

Noise Removal from Brain Image using Region Filling Technique

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Abstract: In today's world, one of the reasons for the rise of mortality among the people is brain cancer. Brain tumour is the main cause of brain cancer. A tumour can be defined as any mass caused by abnormal or uncontrolled growth of cells. This mass of tumour grows within the skull, due to which normal brain activity is hampered. Which is if not detected in earlier stage, can take away the person's life. Hence, it is very important to detect the brain tumour as early as possible. For detection of brain tumour, first we have to read the MRI image of brain and then we can apply segmentation on the image. But in the MRI brain image, some confidential information of patient's is always there. To apply segmentation, this unnecessary information has to be removed, as it can be considered as noise. Here we present an efficient method for removing noise from the MRI image of brain using Region filling method.

Keywords: Brain tumor, Noise, Filtering, Region of Interest, Region Filling.

1. INTRODUCTION

Brain cancer is one of the leading causes of death in the world now days. An uncontrolled growth of cancer cells in the brain leads to brain cancer, which is a very serious type of malignancy. A malignant brain tumour is the main cause of brain cancer. All brain tumours are not malignant, some are benign also. Brain cancer is also called glioma and meningioma [1].

According to the National Brain Tumour Society, US, over 600,000 people are living with the primary brain tumour. Among these 600,000 people, 28,000 are children under the age of 20. Metastatic brain tumours (cancer that spreads from other parts of the body to the brain) are the most common type of brain tumour, which is the reason of cancer for 20% to 40% of persons. Over 7% of all the primary brain tumours reported in the United States are diagnosed among children under the age of 20. 210,000 people in the United States are diagnosed with a primary or metastatic brain tumour every year i.e. over 575 people a day.

In general, the risk of developing a malignant CNS or brain tumour over the course of one's lifetime is less than 1%. But the risk increases with the age. 4.5 per 100,000 persons under

the age of 20 will be diagnosed with a malignant brain tumour. After the age of 75, this rate rises to 57 per 100,000 persons. Among the people over the age of 85, the risk stops increasing. The risk for developing brain cancer is very high among the people with a family history of brain cancer and those who had radiation therapy of the head.

2. RELATED WORKS IN NOISE REMOVAL

T. Logeswari and M. Karnan [1] applied weighted median filter for removing the noise presented in the MRI image of the brain. Weighted median filter is a type of nonlinear filters. It retains the robustness and edge preserving capacity of the image. Dr. Samir Kumar Bandyopadhyay [3] removed noise based on Maximum Difference Threshold value, which is constant threshold value determined by observation. Pratibha Sharma and co-authors [4] applied spatial noise filter for removing noise from the MRI image of a brain. Sudipta Roy, Samir K. Bandyopadhyay [5] first used high pass filter and then finally used median filter for removing noise. Here a high pass filter is used in matlab, by which each pixel of the image is replaced by weighted average of the surrounding pixels. Then merging of gray scale image and filtered image is done for enhancing the image quality. Median filter is applied to the enhanced image. High pass filter is used by Rajesh C. Patil, Dr. A. S. Bhalchandra [6] for removing noise and then they applied median filter to enhance the quality of the image.

Noise removal has to be done in such a way that it should not affect the portion of the brain in the image as each portion is the most important part to detect the tumor. Hence noise removal should not blur the image.

3. NOISE AND MEDICAL IMAGE

"Noise" originally means "unwanted signal" i.e. noise represents unwanted information which deteriorates image quality. The process which affects the acquired image and is not part of the scene can be defined as noise. A random variation of brightness or color information in images can also be termed as noise [10].

Noise can be produced by the sensor and circuitry of a scanner or digital camera. The acquisition process for digital images converts optical signals into electrical signals and then into digital signals and is one of the processes by which the noise is introduced in digital images. Each step in the conversion process experiences fluctuations, caused by natural phenomena, and each of these steps adds a random value to the resulting intensity of a given pixel. MRI scan image of a brain usually contains the patient's information. This image also contains the information about the institute where this test was done and the machine used. All these information are required to identify the patient and institute, but this information are not helpful to detect the presence of tumour in the brain. So these are unwanted information which can be termed as noise. For further processing of detecting the tumour, this noise needs to be removed.

