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Early Detection of Alzheimer's Disease using Image Processing

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***Abstract*-Alzheimer's disease (AD) is an irreversible, progressive brain disorder that slowly destroy memory and thinking skills. Alzheimer's is one of the most common cause of Dementia. Dementia means loss of Cognitive functioning – thinking, remembering and reasoning – and behavioral ability to such an extent that it interfere with Daily life. The image processing is widely used in medical field in order to detect disease and help doctor in decision making based on observation. The paper aim to detect the Alzheimer's disease at earliest so that patient can be prevented before irreversible changes occur in brain. We propose the image processing technique to process the Magnetic Resonance Imaging (MRI) of brain from axial plane, coronal plane and sagittal plane. The image segmentation is used to highlight the affected region in brain MRI. The diagnosed region in brain MRI include hippocampus and volume of brain. The comparative identification of person affected with the Alzheimer's disease, Healthy cohort and Mild Cognitive impairment is done.**

Keywords- Alzheimer's disease, Dementia, Mild cognitive impairment, Computer aided diagnosis, Image processing.

I. INTRODUCTION

Brain is the primary organ of the human body. The diseases that affect brain is very crucial to handle since mostly once changes occur it is irreversible in extreme cases. Dementia means the loss of cognitive functional thinking. Alzheimer's is most common cause of Dementia. Alzheimer's first appear in their mid-60's.It is estimated that more than 5.5 million people are having Alzheimer's .The Alzheimer's disease symptoms include memory loss, language problem, behavior changes. . The non-memory aspect symptoms are difficulty in word finding, vision issue, impaired reasoning and impaired judgement. The biological sign are brain images, cerebrospinal fluid and blood. The Alzheimer's disease can be classified As Mild Alzheimer's disease, moderate Alzheimer's disease and severe Alzheimer's. The Cause of Alzheimer's Disease are some genetic component for early onset Alzheimer's and Late – onset Alzheimer's begin from complex series of brain change. The other causes are genetic environment Lifestyle, Health and Detecting changes in body fluid and changes in body fluid and changes in brain can detect Alzheimer's disease. The Chemical or protein found in Alzheimer's disease are abnormal clumps (amyloid plaques), tangled bundles of fiber (Tau Tangle) and Loss of connection between nerve cell in the brain. The symptoms of the Alzheimer's disease appear decade after it begin or onset. The deposit of protein Tau Tangle and amyloid plaques throughout brain lead to stopping of functionality of healthy neuron and once its stop function the connection, with the other neuron is lost and die. The damage will first affect hippocampus, the part of the brain essential informing memories. Slowly it spread to other part and, the brain affected due to this chemical start shrinking and till final phase the complete brain size is shirked significantly [1].The Objective of the research is diagnosis of brain MRI for Hippocampus region and brain volume.

II. LITERATURE SURVEY

MRI Scan can be used for in 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) [2].Image processing is process of extracting the Region of interest from the image using different image segmentation technique. The image segmentation technique 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 [3].The K-means algorithm is one of the widely used algorithm for clustering. This paper discuss 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 center 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[4]. The deep learning architecture for the detection of AD is proposed that overcome the drawback of machine learning algorithm approach used for detection. It detect both the AD and Mild Cognitive Impairment cases. It proposes a deep learning architecture that uses stacked auto encoder and softmax output layer to detect the prodromal stage of AD, MCI. This architecture is able to perform detection using domain prior knowledge, analyzing multiple classes of

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training and less labeled training sample [5].Brain Tumor is one of the life threatening disease. Image processing can be extremely useful in the identifying. The Purpose of the paper is to propose an algorithm to identify tumor inside brain. So, K-means algorithm is used in detection of tumor. K points are chosen with in the MRI image once the algorithm is working all the point with least differences in their intensities start moving toward their respective centroid after all cluster are competed the tumor is clearly visible in MRI[6].The Bi-Cubic interpolation method is used for detection and Diagnosis of Alzheimer's Disease. The pixel intensity is used to classify the dead and live tissue inside brain MRI [7].The shape of the brain is not always deformed due to disease there is natural process through which the brain transform its shape. So, In Image processing it is challenging to differentiate the deformation of shape of brain due to pathology reason. The Mathematical Model can be developed for identification of deformation reasons. The brain elastic property is used to compensate the deformation on non-pathological ground. This will help us in identification of the deformation of the shape of the brain due to pathological reason. This Technique is used in the classification of the patient based on the disease like Schizophrenia, Alzheimer's disease healthy volunteer and normal-pressure hydrocephalus [8].

