

Brain Tumor Identification using Multi-Atlas Segmentation

M. Loganayaki, K. Geetha

Abstract: A brain tumor in humans is caused by abnormal cell growth persisting in the brain. It is a life-threatening disease to a human being. Early detection of the tumor is the best way for a patient entering into the adverse condition of the disease. Image segmentation is the popular field in image processing to differentiate between tumor cells and normal cells. The tumor can be detected using the technique called segmentation in the field of image processing which can accurately be identified using MRI images in the field of medical images. The tumor affected region and the size of the tumor can be identified with the assistance of radiologic evaluations. Magnetic resonance imaging is a fast-growing tool in recently used to detect the defected part of the body. Principal Component Analysis (PCA) is mainly used for analysing the components from the image. Extracting components relevant to tumor detection is performed using mutual information extraction (MIE). It provides better accuracy in classifying the traumatic brain injury from the MRI images. The proposed system, Multi-atlas segmentation is done on sample digital images with tumor. The GUI is developed to accept the input image from a folder and to display the results

Index Terms: Image processing, Brain tumor, Biopsy, Image enhancement, Multi-atlas segmentation.

I. INTRODUCTION

In recent years, image processing plays an important role in real-time applications. There are few steps and number of techniques to achieve better results in image processing which includes enhancing the clarity of an image, dealing with noisy images, classification of images, and compressing the original image so as to reduce the storage space. There are a number of researches in progress in digital image processing steps which includes feature extraction, restoration, and image enhancements. Image processing is a technique to extract information by transforming an image into digital form and doing manipulation over it. The output of image processing will be an image or it is characteristics related to project information of the considered. Image processing techniques is a process of altering an existing image into a clear readable format. Mostly images are treated as two-dimensional signals and for manipulation signal-processing techniques are applied. Image processing has a broad spectrum and applications such as remote sensing images via satellites and other spacecraft can be used to predict the material and resources available on the land. Image-based analysis research software like MATLAB, WINGRASS, and ArcGIS, Mathcad used to process images and to make an analysis on it.

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MATLAB is a product of Works, a multi-paradigm numerical computing environment and proprietary programming language. When images are dealing as two-dimensional data, this matrix laboratory is a useful tool for making analysis over images. The medical image is also taken for analysis which processed on the basis of visual representation of the human body. Medical image processing is capable to view the internal structure of the hidden organs covered by skins and bones to predict the exact cause of the disease for further treatment procedure. The biological image is obtained from radiology which uses technologies like X-ray, radiography, magnetic resonance imaging medical ultrasonography and endoscopy. Image processing plays a vital role in Robotics vision in which automated vision keeps on being dealt with including distinctive techniques for handling, dissecting, understanding and navigating. Optical Character Recognition (OCR) is another area of image processing which is the mechanical or electronic transformation of pictures, written by hand or printed content into a machine-readable format. Sources like OCR has performed scanned document, a photo of a document. Image analysis is helpful in medical field to save time and cost. Medical images are captured using advanced sensors, CT scan, and ultrasound, MRI images in which image processing techniques are reconstructed and modelled in the processing of 2D images to create 3D images. Image processing software assists to modify the appearance of the images to make them as for how they visible to the human eye. Temporal and spatial techniques are used to detect the characteristics of tumor and other ailments in an MRI. It is also possible to find the diameter, volume, and vasculature of a tumor and flow of blood or other fluid. Medical images are used for both, diagnosis and therapeutic purposes. It is the most powerful resource that effectively cares for our patients. X-ray, ultrasound, computer aided tomography is mostly used to identify diseases.

II. LITERATURE REVIEW

K. Sumithra, et. al., explained about image restoration, image enhancement, image segmentation, image recognition techniques briefly and also provided a clear view of applications used in image processing.

Nida M. Zaitoun, et. al., described the image segmentation using a number of variance decision methods for all kinds of images. Image segmentation is an important and challenging issue in image processing.

Ana Ferrazetal, et. al., presented a prototype for the pretransfusion testing, specially dedicated for emergency situations. The prototype is characterized by its portability, efficiency and fast results. It

was the first developed prototype. Based on its characteristics it was possible to model a final prototype that introduced significant improvements (Kiran et al., 2015).

M.A. Aswathy, et. al., made a study to point out the recent developments in breast cancer detection and classification. It gave an outlook on efficiency, authenticity, and accuracy of different techniques. Digital mammography was extensively used for early detection of cancer. The biopsy was the most accurate imaging method. Due to its adverse effects on the human body.