4. NOISE REMOVAL USING FILTERING

To modify an image in some way which includes blurring, deblurring, locating certain features within an image etc. filtering is used. A filter is basically an algorithm for modifying a pixel value, over original value of the pixel and the values of the pixels surrounding it. There are literally hundreds of types of filters that are used in image processing. Among all the filtering techniques, common ones are:

- Gaussian Filter or Gaussian smoothing
- Mean Filter
- Median Filter

Blurring an image using Gaussian function can be known as **Gaussian Filter** or **Gaussian Smoothing**. It is a widely used effect to reduce image noise and reduce details. [11].

Gaussian filtering is used to blur images and remove noise and detail. It is not particularly effective at removing salt and pepper noise. The Gaussian filters works by using the 2D distribution as a point-spread function. This achieved by convolving the 2D Gaussian distribution function with the image. We need to produce a discrete approximation to the Gaussian function. This theoretically requires an infinitely large convolution kernel, as the Gaussian distribution is non – zero everywhere.

A **Mean Filter** is a filter that takes the average of the current pixel and its neighbors. The average of intensity values in an $m \times n$ region of each pixel (usually $m = n$) is taken. In mean filter average (mean) of all the pixel values in the window replace the center values in the window.

Median Filters are some nonlinear neighborhood operations that can be performed for the purpose of noise reduction that can do a better job of preserving edges than simple smoothing filters. A median filter is almost similar to an averaging filter. The averaging filter examines the pixel of the required area and its neighbor's pixel values and returns the mean of these

pixel values and the median filter looks at this same neighborhood of pixels, but returns the median value. Thus noise can be removed, without blurring the edges much.[5]

5. REGION FILLING METHOD

Sometimes it is required to process a single sub region of an image, leaving other regions unchanged. This is commonly referred to as region-of-interest (ROI) processing. Many operations that support an ROI can execute considerably faster when the ROI is used to define a region that is much smaller than the full image. ROI is completely random i.e. it may be defined by any set of image pixels. In particular, the ROI does not have to be rectangular or connected. It may consist of one or more separate regions. A process that fills a region of interest (ROI) by interposing the pixel values from the boundaries of the region is known as Region Filling. This process can be used to make objects in an image seem to evaporate as they are replaced with values that blend in with the background area.

Filling of a region is useful for removal of superfluous facts or substances of a binary image. Region filling can be performed using an interpolation method based on Laplace's equation which results in the smoothest possible fill specified the values on the boundary of the region.

6. PROPOSED METHOD

These are the following steps involve for the region filling process:

