CONTRAST ENHANCEMENT IMPACT ON DETECTION OF TUMOR IN BRAIN MRI

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ABSTRACT- *Medical image processing has become one the most difficult fields these days and it is enjoying extensive research focus from past few decades. Contrast enhancement is an intriguing area in image processing; it enhances the nature of an image. Contrast enhancement is purely a subjective concept and it is difficult to judge performance of each technique visually. One method may look good to one individual but may not look awesome to someone else. Thus, the performance criteria of every technique should be judged from machine discernment. In this paper, different contrast enhancement techniques are discussed and compared on the basis of their histograms, entropy, area and time calculation. At this stage, the most important factor is area, the technique that helped in the detection of tumor with maximum area. The proposed methodology was applied on different MRI slices of brain for different patients and results were compared and it also helped in minimizing major problem of over-segmentation in watershed algorithm. The results exhibit an interesting mixture of numbers that helped in tuning overall performance of the process.*

Keywords— area, brain, filtering, contrast enhancement, image processing, MRI, segmentation, tumor, watershed

I- INTRODUCTION

Contrast enhancement is a critical step towards thresholding and segmentation that helps in the enhancement of hidden features in an image. By carefully choosing the contrast enhancement technique, quality of image can be improved to acquire desired output.

Brain tumor should be detected accurately during early stages as it is a life threatening disease. There are many scanning techniques but MRI is most efficient in case of brain scan. It helps in viewing maximum detail of the disease and does not influence human body because no radiations are used in MRI. From past few decades, researchers have been developing new methodologies to detect brain tumor [1-4]. Medical science is also trying to develop strategies to detect tumor before it starts its development. There are many methods for detecting brain tumor, each with its own advantages and disadvantages. In this paper, a new methodology is proposed that helps in accurate detection of tumor alongside over-segmentation minimization in watershed. Segmentation is an important aspect in image processing. It helps in the manipulation and visualization of data with computer and separating different regions from one another in an image. For the effective segmentation of an image, it is critical to improve quality of image. Contrast enhancement makes it easy to do further analysis on image by removing unwanted noise, sharpening, brightening or enhancing hidden features. There are many contrast enhancement technique in image processing. Some of these are contrast stretching, contrast limited adaptive histogram equalization (CLAHE), histogram equalization, power law transformation, decorrelation stretching and many more. Every technique has some pros and cons.

In histogram equalization, the intensities are stretched out and distributed on the image by increasing the global contrast and enhancing low contrast areas [5,6].

CLAHE plays an important role in enhancing the contrast of low quality images having low contrast and it was originally developed for medical images. It works in such a way that an image in partitioned into small regions and histogram equalization is applied to each region with a clip limit, thus making hidden features of the image more visible [7,8].

Logarithmic transformation maps input values to output values, compressing the higher values and expanding the values of dark pixels [9].

Local enhancement is used to enhance small area features in an image. This method involves repeated computation of histogram over all pixels and it is a time consuming process [7].

Contrast stretching increases the dynamic range of gray levels in an image and it is one of the simplest technique for enhancing contrast [10].

Decorrelation stretching is used to highlight contrasts in an image that are excessively unpretentious for a human, making it impossible to see. Normally, this technique is used for color images [11] but in this paper it is tested on different MRI's of brain and results were observed.

In this paper, different contrast enhancement techniques are compared that helps in accurate detection of tumor in MRI of brain. These methods are compared on the basis of entropy, area calculation, time consumption and histograms. After converting input image to grayscale, filtering is performed. Here, a low pass filter is used followed by filtering and contrast enhancement to enhance hidden features of interest. After that, thresholding along with some morphological operations are performed to remove unwanted background and afterward watershed segmentation is applied to segment the image and detect tumor.

II- PROPOSED METHODOLOGY

The algorithm involves three stages. The initial stage is pre-processing and in second stage, thresholding is performed and final stage is segmentation of image. The flow chart of algorithm is shown below.

