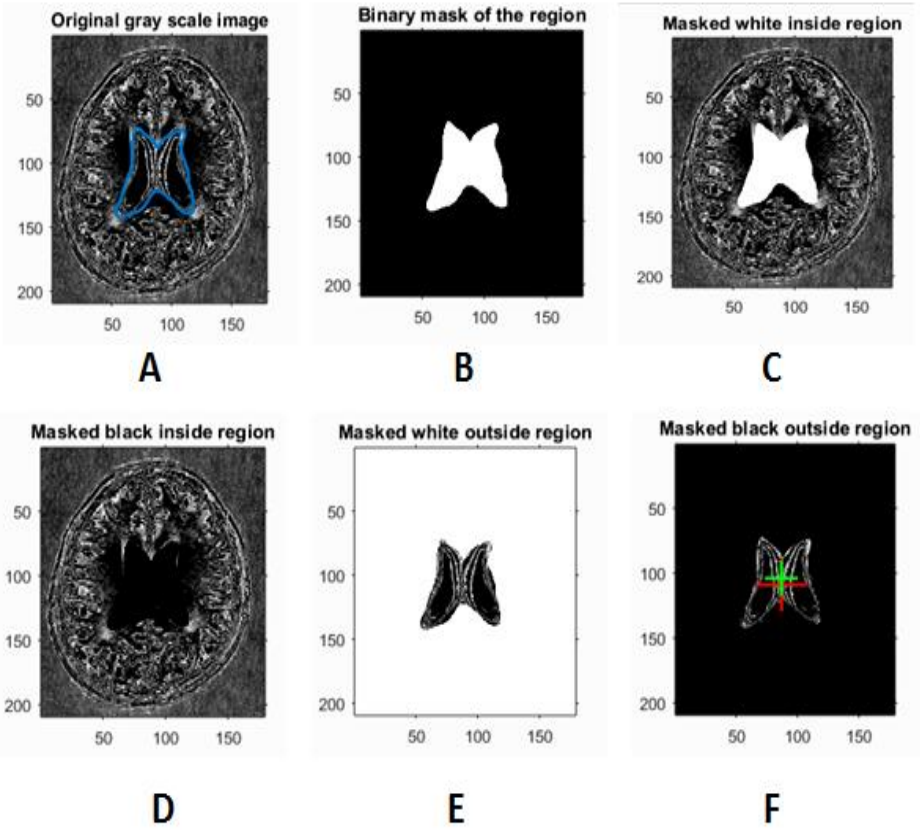


Figure 5. MRI Images of Alzheimer Disease Patient for the Parameter - Cortical Thickness

A. Feature extraction in MRI image
B. Binary mask for extracted region
C. Masked with white inside the extracted region
D. Masked with black inside the extracted region
E. Masked with white outside regions for cropped image
F. Marked centre using Threshold value to measure the distance

Table 1. Distance Measured for Cropped using Threshold Value in ventricles Enlargement of MRI image

Image	Parameter	Total Area of extracted object	Threshold value	Distance (mm)
Healthy individual	Cortical Thickness	1838 Pixels	0.03	28.98
Alzheimer diseased Patient	Cortical Thickness	2821 Pixels	0.03	36.59

3.2. Feature Extraction based on Hippocampus Shape

Elderly major depression is allied with alterations in brain structure, sub cortical regions of the limbic system and vascular lesions. Results are varied on studies considering hippocampus volumetric differences in depression, possibly due to secondary

volume differences to local shape changes instead of overall volume. Shape analysis facilitates the ability to detect such changes.

