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Quadrants Dynamic Histogram Equlization Based Contrast Enhancement with Median Filtering

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Abstract— Low contrast image is a challenging problem in image processing field especially in medical image processing. It reduces the obsever visualization power of an image. The best method for enhancing the contrast of an image is Histogram Equlization . Using this technique we can find the exact location of cancerous region or any other abnormalities. Dyanamic Histogram Equlization takes control over traditional Histogram Equlization for appropriate contrast enhancement of image without introducing any severe side effects. "Quadrants Dynamic Histogram Equlization Based Contrast Enhancement with Median Filtering" is proposed in this paper, which enhances the contrast of the medical image . Mainly this process contains two steps, first one is QDHE, which enhances the contrast of the image and also reduces the possibilty of low histogram components to be compressed. The second step is a Median Filtering for imge sharpening and noise removal.

Keywords— Medical image enhancement, Histogram equalization, Contrast enhancement, Median flitering, Quadrants Dynamic Histogram Equalization.

I. INTRODUCTION

Image enhancement is the process of changing the pixels' intensity of the input image, so that the output image subjectively look better [1]. Image enhancement improves the interpretability of information contained in image for human viewer.It produce a "better" input for different automated image processing system. Contrast enhancement can be achieved by stretching the dynamic range of important objects in an image. There are many algorithms for contrast enhancement [1]–[7] and among these, histogram equalization is the most common method used due to its simplicity and effectiveness.

Histogram equalization can be partitioned into two methods: global and local histogram equalization.In Global histogram equalization, transformation fucton is the histogram information of the whole input image . This transformation function stretches the contrast of the high histogram region and compresses the contrast of the low histogram region. Lost the lower and narrower histogram regions, such as the background. GHE cannot adapt to local brightness features of the input image. It uses only global histogram information over the whole image. Local histogram-equalization method has been developed for overcoming this limitation.

Several brightness preserving methods have been proposed. These enhancement methods can be classified into two categories partitioned histogram equalization (PHE) or dynamic partitioned histogram equalization (DPHE). The PHE and DPHE utilize histogram statistical information to separate the original histogram into several subhistograms. The difference between the DPHE and PHE is each subhistogram in the DPHE is assigned to a new enhanced dynamic range instead of using the original dynamic range. Kim [8] introduced PHE based methods is the mean brightness preserving bi-histogram equalization (BBHE). In BBHE, the original histogram is divided into two sub-histograms. Division is based on the mean brightness of the input image. Then HE for each sub-histogram. consequently, the mean brightness can be preserved thus the original mean brightness retained.

Wan et al. [9] proposed a bi histogram equalization, called the dualistic sub-image histogram equalization (DSIHE). The DSIHE algorithm separates the histogram into two sub-histograms with equal number of pixels. Median of the input image is the separating point.The bi-histogram equalization plateau limit (BHEPL) is proposed in [10] to control the enhancement rate of the BBHE. In general, the BBHE applies more stretching process to the contrast of high histogram regions and compresses the contrast of low histogram regions. This may cause intensity saturation as the intensities are squeezed in the low histogram regions. A clipping process is applied to each subhistogram of BBHE for intensity saturation problem. BBHE control the enhancement rate by setting the plateau limit as the average number of intensity occurrence. If the bins for any intensity exceed the plateau limit, those bins will be replaced by the level of plateau limit; otherwise remain the same as original bins of the input histogram. Final processe is HE of the clipped subhistograms. Then the resultant image will maintain the mean brightness of the original image without the problem of intensity saturation and over-enhancement.

II. HISTOGRAM EQUALIZATION

The histogram of an image is the graphical representation of an image. It gives the total description of the appearance of an image. Many contrast enhancement techniques based on histogram are existing. It improves the human visual perception of an image. Histogram equalization is the most common approach and a preprocessing technique to enhance contrast in all type of images. Equlization is Mapping from given intensity distribution to uniform intensity distribution . So the intensity values are spread over the whole range. Using this we can achieve close to equally distributed intensities in an output image. For this we consider an image as a 2 dimensional array of gray levels.

Let (i,j) be the element of the array is $X(i;j)$. Intencity of the pixels in an image ranges from 0 to (L-1) levels that is L discrete gray levels denoted by { $X_0, X_1, \ldots, X_{(L-1)}$ }.

$P[X_k]$ is probability mass function (PMF) of of gray level X k . PMF is defined as:

$$P[X_k] = \frac{n_k}{n}, k = 0, 1, \ldots, L-1. \qquad \text{(Equation 1)}$$

where nk be the number of pixel having intensity be the total number of pixels in image.

