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Brain tumor segmentation using threshold method: Applications of image processing techniques in medical sector

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***Abstract*---** Tumor cells are uncontrolled cells that grow uniformly and without control when they are deprived of normal factors. The death rate from brain tumors among humans is high every year. In the United States, about 50 patients diagnosed with primary brain tumors die each year. Magnetic Resonance Imaging (MRI) is one of the most commonly used and popular methods of diagnosing brain tumors. This research work presented an automated method for brain tumor detection using gray-scale MRI images. This method involved initial enhancement to reduce gray-scale colour fluctuations. A filter was used to improve segmentation.A threshold-based OTSU segmentation instead of colour segmentation in this study because the images were grayscale. Finally, pathology experts gave information that was used to establish the study's focus areas (brain tumor region). The testing results revealed that the proposed strategy outperformed existing available alternatives in terms of accuracy while retaining an acceptable accuracy rate for pathology experts.

***Keywords*---**brain tumor, MRI, OTSU's segmentation.

Introduction

BRAIN TUMOR can occur when tissues in the brain or central spine magnify uncontrollably, compromising proper brain function.[1]. unlike primary brain tumors, secondary (metastatic) brain tumors start in another part of the body and

increase to the brain [1]. Brain tumors can be malignant (cancerous) or benign (non-cancerous) (benign). The WHO (World Health Organization) has established over 120 relegations for brain tumors based on tumor cell type and location [2]. They're categorized by the cells from which they emerge and a number ranging from I to IV .Lower-grade tumors are classified as grades I and II, whereas higher-grade tumors are classified as grades III and IV. It is important to perform tumor tissue analysis in order to make a precise diagnosis and treatment of a patient with brain tumors in the pathology lab using-

- A microscopic examination, such as a biopsy
- CT, Ultrasound, MRI, and other electronic modalities

Among all electronic modes of communication, one of the most widely used and popular procedures for identifying brain tumors is Magnetic Resonance Imaging (MRI).A three-dimensional assessment of the lesion is provided by the use of high-resolution, high-contrast images of the brain in three orientations: axial, coronal, and sagittal. [3,16]. In this study, an automated method for detecting brain tumors was proposed, which incorporated MRI gray-scale images.Medical image processing techniques, Preprocessing and post processing were used to identify the tumor location exclusively using brain tumor images as input. Enhancement, filtering, and segmentation are part of the pre-processing, whereas feature extraction and identification are part of the post-processing.

Related Works

[4] Suggested a method for detecting and localizing brain tumors using MRI scans of patients. A proposed method (thresholding) involves pre-processing, edge detection (Sobel, Prewitt, and Canny edges), and segmentation.After that, K-means clustering was used to identify the tumor region.However, According to their method, more regions were detected than the tumor region, so the output image might be confusing. The accuracy of brain tumor detection was proven in a study by [5], which used On three datasets, a watershed segmentation method and morphological operation were evaluated and was found to yield an average accuracy of 97.34 percent, despite the presence of certain undesired features.. [6] The morphological operations technique was proposed to detect the tumorfrom an MRI picture in a previous study. To work on the required part of the image, threshold segmentation was utilized. NMF (nonnegative multiplier factor) is a term used to describe the feature extraction method was also utilized to excerpt the features of the tumor[7] suggested Using K-means clustering, segment and group MRI images of the brain, followed by morphological screening for miss clustered tumors. [8] utilized MRI scans for brain tumor analysis in another study. The process began with converting the photos to grayscale, followed by sharpening and enhancing techniques. After that, histogram-based threshold segmentation is used. The border was then extracted using edge detection algorithms. Finally, mathematical procedures were performed to determine the brain tumor's shape and size. As discussed in the research, segmentation is the most important aspect of brain tumor analysis. The success of segmentation determines the location of the tumor. The research incorporates grayscale images, which were segmented using threshold-based OTSU segmentation rather than colour segmentation.

The Proposedmethod

The proposed approach's architecture is depicted in Figure 1.

The procedure begins with the capture of an MRI picture. There are two steps to identifying a brain tumor using MRI images: pre-processing and post-processing.