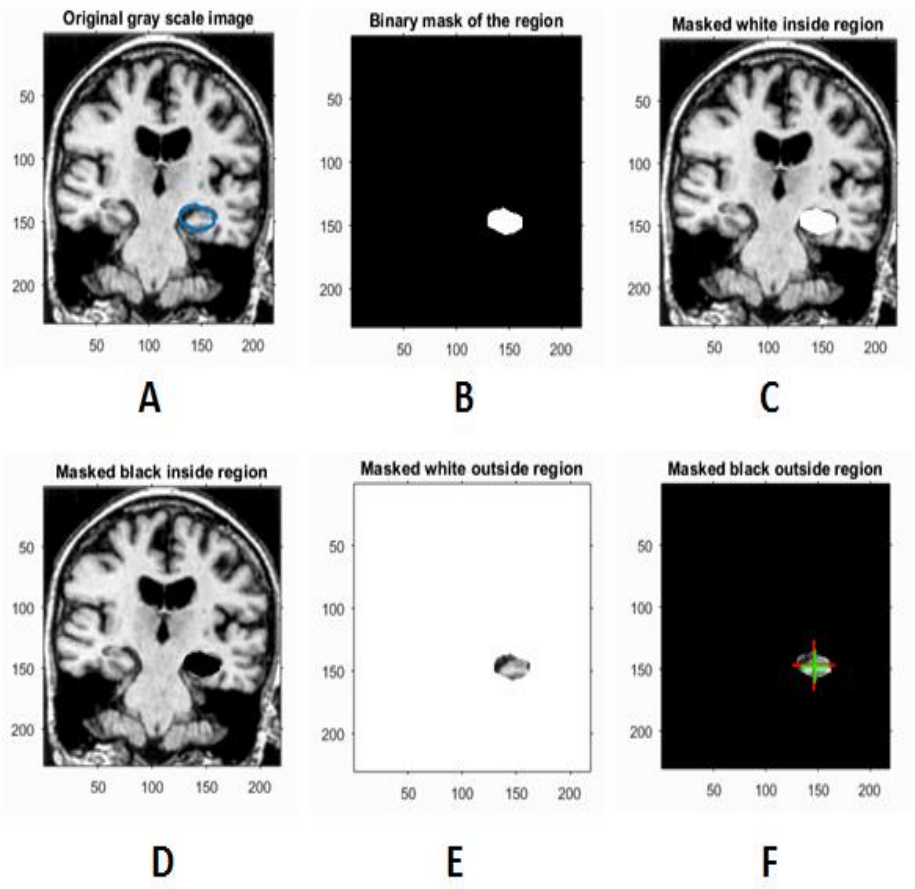


Figure 6. MRI Images of Healthy Individual for the Parameter - Hippocampus Shape

A. Feature extraction in MRI image
B. Binary mask for extracted region
C. Masked with white inside the extracted region
D. Masked with black inside the extracted region
E. Masked with white outside regions for cropped image
F. Marked centre using Threshold value to measure the distance

The following diagrams shows the feature extraction based on hippocampus shape for the given input MRI image of healthy individual by applying region of interest method. Then applying the binary mask for the extracted region to crop the image and measure the distance of cropped image based on the threshold value.

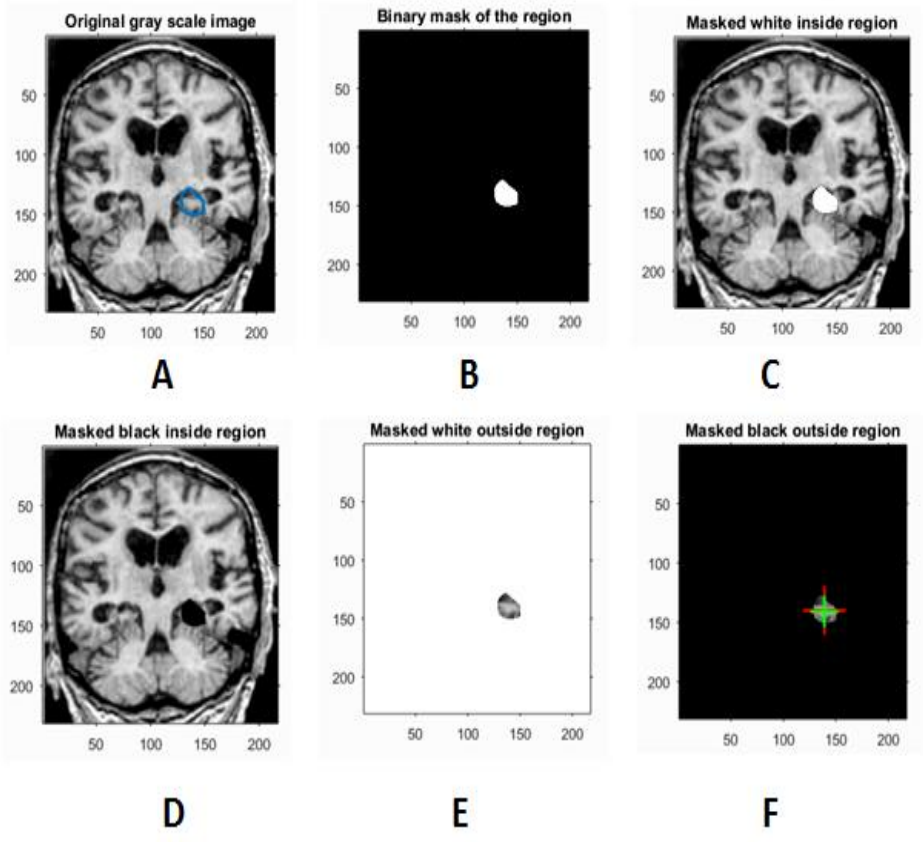


Figure 7. MRI images of Alzheimer's Disease Individual for the Parameter - Hippocampus Shape