Detection of Alzheimer's and Parkinson disease is more accurate as more significant feature are considered from 3D MRI. The Evolutionary optimization algorithm including Particle Swarm Optimization, Bat Algorithm, Simulated Anneling and Pattern search and genetic algorithm is used. The accuracy of detection is improved on by applying this algorithm to AD Feature extraction to produce optimum result to produce higher accuracy [9].The existing methodology is working on the principle of amount of brain volume damaged due to Alzheimer's. As the patient move more toward Alzheimer's the count of what matter (Tau Tangle) keep on increasing and due to no communication between neuron cell the brain cell die and volume of brain size decrease. The existing technology focuses on identifying the volume of the brain from different view. This view are mentioned as axial plane, coronal plane and Sagittal Plane. Also compute the percentage of grey matter and white matter. If white matter percentage is 65 and 68 then it is treated and first phase and second stage of Alzheimer's disease. The cases of Hippocampus atrophy is not covered under this detection mechanism [2]. In detection Alzheimer's not only region around the brain play key role but also the damaged region in central part of the brain is used for detection .This include vascular region enlarged and damage made to hippocampus [3].

III. PROPOSED SYSTEM

Fig.1 represent the flow diagram for the processing of brain MRI for detection of Alzheimer's. This process include identifying Brain atrophy and Hippocampus brain region and applying different image segmentation technique for the following. Fig 1. Represent Block Diagram of Brain MRI image processing steps.

A. Brain MRI Input Image

The Radiological imaging technique, Magnetic Resonance imaging (MRI) was developed during abandonment of ultra sound. It was widely used for brain tumor detection through imaging. MRI is used to create detailed image of the human body organ. It is also known as magnetic resonance imaging. Radio waves and strong magnetic field is used to observe the part of the body that were earlier not possible X-rays, CT-Scan or Ultra sound. Doctor can now observe inside tendons, ligament, muscles, cartilage and joints [18].

Block Diagram:

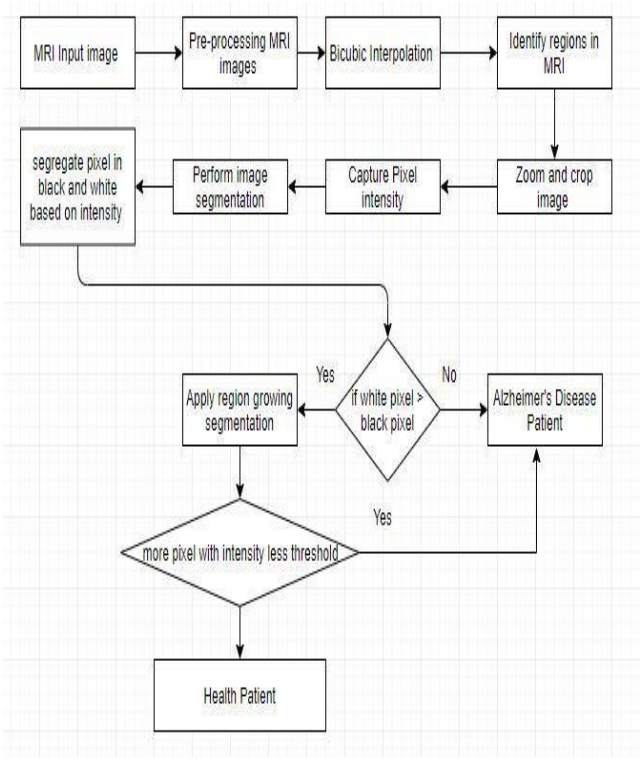

Fig.1. Flow chart of proposed algorithm.

