IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 8, Issue 3, March 2020

An Adaptive Image Enhancement Technique Preserving Brightness Level

Ritu[1], Maninder Singh[2]

M. Tech., Student, ECE Department, Haryana Engineering College, Jagadhri, Haryana, India[1]

Assistant Professor, ECE Department, Haryana Engineering College, Jagadhri, Haryana, India[2]

Abstract: Now a day, everyone is fond of selfies. Not only selfies, man wishes to capture all his memorable events. This results in the increase of number of images and videos. It is obvious that a more amount of memory is needed to store all these images and videos. If these images are needed to be transmitted, it even requires large bandwidth. So, there comes the need of image compression techniques. Image compression is a type of data compression applied to digital images, to reduce their cost for storage or transmission. These image compression techniques reduce the storage space occupied by the image without any loss to image quality. Thus, the image size can be reduced by selecting proper compression technique depending on the requirement of user or application. Algorithms may take advantage of visual perception and the statistical properties of image data to provide superior results compared with generic compression methods. The image size can be reduced by selecting proper compression technique depending on the requirement of user or application. Image compression is a technique in which the storage space of image is reduced without degrading the image quality. We used SVD for the compression. In this, the image is compressed such that there is loss in image data, that is, image cannot be reconstructed if once compressed. This technique is best suited for normal photographs where a small loss of fidelity is acceptable. Most of the regular image compression techniques used today is lossy techniques. SVD is also a lossy image compression technique. SVD is robust and reliable orthogonal matrix decomposition method. Due to SVD conceptual and stability reasons, it becomes more and more popular in signal processing area. SVD has prominent properties in imaging. Although some SVD properties are fully utilized in image processing, others still need more investigation and contributed to. A key property of SVD is its relation to the rank of a matrix and its ability to approximate matrices of a given rank. Digital images are often represented by low rank matrices and, therefore, able to be described by a sum of a relatively small set of eigen images. This concept rises the manipulating of the signal as two distinct subspaces. SVD is an attractive algebraic transform for image processing. The method cum procedure using SVD and compress an image

Keywords: Image Enhancement, SVD, Brightness Level

I. INTRODUCTION

Digital image enhancement is one of the most important images processing technology which is necessary to improve the visual appearance of the image or to provide a better transform representation for future automated image processing such as image analysis, detection, segmentation and recognition. Producing visually natural images or modifying an image to better show the visual information contained within the image is required for many important areas such as vision, remote sensing, dynamic scene analysis, autonomous navigation, and biomedical image analysis. The enhancement of contrast is one purpose of image enhancement. Enhancement of images is required for better visualization of dark images to improve visual perception and to enable accurate interpretation. Many images have very low dynamic range of the intensity values due to insufficient illumination and therefore need to be processed before being displayed. Large numbers of techniques have focused on the enhancement of gray level images in the spatial domain. These methods include histogram equalization, gamma correction, high pass filtering, low pass filtering, homomorphic filtering, etc. Another technique has also been reported in RGB space that uses equalization of the 3-D histograms. Noise is usually considered to be a nuisance that decreases the Signal-to-Noise Ratio (SNR) of signal processing systems. Stochastic resonance, on contrary, is a phenomenon in which noise can be used to enhance rather than hinder the system performance. Traditionally considered undesirable, noise can sometimes play a constructive role in image processing also.

The idea behind image enhancement techniques is to bring out the detail that is obscured or simply to highlight certain features of interest of an image. The goal of image enhancement techniques is to improve the quality of an image such that enhanced image is better than the original image. Image enhancement is one of the most important issues in low-level image processing. Its purpose is to improve the quality of low contrast images, i.e., to enlarge the intensity difference among objects and background.

Copyright to IJIREEICE

II. PROPOSED METHOD

Image Acquisition

The very first step for the image enhancement method is the image acquisition. During this step various images are captured for the image enhancement task. In this work the images are captured from the nokia 5233 mobile phone and also taken from the internet. Images are captured at different time to check the validity of the proposed algorithm on various shades of the images. Images of car, bikes and kids are collected for the next processing task. The image captured through the mobile phone have rgb format and they have been converted into gray scale format to implement the algorithm. The rgb to gray scale conversion is described in the next section.

RGB to Gray Scale Conversion

The acquired image using the mobile camera is in jpeg format with 24 bits color format. The jpeg image format is converted to gray color format using rgb2gray Matlab command.

```
Image = imread('F:\thesis_wrk\Images\1.jpg');
Figure,
Imshow(Image);
Title ('Original Image');
Gray = rgb2gray(Image);
Figure,
Imshow(Gray);
Title ('Gray Image');
```

This MATLAB command converts the rgb image to a gray scale image for further processing task.

