# A Study on Detection of Alzheimer's Disease Using Image Processing

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***Abstract-*** *Alzheimer's is the most common cause of dementia, a general term for memory loss and other cognitive abilities serious enough to interfere with daily life. Alzheimer's has no current cure, but treatments for symptoms are available and research continues. Today, there is a worldwide effort under technique to find better ways to treat the disease, delay its onset, and prevent it from developing. In this paper, a method to detect Alzheimer's Disease from MRI using Machine Learning approach is proposed. The paper aim to detect the Alzheimer's disease at earliest so that patient can be prevented before irreversible changes occur in brain. The proposed approach is under implementation and is expected to give better accuracy as compared to conventional approaches.*

***Keywords***- Alzheimer's Disease, MRI, GLGM, Moment Invariant, ANN

## I. INTRODUCTION

Alzheimer's is a type of dementia that affects memory, thinking and behaviour of human being. Symptoms eventually grow severe enough to interfere with daily tasks. The brain has 100 billion nerve cells called neurons. Each nerve cell connects with each other's to form communication network. Scientist believed that Alzheimer's disease (AD) damages that communication networks. Alzheimer's Disease is a progressive and irreversible neurological disease and is the most common cause of Dementia in people of the age 65 years and above.Dementia means loss of Cognitive functioning – thinking, remembering and reasoning – and behavioral ability to such an extent that it interferes with Daily life Detection of Alzheimer's disease at prodromal stage is very important as it can prevent serious damage to the patient's brain.Two abnormal structures called plaques and tangles are prime suspects in damaging and killing nerve cells. The plaques and Tangles are some of the main features in AD.v The first region affected in the brain is the Hippo campus, which is responsible informing memories and serving as a relay structure between the brain and body. Alzheimer's disease accounts for 60-80% of dementia cases. In an Alzheimer's affected brain, the hippo campus shrinks abnormally between 2.2 to 5.9 percent annually. The shrink age of the hippo campus is mainly due to cell loss and damage of synapses. The destruction of synapses results in loss of signalling between the neuronsto communicate with each other. The Alzheimer's disease progresses slowly in three general stages: mild, moderate and severe. In the early stage of Alzheimer's, a person may function independently. Middle stage Alzheimer's is typically the longest stage and can last for many years. During this stage, damage to nerve cells in the brain can lead to difficulty in expressing thoughts and performing routine tasks. The symptoms are also notice able to others during this stage. In the last stage of the disease, the patient loses ability to respond to its environment, for carrying out conversations and even to control movements. As memory and cognitive skills continue to worsen, individuals need extensive help with daily activities. Imaging modalities such as Magnetic Resonance Imaging (MRI) scan, Positron Emission Tomography (PET) scan and Single photon Emission Computed Tomography(SPECT) scan are used to track changes in the brain and diagnose Alzheimer's at early stages. In the proposed approach, various shape and texture features are extracted from the hippo campus for detection of Alzheimer's disease. The texture features are extracted using Gray Level Co Occurrence Matrix(GLCM). GLC Misa method used for extracting second order statistical texture features. The shape features are extracted using the seven moment in variants. The Moment in variants define set properties of region that can be used for identification of shape. Based on the features extracted from the hippo campus, AD can be classified in to various stages using a trained classifier. A neural network will be trained using Error Back Propagation(EBP) algorithm for the same.

## II. LITERATURESURVEY

MRI Scan can be used for an Image processing to estimate possibility of early detection of AD. Image processing technique used in MRI are intensity adjustment, K-means clustering and Region growing algorithm for extraction of white matter and gray matter. The volume of brain can be calculated using the same algorithm. The MATLAB is the tool used for the quantitative and clinical Literature analysis of the

brain MRI from axial plane (top view), coronal plane (back side) and sagittal plane (side view) [1].

Image processing is process of extracting the Region of interest from the image using different image segmentation technique. This include region growing, watershed, thresholding, split and merge and K-means clustering method. The segmentation method listed are used in segmentation of radiographic weld images in which defect like porosity and lack of fusion, incomplete penetration and wormhole are detected .This method are used to identify flawed region.so, they are widely used in processing of medical imaging, computer vision, optical character recognition, industrial radiograph [2].

