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Detection of Brain Disease Using Morphological Operation and Artificial Intelligence Technique

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Abstract: *Artificial Intelligence is being used in medical field for various applications like disease diagnosis. One specific application of this using ANN and ANFIS in medical disease diagnosis is the analysis of brain MRI with the aid of image segmentation technique. Image segmentation is a field of digital image processing in which an image is splitted in various parts using one of available techniques such as edge detection or cluster dependent area. In this paper brain MRI Image is segmented using image segmentation method and it is converted in frequency domain using DWT operation then after applying morphological operation and watershed operation an image is compared with a set of images showing various diseases using artificial intelligence and hence disease is diagnosed .The simulation results are enhanced to somewhat 94% using AI technique.*

Key words: *Segmentation, Artificial Intelligence, Morphological Operation, Watershed Transform, Alzheimer Disease.*

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I. Introduction

The technique of extracting significant qualities or sections of a picture is known as image segmentation.

In medical imaging, image processing makes a tremendous difference. Medical image segmentation is used to cope with a wide range of medical modalities, including MRI, computed tomography, X-ray, and chest radiography, to name a few. Accuracy and precision in medical imaging are extremely helpful in making accurate diagnoses. The fundamental purpose of medical image segmentation is to enhance the visualization process so that sickness detection may be handled more successfully[1,2]. In the case of an alzheimer, precise detection and identification is a very sensitive and significant decision. Similarity and discontinuity are the two primary ideas that can be used to segment data. In the first category, objects with comparable attributes are grouped together, whereas in the second category, boundaries are discovered to split sub regions [3,4.]

In the brain MRI image segmentation, the primary three areas of white matter, grey matter, and cerebrospinal fluid are partitioned. These anatomical characteristics aid the radiologist in determining the tumor's exact shape, size, and appearance. Pre-processing of the picture, feature extraction, edge identification, and tumor detection are all crucial phases in brain MRI image segmentation[5,6].

Different strategies for detecting Alzheimer's disease have been proposed by a few analysts, which are addressed in the related work section. The sample data collected, pre-processing technique used, Feature Extraction techniques used, and implementation of Adaptive Neuro Fuzzy Inference System (ANFIS) are detailed in the methodology section. The comparative outcomes of the study done in this paper are found in the experimental results section. Finally, based on the findings, the conclusion of this article is discussed in the conclusion section.

II. Image Segmentation Process

Some segmentation approaches are combined with morphological operators in this paper. The dilation and erosion morphological operators are used. In light of different advancements, picture division approaches are presently divided into the following classifications, based on two image attributes.

Image Texture Analysis

Surface is a term used to define the surface of a protest or wonder, and it is without a doubt one of the most important features. Surface can be seen in a wide range of photographs, from multispectral distant sensing data to minute images. A solution to the surface investigation problem will significantly advance the fields of image preparation and design recognition.

Statistical Approach

Real surface examination procedures measure the spatial movement of pixel. These are all over set up in the PC vision world and have been broadly associated with various tasks. Innumerable surface features have been proposed, running from first solicitation estimations to higher solicitation bits of knowledge.

Structural Approach

In assistant techniques, surface is portrayed by surface locals or surface parts, and the spatial course of action of these locals. Hence, the fundamental destinations of helper systems are first thing to eliminate surface locals, and furthermore to show or summarize the spatial position rules. The surface unrefined can be just about as fundamental as individual pixels, a region with uniform dark levels, or line segments.

Filter Based Approach

The strategies reviewed in this type generally share an average brand name, which is applying channel relies upon the image and cycle the essentialness of the channel responses. The systems can be disconnected into spatial space, repeat region, and joint spatial/spatial-repeat region techniques.

Model Based Approach

It is characterized as the task of names to pixels or voxels by matching the deduced realized article model to the picture information. Marks might have probabilities communicating their vulnerability. Especially contrasting streamlining techniques and the information based framework approach.