A. Feature extraction in MRI image
B. Binary mask for extracted region
C. Masked with white inside the extracted region
D. Masked with black inside the extracted region
E. Masked with white outside regions for cropped image
F. Marked centre using Threshold value to measure the distance

The following diagrams shows the feature extraction based on hippocampus shape for the given input MRI image of Alzheimer's disease patient by applying region of interest method. Then applying the binary mask for the extracted region to crop the image and measure the distance of cropped image based on the threshold value.

Threshold Values for Extracted Images:

After extracted the exact feature from the given input image various thresholds (numerals depict the threshold gray value) values are applied to calculate the length from the centre of the cropped image. The distance from centre of the image has to be calculated based on total area of extracted object and the threshold value. Using the threshold value 0.03 yielding the correct values of the distance measured from the centre of the image to inner edge of the cropped image.

Table 2. Distance Measured for Cropped using Threshold value in Hippocampus of MRI

Image	Parameter	Total Area of extracted object	Threshold value	Distance
Healthy individual	Hippocampus Shape	372	0.03	10.97
Alzheimer diseased patient	Hippocampus Shape	517	0.03	32.47

3.3. Feature Extraction Based On Corpus Callosum

The corpus callosum (CC) region that connects right and left cerebral hemispheres has been examined widely for signaling of Alzheimer's disease prevalence. Previous studies of the CC in Alzheimer's disease had been worried with its size, in particular its mid-sagittal cross-sectional area (CCA).

The CC shape is extracted based on region of interest (ROI) method and can be done automatically when the image is taken.

The Figure 8 shows the feature extraction based on corpus callosum shape for the given input MRI image of healthy individual by applying region of interest method. Then applying the binary mask for the extracted region to crop the image and measure the distance of cropped image based on the threshold value.

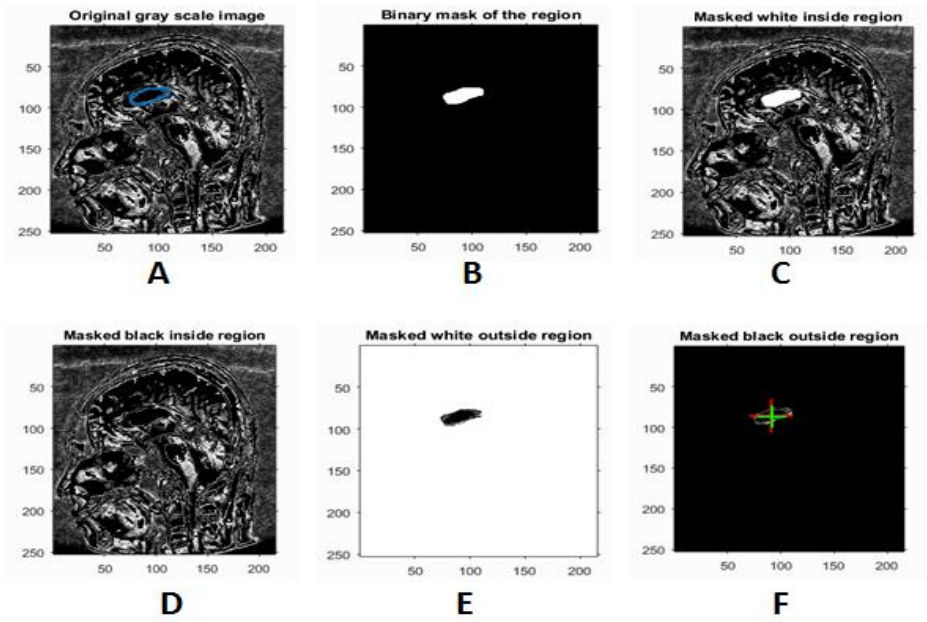


Figure 8. MRI Images of Healthy Individual for The Parameter - Corpus Callosum Shape

A. Feature extraction in MRI image
B. Binary mask for extracted region
C. Masked with white inside the extracted region
D. Masked with black inside the extracted region
E. Masked with white outside regions for cropped image
F. Marked centre using Threshold value to measure the distance

The Figure 9 shows the feature extraction based on corpus callosum shape for the given input MRI image of Alzheimer's disease patient by applying region of interest method. Then applying the binary mask for the extracted region to crop the image and measure the distance of cropped image based on the threshold value.

