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Measure of image enhancement by parameter controlled histogram distribution using color image

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***Abstract*:** Histogram Equalization (HE) technique is simple and effectively used for contrast enhancement. But HE is not suitable for consumer electronic products because it may produces washed out appearance image. The new quantitative measures of image enhancement and frequency domain based methods used for object detection and visualization and enhancement technique driven by both global and local process on luminance and chrominance components of the image. This measure of image enhancement is related with the concepts of Weber's law of the human visual systems. It helps to choose the best parameters and transform. This approach based on parameter controlled histogram distribution method can enhance simultaneously overall contrast and sharpness of an image. This approach also increases the visibility of specified portions or better maintaining image color. This analysis provides better performance for contrast enhancement

Index terms: Histogram equalization, Image enhancement, Contrast enhancement,

I.INTRODUCTION

A digital image is converted into analogy signal which is scanned into a display. Before the processing image is converted into digital format, Digitization includes sampling of image and quantization of sampled values. After converting the image into bit, information is processed. In image processing, images are available in digitized form that is arrays of finite length binary format. For digitization, the given images are sampled on a discrete grid and each sample or pixel is quantized using a finite number of bits. The digitized image is used in computer.

Image enhancement which transforms digital images to enhance the visual information. To enhance image contrast is the intensity mapping that reassigns the intensity of pixels through a monotonically increasing function. Primary operation for all vision and image processing tasks in several areas. In forensic video/image analysis tasks surveillance videos have quite different qualities compared with other videos such as the videos for high quality entertainment or TV broadcasting. Enhancement transformation to modify the contrast of an image within a display's dynamic range is therefore required in order to show full information content in the videos.

Contrast enhancement is an important function in image processing applications. The objective of this method is to make an image clearly recognized for a specific application. Point operation based enhancement techniques are contrast stretching, non-linear point transformation, histogram modeling. The non-linearity is introduced by many imaging lighting device which can be described with a point operation. Gamma correction is using the power law's light intensity operation [1] which is adjusting the lightness/darkness level of their prints.

$$X=(x)^{(1/\text{gamma value})}$$

Where x is the original pixel value. Depending on the gamma value, image can be lightened or darkened. so, it will improve visual contrast and also decreases the visual contrast too.

Histogram Equalization (HE) is most popular technique for contrast enhancement. HE makes uniform distribution of the gray level for an image. But, consumer electronics such as Flat panel display (FPD), HE is rarely applied in directly because the significant changes in brightness [2]. The HE effectiveness is depends on the contrast of the original image. In general, HE will flatten out the probability distribution of an image and increase its dynamic range and also will make the average brightness towards the middle gray level of an image regardless of the input image, and produce the objectionable artifacts and unnatural contrast effect. This makes the visual quality of processed image is unsatisfactory. Surveillance videos have quietly different qualities compared with other videos such as videos for high quality entertainment or TV broadcasting. High quality entertainment movie or game videos are produced under controlled lighting environment where as surveillance videos for monitoring outdoor scenes are acquired. Many methods have been proposed to improve the enhancement.[3]-[8]

Brightness preserving Bi-Histogram equalization (BBHE) was proposed to preserve the entire mean of image [3], compared to global HE. The BBHE is to first decompose an input image into two sub images based on the mean of input image. These histograms are equalized independently. To achieve higher degree of brightness preservation without artifacts, minimum mean brightness error bi-histogram equalization [5] method used to find the absolute difference between input mean and output mean value and to compute the threshold gray level to separate the input histogram. This function is similar to the mean value of BBHE or that of median of DSIHE. This algorithm is time consuming. Similar to MMBEBHE, Dynamic Range Separate Histogram equalization (DRSHE) [6] method is proposed. DRSHE uses weighted average of absolute color difference to makes uniform histogram distribution. DRSHE separates the dynamic range of histogram into k sub-histograms and redistributes the pixel intensities based on its ratio. These methods have been developed in order to overcome the drawbacks of histogram equalization.

Most one of the common defects of surveillance videos is poor contrast resulting from reduced image chrominance. This approach is driven by both global and local process of image component to enhance the visual information and maintaining the image color. Primary operation for almost all vision and image processing tasks in several areas such as biomedical image analysis, forensic analysis, remote sensing .