Yang Hanand Xing Ming Zhao[3] proposed a new selection based approach for detection of Alzheimer's Disease known as Hybrid Forward Sequential Selection (HFS). This method bines the filter and wrapper approaches to detect informative features from the MRI data which was obtained from the Alzheimer's Disease Neuro imaging Initiative (DNI) database. In this method the features were ranked and top k features are selected. The Support Vector Machine (SVM) was used as the classifier. The authors claim that proposed approach out performs other feature selection methods, improves accuracy of diagnosis and reduces computational cost.

Saraswathi*et.al*[5] projected that, a Alzheimer's Disease detection method using combination of three machine learning algorithms. The Genetic Algorithm(GA) is used for feature selection. The Voxel based Morphometry is used for feature extraction. The classification is done using Extreme Learning Machine(ELM) and the Advanced Particle Swarm Optimization(PSO) algorithm optimizes the classification results.

Rigel Mahmoodand Bishad Ghimire[6] developed an automated system based on mathematical and image processing techniques for Alzheimer's disease classification. Evanchalin Sweetyand WiselinJiji[7] disussed a Particle Swarm Optimization (PSO) and Decision Tree Classifier based method for Alzheimer's disease detection. In the proposed approach, the processed images are normalized and the Markov random filter is used for noise reduction. Features are extracted from the normalized images using moments and Principal Component Analysis. The particle Swarm Optimization for reduction of extracted features and the classification is done using the Decision Tree Classifier. The authors claim that for similar work their proposed approach gives an accuracy of 92.07 % on SPECT images and 86.71% on PET images. Chetan Patil*etal.,* [8] proposed an approach to estimate the possibility of early detection of Alzheimer's by evaluating the utility of image processing on MRI images. The authors demonstrated the applications of image processing techniques such ask means clustering, wavelet transform, water shed algorithm and a customized algorithm implemented on open source platforms, OpenCV and Qt. In the proposed approach, the T1 weighted MRIs were used for image processing to evaluate the Hippocamp alatrophy. The K-means algorithm is one of the widely used algorithm for clustering.

Nemirakpam*etal*.,[9] reported that the modified version of the k-means algorithm such that first partial stretching enhancement is applied to the image to improve the quality of image. Subjective cluster is used to generate the initial centre of the cluster and subjective clustering is a method of generating potential value of the data point. The generated center is used in k- means algorithm for segmentation of images.

Devvi Sarwindaand Aniati M. Aryamurthy[10] proposed a computer aided system based on feature selection approach using 3DMR images for texture analysis. In this proposed approach, the feature selection approach and feature extraction of 3D descriptor is combined where, feature selection is done using Kernel PCA and feature extraction is done using magnitude from three orthogonal planes as wellas Complete Local Binary Patternof Sign. The classification is done using Support Vector Machine. The authors claim that their proposed approach gives an accuracy of 100% for classification of Alzheimer's disease and normal brain. It is also claimed that the proposed system gives an accuracy of 84% for Alzheimer's and Mild

## III. THE PROPOSED APPROACH

The proposed approach is divided in to two phases: Training phase and Classification phase.

**1) Training phase:** The training phase can be concise as follows:

a) Extract features- Texture, Shape and Area from the pre-processed MRI scans.
b) Train an ANN classifier using this feature set.

The output of the training phase is a trained classifier capable of predicting classification label based on features of MRI scan. The performance of the trained classifier can be evaluated using measures like accuracy, sensitivity and specificity.

**2) Classification:** This phase can be summarized as follows:

a) Take as input, MRI scan of a patient.
b) Pre-process the MRIs can.
c) Extract the required features from the patient's MRI scan.
d) Use the trained classifier to predict the classification label for the patient's MRI scan.

The output of this phase is a classification label suggesting probable AD stage for the subject.Fig.1 represent the flow diagram for the processing phases.

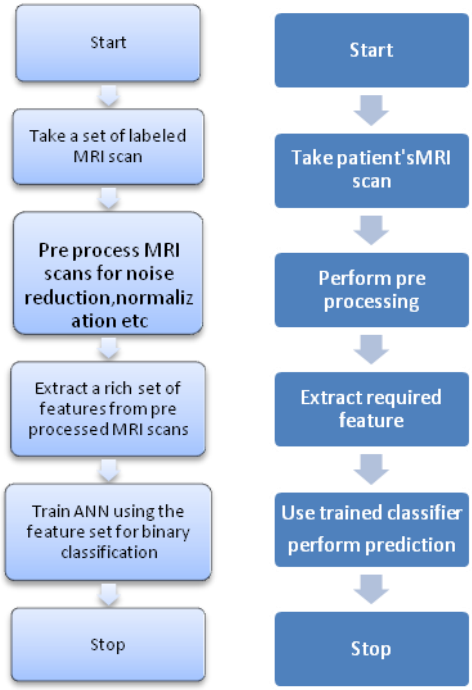


Figure 1.Flow of the proposed approach [11]

**A. Data set:**

An MRI based dataset is measured from the Open Access Series of Imaging Studies (OASIS): the project aimed at making MRI datasets of the brain freely available to the scientific community. The dataset consists of processed MR images. The basic information about the patient also available in the data set.