Pre Processing of MRI Images

In this Phase the MRI is processed by using necessary image segmentation technique. This image segmentation technique is used to improve the feature of the image at lowest level. This need not add some extra feature but remove undesirable feature from image. Image resizing, Image Conversion, and intensity adjustment of images are done.

B. Bicubic Interpolation

In Original Brain MRI the region are not smooth enough to be used for detection of feature possessed by pixel. So, Interpolation are the technique that is used to enhance image such that it is smooth enough and used in several image processing application. In this context it is for medical MRI image detection. Interpolated surface is smoother than corresponding surface obtained bilinear interpolation and nearest- neighbor interpolation [19].

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C. *Region of Interest:*

Identify the Region of Interest in the MRI. For detection of Alzheimer's disease the region of interest are Hippocampus atrophy, brain atrophy, parietal lobe.

Fig 2. Highlight the region of interest observed in Brain MRI.

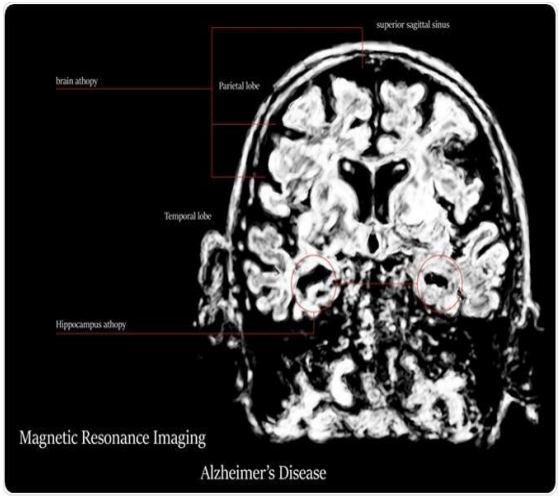

Fig.2. Region of interest

e. *Image Segmentation*

The Co-ordinate position of the region of interest is identified and the selected region is cropped and zoom. This cropped image is used for adjusting the pixel intensity. The pixel are classified based on the intensity of the pixel as white and black for cropped image. Here, White region represent the live tissue and black region represent the dead tissues. The count of white pixel and black pixel is measured and if the black pixel are very small in fraction as compared to white then the patient is healthy. Based on the fraction of the presence of the black pixel the patient is classified as mild cognitive impairment, Alzheimer's disease or Healthy patient.

f. *Watershed Segmentation*

Brain atrophy is clearly visible for patient already in initial phase of Alzheimer's disease. So, Patient further brain damage can be protected by taking proper medication and changing lifestyle. To identify brain atrophy the region growing segmentation is used. The working of region based segmentation is given as follows:

- Watershed segmentation is not applied directly to image but it is applied to gradient of image. Image is treated as 3 dimensional and minimum point is computed for each pixel. Fig 3 represent the gradient of Brain MRI.
- The pixel having same minimum point are grouped together or pixel together form catchment basin.
- If water drop is placed, the drop fall to certain minimum. There are critical point where the water drop is placed, it fall to more than one minimum with equal probability.
- These critical point form the crest line. Watershed algorithm determine this watershed line.

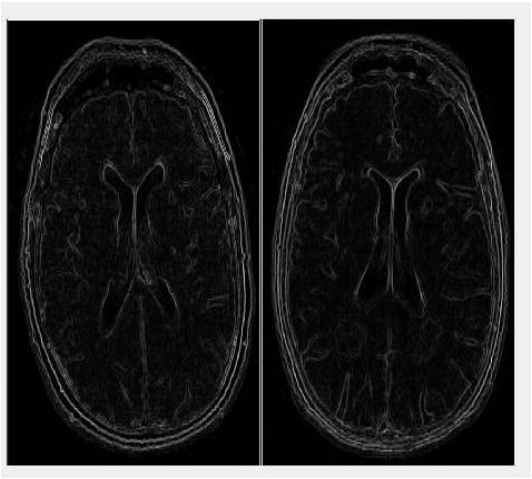

Fig.3. Gradient of the original image using Watershed Segmentation.