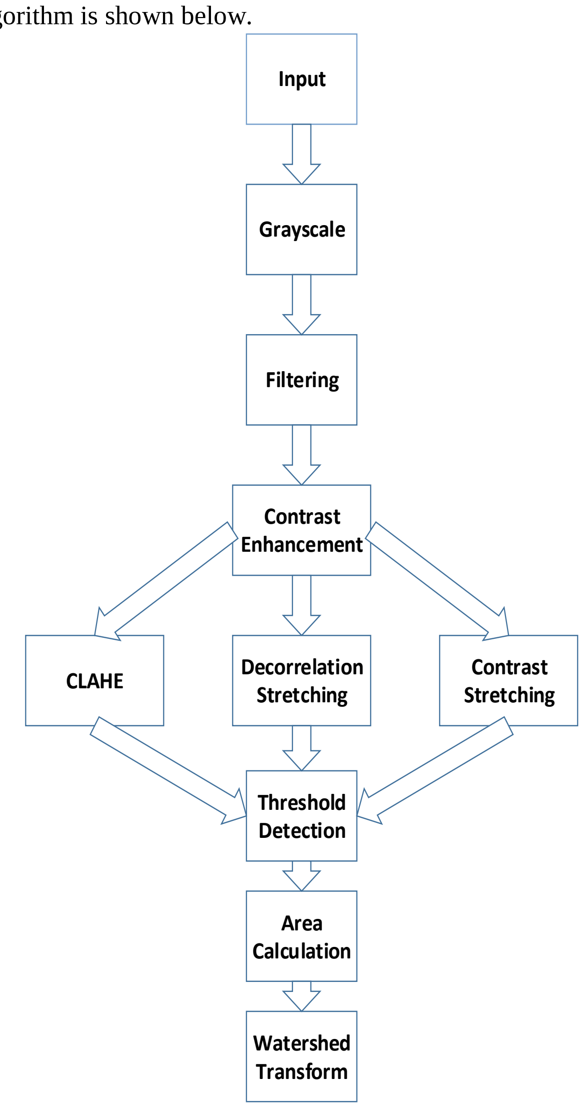

Figure 1-flow chart

Each step is explained next.

Grayscale

First, input image is converted to grayscale to make further pre-processing easier.

Filtering

In image processing, filtering is an important technique as it is used to attain many objectives like noise reduction, interpolation, feature extraction and interpolation etc. Now it depends on the nature of the experiment that which filtering technique should be applied on given information. In some cases where image has low noise and high magnitude, high pass filter may be used but in cases where noise is high but magnitude is low then may be a low pass filter is more suitable.

Contrast Enhancement

Contrast enhancement improves the image quality by enhancing hidden information and gives output image with better quality than input image.

In this paper, different contrast enhancement techniques are discussed and compared on the basis of histograms, entropy, and area and time calculation.

In image processing, the entropy level tells the amount of information present in an image. Higher entropy value means more information and lower value means less information present but again, this is a subjective concept. It depends on the type of experiment whether lower entropy is desirable or higher. In this case, lower value is desirable as the objective is to get output image with only tumor region with maximum area.

The entropy of CLAHE came out to be 7.17 that is maximum among entropy values calculated for other methods. Contrast stretching and decorrelation stretching has almost same values of entropy and area calculation. Although, CLAHE has maximum entropy but it lags in case of area calculation. The most important factor while detecting tumor is the area coverage. As the goal is to detect tumor with maximum area, so in this case, our choice would be the one covering maximum area of tumor. It can be seen from table 1 that decorrelation stretching covers maximum tumor area. The histograms of all three techniques are shown in fig 2.

Keeping time calculation under consideration, contrast stretching took minimum time to run complete algorithm using single MRI slice. Whereas, CLAHE took maximum time to do processing on one slice. At this stage, decorrelation stretching exhibits efficient combination of numbers and histogram. So, among all techniques discussed, decorrelation is the most suitable.

Table 1-comparison of different techniques

CE technique	Entropy	Area (cm^2)	Time (sec)
CLAHE	7.17	2.79	2.74
Decorrelation stretching	5.88	2.86	2.73
Contrast stretching	5.86	2.83	2.47

Threshold detection

Threshold detection converts grayscale image to binary image. Global threshold detection is used here with threshold value of 128. All pixels below 128 were converted to black and all pixels above 128 were converted to white.

Watershed

Image segmentation helps in separating background objects from foreground and each other. It is one of the most difficult tasks in image processing. The success or failure of image analysis procedure depends on segmentation accuracy and that accuracy depends on pre-processing steps. Besides detecting tumor, the proposed algorithm also minimized major problem faced in watershed segmentation, the problem of over-segmentation. By using this methodology, there is no need to use complex methods along with watershed like Marker Controlled or Meyer's Flooding method, that help in avoiding problem of over-segmentation [12,13].

