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A Review on Image Enhancement Techniques using Modified Approach of Histogram Equalization

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ABSTRACT:Image enhancement in one among in image processing and it used to improvise image visibility. Contrast is an important feature in an image and it should be in balanced & equally distributed throughout the image. Contrast enhancement is one of the image enhancement operation and it is used regularize the contrast of an image. Histogram equalization is traditional approach in contrast enhancement technique. Even though Histogram equalization is traditional one and it has been modified by many researchers in current years and produced good results in contrast enhancement. In this paper various type of modified histogram of recent years are discussed with it features.

INTRODUCTION:

Image enhancement is a process involving changing the pixels' intensity of the input image, so that the output image should subjectively looks better. The purpose of image enhancement is to improve the interpretability or perception of information contained in the image for human viewers, or to provide a "better" input for other automated image processing systems. There are many image enhancement methods have been proposed. A very popular technique for image enhancement is histogram equalization (HE). This technique is commonly employed for image enhancement because of its simplicity and comparatively better performance on almost all types of images. The operation of HE is performed by remapping the gray levels of the image based on the probability distribution of the input gray levels. It flattens and stretches the dynamic range of the image's histogram and resulting in overall contrast enhancement Contrast enhancement plays an important role in the field of image processing applications. The objective of this method is to make an image clearly recognized for a specific application. One of the most popular contrast enhancement methods is histogram equalization (HE). The mechanism of HE is to transform the gray levels of an image to a uniform histogram based on the probability of occurrence of gray levels in an input image. In general, HE will flatten out the probability distribution of an image and increase its dynamical range. However, the effectiveness of HE depends on the contrast of the original image. The lower the contrast, the more the effectiveness is. Since its simplicity and ease to implement, it is usually applied in many areas including medical image processing, texture synthesis, and speech recognition. Histogram equalization is a well-known contrast enhancement technique due to its strong performance on almost all types of image. Generally, histogram equalization can be categorized into two main processes: global histogram equalization (GHE) and local histogram equalization (LHE). In GHE, the histogram of the whole input image is used to compute a histogram transformation function. As result, the dynamic range of the image histogram is flattened and stretched, and the overall contrast is improved. The computational complexity of GHE is comparatively low, making GHE an attractive tool in many contrast-enhancement applications. The major drawbacks of GHE are that it cannot adapt the local information of the image and preserve the brightness of the original image. In contrast, LHE uses a sliding window method, in which local histograms are computed from the windowed neighborhood to produce a local intensities remapping for each pixel. The intensity of the pixel at the center of the neighborhood is changed according to the local intensity remapping for that pixel. LHE is capable of producing great contrast results but is sometimes thought to over-enhance images. It also requires more computation than other methods because a local histogram must be built and processed for every image pixel.

1)BRIGHTNESS PRESERVING DYNAMIC HISTOGRAM EQUALIZATION (BPDHE):

Brightness preserving dynamic histogram equalization (BPDHE) which is proposed in this paper consists of five steps:

1. Smooth the histogram with Gaussian filter.
2. Detection of the location of local maximums from the smoothed histogram.
3. Map each partition into a new dynamic range.
4. Equalize each partition independently.
5. Normalize the image brightness.

The details of each step are described in the following subsections.

A. Smooth the histogram with Gaussian filter.

Because the histogram of the digital image is normally fluctuated and also the probability for some brightness levels is missing, it is difficult to detect the local maximums of the histogram without smoothing the histogram. In this step, first, the disappeared brightness level is filled up by using the linear interpolation. Then, the histogram is smoothed up by using one dimensional Gaussian filter. The Gaussian filter is defined by the following equation:

$$G(x) = \exp(-x^2/2\sigma^2)$$

B. Detection of the location of local maximums from the smoothed histogram.

The smoothed histogram is only used in the process of splitting the original histogram. The histogram is divided into sub-histograms based on local maximums. We choose to use local maximums as the separating intensities rather than local minimums because this selection is better in maintaining the mean brightness.

C.Map each partition into a new dynamic range.