g. *Thresholding:*

Thresholding is one of the common mechanism to perform image segmentation. In this image segmentation technique the segmentation is performed on greyscale or pixel intensity. It also type as bi-level thresholding for classification of pixel into two group based on image pixel intensity. It also support multilevel thresholding support more than two class in which pixel is classified [3].

h. Algorithm:

1. Accept input image of Brain MRI.
2. Apply bi-cubic interpolation to input MRI Image.
3. Extract the hippocampus region or enlarged ventricles region.
4. Summation of red, green and blue value for each pixel in extracted hippocampus and enlarged ventricles region.
5. If summation of values from red, green and blue array are found to be zero consider as black pixel.
Else
Consider given pixel as white pixel
6. Count of black pixel are added to cavity region and count of white pixel are added to cortex region.
7. Check the length of cavity and cortex region and compare them.
7.1 If cavity region have more than 50% of region then person is in stage 2
7.2 If cavity region is having more than 30% to 50% pixel then person is in stage1.
7.3 If cavity region is having more 10% and less 30% then Patient is having MCI.
7.4 If Less than 10% then go to step 8.
8. Obtain the gradient image of the brain MRI using watershed algorithm. Consider complete brain MRI.
9. Count all the pixel with pixel intensity 0.
9.1 If the pixel with pixel intensity as 0 is exceeding threshold. Then consider patient as having AD.
9.2 Else the patient belong to healthy cohort.

IV. EXPERIMENT

Our experiment used the neuro imaging data as Brain MRI and performed different image segmentation technique on

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Brain MRI to check the Brain atrophy, Hippocampus region, and Vascular Enlargement for the detection of the Alzheimer's disease [2, 3, 4, and 5]. For this different image segmentation technique are used like pixel intensity, gradient of image. This experiment was performed on12 MRI sample of Alzheimer's disease Patient.

V. RESULT

	Predicted No	Predicted Yes	
Actual NO	TN=0	FP=0	
Actual Yes	FN=1	TP=11	12
	1	11	Total = 12

- **Accuracy :** (TP+TN)/Total = (11+0)/12 =0.9166
- **Error Rate Misclassification Rate :** (FP+FN)/Total = (0+1)/12=0.0833
- **True Positive Rate :** (TP/Actual Yes) = (11/12)= 0.9166
- **False Positive :** (FP/Actual No)=(0/0)=0
- **Specificity :** (TN/Actual No)=0
- **Precision :** (TP/Predicted Yes)=(11/11)=100
- **Prevalence:** (Actual Yes/Total) = (12/12)=100

VI. CONCLUSION

The purpose of early detection of Alzheimer's disease is achieved. Enlarged Vascular and Brain atrophy. The implementation is done using image segmentation for the identification of enlarged Vascular. The amount of enlargement will classify the patient as Healthy patient, 1st stage AD, 2nd Stage AD, Mild Cognitive impairment cases. Another important factor for the detection of the AD is Brain atrophy. Watershed algorithm for image segmentation is used to detect Brain atrophy. Gradient of image is used to check the Cavity in Brain atrophy. This automated method is having simple methodology and low time complexity of the image. This overcomes the problem of earlier detection with no damage cause to brain. This will boost the research in the area of medical imaging.

VII. FUTURE WORK:

The result generated in the above procedure is capable of detecting only single image at a time. Database of image or image repository can be assigned as input to the process so, that it will scan and detect the number of AD, MCI and Healthy patient. Neural network is another booming field in the computer science and it is widely used in medical imaging filed. This can be used as another alternative to image processing for detection of life taking disease. Machine learning algorithm like SVM and Concept of Deep learning like CNN can be used in order to produce more accurate and better result.

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