INTERNATIONAL JOURNAL OF TECHO-ENGINEERING

ISSN : 2057-5688

Semantic Segmentation of Brain Tumor from MRI Images and SVM Classification using GLCM Features

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Abstract: Brain tumors are a condition that causes damage to the brain or alters its functioning. It is difficult to identify brain tumor tissue in the entire brain. To save a patient's lives, it is important to detect tumors early. Segmentation or detection techniques are used to locate and segment brain tumors from MRI images. This is a very effective method that has been developed in recent years. Medical magnetic resonance-imaging is a difficult field of image processing. It must have a high accuracy percentage to give doctors a good idea about patients' diseases and save their lives. As input data, some MRI images were taken. To separate brain-tumor tissue from brain MRI pictures, the brain tumor segmentation process must be performed. The MRI images need to be processed using the median filtering method and skull stripping. The thresholding process is done on the MRI images by using the watershed segmentation technique. Finally, the tumor area is segmented. Then, other phase features are extracted using GLCM methods with MATLAB software. Next, images were classified with a support vector machine. This system achieved an average accuracy of 93%.05%. This is a lot better than conventional models.

Keywords: Grayscale image, Magnetic Resonance Imaging (MRI), Skull stripping, Watershed Segmentation, Brain Tumors, MATLAB, GLCM features, SVM classifier

I. Introduction

A brain tumor is the growth of unwelcome cells in the brain. These cells can divide and grow to form a lot of unwelcome tissues. This is called a tumor. Brain tumors are cells that grow and cause damage to brain tissue. There are two types: benign tumors and malignant tumors. Malignant tumors grow rapidly and may spread to the brain. This can cause damage to normal brain cells and put pressure on the brain. Some tumor cells can be cancerous but not all. MRI images of the brain are required to detect the location, size, and shape of brain tumor tissue. MRI images can be used to separate brain tumors from the entire brain. According to the International Agency for Research on Cancer, (IARC), more than 125000 people are diagnosed each year with brain-tumor diseases with a mortality rate of over 97000 [2]. To save a patient's lives, it is important to quickly get the correct results for tumor detection. Although there are many ways to obtain brain images, the Magnetic Ajay Khunteta Department of Electronics Engineering at Rajasthan Technical University in Kota (India akhunteta@rtu.ac.in) Resonance Imaging scan is far more effective than any other scanning methods like Computed Tomography scans. Because it does not contain radiation, it won't cause any harm to the human body. The MRI machine produces images with very useful information using a strong magnetic field, radio waves and radio waves. These images can be segmented to show the size and shape of the tumor. This information is used to segment the tumor using thresholding, which is intensity-based [4]. Digital Imaging and Communications in Medicine (DICOM), is used to process and present information about medical images. Segmentation of a medical image is the process of dividing or separating a digital image into different parts, as well as the different groups and pixels. Pre-processing is the first step. This prepares the images for processing by some important method. The median filtering filter is used to remove noise. Median filtering sets the pixel value for the input image to the value of the middle pixel. This smoothens out the image. Next, the skull removal method is used to extract the brain area from MRI images that have bones at the edges. The watershed segmentation technique is used to detect the area of tumor. It uses the same method as the MRI system that sets a minimum intensity level of pixels. The thresholding technique is determined by the intensity of the pixels in the input image. This is used to distinguish tumor areas from normal brain images. The watershed method works by marking the tumor area and normal areas in the brain images [8]. Watershed segmentation uses different colours to mark the areas.

II. Related Review

The study is based on the proposal of a novel method for the classification of brain tumours from MRI brain images; the used feature vector is composed of parameters obtained by applying the central moment's method. The obtained results are very encouraging and very promising, the system arrives to properly affect 88.333% of the images of the databases, this is a very interesting recognition rate and very motivating, the results can be further improved,

ISSN : 2057-5688

this can be achieved by analysing the images for which the system has encountered difficulties for affecting them to their proper classes. This analysis allows to identifying the reasons for the misclassification and therefore to propose the necessary solutions.