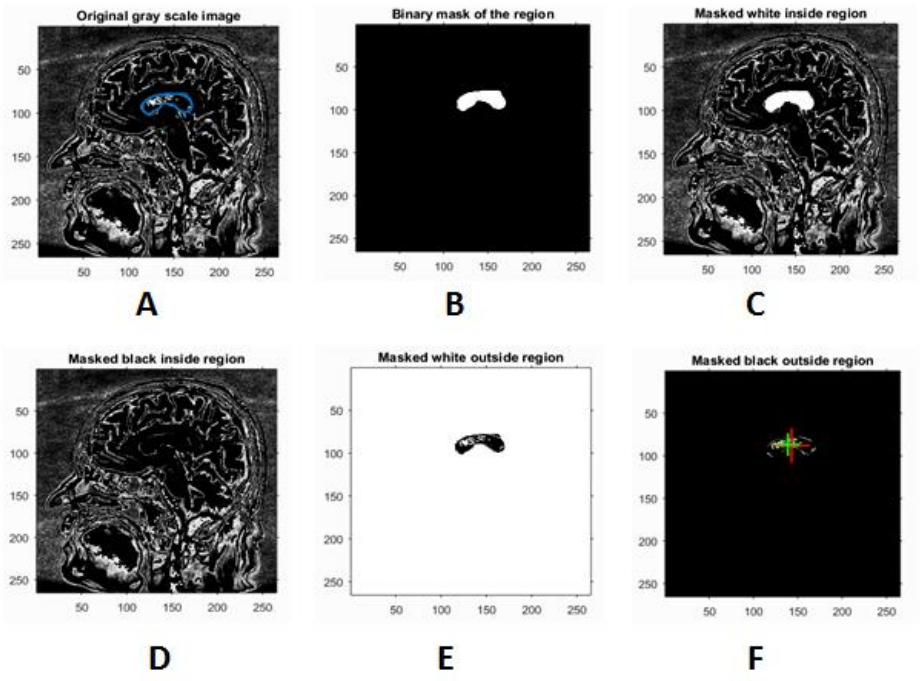


Figure 9. MRI Images of Alzheimer's Disease Individual for the Parameter - Corpus Callosum Shape

A. Feature extraction in MRI image
B. Binary mask for extracted region
C. Masked with white inside the extracted region
D. Masked with black inside the extracted region
E. Masked with white outside regions for cropped image
F. Marked centre using Threshold value to measure the distance

Threshold Values for Extracted Image:

After extracted the exact feature from the given input image various thresholds (numerals depict the threshold gray value) values are applied to calculate the length from the centre of the cropped image. The distance from centre of the image has to be calculated based on total area of extracted object and the threshold value. Using the threshold value 0.03 yielding the correct values of the distance measured from the centre of the image to inner edge of the cropped image.

Table 3. Distance Measured for Cropped using Threshold value in corpus callosum of MRI image

Image	Parameter	Total Area of extracted object	Threshold value	Distance
Healthy individual	Corpus callosum shape	502	0.03	8.78
Alzheimer diseased patient	Corpus callosum shape	879	0.03	30.13

4. Multi-Scale Refinement of DNN Localizer

The DNN classification technique Multi Scale DNN based Localization algorithm is used to train the given dataset based on the parameters cortical thickness, hippocampus shape, corpus callosum. The DNN weights for the given dataset are shown and the classification variance is present in respect to bar charts. For ANN error back propagation technique is used and for DNN Multi Scale DNN based Localization is used to train the data. The best classification technique to diagnosis the Alzheimer Disease is shown in the above table.

The Error Back Propagation method is applied for calculating the weights and network supervised learning for classification of the given data set. To overcome the drawback of Artificial Neural Network *i.e*, to find the most apt grouping of learning, training and transfer function for classifying the data sets with growing number of features and classified sets, Deep Neural network is applied. DNN performs automatic feature extraction without human intervention, unlike most traditional machine learning algorithm.

