Tumor Detection using threshold operation in MRI Brain Images

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Abstract- **Medical Image Processing is a complex and challenging field nowadays. Processing of MRI images is one of the parts of this field. This paper proposes a strategy for efficient detection of a brain tumor in MRI brain images. The methodology consists of the following steps: pre-processing by using sharpening and median filters, enhancement of image is performed by histogram equalization, segmentation of the image is performed by thresholding. This approach is then followed by the further application of morphological operations. Finally the tumor region can be obtained by using the technique of image subtraction.**

Keywords – **Morphology, Threshold, Image Subtraction, Tumor Identification, Filter.**

I. INTRODUCTION

Tumor is defined as the abnormal growth of the tissues. Brain tumor is an abnormal mass of tissue in which cells grow and multiply uncontrollably, seemingly unchecked by the mechanisms that control normal cells. Brain tumors can be primary or metastatic, and either malignant or benign, may be localized or extended while secondary tumors could be in different locations [3]. Primary brain tumors include any tumor that starts in the brain. Primary brain tumors can start from brain cells, the membranes around the brain (meninges), nerves, or glands. Tumors can directly destroy brain cells. They can also damage cells by producing inflammation, placing pressure on other parts of the brain, and increasing pressure within the skull. A metastatic brain tumor is a cancer that has spread from elsewhere in the body to the brain.

To identify a tumor, a patient will undergo several tests [1]. One should be careful when dealing with sensitive organs like the brain and hence most commonly techniques like Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) are used to locate brain tumor. Magnetic resonance imaging (MRI) is a medical imaging technique used in radiology to visualize internal structures of the body in detail. From this, detailed anatomical information is derived to examine human brain development and discover abnormalities [4]. The information obtained will influence the treatment a patient will receive. Perhaps the most widely used clinical diagnostic and research technique is MRI [3]. The incidence of brain tumors is increasing rapidly, particularly in the older population than compared with younger population. Over the last 20 years, the overall incidence of cancer, including brain cancer, has increased by more than 10% as reported in the National Cancer Institute statistics (NCIS). National Brain Tumor Society is committed to identifying and responding to the needs of the brain tumor community. In January of 2009, it released findings from a national survey of over 1,400 patients that were affected by brain tumor. Therefore it is becoming increasingly important for us to detect a brain tumor at the earliest stage of the tumor.

Many different kinds of image processing techniques are used for diagnosing and visualizing the anatomical structures and metabolic or functional information of the human body. Nowadays there are several methodology for classifying MRI brain images, which are fuzzy methods, neural networks, atlas methods, knowledge based techniques, shape methods, variation segmentation. In this paper, the algorithm deals with pre-processing, enhancement, segmentation and then finally morphological operations [4]. Pre-processing of MRI images is the primary step in image analysis, which perform image enhancement and noise-reduction techniques, which are used to enhance the image quality [1]. Thresholding is the simplest method of image segmentation. Thresholding [1] can be used to create binary images from a grayscale images. The morphological operations are basically based on some assumptions about the size and shape of the tumor. These operations are applied on the image obtained after threshold segmentation. The final technique of image subtraction is applied to obtain the exact tumor region.

II. METHODOLOGY

The architecture fully described about overall process of the system. In this, first it starts with the MRI brain image, which is considered as an input image. Here the preprocessing of this input image has been takes place. Now, the segmentation of this image is done after the histogram equalization. Based on this segmentation, the produced image is again going for a morphological operation. Finally, the subtraction of this image is done to

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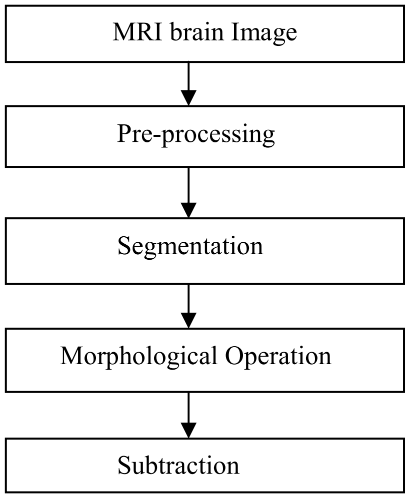
detect the exact tumor place. After all this process, the final tumor detected image is produced as an output.