However, the equalized version of these sub-histograms does not assure a very good enhancement, because sub-histograms with small range will not be enhanced significantly by HE. Hence, following the same concept as DHE, BPDHE spans each sub-histogram first before the equalizations are taking place. Let the range of the output sub-histogram i is [starti, endi]. If we set the first sub-histogram of the output image is in the range of [0, range1], then the starti and endi (for i> 1) can be calculated as follow:

$$start_i=\sum_{k=1}^{i-1} range_k+1$$
$$end_i=\sum_{k=1}^{i} range_k$$

D. Equalize each partition independently.

The next step in BPDHE is to equalize each partition independently. For sub-histogram i with the range of [starti,endi], the equalization of this section

E. Normalize the image brightness.

In this step, the mean brightness of the input, Mi, and the mean brightness of the output obtained after the equalization process, Mo, is calculated. In order to shift back the mean brightness to the mean brightness of the input.

$$g(x,y)=(M_i/M_o)f(x,y)$$

2) BRIGHTNESS PRESERVING WEIGHT CLUSTERING HISTOGRAM EQUALIZATION

Here, we introduce the proposed BPWCHE method. When generating the initial clusters from the original histogram, we assign each non-zero bin to a unique cluster. To reduce the number of clusters, we merge neighboring clusters in the original image histogram according to three criteria: cluster weight, cluster weight ratio, and cluster width of two neighboring clusters. The cluster weight criterion (W%) utilizes the percentage of the total weight of the entire original image histogram that is occupied by the current cluster. The main role of this criterion is to avoid the effects of bins of disparate weights. When the histogram has few large bins that contain most of the information in the input image, previous methods fail to enhance visualization of the image. For instance, GHE, DSIHE, and BPDHE have a washed-out appearance in some images. The cluster-weight criterion enables us to avoid this pitfall. In our algorithm, we chose a cluster weight of W=5. Two neighboring bins the weights of which sum to less than W can be merged into one cluster. The cluster weight ratio criterion (R) expresses the degree of similarity between two neighboring clusters with respect to cluster weight. We chose R to be in the interval [R1, R2] (where R1== 40:60 =0.67 and R2= 60:40 =1.5). If two neighboring clusters have widely differing weights, they are not merged because these clusters may contain different visual information in the image. The cluster width criterion (T) describes the degree to which the gray levels of two neighboring clusters are similar. When the cluster width and

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cluster weight criteria for two neighboring clusters are less than T and W, respectively, these clusters are merged into one cluster without considering the criterion R. We have chosen T=3 because we assume that three adjacent intensities will be perceived similarly by the human eye.

Basic BPWCHE

a)The basic steps in the new method are explained below.

Let the original image have dimensions N by M on the grayscale [0, L-1] and let Hn(k) denote the histogram of the original image. To perform histogram weight clustering, we first assume that each non-zero bin is assigned to a unique cluster. Let the i-th non-zero bin be assigned to a cluster Cn(i) and its corresponding weight be Wn(i), where n is the total number of non-zero bins.

b) We then merge each pair of neighboring clusters when the sum of their cluster weights is less than W, and when the weight ratio, R1, R2, is in the interval [0.67, 1.5]. If the j-th cluster satisfies above criteria.the merge will be executed as follows:

$$R1=Cn(i)/Cn(i-1) \text{ or } R2=Cn(i-1)/Cn(i)$$

c) Next, if the sum of the widths of two neighboring clusters is less than T and the sum of their weights is less than W, we then merge these clusters into one cluster without considering the criterion R. These clusters will be merged as in formulas (2) and (3). After the above steps, we have m clusters found using three criteria. The main concept of the proposed BPWCHE method is that all created clusters, m, should play equal roles, which means that the result image histogram is divided equally into m partitions between First bin and Last bin, which contain the lowest and highest intensities of the input image, respectively. Next, we will compute the number of bins to be occupied by one cluster in the partition of the result image histogram. The essential idea is that all clusters, m, occupy the same partition in result image histogram.

$$PSize = \text{integer } [(Lastbin+1-Firstbin)/m]$$

$$Em(i)=PSize$$

$$D = (Lastbin+1-Firstbin) - m*PSize$$

whereEm(i) is the number of bins in the corresponding partition of the result image histogram, for the i-th cluster, and D is the remainder from (4). If D is nonzero, then it is necessary to alter Em(i) for each cluster. To do this, we sort Em(i) by the weights of the corresponding clusters from largest to smallest, and then to the largest Em(i), for i from 1 to D, we add one bin each. Thus, the sum of Em(i) is fixed when D is nonzero.

d)Finally, we create the transformation function.

$$T(x)=start_i+(end_i+start_i)\sum_{k=start}^{x} nk/m$$

wherenk is number of pixels with intensity k, and M is the total number of pixels contained in that partition.