Image Watershed Transform

A watershed is a change characterized on a grayscale picture. The watershed change treats the picture it works upon like a geological guide, with the splendor of each point addressing its stature, and finds the lines that run along the highest points of edges. A watershed has several specialized meanings. Watershed lines can be identified on the hubs, on the edges, or on the two hubs and edges in charts. Watersheds can also be defined in the nonstop domain[1]. Watersheds can also be registered by a variety of computations. Watershed calculations are utilized in picture handling fundamentally for object division purposes. This considers counting the items or for additional examination of the isolated articles.

III. Adopted Methodology

Firstly the medical image I is read which is resized and it is transformed through one level DWT followed by two level DWT .The approximated image is retrieved by two level IDWT . On this approximated image entropy separation followed by removal of undesirable openings under 100-pixel size is operated. Morphological operation for image filling process is used and then creation of texture based segmented image is done.For highlighting the edge boundaries sobel filtering is applied. Then calculation of the gradient magnitude to find image with one at boundaries and zero for inner regions. The Erosion is applied on object with less than 4 pixel size and reconstruction is performed. The Dilation is applied on object with less than 4 pixel size and reconstruction is performed.Threshold on the edge objects is applied for selecting the segmented boundaries to high intensity .The image after segmentation is transformed through watershed operation. Through alpha mixing the surface based segmented image is superimposed over this watershed transformed image .The image features are extracted using entropy, wavelet coefficients and textures data for all the image. After this the training and tested data is developed then clustering is applied to generate fuzzy inference system.ANN is applied to reform the developed fuzzy system.

IV. Performance Analysis

The example image for implementation was taken from the internet. The performance parameters are used to validate the efficiency of the suggested method.

The performance metrics employed in the suggested technique's qualitative analysis are precision, recall, specificity and sensitivity.

The outline of these boundaries is as follows:

Precision=TP/ (TP+FP)

Recall=TP/ (TP+FN)

Specificity=TN/ (TN+FP)

Sensitivity=FN+FP/ (TP+FN+FP+TN)

Where the parameters TP, FP, TN and FN are defined as,

True positive (TP) = Alzheimer exist and it is detected correctly

True negative (TN) = Alzheimer does not exist and it is not detected

False Negative (FN) =Alzheimer does not exist but it is detected

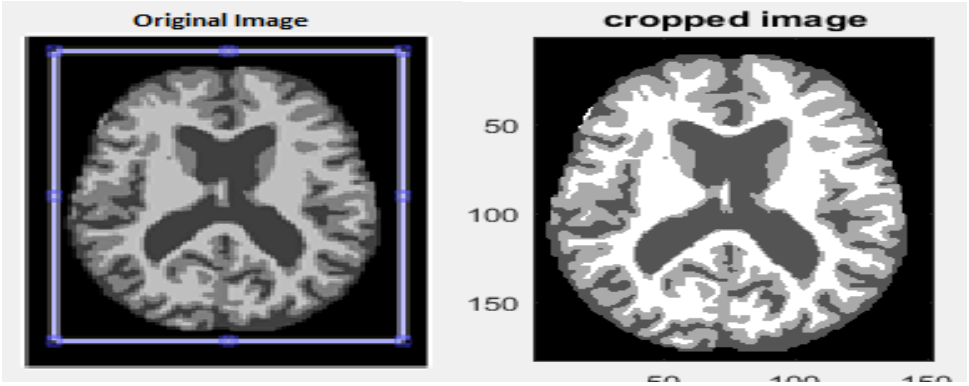
False Positive (FP) =Alzheimer exist but it is not detected

Precision can be given by the ratio of TP's to the sum of both positive. Recall gives the ratio of TP's to all positive which is sum of TP and FN. Specificity is the proportion of TN's to the amount of TN and FP while sensitivity gives the proportion of amount of FN and FP to the sum of TP,TN,FN and FP.