The insufficient resolution issue of the network output is dealt with in two ways: (i) use of the DNN localizer over several scales and a few sub-windows; (ii) refinement of detections on the top inferred bounding boxes. Three scales are used namely the complete image, the window size at a given scale, half the window size at the previous scale. The image is covered at each scale with a 20% overlap in windows area. At inference time, the DNN is applied on all windows. It is also cleared that it is pretty different from sliding window approaches as evaluation of less than 40 of windows per image is needed. The generated object masks at each scale and are merged by maximum operation. This gives us three masks of the size of the image, each looking at objects of different sizes. For each scale, the bounding box inference is applied from Sec 5.2 to arrive at a set of detections. The top 5 detections per scale are considered, resulting in a total of 15 detections. To improve the localization, the second step of DNN regression called refinement is applied by the initial detection stage each of 15 bounding boxes enlarged by a factor of 1.2 and is applied to the network.

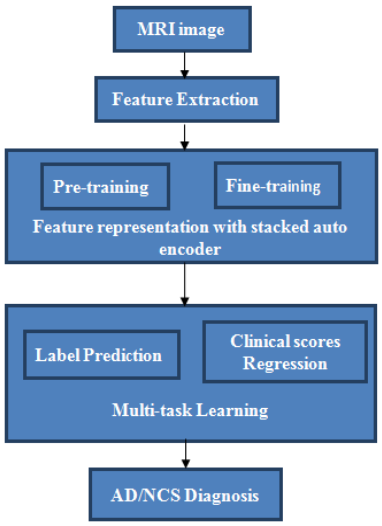


Figure 10. Deep Leaning Approach to Diagnosis Alzheimer's Disease

4.1. DNN Training

The classifier is really replaced by means of a mask era layer without any smoothness earlier or convolution shape. But, it desires to be trained with a massive quantity of training records: Objects of different sizes. For training the mask generator, 60% negative and 40% positive image samples are generated.

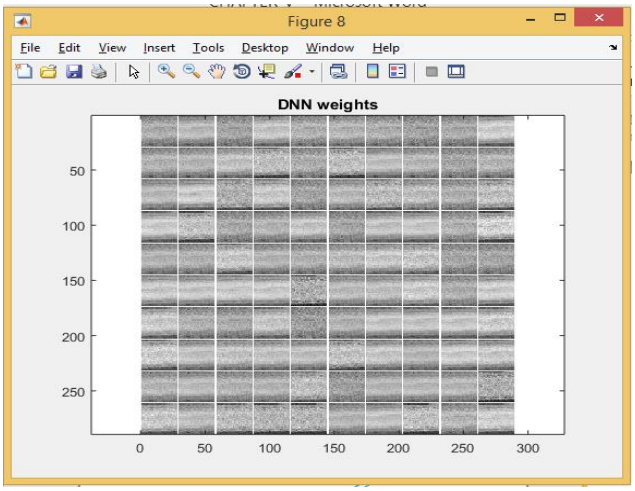


Figure 11. DNN Weights for the MRI Images

Identical procedural steps are used to train the classifier used for the final pruning of our detections. The negative samples are those whose bounding boxes have less than 0.2 similarities with any of the floor truth object bins and the high-quality samples must have at the least zero.6 similarities. it's far important first of all the weights of a model with excessive first-class low-level filters. To achieve this, the network was trained first for classification and reused the weights of all layers with the localization classifier. For localization, the whole network, including the convolution layers is fine tuned.

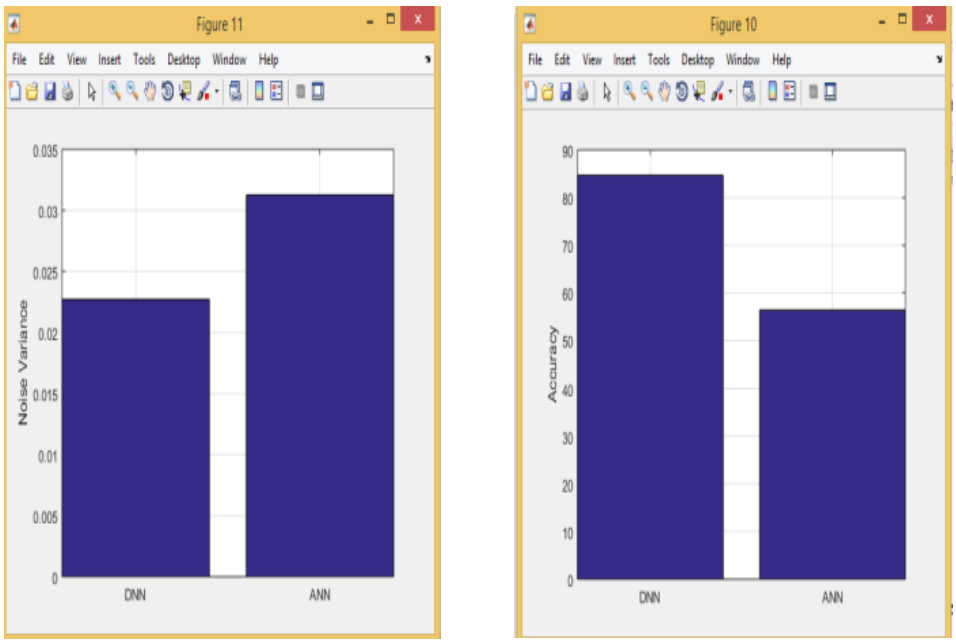
4.2. Classification Accuracy Using Deep Learning Technique