It is a time-consuming and tedious task to identify, segment and detect infecting areas in brain tumor MRI images. An image processing concept can help you visualize the different anatomy of your body. It is difficult to see the abnormal structures of the human brain with simple imaging techniques. The magnetic resonance imaging technique clarifies and distinguishes the brain's neural architecture. MRI technology includes many imaging modalities that can scan and capture the brain's internal structure. This study focuses on noise removal, the extraction of gray-level co-occurrence matrix (GLCM), features, and DWT-based brain tumour region growing segmentation. These are all to improve the performance and reduce complexity. The noise created after segmentation was removed by morphological filtering. To train and evaluate the accuracy of the probabilistic neural network classification in the detection a tumor in brain MRI images, the results were used. The proposed technique abilistic neural networks was demonstrated to be effective by the experimental results that nearly 100% of brain MR images were able to identify normal and abnormal tissue.

The Human Brain Tumor uses the template-based K–means algorithm to initiate segmentation. This is done by selecting the best template based on the gray-level intensity of the image. Second, the updated membership is determined using the fuzzy C–means (FCM), which calculates the distances between cluster centroid and cluster data points. It then contacts its best result. An improved FCM clustering algorithm can be used to detect tumor position by updating the membership function. This is based on different features of tumor images including Contrast Energy, Dissimilarity Homogeneity Entropy and Correlation. Simulations show that the proposed algorithm detects abnormal and healthy tissues in the human brain with a small amount of gray-level intensity. This algorithm also detects brain tumors in humans much faster than other algorithms, and it does so in seconds.

Brain first: The acquisition of the human brain MR images is completed. The input image is pre-processed, and enhancements to the MR images are also performed. The template base window is then selected, and the window's output has been segmented using the temper-based K-means clustering segmentation. Then, the required features are extracted. The final step is to detect the tumor using the red line, which is marked with the new fuzzy C-means algorithm and updated membership. This is done by the clustered images, which are automatically selected from the image feature.

III. Proposed Methodology

Methods for segmenting Brain tumors include median filtering (preprocessing), thresholding, and watershed segmentation. Then, GLCM features are extracted. This experiment was implemented with MATLAB R2019a. Fig. illustrates the flow of this procedure. 1.