Mahmud, et. al., described in modern-days photography and other industries employed the digital image processing. Most of the research had to improve the prevailing issues of digital images. Recognition of characters helped in capturing the best matching the photographs and images. In modern days photography and digital image processing were used by many industries.

Donna Giri, et. al., (2013) proposed the automated diagnosis of Coronary Artery Disease affected patients using combination strategies of feature extraction methodology. The proposed approach is based on the decomposition of heart rate signals in order to detect the normal *and* Coronary Artery Disease conditions. They concluded that Independent Component Analysis (ICA) coupled with Gaussian Mixture Model (GMM) classifier combination resulted in highest accuracy for detection of the abnormalities in heart diseases (Sumithra et al., March-2015).

Vijendra Prasad, et. al., (2017) proposed the automated pathological brain detection system that allows the classification of brain abnormalities. The proposed scheme gave an efficient pathological brain detection system lies in the use of Simplified Pulse-Coupled Neural Network (SPCNN) for segmentation, Fast Discrete Curvelet Transform (FDCT) to extract curve like features, Principal Component Analysis (PCA) to reduce the features and finally Probabilistic Neural Network (PNN) for classification. They concluded that PNN was the simple network structure and faster learning method used to compare with the other classifiers.

Miguel Caixinha, et. al., (2017) proposed the automatic classification of cataract diseases based on ultrasound technique by using Machine Learning methodology. The proposed scheme used the acoustical parameters and backscattering signals obtained from porcine lenses with different cataract degrees are used for objective and automatic cataract classification. They concluded that the Support Vector Machine (SVM) shows the highest performance for classifying the cataract disease abnormalities (Singh et al., 2003).

Ramakrishnan, et. al., (2017) proposed the classification of brain tumor images by using combination strategies of Support Vector Machine approach along with Sequential Minimal Optimization (SVM-SMO) methodology. This algorithm was effectively employed to construct the hyperplane equation for statistical evaluation to reveal the huge margin for reducing the overshoot in dimensionality. They concluded that the linear kernel of SVM with SMO approaches gave a better accuracy classification between tumor and non-tumor images.

Tanvi Gupta, et. al., (2017) proposed the Classification of patients with tumor using Magnetic Resonance Imaging with volumetric Fluid Attenuated Inversion Recovery (MRI-FLAIR) acquisition. This method estimated the classification performance by using the linear kernel in SVM method for obtaining better accuracy than the neural network algorithm in brain tumor images. The proposed algorithm used the entire patient data set for a single sequence of classification within a short computation time (Wang et al., 2009).

Akhanda Nand Pathak, et. al., (2017) proposed the brain tumor classification using a multiclass SVM algorithm. The contribution of this work was to the integration of an efficient feature extraction tool and a robust classifier to perform accurate automated classification of a brain tumor in MRI images. They concluded that the highest classification accuracy is achieved for different types of tumor in the brain and less computation value. Due to the feature reduction based on the PCA (Yasmin et al., 2012).

III. METHODOLOGY

The traumatic hematoma usually consists of different densities in various regions of brain MRI images. In the proposed work, MRI images were considered and injured part of the images is segmented. Before segmenting the image, image pre-processing is done using CLAHE enhancement techniques. It is followed by the segmentation multiatlas technique and the results were analyzed in terms of MSE, PSNR DSC values of the images. MRI images of test and trained images are considered for identification of hematomas.

3.1 IMAGE PRE-PROCESSING

The image preprocessing techniques are mainly processed to discard unnecessary items present in the images. Preprocessing mainly focuses on removing the noise present in the considered image. Conversion of the source image to grayscale representation is the important process in the preprocessing technique. In canny edge detection method is used for Different filter techniques are used for removing the noise present in the image.



Fig 3.1 Grayscale image

3.1.1 EDGE DETECTION USING CANNY METHOD

The edge detection is a basic characteristic method



of the image. Edge is represented by the collection of pixels and it is present between the objects and background. It contains property, size, and shape. It is mainly helpful in describing the target object of the MRI image. It is to detect a wide range of edges in the MRI images. The first step is canny edge detection smooth the image and eliminates unwanted noise. It also finds the MRI images to gradient for highlighting the regions with high spatial derivation. To analyse the MRI images canny edge detector is used with the following information to extract MRI brain images. Analysis of the MRI images depending on the intensities of the different regions and pixels of the brain images. This canny edge detection method is the most robust technique to check the abnormalities persist in the growth of the brain area from the MRI images.