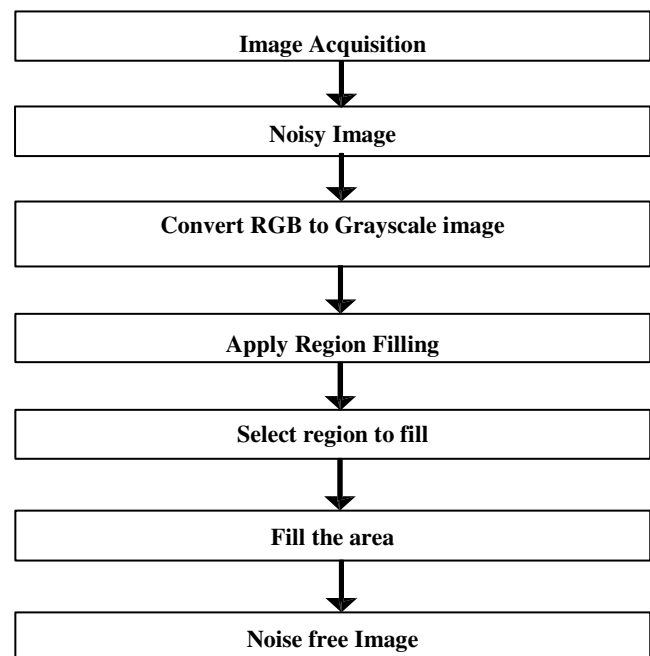


Fig 6.2: Flow of the proposed method

The action of retrieving an image from some source, usually a hardware based source is known as image acquisition [2]. In image acquisition the image can be passed through whatever processes need to modify it or to collect the extract information from it. Here images are obtained from MRI Scan of brain. Different formats like jpg, png etc. are used for storing the digital images obtained from MRI of a brain. These images are stored in matrix form in matlab. MRI Scan images may be in RGB form. In that case, we have to convert this RGB images into grayscale (a grayscale or a grayscale digital image is an image in which the value of each pixel is a single sample, that is, it carries only intensity information) images. After converting RGB image to grayscale image, region filling will be applied on the grayscale image. Here we have to select the area for applying region filling.

After selecting the desired area, the region filling technique is applied for eliminating the noise or for removal of the entire artifact from the image.



Fig 6.1 (a): Grayscale image of MRI of a brain

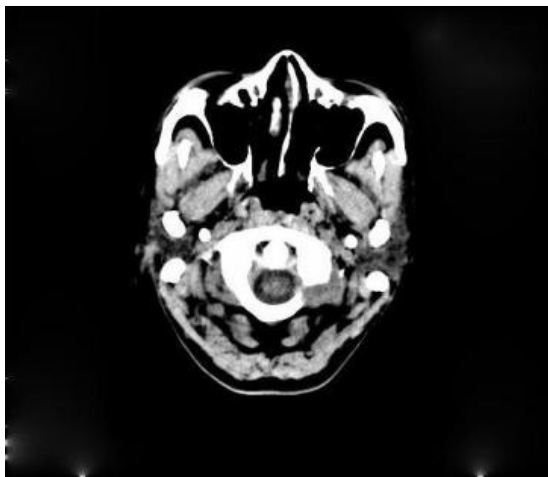


Fig 6.1 (b): Image after applying region filling



Fig 7.1 (a): Gaussian filter

This can be passed through any other required process. The output of region filling is shown in fig 7.2. Here with this method noise is removing completely without affecting other portion of image.

7. RESULT ANALYSIS

Different filtering viz Gaussian filter, Averaging filter, Median filter can be applied to a gray scale image of MRI. Results of different filtering are as shown in the figure above.

We can see that Gaussian filter and averaging filter cannot remove the noise from the image whereas median filter removes the noise partially but not completely. Median filter also blurs the image.