A total of 100 samples are used with each having a set of 13 parameters which are obtained from the MRI image based on the cortex thickness, hippocampus shape and corpus callosum individually to classify normal or abnormal cases. The list of parameters considered and the extracted length of feature are listed below.

Table 4. List of Parameters and the Extracted Lengths

Attribute	Feature extracted	Length(mm) Normal	Length(mm) Abnormal
Cortex thickness	Cortex shape	28.98	36.59
Hippocampus	Hippocampus shape	10.97	32.47
Corpus Callosum	Corpus callosum shape	8.28	30.13

Finally, the accusation results of ANN and DNN on MRI images is shown based on the parameters that are considered for diagnosis of Alzheimer's disease. The following Figure shows the Noise variance 0.02 in ANN and 0.03 in DNN and accuracy of classification 56.76 in ANN and 84.69 in DNN in the MRI image of Cortical thickness, Hippocampus shape and corpus callosum.



(A) (B)

Figure 12. Noise Variance (A) and Classification Accuracy (B) in DNN and ANN of MRI Image for the Parameters Cortical Thickness, Hippocampus Shape and Corpus Callosum

5. Discussion

The problem addressed is early diagnosis of Alzheimer's disease based on the MRI images using Digital image processing and Deep Neural Networks. The resultant extracted features based on the parameters and the lengths are measured for Normal control subject and Alzheimer's disease patients of MRI images. The resultant images are used further for classification to early AD diagnosis.

The Features are extracted mainly based on three parameters such as cortex thickness, Hippocampus shape, and Corpus callosum. Then classification is done based on Error back propagation neural networks and Multi scale DNN based Localization Deep Neural Networks as it is able to classify to diagnosis of Alzheimer's disease. This makes the developed system is a support tool for the physician to diagnosis the Alzheimer's disease. During the study, there are number of issues are raised, solved and inferences are derived.

Increasing Alzheimer's disease, this proposed analysis method can be beneficial for helping to make decision on the ailment as a aid device for Radiologists for early diagnosis of Alzheimer's disease. To develop the system Multi scale DNN based Localization Deep Learning Neural network is used for classification. By using the developed system it is useful for the older people especially in remote areas, where there is lack of expertise physicians to diagnosis the AD of the patient. The general population with dementia are qualified for an opportune conclusion right when they and their families' initially express concerns and have a requirement for exhortation, treatment or support .To extract this feature an automatic feature extraction algorithm is developed using Image processing techniques for pixel variations, pixel intensities and smoothing process. The exact features from MRI images can be extracted automatically by new ROI algorithm based on boundary. And the lengths are measured for these extracted images to diagnosis the normal and abnormal image.

Initially For the given MRI images the Normalization, Gray scale conversion and Noise removal are done. The salt and Pepper noise removal is done for removing the noise and to extraction the features Region of Interest is used. Further these features values are stored and the stored features are fed to Error Back propagation neural network and Multi-scale DNN based Localization neural network for classification.

In our study, the accuracy of artificial neural network and Deep Learning neural networks are compared for, normal and abnormal disease diagnosis and is showed that the accuracy increased in Deep Learning technique compared to artificial neural network. A system is developed based on the features like Cortical thickness, Hippocampus shape and corpus callosum shape are fed to the multi scale DNN based Localization and the training is done based on Error Back propagation Neural network algorithm and Multi scale DNN base Localization algorithm.

In addition, an extension of this work using the other types of images like Functional magnetic resonance imaging (fMRI), Magnetic Transfer Imaging (MTI) for enhancement are in progress and also the present study provides source for development of new procedures using biomarkers that are left over. Further enhancement can also be performed by considering the parameters like frontal lobe, Parietal Lobe, Occipital lobe, Thalamus, *etc.*, which could be extended for other kinds of dementia in future.