3) IMAGE CONTRAST ENHANCEMENT USING A MODIFIED HISTOGRAM EQUALIZATION

The histogram equalization is the basic technology in image processing, which is widely used to increase the integral contrast of the image and is characterized by high efficiency. However, known techniques of histogram equalization have a number of disadvantages, the major one of which is a decrease in the contrast of small objects in the image. To address this disadvantage, a new technique of modified histogram equalization is proposed based on the assessment of the two-dimensional probability distribution of brightness in the image. A new method of increasing the contrast of the image based on the modified equalization of histogram is also proposed. The proposed technique of modified histogram equalization can be recommended to increase the image contrast in automatic mode in imaging and image processing.

The methods of image enhancement by histogram transformation are widely used for images processing to increase their integral contrast and are characterized by high efficiency. The techniques of image processing by histogram equalization provide the most effective enhancement of image contrast and are widely used to improve the image quality. At present, histogram equalization is the basic technique of image enhancement. However, known techniques of histogram equalization have a number of disadvantages that substantially limit their practical use in the automatic mode. The main disadvantages of the known methods of image enhancement by histogram equalization are an overly increase in the contrast of large-sized objects in the image. The efficiency of techniques of linear stretching (1), nonlinear stretching using the sigmoid function (3) and gamma correction (4) for images enhancement depends significantly on the distribution of image brightness and the values of parameters of the

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transformation function which significantly limits the use of these methods. The use of modified equalization of histogram based on the assessment of the two-dimensional probability distribution of brightness allows increasing the efficiency of contrast enhancement.The proposed method for image processing by modified equalization of histogram increases the contrast of small sized objects and the integral contrast for all test images. At present, the solution of the task of enhancement of image quality with an acceptable level of computational costs is urgent as never before. The histogram equalization is currently the basic technique of image processing. The technique of histogram equalization and its modifications are widely used for images processing to increase image contrast and are characterized by high efficiency. Histogram equalization techniques provide an effective increase of the generalized contrast and enhance the objective quality of the image. However, known techniques of histogram equalization have a number of disadvantages that limit their use for image processing in the automatic mode. Their main disadvantages are an overly increase in the contrast of large-sized objects and also a decrease in the contrast of small-sized objects in the image. To address these disadvantages, a new technique of modified histogram equalization was proposed. The proposed technique of modified histogram equalization is based on the assessment of the two dimensional probability distribution of brightness. To demonstrate the possibilities of the proposed technique, a new method to increasing the integral contrast of complex monochrome images based on the modified equalization of histogram was proposed. The proposed method provides an effective increase in the contrast of small objects in the image, and also increases the integral contrast of the complex multi-element image as a whole. The research of the proposed method of modified equalization of histogram was carried out. The research was carried out by analyzing the results of the measurement of integral contrast for monochrome test images that were processed using the known and proposed methods of image enhancement. To measure the integral contrast of the test images, the metrics of contrast were used. The proposed technique of modified histogram equalization provides effective enhancement of image quality and can be recommended to increase the integral contrast in imaging and image processing in automatic mode.

4) NEW APPROACH TO THE IMPLEMENTATION OF HISTOGRAM EQUALIZATION

Histogram equalization is one of the most well known techniques of image processing in the spatial domain and is widely applied to enhance images in various applications owing to its high efficiency and simplicity. However, the traditional definition of histogram equalization procedure does not satisfy a number of basic requirements to image intensity transformations. This paper proposes a new approach to defining a histogram equalization procedure based on the analysis of the basic requirements to the image intensity transformation function. Based on this approach, we propose a new implementation for the histogram equalization procedure that satisfies the basic requirements to image intensity transformations and meets the criterion of self-duality.