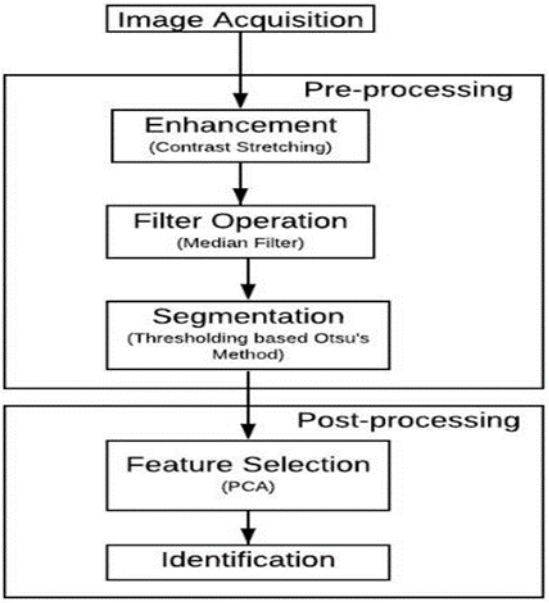

Fig 1. System for identifying brain tumors proposed

Image Acquisition

The proposed method has been implemented usinga brain tumor dataset [9]. The collection includes 120 T1-weighted contrast-enhancedpictures from three patients who each had a different type of brain tumor glioma, meningioma, or pituitary tumor. In this study looked at three batches of images, each with 40 images. MRI scans are represented as two-dimensional matrices with pixels as elements. For this study, photos of size 350 X350 in JPEG image format are stored in MATLAB and shown as RGB grey scale images with entries ranging from 0 to 1. 0 symbolizes total darkness, 1 represents pure white, while entries 0-1 reflect a range of intensities between black and white. To process RGB grey scale photos, they are transformed to HSV format, where H stands for hue, the colour portion of the colour model, and is expressed as a number between 0 to 360 degree.S stands for saturation, which refers to the amount of grey in a colour ranging from 0 to 100%. V stands for value, and it specifies the color's intensity on a scale of 0 to 100, with 0 being entirely dark and 100 being the brightest. Only the V channel is subjected to further analysis, such as augmentation and filtering.

Pre-Processing

Pre-Processing includes a variety of steps, including:

- Image Enhancement
- Filter Operation
- Segmentation.

Image Enhancement

For this investigation, the initial phase of image pre-processing is image enhancement. Contrast stretching was chosen in this investigation because it performs better on grayscale images as contrast increases without altering relative grey level intensities [10]. As a result, unlike histogram equalization, it produces no artificial-looking images. Contrast stretching boosts picture contrast by expanding the image's range of intensity values to cover the desired range of 0 to 1. It removes any uncertainty that may exist in different areas of the dataset image. The picture enhancement results for this study test image are shown in Figure 2.

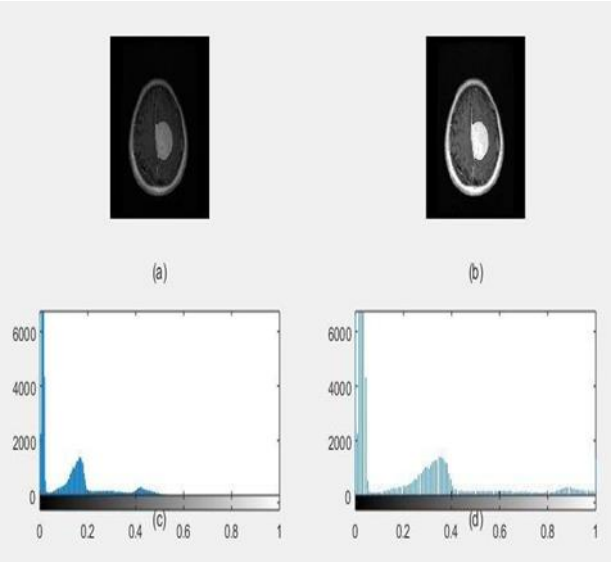

Fig 2. (a)Test image from the beginning (b)Enhancement approach applied, (c)Histogramof (a),(d) Histogramof (b).