Measure of image enhancement to quantify the visibility of errors between a distorted image and a reference image using a variety of known properties of the human visual system. The image enhancement estimation is to develop quantitative measures that can predict perceived image quality. Measure of image enhancement is important for image processing applications. First, it can be used to optimize algorithms and parameter settings of image processing systems; second, it is used to dynamically monitor and adjust image quality.

A.PROBLEM FORMULATION :

In surveillance videos/images, bio medical images, the luminance histogram is linearly quantized. Most of the pixels possess a luminance less than the average. In such images, details in the darker regions are often not observable. Histograms are used to describe the image statistics in an image interpreted the visual format. It is easy to define certain types of problems in an image, such as if the image is properly exposed. Luminance and component histogram both provide useful information about the lighting, dynamic range, contrast and saturation effects relative to individual color components [2].

The proposed enhancement technique is to satisfy the particular practical demands and requirements for color image/video analysis. This technique is driven by both global and local processes to achieve overall contrast, also enhancement details in identified features/areas of a color image. This processed enhanced color image should not be saturated at one or both ends of the dynamic range.

The rest of organized as follows; Section II the proposed method is discussed. Section III presents the results and discussion of the proposed work followed by conclusion

II.PRINCIPLE OF THE PROPOSED METHOD

The goal of the proposed method is to find a monotonic pixel brightness transformation q=T(p) for a color image such that the desired output histogram can not only meet specific requirements but also be as uniform as possible over the whole output brightness scale.

Let $C \equiv \{c = (c1, c2) | 1 \leq c1 \leq M, 1 \leq c2 \leq N\}$ denote the pixel coordinates of a color image, where M and n are the height and width of the image, respectively. At each pixel coordinate, $c \in C$, a multivariate value x_{RGB} is represent the pixel in Red, Green, Blue (RGB color space) position and a multivariate value $X_{YcbCr}(c)=[x_Y(c),x_{Cb}(c),x_{Cr}(c)]^T$ is used to represent the pixel in YC_bC_r color space [2].

The cumulative histogram for each RGB component and luminance component Y for the YC_bCr color space are defined by extending the definition of cumulative histogram from gray-scale image respectively as

$$H_R(x,y) = \sum_{i=p0}^{p} h_R(i) \quad (1)$$

$$H_G(x,y) = \sum_{i=p_0}^{p} h_G(i) \quad (2)$$

$$H_B(x,y) = \sum_{i=p_0}^{p} h_B(i) \quad (3)$$

and

$$H_Y(x,y) = \sum_{i=p0}^{p} h_Y(i) \quad (4)$$

Where the input brightness value is $[p_0,p_k]$.The cumulative histograms are monotonic no-decreasing functions. Compared with the original image an enhanced image with good contrast will have a higher intensity of the edges. Laplacian operation is applied to each of the RGB channels, respectively

$$L_{RGB}(c) = |\nabla^2 x_R(c)| + |\nabla^2 x_G(c)| + |\nabla^2 x_B(c)| \quad (5)$$

Based on (5), we define set of pixel coordinates of an image S_{Lap}

$$S_{Lap} = \{c \mid L_{RGB}(c) > T_{la}, c \in C\} \quad (6)$$

i.e., $S_{Lap} \subset C$. where threshold $T_{la} \in [1,10]$, and default threshold T_{la} is set to 3.Each of the pixels with their coordinates in the set S_{Lap} has a sum of absolute value of output of the pixel processed with a laplace operator ∇^2 and the sum value is greater than T_{la}.We define special density function $h_{Y_T}(y)$,

$$h_{Y_T}(y) = \{c \mid x_Y(c) = y, c \in S_{Lap}\} \quad (7)$$

Where the input brightness values are $[p_0,p_k]$ find out this histogram H,H_1 and H_2 are defined as follows,

$$H(x,y) = \sum_{i=p_0}^{p_k} h_Y(i) \quad (8)$$

$$H_1(x,y) = w \sum_{i=p_{k0}}^{p_{k1}} h_{Y_W}(i) \quad (9)$$

And

$$H_2(x,y) = v \sum_{i=p_0}^{p_k} h_{Y_T}(i) \quad (10)$$

Where the p_k and p_{k10} are in the range of $[p_0,p_k][0,255]$; w is a parameter with the default value is set to 2.v is a parameter with the default value is set to 1.Here H_1 is designed to suit special enhancement requirements for the image interpretation.