***B. ROI Extraction:***

The hippo campus is the first region in the brain that gets affected during the Alzheimer's disease. Therefore, the proposed work focuses on the hippo campus region for detection of AD which will be extracted as the Region of Interest from the MRI scan. Masking based correlation technique will be used for extraction of ROI. In this technique, a mask with ROI extracted manually is run through the subject image and the hippo campus region from the subject image is extracted as ROI using maximum correlation value.

**C. Feature Extraction:**

The Texture, Shape and Area features will be extracted from the Hippo campus region of the Brain.. The Gray Level Cooccurrence Matrix will be used to extract the texture features and the Shape, Area features will be extracted using seven moment in variants. The features available with the data set such as age, gender, education, socio economic status, Mini Mental Examination Score will also be extracted. These extracted features will be used to generate the feature vector [11].

*1)Gray Level Co-occurrence Matrix(GLCM):*

GLC Mis a method used for extracting the second order statistical texture features. It is a matrix in which the number of rows and columns are equal to the number of gray levels in the image. GLCM of an image is computed using a displacement vector d(δ,θ), where δ is radius and θ is orientation. The value of the radius ranges between 1 to 10 where, δ= 1 and 2 yield best result as applying large displacement value to a fine texture would give a GLCM which does not capture detailed textural information. Every pixel has eight neighbouring pixels allowing eight choices for θ, which are 0°, 45°, 90°, 135°, 180°, 225°, 270° or 315°. However, the co-occurring pairs obtained by choosing θ equal to 0° would be like those obtained by choosing θ equal to 180°. This concept extends to 45°, 90° and 135° as well. Therefore, there are four choices to select the value of θ. In this paper, some important texture features are extracted using GLCM:

I. Entropy: It measures the complexity in the image

**Entropy**

$$= \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} - p_{ij} - \log p_{ij}$$

II. Energy: It is a measure of global uniformity in the image.

$$\textbf{Energy} = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} - p_{ij}^2$$

III. Local Homogeneity: It is a measure of local uniformity in the image.

$$\textbf{L.H} = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} - p_{ij}^2 \, / \, 1 + (i+i)^2$$

(L.H – Local Homogeneity)

IV. Contrast: It measures intensity variation between a pixel and its neighbourhood

$$\text{Contrast} = \sum_{i,j=0}^{Ng-1} p_{ij}\,(i-j)^2$$

V. Variance: It is a measure of heterogeneity.

$$\sigma_i^2 = \sum_{i,j=0}^{Ng-1} (i-\mu_i)^2 p_{ij}$$

$$\sigma_j^2 = \sum_{i,j=0}^{Ng-1} (i-\mu_j)^2 p_{ij}$$

*2)Moment Invariants:*

The moment invariants were first introduced by Huin 1962. Six absolute orthogonal invariants and a skew orthogonal invariant based on algebraic invariants were derived. These derived invariants were independent of position, size, orientation as well as parallel projection. These invariants define the calculated set of properties of region that can be used for class identification as well as identification of shape. Central Moments are given by:

$$\mu_{p,q} = \sum_{x,y} (x-x_c)^p (y-y_c)^q$$

Where, $(x_C, y_C)$ is the centre of the object.