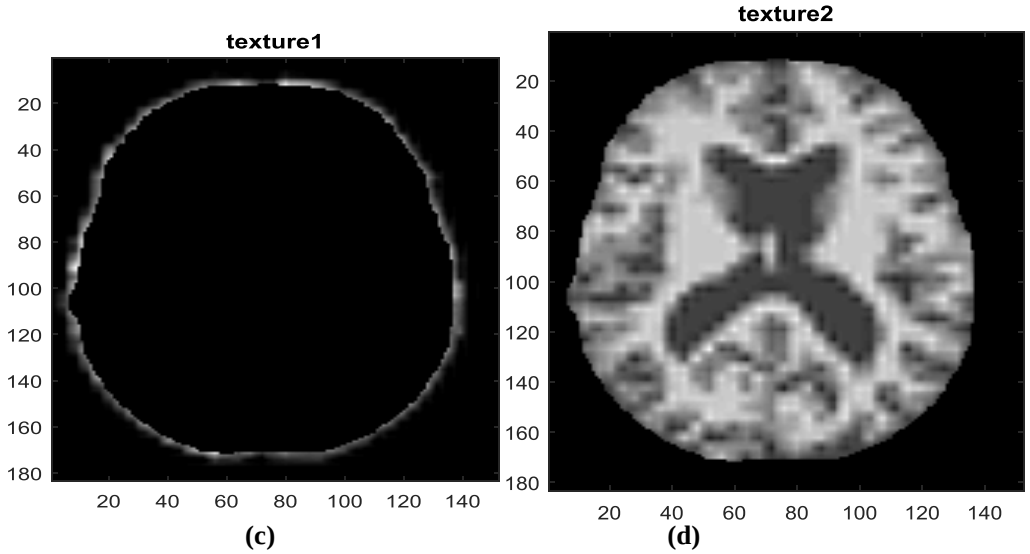
V. Results and Discussion

The proposed algorithm is applied on each image and the results are displayed and image features are extracted. Similar operations are applied for all the images under the data group of normal persons and the patients suffering from the Alzheimer disease. The information is saved as the entropy level, gradient, texture area, wavelet coefficient value. These features are giving the info of the number of pixels under different segments of image and taken as the input. For developing the image classifier used is ANFIS.

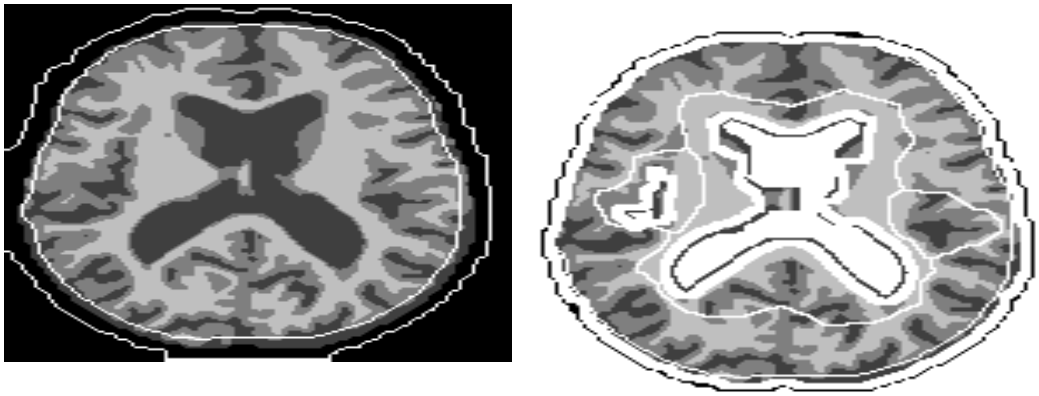
The Figure 1 demonstrates the picture of brain MRI without any disease. This picture 1(a) is utilized for envisioning WATDWT division of these organs pictures for the point of location and separation of textures and contamination from different tissues and picture foundation. The removed locale is deciphered by doctors to assess conclusion. The WATDWT division display was connected to assess surface highlights [Figures 1(b) and 1(c)] where both show diverse districts in light of the surface. Figure1 (d) demonstrates the surface based fragmented picture, while Figure 1(e) demonstrates the markers and protest limits superimposed on unique picture. Division aftereffects of the picture in Figure1 (b) are gone through watershed changes to get fragmented hues for various locales 1(f). At last the shaded portions of water shed change Figure 1(f) are superimposed with surface based sectioned picture Figure 1(d) to get Figure 1(g). The images are taken from interface. The connection comprises of 101brain MRI images of interest having both kinds of subjects with and without Alzheimer disease. The Figure 1 is for brain MRI without any disease. For applying the image classification the ANFIS model is developed by taking the features data of 101 images taken from OASIS database. The data is separated into training and testing data by randomly shuffling the images and dividing into two containing both kings of images with and without Alzheimer disease. If the AD is absent the output is marked as zero, for mild level of AD output is 0.5 and high level of AD output is 1.The inputs are entropy value under texture 1 and 2, wavelet coefficient value in both textures and number of pixels under inner segment of watershed line and outer part of watershed line. The ANFIS model is developed using the training data and finally the developed is tested on remaining data to find the accuracy. For this purpose first of all a fuzzy inference system is developed for the input data by clustering technique then ANN is used to further improve the fuzzy inference system by learning algorithm.