Architecture of the system

Brain tumor is diagnosed at advanced stages with the help of the MRI image. The algorithm contains three stages, first is pre-processing of given MRI image, then segmentation and finally performing morphological operation on that image. Some operations like grayscale conversion [1], histogram equalization [5] are applied on the images as a part of preprocessing the image. The filtering techniques such as High Pass Filter and Median Filter [1] are applied to remove the high frequency components in the MRI image and the performance evaluation is measured, all this being a part of preprocessing of the image.

Segmentation is an important process to extract suspicious regions from MRI brain images. Segmentation methods are divided into many categories and the thresholding [1] approach is one of them. MRI brain image segmentation is done in order to change an MRI image into more meaningful form which will make it easier for us to identify the tumor in the brain.

Morphological operations [6] such as spur, open, dilate, close are then used to enhance the image quality and then finally the image subtraction technique is used to get the tumor region in the brain.

A. Grayscale Imaging

Gray scale imaging is sometimes called "black and white," but technically this is a misnomer. In true black and white, also known as halftone, the only possible shades are pure black and pure white [6]. Gray shading in a halftone image is obtained by considering the image as a grid of black dots on a white background (or vice versa), and the sizes of the individual dots will determine the apparent lightness of the gray in their vicinity. In the case of transmitted light (for example, the image on a computer display), the brightness levels of the red (R), green (G) and blue (B) components are each represented as a number from decimal 0 to 255, or binary 00000000 to 11111111. For every pixel in a red-green-blue (RGB) grayscale image [1], R = G = B. The lightness of the gray is directly proportional to the number representing the brightness levels of the primary colors. Black is represented by R = G = B = 0 or R = G = B = 00000000, and white is represented by R = G = B = 255 or R = G = B = 11111111. Because there are 8 bits in the binary representation of the gray level, this imaging method is called 8-bit Grayscale. Grayscale can be collectively called as the range of shades of gray [6]. The darkest possible shade is black, which is the total absence of transmitted or reflected light. The lightest possible shade is white, the total transmission or reflection of light at all visible wavelengths. So the very first step in this method is the conversion of the input image i.e. MRI image to be pre-processed into a Grayscale image.

B. *Histogram Equalization*

Histogram equalization is a gray-level transformation that results in an image with a more or less flat histogram. Now an image may have a peaked histogram. Such a peaked or non-flat histogram shows that pixels do not equally occupy all the gray levels [5]. This results in a low contrast image and the remedy of this image is by carrying out the operation called histogram equalization. Histogram equalization is a common technique for enhancing the appearance of images. Suppose an image is predominantly dark [6]. Then its histogram would be skewed towards the lower end of the grey scale and all the image detail is compressed into the dark end of the histogram. If the grey levels could be 'stretched out' at the dark end to produce a more uniformly distributed histogram then the image would become much clearer. Histogram equalization involves finding a grey scale transformation function that creates an output image with a uniform histogram. Histogram equalization [5] is a way by which image intensities can be adjusted to enhance contrast. By this method the global contrast of many images can be increased, especially when the usable data of the image is represented by close contrast values [3]. Through this adjustment, the intensities can be better distributed on the histogram. This allows for areas of lower local contrast to gain a higher contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values.

C. High Pass Filter

After this the grayscale image is given as an input to high pass filter. A high pass filter is the basis for most sharpening methods. Sharpening is a technique in which fine details of the image are highlighted. It is used for edge detection. Sharpening takes place when an image is passed through high-pass filter[2]. These filters [1] sharpen images by creating a high contrast overlay that emphasizes edges in the image. An image can be sharpened by enhancing the color contrast around edges in the image. So it can be said that enhanced image is the result of the addition of the original image and the scaled version of the line structures and edges in the image. Line structures and edges can be obtained by applying a difference operator on the image.

An image is sharpened when contrast is enhanced between adjoining areas with little variation in brightness or darkness. A high pass filter tends to retain the high frequency information within an image, while reducing the low frequency information [1]. The kernel of the high pass filter is designed to increase the brightness of the center pixel relative to neighboring pixels. The kernel array usually contains a single positive value at its center, which is completely surrounded by negative values. A Laplacian filter has been used to illustrate sharpening [6]. The Laplacian filter is a high-pass filter which provides sharpening. The concept of double derivatives and Laplacian formula is used to get the output.

