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An Adaptive Filtering Technique for Brain Tumor MR Image with Area Calculation

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ABSTRACT: Brain is the vital part of the human body. The brain sends electrical signals across the body along nerve fibres and in this way controls the body. The brain can be termed as the control centre of the human body. A brain tumor is a mass of abnormally grown cells in the brain. Detection of the brain tumor is essential but at an early stage the MRI image does not provide clear results. The edges of the MRI image are not sharp in case of an early brain tumor. Hence, image enhancement is required. In this paper, homomorphic filtering technique has been used for smoothing of the image. When the input image suffers from poor illumination conditions, homomorphic filtering technique is effective for digital image enhancement. The area of the tumor area also has been calculated by use of a simple procedure (thresholding and negative of the image). Better results have been obtained in comparison to edge detection procedures. The implementation has been done using MATLAB.

KEYWORDS: Brain tumor, Image enhancement, Homomorphic filter, Thresholding, Tumor area.

I. INTRODUCTION

The brain is the control centre of the human body. It controls the body through electrical signals that are sent via nerve fibres. A tumor is an abnormal growth of cells. Brain tumor can build up in any part of the brain. The brain is protected by the skull. Tumor detection can be done by using different imaging techniques. This is one of the major applications of Digital Image Processing. In the field of medical imaging also Digital Image Processing has come into frequent and well-known use. Medical imaging of the brain tumor can be done in form of Magnetic Resonance Imaging (MRI), Nuclear Medicine Imaging, Computed Tomography (CT), etc.

But, at an early stage, brain tumor detection is a difficult task. Because the edges of the tumor are not sharp in the MRI image and thus the segmentation results are not accurate. In this paper, homomorphic filtering technique has been used for the detection and analysis of the brain tumor and the area also has been calculated after the thresholding process.

The following paper is organized as follows. Section II discusses the background work done. Section III discusses the proposed work. Section IV illustrates the results and Section V puts forth the conclusion.

II. BACKGROUND

An image can be technically defined as a 2-D light intensity function. Generally, a digital image is in a matrix format, hence it is two-dimensional. In digital image processing, i.e. processing on the two-dimensional image, the pixels are operated on.

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Work on segmentation of the brain tumor MRI scan images have been done earlier. A semi-automated segmentation method has been proposed [1]. A computational algorithm for image decomposition employing “morphological filter reconstruction” has been proposed [2]. Even clustering method has been put forth in earlier works. K-means clustering technique has been used for tracking of tumor in MRI by using color-based segmentation method [3].

Calculation of the area of the brain tumor has also been done earlier, but in the prior work, high pass median filter has been used and thresholding has been followed by reconstruction based morphology [4]. Work on detection of range and shape of tumor has been discussed by using a combination of two algorithms [5].

The paper takes into consideration the above researches and conceptualizes an idea of calculation of the brain tumor area using a very simple algorithm using homomorphic filtering technique.

III. PROPOSED TECHNIQUE

Different techniques for analysis and detection have been discussed below. Fig. 1 and Fig. 2 show the block diagrams of the techniques for analysis of the brain tumor image and detection of the tumor respectively.

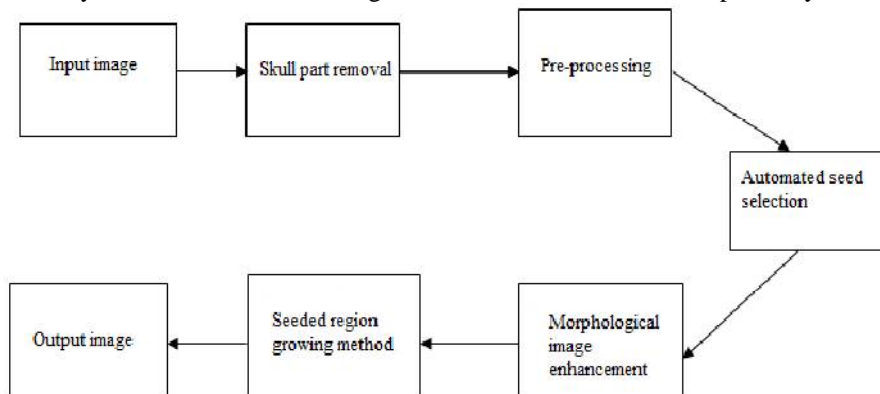


Fig. 1 Proposed Technique for analysis

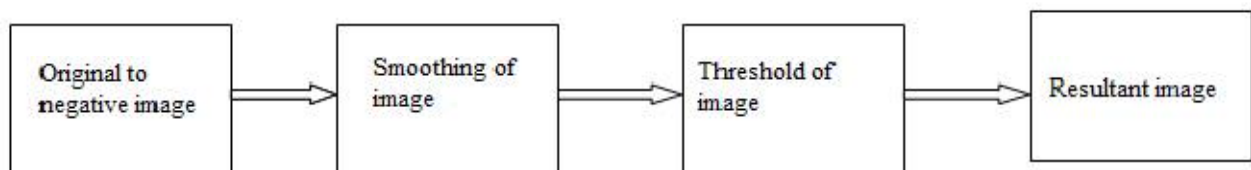


Fig. 2 Proposed Technique for detection

Skull part removal (a pre-processing step) is used so that seed selection would be simpler. Seed point selection is generally a problem because of the same intensities of the intracranial tissues and the non-cerebral tissues. For the stage of pre-processing, digital filters are used. The image obtained after the skull removal step is sent as an input for the next step of seed point selection. The next step is the morphological enhancement of the image. Morphological enhancement can be done using built-in functions of MATLAB (erosion and dilation).

For the detection of tumor, the first step is negative of the image. Fig. 3 shows the original MRI scan image and the negated image.