(a) **(b)**



(c) **(d)**



(e) **(f)**

Fig 1

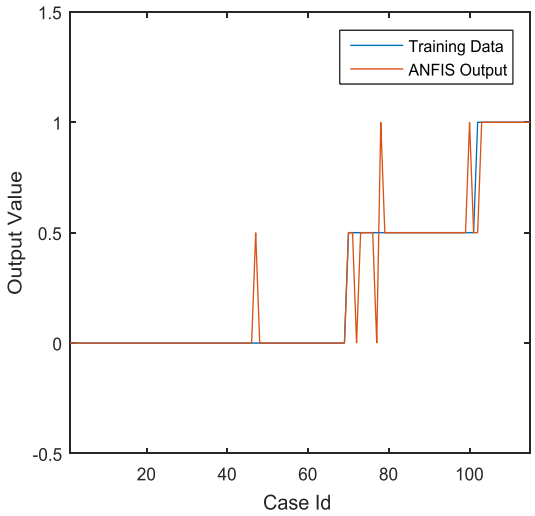


Fig 2

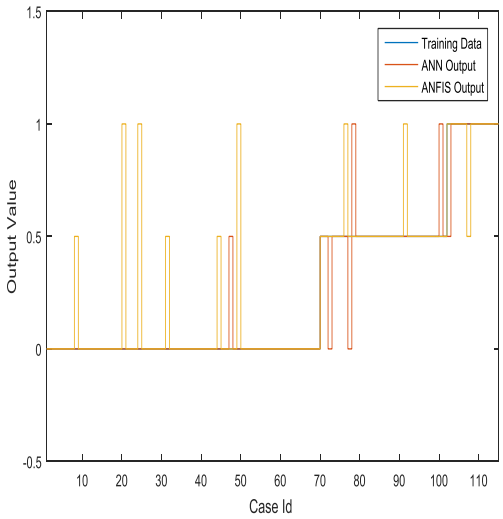


Fig 3

Above Figure (2) & (3) shows the plot for representing the matching of the predicted results of ANFIS with the actual results these values are used to finally calculate the accuracy. It is observed that the developed model has accuracy of 94.78%.