Filter Operation

An image is subjected to a filter operation to improve its smoothness, sharpness, and edge enhancement. In our proposed strategy, we have used the median filter instead of other filters such as the mean and Gaussian filters.This is due to the fact that the mean filter reduces noise better but does not preserve the edge, while the Gaussian filter preserves the edge but blurs the image [11]. When compared to mean and Gaussian filters, the median filter is useful because it reduces noise to a manageable level while maintaining edges.In addition, it produces a less

fuzzy image than the Gaussian filter.The median filter was utilized in this investigation using a [7/7] sample window. Despite the fact that the default sampling window is [33], we applied it up to [2121], but [77] produced the best results. On the V channel, the median filter was also used. The conclusion V was then subtracted from the original V, and the image was converted back to RGB format. The outcomes of this study test image are shown in Figure 3.

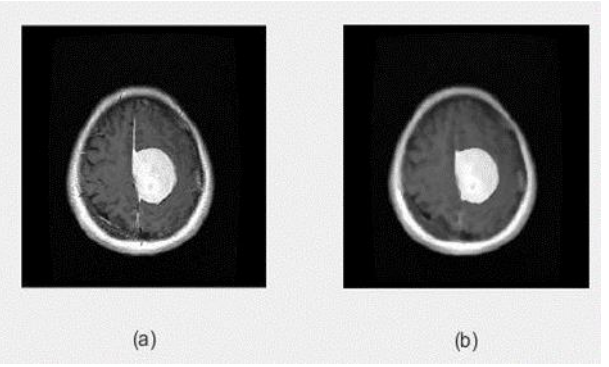

Fig 3. (a) Test image from the beginning (image enhancement), (bresultant image using medianfilter

Segmentation

An image is segmented based on features that are comparable. In essence, For further analysis of the image, key elements were extracted using segmentation. Otsu's approach, which is based on thresholding, is widely used to segment imagesfor additional processing such as feature analysis and to perform binary transformations. The threshold value is also computed faster than with other strategies because the mathematical statement is simple [12]. During investigation, it was discovered that only the green and blue channels in an RGB grey scale image are necessary to detect a brain tumor. Due to this, Otsu's segmentation was limited to the green and blue channels of the final image, and the red channel was eliminated. The final image was created in this study by combining Channels green and blue and computing the complement of the resultant image. Otsu's method was used to transform the complemented image into a binary image with only the values 0 and 1, where 0 represents black and 1 represents white.

After-Processing

- Feature Extraction
- Identification
- Feature Extraction

Various form criteria are essential to diagnose the brain tumor, according to existing research [13] and medical expert recommendations. MATLAB function region-propose provides a set of attributes for each form in the image.We employed four parameters in our study: area, circularity (roundness and diameter), and solidity. We also used the PCA feature selection technique to

ensure that the features we chose were appropriate for detecting the ROI (Region ofInterest). A zone's area is determined by how many pixels are displayed within that area [14].

Circularity

Circularity is measured by the degree of similarity between particles [15]. It incorporates the shape's roundness and diameter.

$$\text{Roundness} = \frac{4\pi \times \text{Area}}{(\text{permeter})^2} ----(1)$$

$$\text{Diameters} = \sqrt{\frac{4 \times \text{Area}}{\pi}} ------(2)$$

Solidity

Solidity can be used to determine the particle's concavity. The particle becomes more solid when the image area and convex hull area approach each other [15].

$$\text{Solidity} = \frac{\text{Image Area}}{\text{Convex hull area}} ----(3)$$

Identification

The purpose of the identification procedure is to locate the ROI. Using the features extracted in the feature extraction stage, the ROI is detected. For the feature measurement, some sizes were chosen. A range of parameters, such as area, roundness, diameter, and firmness, was specified to determine the tumor location. Whenever a region falls within the range of values for each characteristic, it is considered to be within the ROI.