$$c_n = \frac{H}{H + H_1 + H_2}$$

Where normalized coefficient a new virtual distribution function is defined

$$\sum_{i=p_0}^{p} h_0(i) = c_n \left(\sum_{i=p_0}^{p} h_Y(i) + w \sum_{i=p_{k10}}^{p_{k1}} h_{Y_W}(i) + v \sum_{i=p_0}^{p_k} h_{Y_T}(i) \right) \quad (11)$$

If M and N are the height and width of an image respectively and the output brightness range is $[p_0.p_k]$. The desired output histogram can be approximated by its corresponding continuous probability density as follows

$$MN \int_{q_0}^{q} \frac{1}{q_k - q_0} ds = \int_{p_0}^{p} h_0(s) ds \quad (12)$$

The left side of equation is the corresponding uniform probability distribution function. The desired pixel brightness histogram transformation T is defined as

$$q = T(p) = \frac{q_k - q_0}{MN} \int_{p_0}^{p} h_0(s) ds + q_0 \quad (13)$$

The default values of these parameters are, q_0=0, q_k=255 and w=2.The parameters can be adjusted by an image interpreter meet to specific requirements. For the various parameter works well without user intervention as changes of the parameters do not affect the enhanced result very much show the results. In this case proposed method can be applied directly to each of RGB channels using the contribution from the color and luminance components for contrast enhancement. It shows clearly better performance in some of the test images.

A.MEASURE OF IMAGE ENHANCEMENT

After an image is enhanced, it is difficult to measure the improvement detail. The processed image can be an enhancement over the original image in which it allows the observer to understand the desirable information in the image. Measure the values at given pixel for enhanced image should depend on the pixels. This quantitative measure is related with the Weber's law of the human visual system.

Let an image x(m, n) be split into k_1k_2 blocks of sizes $l_1 * l_2$ and let $\{\varphi\}$ be a orthogonal transforms used for image enhancement with enhancement parameters ,then we define

$$EME(f) = EME_\varphi(f) = \frac{1}{k^2} \sum_{m=1}^{k} \sum_{l=1}^{k} \frac{20 \log (\max(f[m,l])}{\min(f[m,l])} \quad (14)$$

Where max(f[m, l]) and min(f[m, l]) represents maximum and minimum of the image X(m, n) respectively. EME is called measure of enhancement or measure of improvement. This quantitative measure is very helpful to select optimal processing parameters.

III. EXPERIMENTS RESULTS

In the proposed method work as analyzed with quality and quantitative of car, library, boat input images.A significant amount of tested colour images results of the compared techniques, such as Histogram Equalization, Gamma correction, Contrast stretching and parameter controlled histogram.

(a)

(b)

(c)

(d)

(e)

Fig 1.Enhancement results for the test image car (a) Original input image (b)HE output image (c) Gamma correction output image (d) Contrast stretching output image (e) parameter controlled enhanced output image.

In order to compare our results with those of the existing methods based on quantitative parameters such as Mean Square Error(MSE),Enhancement Error (EME) is to be calculated. Mean Square Error value is depending upon the pixel resolution chances the brightness and contrast of image are low or high preserved as well as enhanced quantitative values are listed in Table I.

TABLE I

Compare the MSE, EME value

Methods	Figure Name	MSE value	EME value
Histogram Equalization	Car image	104.9909	13.1934
Gamma Correction	Car image	34.5471	12.9597
Contrast Stretching	Car image	60.6940	8.2458
Proposed Method	Car image	26.8973	6.4590

IV.CONCLUSION

A Parameter controlled histogram distribution is driven to process on luminance and chrominance components of the image and the new hybrid image enhancement approach measure the improvement of an image. Simultaneously the overall contrast and sharpness of an image were enhanced. The proposed approach introduces the parameters to increase the visibility of specified features portion or aspects of the image. Automatic process and choose the better optimal parameter for improvement measurement also potential for various applications to enhance specific categories of images, such as surveillance videos/images, biomedical images and satellite images.

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