5) CONTRAST LIMITED ADAPTIVE HISTOGRAM EQUALIZATION

The CLAHE methods have produced good results on medical images. Therefore, the proposed image enhancement for 3D images of stereoscopic endoscopy is based on CLAHE.

There are six steps for CLAHE:

Step1: The image is divided into several non-overlapping regions of almost equal sizes. To achieve good statistical estimation, 64 tiles in 8 columns and 8 rows is a common choice.

Step2: Histogram of each region is calculated.

Step3: Based on a desired limit for contrast, calculate the clip limit. The clip limit Ncl is defined in following equation.

$$Ncl = Nmc(N_x N_y / N_{gray})$$

Where Nx and Ny are the numbers of pixels in the X and Y directions of the contextual region. Ngray is the number of gray level in the contextual region. Nmc is the maximum multiple of average pixels in each gray level of the contextual region.

Step4: Redistribute each histogram in such a way that its value does not go beyond the clip limit. If the number of pixels is greater than Ncl, the pixels will be clipped. The extra counts, beyond the clip limit, are uniformly distributed among the grayscales with counts less than the clip limit. Then, the

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new histogram can be achieved.

Step5: Apply histogram equalization to the gray level histogram which is limited contrast in each region.

Step6: The center points of the contextual region are regarded as the sample points. Then, the result mapping at any pixel is interpolated from the sample mapping at the four surrounding sample points.

B.Choosing reference image

After processing by CLAHE, two stereo views are converted from RGB to YCbCrcolor space. Where Y is the intensity, and Cb, Cr are the color components. Then, we calculate the average values Yavg1 and Yavg2 of Y for each image. The image the average brightness value of which is major is selected as reference image.

C. Color matching

In order to reduce the computational complexity, we correct colors between two stereo views based on global histogram matching. Histogram matching is the process of updating a given histogram according to a prescribed one, making the position and shape of both similar. As already mentioned, we have chosen one image of two stereo views as the reference image Iref. In this step, the other image of two stereo views as the target image Idist is transferred to the reference image Iref by defining a mapping function M[i]. All calculation steps will be conducted independently on each color channel. There are five steps for histogram matching.

There are five steps for histogram matching.

Step1: Calculate histograms Hdist[i] and Href [i] for both images I_{dist} and I_{ref} .

Step2: Normalize histogram, so that individual bins will then represent the fraction of the total number of events assigned to the entire histogram.

Step3: Compute the cumulated histograms CD[i] and CR[i] for both images I_{dist} and I_{ref}

Step4: Get the transform function M[i] according to cumulated Histogram

Step5: The color corrected image I_{new} is calculated by applying the mapping function M[i] to I_{dist}

DISCUSSION AND CONCLUSIONS

BPDHE is that there is no parameter need to be tuned. Experimental results shows that BPDHE can enhance the images without introducing unwanted artifacts, while at the same time maintain the input brightness. Furthermore, similar to other HE based algorithms BPDHE is easy to implement and can be used in real time system because of its simplicity.

BPWCHE method for contrast enhancement. BPWCHE can not only preserve image brightness but can also enhance image contrast without deterioration of visualization of the original image. Although previous extensions of GHE can preserve image brightness, depending on the characteristics of the image, they can either overdraw or fail to enhance image contrast and visualization. BPWCHE eliminates these problems without undesirable Artifacts. BPWCHE requires no parameters and is both simple and fully automatic, while preserving image brightness and enhancing image contrast and visualization. Modified histogram equalization provides effective enhancement of image quality and can be recommended to increase the integral contrast in imaging and image processing in automatic mode. New Approach to the Implementation of Histogram Equalization method implementation of the histogram equalization procedure has low level of computation cost, effective computationally and simple to implement. The proposed definition can be recommended for the implementation of histogram equalization procedure in various image processing techniques. Contrast limited adaptive histogram equalization algorithm produces high quality 3D images by improving image contrast, enhancing the details of the image obviously, removing the color cast and improving consistency of two stereo views. However, compared with HE, AHE and CLHE, the computational complexity of the proposed method is high. In the future, our research will be focused on decreasing computational complexity.

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