Central moments can be standardized to make them scale-independent,

$$\eta_{p,q} = \frac{\mu_{p,q}}{\mu_0^{\gamma},0}$$

**Where,**

$$\gamma = \frac{p+q+2}{2}$$

Hu brought forward. Seven moments independent of translation, rotation and scaling based on these moments.

$$\phi_1 = \mu_{2,0} + \mu_{0,2}$$
$$\phi_2 = (\mu_{2,0} - \mu_{0,2})^2 + 4\mu_{1,1}^1$$
$$\phi_3 = (\mu_{3,0} - 3\mu_{1,2})^2 + (\mu_{3,0} - \mu_{2,1})^2$$
$$\phi_4 = (\mu_{3,0} + \mu_{1,2})^2 + (\mu_{0,3} + \mu_{2,1})^2$$

$$\phi_5 = (\mu_{3,0} + \mu_{1,2})(\mu_{3,0} +)[(\mu_{3,0} + \mu_{1,2})^2 - 3(\mu_{2,1} + \mu_{0,3})^2 + (3\mu_{2,1} - \mu_{0,3})(\mu_{2,1} + \mu_{0,3}) .\left[3(\mu_{3,0} + \mu_{1,2})^2 - (\mu_{2,1} + \mu_{0,3})^2\right]$$

$$\phi_6 = (\mu_{2,0} - \mu_{0,2})\left[(\mu_{3,0} + \mu_{1,2})^2 - \binom{\mu_{2,1} +}{\mu_{0,3}}^2\right] + (\mu)(\mu_{2,1} + \mu_{0,3})$$

$$\phi_7 = (3\mu_{2,1} - \mu_{0,3})(\mu_{3,0} - \mu_{1,2})\left[(\mu_{3,0} + \mu_{1,2})^2 - 3(\mu_{2,1} + \mu_{0,3})^2\right] - (\mu_{3,0} - \mu_{1,2})(\mu_{2,1} - \mu_{0,3}) .\left[3(\mu_{3,0} + \mu_{1,2})^2 - (\mu_{2,1} + \mu_{0,3})^2\right]$$

All the extracted features are merged to form a feature vector. The training set consists of feature vectors extracted from the MRI scans. Each feature vector has 18 features. The following table summarizes the number of features in each section

| Feature Vectors | GLCM | Moments | MRI | Total |
|---|---|---|---|---|
| Data Set | 06 | 07 | 05 | 18 |

**D. Artificial Neural Network:**

The Artificial Neural Network is used widely for this purpose. Forn-class classification using ANN, the network has n neurons in the output layer where each neuron represents a different class.

In the proposed work, the number of neurons in the input layer of the ANN is 18 as it is the length of feature vectors. The output of the 4 neurons in the output layer are used to classify the subject in to normal, mild, moderate or severe category. A hidden layer is considered and the number of neurons in this layer is dependent on the number of neurons in the input and the output layer.

n = (input – neurons + outpour – neurons)/2

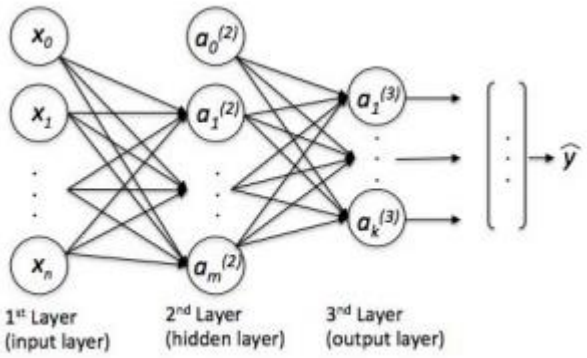


Figure 2 showed the architecture of the neutral network
Fig2. ANN Architecture with hidden layer [11]

The neutral will be trained on known 100 MR scan using Error back propagation (EBP).

*1)Error Back Propagation(EBP):*

In Error Back Propagation training there are two computational passes, a forward pass and a backward pass. In the forward pass, input vector is applied to the nodes of the input layer. The output vector from a layer is passed to the next layer as input. Network weights are fixed during forward pass. This output along with the labelled training set is used to calculate the error occurred during the forward pass. This error is back propagated from the output layer to input layer during the backward pass. During this pass, the network weights are updated so as to reduce the error in the next forward pass. This process is repeated until the error is minimized. At the end of the algorithm, the network has all the learnt weights according to the training feature set. The training phase of the proposed approach ends with EBP algorithm.

## IV. CONCLUSION

The proposed approach extracts texture and shape features of the Hippo campus region from the MRI scans and a Neural Network is used as Multi-Class Classifier for detection of various stages of Alzheimer's Disease. The article describe, a method based on Artificial Neural Network is presented for detection of Alzheimer's Disease from MRIS can. This proposed practices GLCM and Moment Invariants to extract features from the hippo campus region of MRI Scans. This above approach, under implementation, is expected to detect ADi nearly stage as compared to conventional approaches.

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