Fig 7.1 (b): Averaging filter

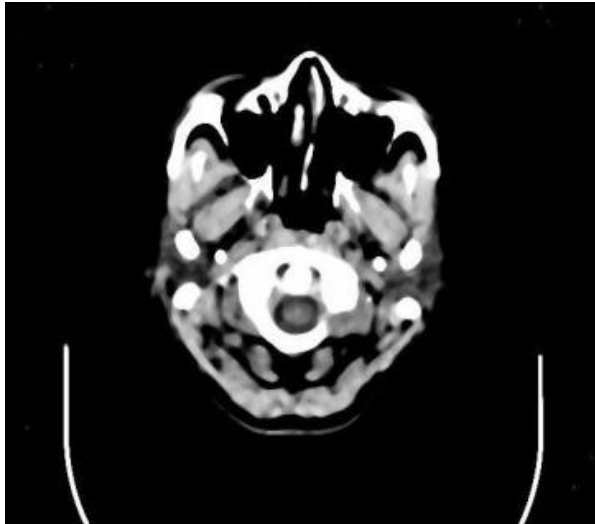


Fig 7.1 (c): Median filter

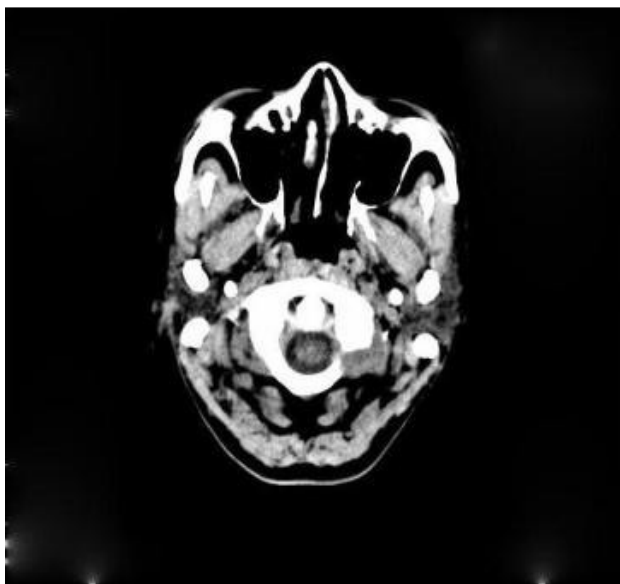


Fig 7.2: Region filling

We need a method which can remove the noise without effecting the main portion of the brain image. After applying region filling method the noise is remove completely without affecting the main portion of image. The above figure 7.2 shown after applying the region filing technique .

Histogram of the images can be used to show the improvement between the original image, median filtered image and image after applying region filling.

From the above analysis it can be seen that, region filling method is more precise for removing noise from an MRI image of the brain image.

Modification of the image after applying region filling can be shown by the histogram of the image before and after filling.

Histograms of the different images are given below:

a. Histogram of the original image

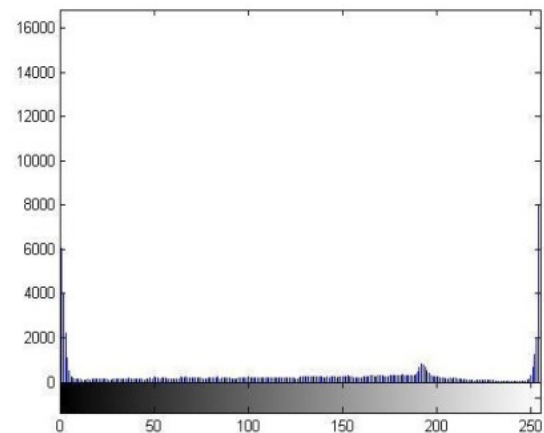


Fig 7.3(a): Histogram of the original image

b. Histogram of the image after applying region filling

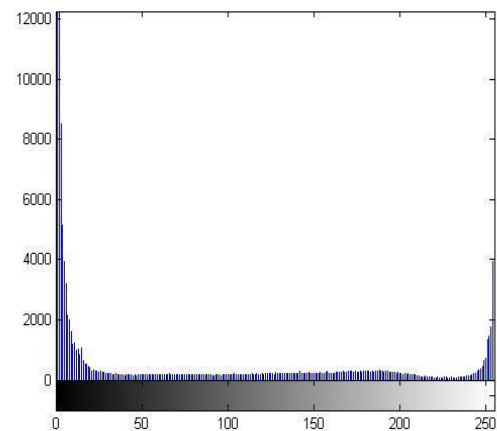


Fig 7.3(b): Histogram of the image after applying region filling

The improvement of the image after applying region filling can be seen in Fig 7.3(a) and Fig 7.3(b). The horizontal axis of both the graphs represents the tonal variation, while the number of pixels in that particular tone is represented by the vertical axis of the graph. The left side of the horizontal axis represents the black and dark areas, the middle represents medium grey and the right hand side represents light and pure white areas. The vertical axis represents the size of the area that is captured in each one of these zones.

8. CONCLUSION

Noise removal is one of the very important step for detecting brain tumour. For this reason, noise removal should be precise. Filtering may remove the noise from the image, but it also blurs the portion of the brain in the image. Region filling can do the work pleasantly without affecting the portion of the brain in the image. When the noise is removed from the MRI image, we can proceed further for the detection of the tumor in the brain. For applying this method, the selection of region of interest should be accurate. So selection of region should be done carefully. The only flaw of this method is that, it requires user interaction, which consists of determining the Region of Interest. The time required for applying this method is little more than that required for the filtering. In future, the time constraint should be improved for this method.

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