III- RESULTS

Figure 2 shows histograms of CLAHE, decorrelation stretching and contrast stretching. Fig 2b shows the histogram of decorrelation stretching, it can be seen that it has maximum information in brighter area. Fig 2c shows histogram of contrast stretching and some information is lost in this case.

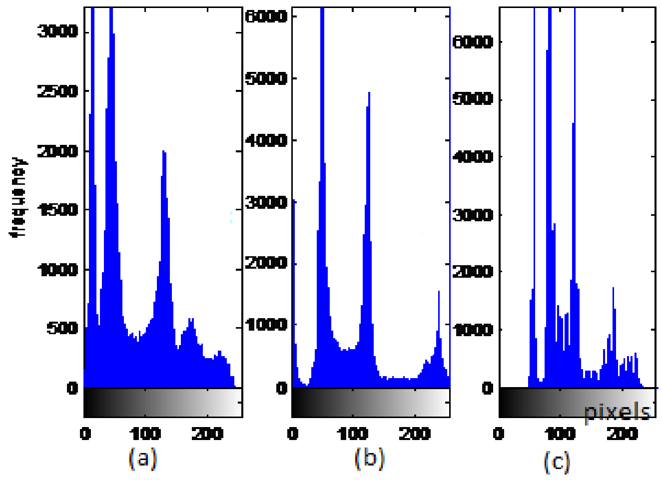

Figure 2-Histogram Comparison

(a) CLAHE (b) Decorrelation Stretching (c) Contrast Stretching

Figure 3 shows results after applying watershed algorithm and it can be seen that over-segmentation is minimized completely.

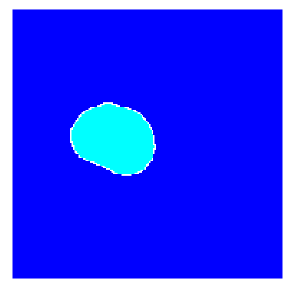

Figure 3-watershed transform

Figure 4 shows the detection of tumor. Fig 4a shows input image and 4b shows output image in which the tumor is detected.

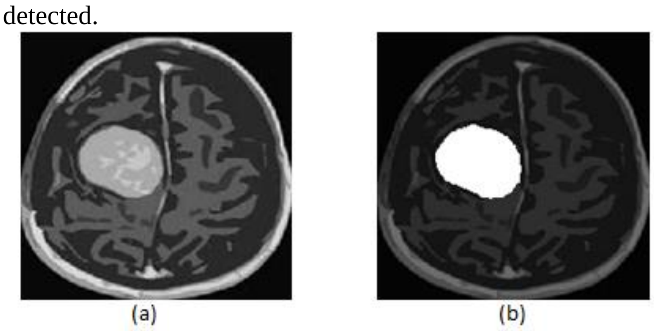

Figure 4-final output

(a) input image (b) tumor detected

Figure 5 shows another axial MRI slice of brain. Fig 5a shows input image and 5b shows output image in which the tumor is detected.

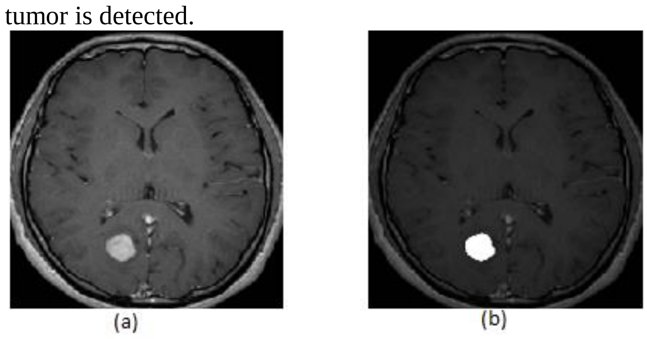

Figure 5-final output

(a) input image (b) tumor detected

IV- CONCLUSION

The results show successful detection of tumor with maximum area in different slices of brain employing decorrelation stretching in all cases. The results also show that major problem of over-segmentation is minimized in watershed algorithm. Future work can be done to work on multiple slices together and visualizing tumor in 3D along with volume calculation.

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