The Experimental Results

Analysis of the proposed method

As shown in Table 1, the proposed method in this study provides the most accurate results when compared to other current methods. According to pathology experts, a 17 percent rate of accuracy is adequate for ultrasound images. In this investigation, the proposed approach was able to achieve an acceptable accuracy rate.

Table 1
Analysis of the Proposed Method's Results

Various approaches were utilized.	Total Test data	Accuracy (%)

Proposedby[4]	Batch1	37	91.5
	Batch2	36	90
	Batch3	33	83
Proposedby[5]	Batch1	37	94
	Batch2	36	92
	Batch3	33	86.5
Proposedby[6]	Batch1	37	89
	Batch2	36	90
	Batch3	33	84
Proposedby[7]	Batch1	37	90.5
	Batch2	36	88
	Batch3	33	83
Proposedby[8]	Batch1	37	92
	Batch2	36	92
	Batch3	33	87
This study Proposed approach	Batch1	37	95
	Batch2	36	92.5
	Batch3	33	87.5

Experimental Outcomes

Figure 4 displays the numerous experimental outcomes of the suggested technique in this study. It displayedthree brain tumour photos from three separate datasets in axial, coronal, and sagittal orientation.

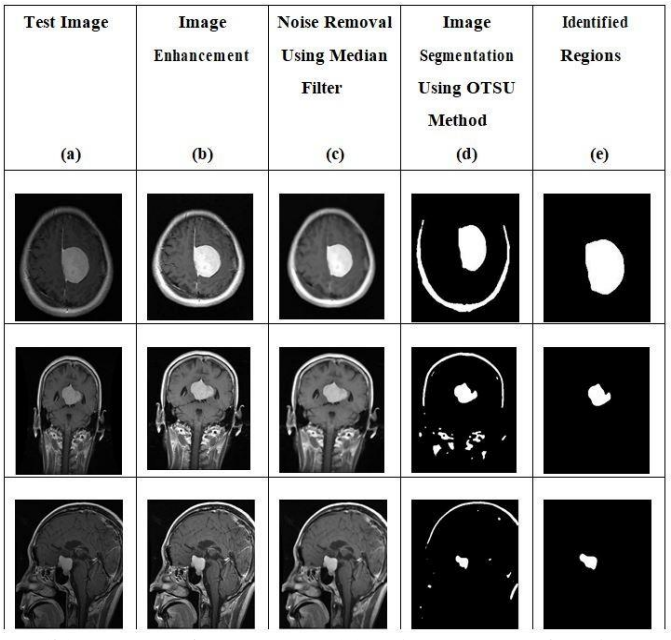

Fig.4:(a)TestImage(b)ImageEnhancement(c)Noise Removal Using Median Filter (d) ImageSegmentation Using OTSU Method (e) IdentifiedRegions

In the first column, the input photos are presented.To improve the image contrast in the second column, an image enhancement technique was used. In the third column, you can see the filtered image using the median filter. Images are split into two colour regions, black and white, in the Threshold based segmentation column. Threshold segmentation is responsible for the white specks observed in the photograph. In other words, those are the areas where the intensity levels are higher than the threshold. High-intensity areas are largely absorbed by the tumor. Finally, only the tumor cell is discovered in the last column. The tumor can be seen as the white area in the photograph.

Comparative Results Analysis

The photographs in Fig. 5 demonstrate a comparison of the outcomes from the proposed approach in this investigation with those from other studies. [4].

Fig. 5. Comparing our suggested strategy to other known approaches for tumor detection

It shows that the output image of the study's recommended method only contains the tumor region, whereas [4]'s proposed output image has more regions besides the tumor region, which could lead to confusion about the tumor region.

Conclusion

The detection of a tumor by hand isn't solely time overwhelming however additionally boring, whereas an automatic approach needs less time. as compared to alternative existing methodologies, the planned approach saves time and enhances accuracy during the analysis.As a result of early detection of a tumor is important for a brain tumor patient, this research could help pathologists detect brain tumors more quickly and correctly. However, the accuracy rate will however be improved. If intra- and inter-observation variability problems among consultants are reduced, the accuracy rate can be improved within the future.

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