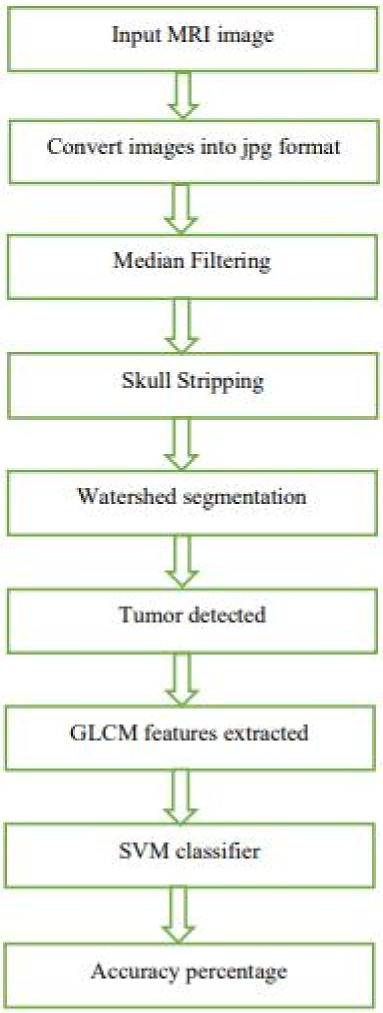


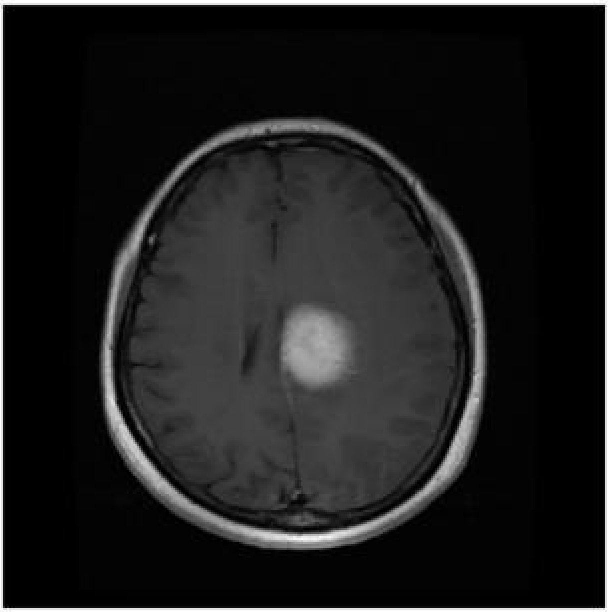
Figure 1: Flow chart of the algorithm about brain tumor detection and classification

Magnetic Resonance Imaging (or 8-bit image) has some brightness information. '0' is for black colour and '255' for white. These images have a size of 512x512 pixels. Grayscale images are a special type of image that only contains brightness information.

Median-filtering, which can remove noise and smoothen the image, is an important technique. After capturing an image or transferring it to another device, noise can occur in the MRI image [11-14-15]. Noise removal is the first step in preprocessing images to improve their quality for future uses. The median filtering technique sets the pixels values to the median value of neighbouring pixels. The filtering process allows images to be altered or enhanced. [16, 17, 18]. To read the pixel values, it is necessary to first determine the median value. The median value can then be calculated by choosing the middle value to change the intensity level of pixels (x and y). (1) The equation for median filtering can be found in (1)

$$y[m, n] = median\{x[t, f]\}, (t\ , f) \in \omega \text{ --(1)}$$

The user defines a neighbourhood by putting the [m, n] marker in the MRI image. The MRI image is always useful when processed with the median filter. The MRI image appears blurred. Fig. Fig. 2 is the result of median filtering. The median filtering technique can remove salt and pepper noises. The three main types of noises that can be found in MR images are Gaussian noise (Rician noise), Rayleigh noise (Rayleigh noise), and Gaussian noise (Rician noise). SNR magnitude can be used to determine the type of noise. If the SNR magnitude is greater than 2, then Gaussian noise is produced. SNR tends to be zero and Rayleigh noise is formed. MATLAB 2019a uses median filtering to remove noise from MR images.



ISSN : 2057-5688

Figure 2: Result of Median Filtering

These methods use morphological operations that involve erosion and dilation to separate the skull or remove bones from the input brain MRI. To extract the brain, the skull stripping method involves cutting out the skull and bone areas from the entire MRI image. This method's final output is largely dependent on empirical experimentation and the finalization of the image parameters [3]. Fig 2 shows the algorithm for skull stripping. The skull is removed using morphological operations. The binary thresholding technique is used to process the MRI images. This technique uses morphological operation and erosion. Other methods that can be used to remove the skull include superimposition, seed growing, seed-growing technique, thresholding-based histogram, anisotropic diffusion and cropping.

Watershed segmentation can be used to identify the background and foreground of an MRI image. The system will only define pixels that are near the edges of an MRI picture and present them as a contour after it has completed the pre-processing steps. This technique allows for a more segmented output. This technique is most useful if the edges of the image are very clear. Clear edges allow for better separation from the rest of the image. Grey Level Co-occurrence Matrix is (GLCM) used to extract the features from MRI images. The technique calculates the features in MRI images such as contrast, correlation and energy. These are shown below [5]. 1) Contrast: This is the measure of the intensity of pixels within MRI images neighbouring or adjacent pixels.