3.2 IMAGE ENHANCEMENT

Image Enhancement is to obtain the improvement of information in medical images for human viewers to get a better accuracy. It accentuates or sharpens image features such as edges, boundaries, or contrast to make a graphic display more helpful for analysis.



a. Original Image



b. Enhanced Image

Fig 3.2 Image Enhancement

3.3 HISTOGRAM EQUALIZATION

The popular technique for image enhancement is Histogram Equalization (HE). It is based on finding the distribution function for a given probability density function. After the transformation of density values, the image with increased dynamic range, high contrast and probability density function of the output will be displayed.

3.4 PERFORMANCE ESTIMATION OF CLAHE (CONTRAST LIMITED ADAPTIVE HISTOGRAM EQUALIZATION)

The Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR) and Dice Similarity Coefficient (DSC) are calculated to estimate the performance between the original and enhanced CLAHE images. The equation shows the formula for computing MSE, PSNR and DSC parameters.

$$MSE = \frac{1}{NXM} \sum_{i=0}^{N-1} \sum_{j=0}^{m-1} [x(i,j) - Y(i,j)]^2$$

$$PSNR = 10 \log_{10} \frac{255^2}{MSE} (dB)$$

$$DSC = 2X \frac{X \cap Y}{|X| + |Y|}$$

The proposed system utilizes major steps, which includes: enhancement of the medical images, feature extraction, segmentation selection of relevant features, and finally classification to classify the tumor type.

Algorithm for segmenting the brain tumor

- Step 1: Im = Input image;
- Step 2: Im1 = Convert image Im to grayscale
- Step 3: Im2 = Apply image enhancement (pre-processing to improve contrast, remove noise etc.)
- Step 4: Im3 = Apply skull stripping to remove extra skin, skull
- Step 5: Apply feature extraction
- Step 6: Im4 = Apply multi atlas segmentation
- Step 7: Calculate area of the extracted tumor
- Step 8: Calculate dice similarity index coefficient
- Step 9: Compare area of the tumor
- Step 10: if (wtemp==1) then
- Step 11: Tumor type = benign or no tumor else
- Step 12: Tumor type = malignant
- Step 13: end if
- Step 14: Finalize decision on tumor type

3.5 FEATURE EXTRACTION

Feature extraction is a well-known method for collecting higher level information in images based upon the spatial or texture features. The texture analysis is an important parameter of human visual perception and machine learning system which is used effectively to improve the accuracy of the diagnosis system by selecting prominent features. It is essential to extract the relevant texture-based features due to the intricate structure of diversified tissues such as Gray matter, white matter and cerebrospinal fluid in the brain MRI images. To obtain relevant information from the input test image, the combination strategies of PCA feature extraction method is used to obtain the transformation of the input image to a reduced set of features. The proposed system provided better accuracy in classifying the traumatic brain injury MRI images.

3.6 MULTIATLAS SEGMENTATION

Multi-atlas segmentation uses multiple atlases instead of using a single atlas to avoid the non-

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systematic errors in the image which allows fully automatic segmentation of image populations that exhibit a large variability in shape and image quality. In this method poorly performing images gets discarded to obtain accurate segmentation results. In the atlas, selection strategy is important to obtain a segmentation of hematoma in brain injury images. For the selection of atlases, the mutual information between the target image and output image is calculated. The spatial domain fusion scheme uses the pixel average method to the input image and the selected atlas images. From the output Sum of Absolute Difference (SAD) method is used to find the measure of similarities in the input image to obtain the segmentation of hematoma.

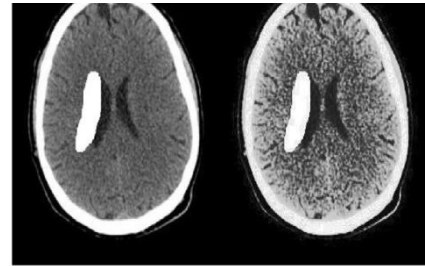
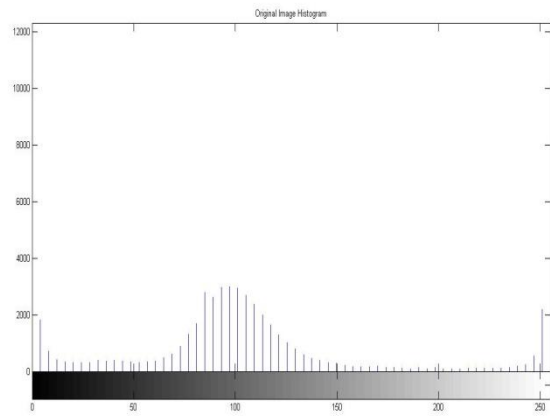
IV. RESULT AND DISCUSSION