The cumulative distribution function (CDF) describes the probability that a real-valued random variable *X* with a given probability distribution will be found to have a value less than or equal to *x*. CDF) of X_k denoted by $C[X_k]$ and defined as

$$C[X_k] = p[X \le x] = \sum_{j=0}^{k} \frac{n_k}{n}, k = 0, 1, \ldots, L-1 \qquad \text{(Equation 2)}$$

Transform function for histogram equalization maps an input ... an output gray level $f(k)$, given as

$$f(X_k) = X_0 + (X_{L-1} - X_0)C[X_k], k = 0, 1, \ldots, L-1 \qquad \text{(Equation 3)}$$

III. QUADRANTS DYNAMIC HISTOGRAM EQULIZATION BASED CONTRAST ENHANCEMENT WITH MEDIAN FILTERING

This section describes the method – Quadrants Dynamic Histogram Equlization Based Contrast Enhancement with Median Filtering. Mainly this method is two step process. First step is global contrast of image is enhanced using QDHE[10] followed by histogram equalization. Second step is image sharpening using median filtering. Finally image normalization.

A. Step 1:QDHE

It is a four step processe, namely the histogram partitioning, clipping, gray level range allocation and histogram equalization.

1)Histogram Partitioning

In DHE and BPDHE, separating point is based on local minima and maxima and it is falsely detected due to the noisy input histogram,. A smoothing filter is first applied before partitioning the histogram. So that in QDHE uses the median intensity value of the input image histogram for partitioning histogram of the original image.The medians from the two partitioned sub-histograms are used as separating points to further division. It divides the two sub-histograms into two smaller sub-histograms each. Thus, four sub-histograms obtained. Then, the minimum and maximum intensity values of the input histogram are set as the separating points.

2)Clipping Process

The clipping process is to control the enhancement rate of HE in order to overcome unnatural and over-enhancement of the processed image to occur. Locate median value of the non-empty bins as the clipping threshold Tc . However, in order to reduce the computational complexity, Tc is replaced by the average of the number of intensity in the QDHE. Then, bins with higher value than the threshold value are replaced by the threshold value itself.

3)New Gray Level Range Allocation

To balance the enhancement space for each subhistogram QDHE allocates a new gray level dynamic range based on the ratio of gray level spans and total number of pixels for each sub-histogram.Mathematically, it is described as follows:

$$span_i = m_{i+1} - mi \qquad \text{(Equation 4)}$$

$$range_i = \frac{L - 1 * span_i}{\sum_{k=1}^{4} spanr_k} \qquad \text{(Equation 5)}$$

where $span_i$ is the dynamic gray level used by i-th sub-histogram in the input image. mi is the ith separating point and it gives the total number of pixels in ith sub-histogram. $range_i$ is given as the dynamic level range for i-th sub-histogram in the output image and r is the amount of emphasis given to m_i.

In the i-th subhistogram the new dynamic range is allocated from$[i_{start} i_{end}]$ defined by (6) and (7) respectively.

The first i_{start}value is initialized to the minimum intensity value of the new dynamic range.

Final step of QDHE is histogram equalization
.

B. Step 2: Median flitering

Enhancement in contrast also leads to enhancement of noise in some visually important areas, hence we are applying median filtering. It reduce the content of noise in histogram equalized image. Window slides, entry by entry, over the entire image. Window means pattern of neighbors. For images, more complex window patterns are possible . Note that if the window has an odd number of entries, then the median we can easily define: it is just find the middle value after all the entries in the window are sorted numerically. For an even numbes, more than one possible median is possible. When we compared median filter with linear filter , it can eliminate the effect of input noise values with extremely large magnitudes.

This filtering technique is one kind of smoothing technique, like linear Gaussian filtering. .Smoothing technique adversary affect the edges but it effectively remove noise in smooth patches or smooth regions of a signal. It reducing the noise in a signal, and it preserves the edges. Edges are of critical importance to the visual appearance of images, for example. For small to moderate levels of noise, the median filter is demonstrably better than Gaussian blur. However, its performance is n much better for speckle noise and salt and pepper noise (impulsive noise).

The median filter works by moving through the image pixel by pixel. Replacing each pixel value with the median value of neighbouring pixels. Window slides over the entire image. The median is calculated by first sorting all the pixel values from the window into numerical order, and then replacing the pixel being considered with the middle (median) pixel value.

C. Normalization

It is a process that changes the range of pixel intensity values. Applications include photographs with poor contrast due to glare, for example. Normalization is sometimes called contrast stretching or histogram stretching. In more general fields of data processing, such as digital image processing, it is referred to as dynamic range expansion.

Image normalization using the formula.

$$g(x,y) = (\frac{x_i}{x_o}) f(x,y) \qquad \text{(Equation 8)}$$

where x_i and x_o are mean brightness of input image and image produced after median filtering respectively.

IV. CONCLUSION

The QDHE with median filtering method provides optimum contrast enhancement while preserving the brightness of given medical image and it is suitable for all types of medical images. It is most robust method to extract the details of the low contrast medical images. With median fltering it reduces the over ehnacement and many types of noise.

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