Histogram Extraction

Histogram of an image is the representation of no. of pixels on Y-axis with respective gray colour intensities on X-axis. Mathematically, the histogram bin is given by:

$$P_i = \text{Total No. of Pixels of } i_{th} \text{ gray level intensity} \qquad 4.1$$

Let's say the histogram of the input gray image is represented by P_i. The probability Density Function (PDF) is given by:

$$(PDF)i = Pi / (r * c) \qquad 4.2$$

Where 'r' and 'c' are the rows and column of the input image.

Histogram Equalized Image

Histogram equalization often produces unrealistic effects in photographs; however it is very useful for scientific images like thermal, satellite or x-ray images, often the same class of images that user would apply false-color to. Also histogram equalization can produce undesirable effects (like visible image gradient) when applied to images with low color depth. For example, if applied to 8-bit image displayed with 8-bit gray-scale palette it will further reduce color depth (number of unique shades of gray) of the image. Histogram equalization will work the best when applied to images with much higher color depth than palette size, like continuous data or 16-bit gray-scale images.

Let's say the final histogram equalized image histogram is represented by: P_i. Consider a discrete grayscale image {x} and let n_i be the number of occurrences of gray level i. The probability of an occurrence of a pixel of level i in the image is

$$p_{x(i)} = p(x = i) = ni/n, \ 0 \leq i < L \qquad 4.3$$

L being the total number of gray levels in the image, n being the total number of pixels in the image, and $p_x(i)$ being in fact the image's histogram for pixel value i, normalized to [0,1].

Let us also define the cumulative distribution function corresponding to px is given

$$cdf_{x(i)} = \sum_{j=0}^{i} p_{x(j)} \qquad 4.4$$

which is also called the image's accumulated normalized histogram.

We would like to create a transformation of the form y = T(x) to produce a new image {y}, such that its CDF will be linear across the value range, i.e.

$$cdf_{y(i)} = i_k \qquad 4.5$$

For some constant k, the properties of the CDF allow us to perform such a transform that is defined as

$$y = T(x) = cdf_{x(x)} \qquad 4.6$$

Notice that the T maps the levels into the range [0,1]. In order to map the values back into their original range, the following simple transformation needs to be applied on the result:

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 8, Issue 3, March 2020

$$y' = y * (\max\{x\} - \min\{x\}) + \min\{x\} \quad 4.7$$

The main limitation or the drawback of the histogram equalization technique is that it results in over and under enhancement. To remove this problem in this work an adaptive gamma correction function is designed and implemented.

Adaptive Gamma Correction

To compensate for the limitations of histogram equalization technique, a technique is developed which creates a balance between high levels of visual quality and low computational costs. In this work a hybrid HM method is proposed to accomplish this goal by efficiently combining the TGC and THE methods. A normalized gamma function can be used to modify each sub-histogram to include multi-equalizations with brightness preservation. However the modified sub-histograms might lose some statistical information, thus reducing the effect of enhancement. Inspired from the RHE method in this work we directly utilized cdf and applied a normalized gamma function to modify the transformation curve without losing the available histogram of statistics. Consequently, the lower gamma parameter generates a more significant adjustment. This observation led us to employ a compensated cdf as an adaptive parameter, which modifies the intensity with a progressive increment of the original trend. The proposed adaptive gamma correction (AGC) is formulated as follow:

$$T(l) = l\max(l/l\max)^{\gamma} = l\max(l/l\max)^{1-cdf(l).} \quad 4.8$$

The AGC method can progressively increase the low intensity and avoid the significant decrement of the high intensity. Finally, the gamma parameter based on cdf of Equation is given as follows:

$$\gamma = 1 - cdf(l) \quad 4.9$$

Exponential Gamma Correction

The exponential transformation is shown as follows:

$$s = c \quad 4.10$$

Where both c and γ are positive real constants, s and t are the intensity variables of the original image and the enhanced image, respectively. The exponential transformation can map a narrow range of pixel values to a wider range of pixel values. Actually, due to the differences of brightness in different images, it is difficult to determine γ and it needs to be settled through large number of experiments. The brightness of input image is not required in determining γ. The input image can be perfectly enhanced even in the circumstances that an image has good mean intensity. Let mean represent the mean brightness of an image. If the absolute difference between the median of the intensity and mean is less than or equal to a certain empirical threshold ε, a better image brightness distribution can be indicated. Otherwise, the image average brightness is too high or too low. γ is determined as follows:

$$\gamma = \log(0.5 + \epsilon) / \log(mean) \text{ when } < 0.5$$
$$\log(0.5 + \epsilon) / \log(mean) \text{ when } > 0.5 \quad 4.11$$

It is observed from equation that γ is larger than 1 if the average brightness is low, and conversely, γ is smaller than 1 if the average brightness is high.