a. Original Image with Brain Tumor

b. Enhanced Image

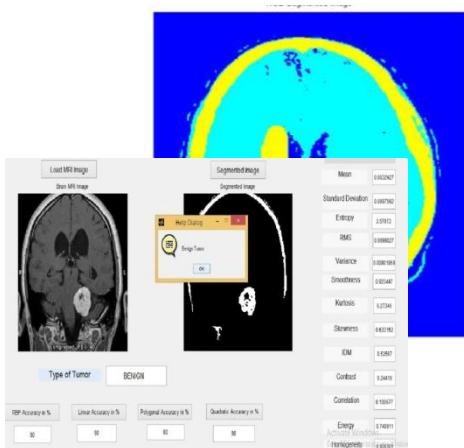
c. Comparing the Original and Enhanced Images



Tumor Segmentation

This process mainly focused to correct the intensity of the image and removing the noise of the input image.

d. Original Image Histogram



f. Displays the Benign Image of Segmentation

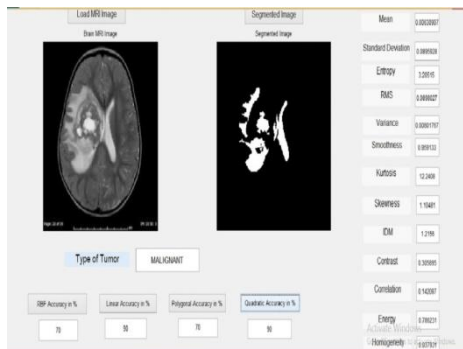
e. R

GB Color

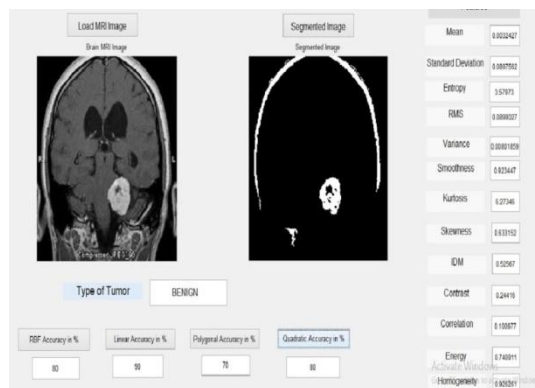
Image for Using Brain

The above figures show that the original image histogram plot the presence tumor. The histogram is displayed as x and y-axis and display the values of x and y. Dark pixels are low in contrast and light pixels are high in contrast to the plotting image. The RGB color image for displaying the segmentation part of the tumor image. This RGB color model used for MRI scanned images to display the result of the tumor.

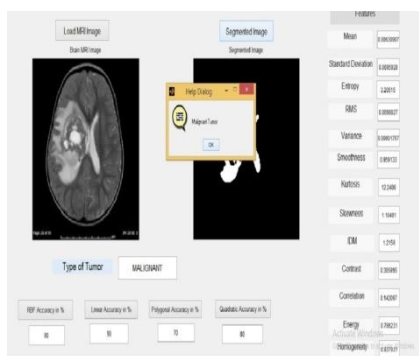
4.2 RESULTS OF ACCURACY VALUES



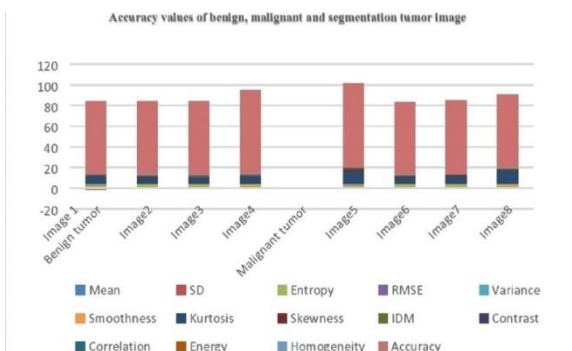
i. Display the Malignant Tumor Segmentation of Accuracy Values