D. *Median Filter*

Median filter is often desirable to be able to perform some kind of noise reduction on an image [1]. The median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing. Median filtering is very widely used in digital image processing. Because under certain conditions, it preserves edges while removing noise [2]. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries instead of the average or weighted average of pixels in the window [1]. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal [5]. The median is calculated by first sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value [6]. This filter enhances the quality of the MRI brain image.

E. *Threshold Segmentation*

Segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images [1]. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. Each of the pixels in region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristics. The simplest method of image segmentation is called the thresholding method [3]. This method is based on a threshold value to turn a gray-scale image into a binary image. The key feature of this method is to select the threshold value.

F. *Morphological Operations*

The term morphology refers to the description of the properties of shape and structure of any objects. Binary images may contain numerous imperfections. In particular, the binary regions produced by simple thresholding [3] are distorted by noise and texture. Morphological image processing pursues the goals of removing these imperfections by accounting for the form and structure of the images [4]. This usually means identifying objects or boundaries within an image. Morphological operations are logical transformations based on comparison of pixel neighborhoods with a pattern. Morphological operations are usually performed on binary images, where the pixel values are either 0 or 1. Most morphological operations focus on binary images.

G. *Image Subtraction*

The pixel subtraction operator takes two images as input and produces as output a third image, whose pixel values are simply those of the first image minus the corresponding pixel values from the second image. Here first the tumor is extracted that is present in the image. This is done based on the principle of the most closely packed pixels present in the image [6]. The part of the image where the most closely packed pixels are present is extracted. Hence the tumor is the one which is removed. Next the image obtained after removal of the tumor is subtracted from the original image, which is achieved after applying morphological operations [4]. Due to this operation, to obtain an image and it is free from all other noise and contains only the tumor.

III. RESULTS

This paper concerns about extracting brain tumor from MRI brain images using image processing. MRI Images of brain tumor cannot exactly denote the position of brain tumor, so to find the exact position of tumor in the MRI image preprocessing, segmentation, morphological operation and subtraction are used. This gives the exact shape of the tumor in that MRI image and finally detection of brain tumor in MRI images is achieved.

The following figures show the images as an output. i.e. original image grayscale image, histogram equalization, filtered image, median filtered image, threshold segmented image, image after morphological operations and finally the extracted tumor from MRI image.

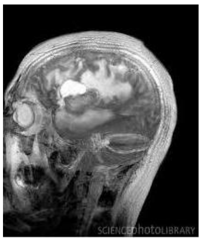


Fig.1. MRI image of tumor

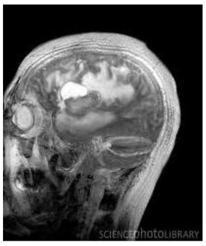


Fig. 2. Grayscale image affected brain

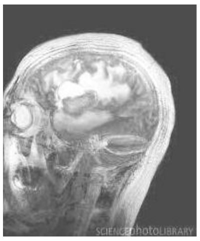


Fig.3. Histogram equalized image

Fig 4. HPF output

Fig 5. Median filtered

Fig 6.Threshold segmented

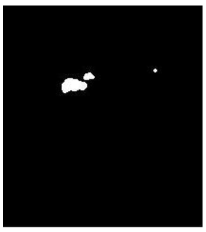


Fig 7. Morphological operation applied image

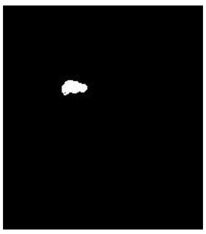


Fig 8. Final tumor detected image

IV. CONCLUSION

Morphological processing technique has proved miraculously helpful in various image extraction and filtering techniques. The morphological operators can change the structuring elements of the image according to their use. Some operators like open, spur, dilate and close have proved helpful in extracting the brain tumor from the MRI brain images. Pre processing of the MRI was done using grayscaling, histogram equalization and filtering techniques. Threshold segmentation was used to work on the desired region of the image. Thus by applying the image subtraction can get the final brain tumor image.

V. FUTURE WORKS

As a part of the defined operations, the outputs are recorded. The recorded outputs are able to distinguish between the affected and the non-affected parts of the brain.

In future this programme can be made more advanced so that tumor can be classified according to its type. Also tumor growth can be analysed by plotting graph, which can be obtained by studying sequential images of tumor affected patient.

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