Table 1. ANFIS and ANN based comparison for predicted output and actual output

	ANFIS	ANN
Accuracy	94.78%	89.56%

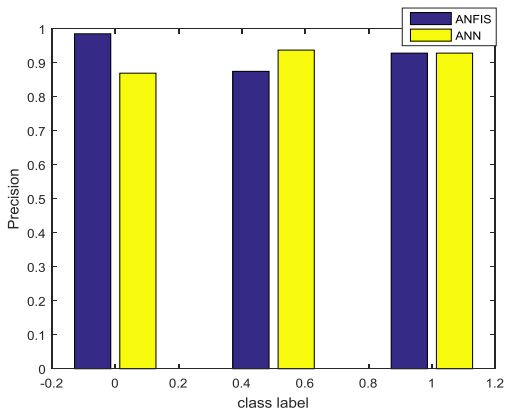


Fig 4

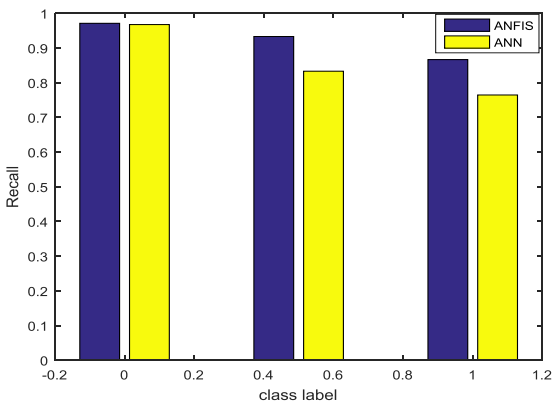


Fig 5

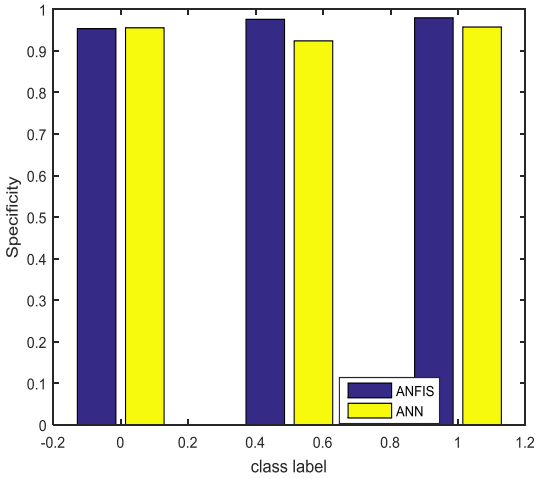


Fig 6

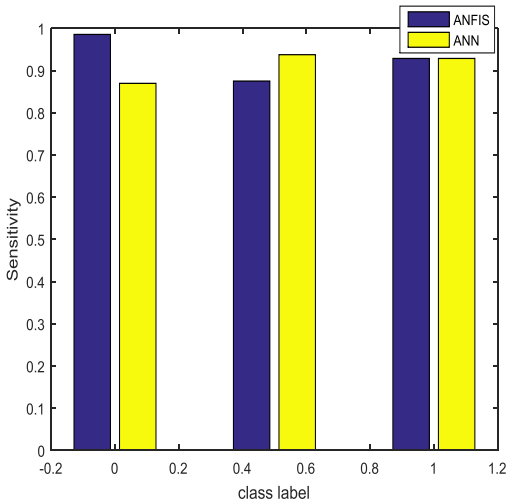


Fig 7

VI. Conclusion

It has been checked on a few articles to consider different image division systems. The greater part of the procedures confronts comparable issues like inadaptability to various modalities, tremendous measure of information to portion and clamor included. The surface is the smoothness of the surface. Various aspects, such as eating habits and hydration, collagen and hormone measurements, and, of course, brain MRI, are taking place on the highlights of this surface. A steady decrease in division quality also happens because of superimposing of abnormal state subtle elements. As subtle elements builds more slender picture designs are created and all the more effectively harm the division quality with the presence of lines and unpredictable thin questions. The crumbling is likewise joined by an obscuring of the foundation or limit shading for an over ingestion of the regular shading color, melanin, by the best most cell layer of body organs. The surface additionally relies upon its body area. By virtue of picture handling, it has been considered the manner in which surface appearance is changing with picture recording parameters, i.e. camera, light and heading of view, an issue basic to any genuine surface.

In this paper, it has been utilized a surface examination and estimations in view of division based approach of the surface acknowledgment. Image is first caught and Level 1 and Level 2 DWT are connected, after which image is reproduced utilizing Level 2 IDWT. After entropy shifting little protests are expelled and morphological preparing and surface concealing are completed. Edge is then identified, dissolved and widened. Utilizing thresholding watershed change is connected. The two images are then superimposed utilizing alpha mixing. Finally the Fuzzy and ANN is used to develop classifier model for discriminating the normal and Alzheimer disease MRI. The results show high accuracy of classification.

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