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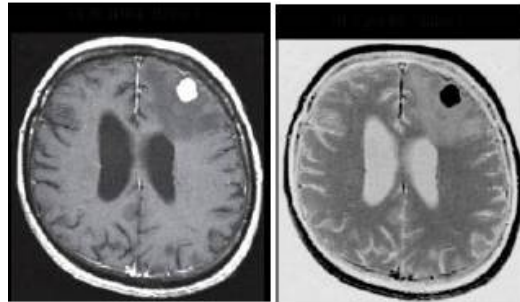


Fig. 3 Original MRI scanned Image and Negative of Image

Smoothing is the next step and smoothing is done for highlighting the fine details in an image or for the enhancement of the blurred details of the image. For smoothing, homomorphic filtering has been used in this paper. With the help of homomorphic filtering, illumination of all kinds present in the image can be filtered.

On the basis of research done on comparison of filters to be used in the smoothing process, it has been found that homomorphic filtering gives the best results. Other filters taken into consideration were the mean filter, median filter and the high-boost filter. The results obtained from the different filtering techniques are shown in Fig. 4.

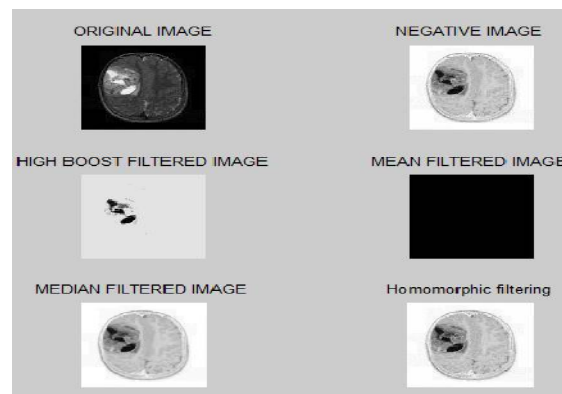


Fig. 4 Images from different filtering techniques

For area calculation of the tumor, it is essential that the tumor area desired to be calculated is properly defined. Keeping this in view, edge detection procedures (Laplacian of Gaussian and Sobel edge) have been used.

The homomorphic filtered image was taken as an input for the edge detection procedures. The results obtained did not properly define the area. Several specks were also obtained in the image.

With the aim of achieving better results than the results obtained by edge detection procedures, the homomorphic filtered image was thresholded. Thresholding of an image refers to assigning „0“ to values below a certain threshold value. The threshold value is considered amidst the total pixel value.

Following the thresholding of the image, the negative of the output was done. The image obtained showed the well-defined area of the tumor. This tumor area was calculated.

IV.IMPLEMENTATION RESULTS

The proposed technique is implemented in MATLAB and a MRI scanned image has been considered as an input. The results obtained by implementing the described procedure are given below.

Fig. 5(a) shows the homomorphic filtered image. Fig. 5(b) shows the result obtained after the homomorphic filtered image has undergone Sobel Edge Detection procedure. Fig. 5(c) shows the output of the Laplacian of Gaussian (LOG) edge detection procedure.



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Fig. 5(a) Homomorphic filtered image



Fig. 5(b) Output of Sobel edge detection procedure

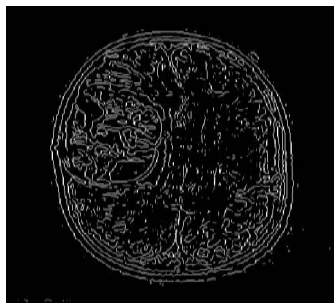


Fig. 5(c) Output of Laplacian of Gaussian edge detection procedure

As evident from the above output images, both the edge detection procedures give rise to specks in the image and the area of the tumor is not properly defined.

The homomorphic filtered image was thresholded and then the negative of the thresholded image was found. Fig. 6 shows the thresholded image and Fig. 7 shows the negative of the thresholded image. Negative of an image is found.

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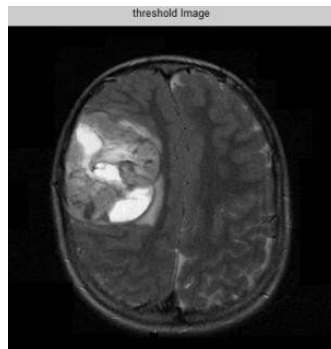


Fig. 6 Thresholded image of the homomorphic filtered image

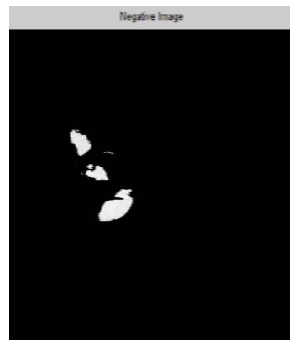


Fig. 7 Negative of the image obtained after thresholding

After obtaining the negative image, area was calculated and found to be 2036.5 pixels. Fig. 8 shows the obtained expression of the calculated area.

$$z = 2.0365e+003$$

Fig. 8 Obtained area (in MATLAB)

The tumor area is calculated with the help of binarization method. In this method, the image is assumed to have only two values, i.e. black (0) or white (1). Area of an image is represented in terms of pixels present in that area. This is calculated by multiplying the dimension of one pixel with the length unit.

V. CONCLUSION

In this study, a new approach of calculating the tumor area has been put forth. This approach is quite simple in comparison to the clustering technique. The output image obtained also was found to be better and more appropriate for area calculation. Homomorphic filtering was used in the smoothing procedure of the tumor detection technique. In comparison to the edge detection techniques, the thresholded and negated image of the homomorphic filtered image was found to be clear. This directs to a better compression as only the region of interest is saved and displayed. The proposed method would serve helpful to doctors and medical professionals as it not only would identify the location of the tumor but also would specify the area affected by the tumor, or the area through which the tumor has spread.



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