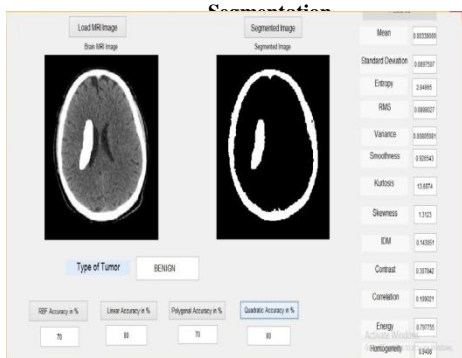
k. Displays the Tumor of the Segmentation



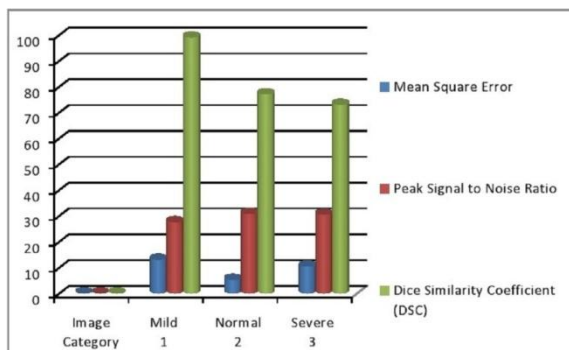
g. Display the Malignant Tumor Image



The above figures show that what type of the tumor from the loaded MRI image and click the segmentation pushbutton,



h. Displays the Benign Tumor Segmentation of Accuracy Values



then displays the benign or malignant tumor of segmentation and the dialog box will also be displayed. The type of tumor and clicks the RBF accuracy and linear, polygonal accuracy, quadratic accuracy values and also displays the features of the benign or malignant tumor image values. accuracy Values Benign, Malignant and Segmentation Tumor Images

i. MSE, PSNR, DSC Values of Bar Chart

The above shown bar chart shows that accuracy values in benign, malignant and segmentation of the tumor images, and comparison of the proposed image with malignant, benign images. It also displays the highest and lowest accuracy values of the tumor images. The comparison of the MSE, PSNR, and DSC accuracy values.



j. Display the Type of Tumor for Segmentation Tumor Image

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S. No	Test Image Category	Mean Square Error (MSE)	Peak Signal to Noise Ratio (PSNR)	Dice Similarity Coefficient (DSC)
1	Mild	13.05	27.61	99
2	Normal	5.26	30.74	77
3	Severe	10.46	30.42	73

Table 4.1 shows the performance of the affected segmentation image of MRI and it is a comparison with

S. No	Benign tumor				Malignant tumor			
	Im1	Im2	Im3	Im4	Im5	Im6	Im7	Im8
Mean	0.003504	0.003242	0.0019393	0.000341193	0.0063090	0.0042599	0.0036506	0.0046417
SD	0.089745	0.089756	0.0897938	0.089499	0.0895928	0.0897136	0.0897405	0.0896947
Entropy	3.15619	3.57973	3.65493	2.9949	3.20515	3.6046	3.37095	3.02899
RMS E	0.089802	0.089802	0.0898027	0.089027	0.0898027	0.0898027	0.0898027	0.0898027
Contrast	0.234149	0.24416	0.203281	0.243326	0.305895	0.227197	0.243326	0.275028
Correlation	0.132059	0.100677	0.112589	0.129391	0.142097	0.13258	0.0932787	0.117994
Accuracy	80.35	70.14	90.56	80.4	70.69	80.64	70.87	90.68

Table 5.1 shows about the benign, malignant tumor image of the accuracy value

The above shown table explains about the comparison at the final stage of the tumor image. It also displays the error rate and high accuracy values.

V. CONCLUSION

The proposed system is used to detect brain tumor using multiatlas segmentation technique. The proposed system identifies the exact location of the tumor in the brain image. A GUI is created to get the MRI input image, pre-processed which includes conversion of gray scale and canny edge detection, PCA feature extracted, segmented with multiatlas technique. Then the results were analysed. Enhancement histogram also employed to get clear detection of brain cells affected by the tumor. Edge detection is used for the representation of black and white pixels values. The accuracy is analysed in terms of MSE, PSNR and DSC values which are extracted from the brain MRI images. Multi-atlas segmentation used for layerization of every partition of the images. The six-layered partitioning of the image is recommended for the correct accuracy of results. This experiment results reduce the error rate of MRI brain tumor. It also can be extended

to identify tumor types and to display the accuracy values for benign, malignant types of tumor images.

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