Fusion of Adaptive gamma corrected image

Histogram Equalized image and the Original image for final image enhancement. In the presented work, the histograms i.e. P_i, P_{agc}, and P_{eq} are fused together to form a new enhanced image and is analysed for its performance parameters.

Let's the final enhanced image histogram is represented by: H_f

H_f is solved by using the following equation:

$$Hf = (H_i + \lambda.H_{eq} + k.H_{agc})/(1 + \lambda + k) \quad 4.12$$

The value of ʎ and K are so adjusted that the output image has maximum entropy and minimum AMBE. It is to be noted that if the values of and k are set to zero, then the final output image becomes as equal to the original image. Therefore, the initial value of the and k are taken to zero and are incremented by a small fraction 0.001 and each time the ambe is computed. The time, at which there is maximum entropy and minimum AMBE is achieved, the iteration is stopped and with final values of and k, final enhanced image is extracted out.

III. RESULT & DISCUSSION

This work proposed a novel image enhancement scheme using fusion technique in which the images obtained from adaptive gamma correction, histogram equalization and the original are combined and the level of the contrast improvement is adjustable by changing the weighting coefficients. It is a contrast enhancement technique with the objective to obtain a new enhanced image with a uniform histogram. The proposed method is compared with the

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 8, Issue 3, March 2020

various conventional histogram equalization methods. The various images are used to verify the performance of the proposed algorithm. The Algorithm is applied, and the results are calculated. The experimental results are compared with the state-of-art technique histogram equalization and brightness preserving bi-histogram equalization technique. The performance of the proposed image enhancement algorithm is checked by using absolute mean brightness error, entropy and standard deviation.

(a) (b) (c)

Fig. 1 four test images (a) car1 (b) car2 (c) car 3

To demonstrate the performance of the proposed method, let's take car1 image as an example. First of all the image is loaded in the MATLAB and the algorithm is executed to demonstrate the output image obtained by histogram equalization method, BBHE and proposed algorithm.

Fig. 2 Original Image car 1

Fig. 3 Histogram Equalized Image car 1

Fig. 4 BBHE Image car 1

Fig. 5 Final proposed Image

IJIREEICE
ISSN (Online) 2321-2004
ISSN (Print) 2321-5526
International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering
Vol. 8, Issue 3, March 2020

The figure shown shows the result obtained by the histogram equalization technique, brightness preserving bi-histogram equalization technique and the proposed algorithm. The result illustrate that the image obtained by the proposed method enhances the contrast of the image while preserving the brightness level with in a limit. To evaluate the improvement in contrast, hence, the visual quality of image, and the brightness preservation in the enhanced image is illustrated by the well –known parameters i.e. absolute mean brightness error, the Entropy and Standard Deviation.

Absolute mean brightness error (AMBE):

$$\mathrm{AMBE} = 1/\mathrm{N} \sum_{i=1}^{l} |\mathrm{E(X)} - \mathrm{E(Y)}| \quad 5.1$$

where N represents the total number of test images, $E(X)$ the average intensity of N^{th} test image N, and $E(Y)$ the average intensity of the corresponding output image. Smaller value of AMBE shows that the average intensity of the input and the output images are similar, and that the corresponding method can preserve the mean brightness of the image.

Entropy: Entropy is the measure of the image information content and can be expressed as:

$$H(X) = \sum_i \mathrm{P(xi)I(xi)} = -\sum_i \mathrm{P(xi)logP(xi)} \quad 5.2$$

The higher value of discrete entropy indicates a richer detail in an image. Therefore, higher value of discrete entropy in enhancement is expected in the image enhancement.

Standard Deviation: The standard deviation is the most common measure of variability, measuring the spread of the data set and the relationship of the mean to the rest of the data. If the data points are close to the mean, indicating that the responses are fairly uniform, then the standard deviation will be small. Conversely, if many data points are far from the mean, indicating that there is a wide variance in the responses,

Table 1 Comparison of AMBE, Entropy & SD of CAR 1 image

METHODS	AMBE	ENTROPY	STANDARD DEVIATION
HE	103.1952	5.3189	.20035

then the standard deviation will be large. The standard deviation is calculated using the following formula.

$$\sigma = \sum \frac{(X-M)^2}{n-1} \quad 5.3$$

Where X = Individual score, M = Mean of all scores, n = Sample size (number of scores)