$$Contrast = \sum_{x,y=0}^{K-1} P_{xy} \ (x-y)^2 \qquad (2)$$

Correlation: It presents the relation among the pixel information of an MRI image.

$$Correlation = \sum_{x,y=0}^{K-1} P_{xy} \frac{(x-\mu)(y-\mu)}{\sigma^2} \qquad (3)$$

Energy: The energy presents the similarity among the pixels in an MRI image and define the repetitions of the pixels having same values.

$$Energy = \sum_{x,y=0}^{K-1} \left(P_{xy}\right)^2 \qquad (4)$$

There are the coordinates of the pixels are x and y of those MRI images and the size of GLCM is (K) and probability of occurrence of the pixels is shown as Pxy is mention in the equations (2, 3, 4).

Classification of images using SVM classifier: Now the other phase of this paper is considered and this part is about classification. There are various classification techniques like CNN, ANN etc., but here SVM classification technique is used to deliver efficient results. In this paper, some features are calculated for the MRI brain images. The features are contrast, correlation, energy, and homogeneity [7]. Procedure for classification: 1. GLCM feature extraction 2. Then the dataset of MRI images are trained and then tested with SVM classifier. 3. After that, the dataset images are separated based on the images with tumor and normal images. For SVM classification operation, some features of images like grey level co-occurrence matrix are calculated. Then, the images are classified using those values, then it will either classify or separate the images in different groups. The SVM classification is a supervised machine learning method in which data analysis and images grouping occur. It has good speed for classify images and can perform the operation on large amount of data. Here 36 images used for train the data and another 26 images for test data. There are equal number of tumorous and normal images. In this machine learning method, there has been created a decision boundary by SVM classifier which contain different images in different area.

Dataset used: Those MR images have been taken from www.kaggle.com, and www.figshare.com websites. All of these images have 256*256 pixels and the grey scale level of 8-bit.

IV. Experimental Result

The proposed work has completed the procedure for detecting the tumor region from 36 brain MRI images using morphological operation for skull stripping and watershed segmentation technique. It is further proceeded by calculating the four GLCM features of these images such as contrast, correlation, energy, and homogeneity. Then in the other phase, these images are classified with the help of support vector machine (SVM) classifier with average accuracy of 93.05%. The proposed research work has used all the six SVM classifiers or support vector machine tools such as Linear, Quadratic, Cubic, Fine-Gaussian, Medium Gaussian, and Coarse-Gaussian SVM classify those images in different groups.

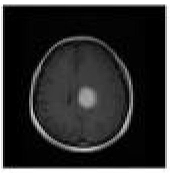
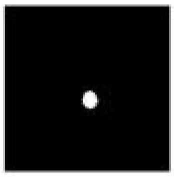
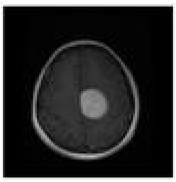
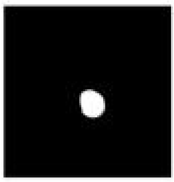
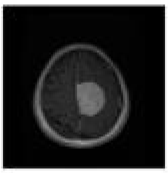
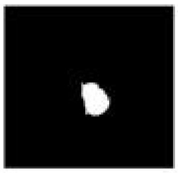
No.	MRI Image	Tumor Segmentation
1.		
2.		
3.		

Figure 3: Tumor segmentation results from some MRI images

V. Conclusions

Medical image processing is a complex process that involves brain tumor detection. This experiment shows that median filtering and skull removal should be performed before segmentation of the brain-tumor area. Because MRI images are noisy and the skull may have a similar intensity to brain tumor areas, this step is important. Various support vector machine models can be used to obtain an average accuracy. The proposed model has higher average accuracy than other models. These GLCM features include contrast, correlation, and energy. The images will then be classified by support vector machine (SVM), such as images with and without cancer. Further research is possible to implement other machine learning models in order to improve accuracy for images with low intensity.

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