6. Comparison Study

Deep Learning has been used successfully in many applications, and is considered to be one of the most cutting-edge machine learning and AI techniques at the time of this writing. The associated algorithms are often used or supervised, unsupervised, and semi-supervised learning problems. For neural network-based Deep Learning models, the number of layers is greater than in so-called shallow learning algorithms. Shallow algorithms tend to be less complex and require more up-front knowledge of optimal features to use, which typically involves feature selection and engineering. In contrast, deep learning algorithms rely more on optimal model selection and optimization through model tuning. They are better suited to solve problems where prior knowledge of features is less desired or necessary, and where labeled data is unavailable or not required for the primary use case.

Table 5. Comparison Study

Existed Methods	Limitations	Proposed Methods	Overcome features of Existed Method
Supervised, unsupervised, Semi Supervised Machine Learning and AI Algorithms	1. The number of layers are more Tend to less complex. 2. Require more up-front knowledge. 3. The physical universe are actually best modeled with nonlinear transformations.	Deep Learning in neural networks	1. It consists of total 7 layers, then first 5 of which being convolution and the last 2 fully connected. 2. Prior knowledge of features is less desired or necessary where ladled data is less desired or necessary. 3.Simple and yet powerful formulation of object detection as a regression problem to object bounding box masks by defining a multi-scale inference procedure is used which is able to produce high-resolution object detections at a low cost by a few network applications

The Unsupervised learning techniques are to discover and learn the structure in the input variables. Supervised learning techniques are also developed to make best guess predictions for the unlabeled data, feed that data back into the supervised learning algorithm as training data and use the model to make predictions on new unseen data.

Many phenomena observed in the physical universe are actually best modeled with nonlinear transformations. This is true as well for transformations between inputs and the target output in machine learning and AI solutions.

In this work, the simple and yet powerful formulation of object detection as a regression problem to object bounding box masks by defining a multi-scale inference procedure which is able to produce high-resolution object detections at a low cost by a few network applications. It consists of total 7 layers, then first 5 of which being convolution and the last 2 fully connected. Each layer uses a rectified linear unit as a non-linear transformation. Three of the convolution layers have in addition max pooling is adapted the generic architecture for localization. Instead of using a soft matrix classifier as a last layer, using a regression layer which generates an object binary mask DNN(x;Θ)€RN where Θ are the parameters of the network and N is the total number of pixels. Since the output of the network has a fixed dimension, we predict a mask of a fixed size N = d×d. After being resized to the image size, the resulting binary mask represents one or several objects: it should have value 1 at particular pixel if this pixel lies within the bounding box of an object of a given class and 0 otherwise.

The network is trained by minimizing the L2 error for predicting a ground truth mask m€[0,1] N for an image x:

$$min_{\theta} \sum_{(x,m)\epsilon D} \left\| (Diag(m)+\lambda I)^{1/2}\left(DNN(x,\theta)\right)-m \right\|_2^2.$$

Where the sum range over training set D of images containing bounding boxed objects which are represented as binary masks

7. Conclusion

In this Paper, the problem addressed of early diagnosis of Alzheimer's disease based on the MRI images using Digital image processing and Deep Neural Networks. Image pre-processing techniques such as gray scale conversion, noise removal, normalization,

object extraction are applied on different parameters of the MRI brain image. The resultant exacted features based on the parameters and the lengths are measured for normal control subject and Alzheimer's disease patients of MRI images. Then Features are extracted mainly based on three parameters such as cortex thickness, Hippocampus shape, Corpus callosum. Then classification is done based on Error back propagation neural networks and Multi scale DNN based Localization Deep Neural Networks as it is able to classify to diagnosis of Alzheimer's disease.

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References

[1] G. J. Siegel, "Basic neurochemistry: molecular, cellular and medical aspects", No. V360 SIEb, **(1999)**.
[2] C. B. Akgül, D. Ü nay and A. Ekin, "Automated diagnosis of Alzheimer's disease using image similarity and user feedback", Proceedings of the ACM international conference on image and video retrieval, ACM, **(2009)**, p. 34.
[3] Y. Hsu, A. Du, N. Schuff and M.W. Weiner, "Magnetic resonance imaging and magnetic resonance spectroscopy in dementias", Journal of geriatric psychiatry and neurology 14, no. 3, **(2001)**, pp. 145-166.
[4] American Society of Health-System Pharmacists, "Alzheimer's Disease Education and Referral Center", American Journal of Health-System Pharmacy 58, no. 9, **(2001)**, pp. 826-826.
[5] S. M. Kim, M. J. Kim, H. Y. Rhee, C. Ryu, E. J. Kim, E. T. Petersen and G. Jahng, "Regional cerebral perfusion in patients with Alzheimer's disease and mild cognitive impairment: effect of APOE epsilon4 allele", Neuroradiology, vol. 55, no. 1, **(2013)**, pp. 25-34.
[6] A.D. Anastasiadis, G.D. Magoulas and M.N. Vrahatis, "Improved sign-based learning algorithm derived by the composite nonlinear Jacobi process", Journal of computational and applied mathematics, vol. 191, no. 2, **(2006)**, pp. 166-178.
[7] A.F.G. Takatak, "The use of Artificial Intelligence and Decision support systems in clinical Diagnosis: A Systematic Review", 1st European workshop on the assessment of Diagnostic Performance, **(2004)**, pp. 129-144.
[8] S. Gonzalez, Diego, J. M. Górriz, J. Ramírez, M. López, I. A. Illan, F. Segovia, C.G. Puntonet and M. Gómez-Río, "Analysis of SPECT brain images for the diagnosis of Alzheimer's disease using moments and support vector machines", Neuroscience Letters 461, no. 1, **(2009)**, pp. 60-64.
[9] B. Al-Naami, N. Gharaibeh and A. A. Kheshman, "Automated Detection of Alzheimer Disease Using Region Growing technique and Artificial Neural Network", In Proceedings of World Academy of Science, Engineering and Technology, World Academy of Science, Engineering and Technology (WASET), no. 77, **(2013)**, p. 12.
[10] P. Coupé, S. Eskildsen, J. Manjón, V. Fonov, J. Pruessner, M .Allard and L. Collins, "SNIPE: A New Method to Identify Imaging Biomarker for Early Detection of Alzheimer's Disease", MICCAI 2012 Workshop on Novel Biomarkers for Alzheimer's Disease and Related Disorders, **(2012)**, pp. 41-51.
[11] S. Farhan, M. A. Fahiem and H. Tauseef, "An ensemble-of-classifiers based approach for early diagnosis of Alzheimer's disease: classification using structural features of brain images", Computational and mathematical methods in medicine 2014, **(2014)**.
[12] "Alzheimer Educational Referral center", https://www.nia.nih.gov/alzheimers.
[13] M. García-Sebastián, E.mFernández, M. Graña and F.J. Torrealdea,. "A parametric gradient descent MRI intensity inhomogeneity correction algorithm. Pattern recognition letters", vol. 28, no.13, **(2007)**, pp.1657-1666.
[14] M. Kumar, Digital Image Processing Photogrammetry and Remote Sensing Division Indian Institute of Remote Sensing, Dehra Dun, **(2012)**.
[15] A. Chincarini, P. Bosco, P. Calvini, G. Gemme, M. Esposito, C. O and Rei "Local MRI analysis approach in the diagnosis of early and prodromal Alzheimer's disease", Neuroimage, vol. 58, no. 2, **(2011)**b, pp. 469-480.
[16] .S.S. Bedi1 and R. Khandelwal, "Various Image Enhancement Techniques" - A Critical Review, IJRCCE, vol. 2, Issue 3, **(2013)**.
[17] H.K. Kim, "Multi Scale Non Linear Constitutive Models using Artificial Neural Networks", a Ph.D. thesis submitted to school of Civil and Environmental Engineering, **(2008)**.
[18] S., Alexandre, M. García-Sebastián, C. Hernández, M. Graña and J. Villanúa, "Classification Results of Artificial Neural Networks for Alzheimer's Disease Detection", In IDEAL, vol. 5788, pp. 641-648.

[19] E. Hosseini Aria, J, Amini and M.R. Saradjian, "Back Propagation Neural Network for Classification of IRS-1D Satellite Image", vol.1, Issue.2, **(2003)**.
[20] L. Fausett., "Fundamentals of Neural Networks", 3rd Edition, Pearson Education, **(2005)**.
[21] R. Hinton, and R. J. Willims, "Learning representations by back-propagating errors", Nature, vol. 323, **(1986)**, pp. 533-536.
[22] C. Plant, "Automated detection of brain atrophy patterns based on MRI for the prediction of Alzheimer's disease", Neuroimage, vol.50, no.1, **(2010)**, pp. 162-174.