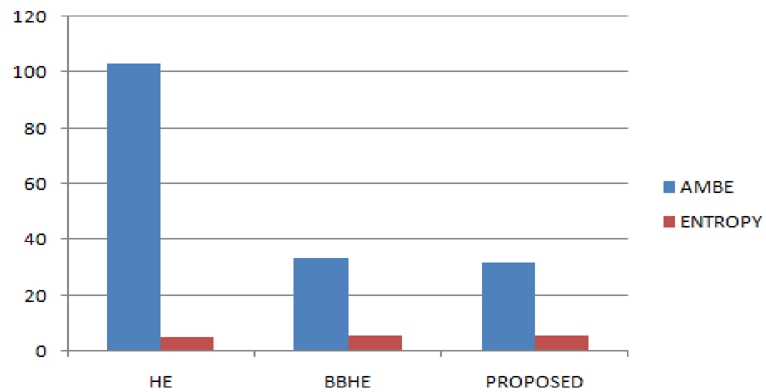

Fig 6. ABME and Entropy graph for car1

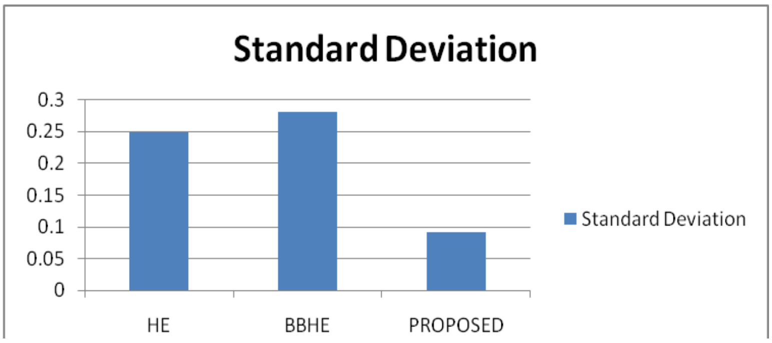

Fig 7. Standard deviation graph for car 1

Copyright to IJIREEICE

IV. CONCLUSION

This work proposed a method of image enhancement based on histogram equalization and adaptive gamma correction. Image enhancement is one of the most important image processing technologies which are necessary to improve the visual appearance of the image or to provide a better transform representation for future automated image processing such as image analysis, detection, segmentation and recognition. This research work adopts a scheme for enhancing the image contrast. The novelty of the proposed technique is that, the weighted average of histogram equalization, exponential transformation and the original image are combined and the level of the contrast improvement is adjustable by changing the weighting coefficients. The method has been implemented on four different images to check experimental results. AMBE, Entropy and Standard Deviation is then calculated to check the performance of the proposed algorithm. It is observed from the experimented results that the proposed method not only enhance the visual quality of the image but also maintained the brightness level.

REFERENCES

[1]. R.C. Gonzales and R.E. Woods (2002), 'Digital Image Processing', Second Edition, Pearson Education Inc.
[2]. H. K. Sawant and M. Deore " A comprehensive review of image enhancement techniques" International Journal of Computer Technology and Electronics Engineering, vol 1, no. 2, pp. 39-44, Feb. 2000.
[3]. Y. Kim, "Contrast enhancement using brightness preserving bi-histogram equalization," IEEE Trans. Consum. Electron., vol. 43, no. 1, pp. 1–8, Feb. 1997.
[4]. Y. Wan, Q. Chen, and B. M. Zhang, "Image enhancement based on equal area dualistic sub-image histogram equalization method," IEEE Trans.Consum. Electron., vol. 45, no. 1, pp. 68 _75, Feb. 1999.
[5]. S. Chen and A. Ramli, "Contrast enhancement using recursive meanseparate histogram equalization for scalable brightness preservation,"IEEE Trans. Consum. Electron., vol. 49, no. 4, pp. 1301–1309, Nov. 2003
[6]. S.-D. Chen and A. Ramli, "Minimum mean brightness error bihistogramequalization in contrast enhancement," IEEE Trans. Consum.Electron., vol. 49, no. 4, pp. 1310–1319, Apr. 2003.
[7]. C.C. Sun, S.J. Ruan, M.C. Shie, and T.W. Pai, "Dynamic contrast enhancement based on histogram specification," IEEE Trans. Consum.Electron., vol. 51, no. 4, pp. 1300–1305, Apr. 2005.
[8]. S. S. Agaian, B. Silver, and K. A. Panetta, "Transform coefficient histogram-based image enhancement algorithms using contrast entropy,"IEEE Trans. Image Process., vol. IP-16, no. 3, pp. 741–758, Mar. 2007.
[9]. T. Kim and J. Paik, "Adaptive contrast enhancement using gaincontrollable clipped histogram equalization," IEEE Trans. Consum.Electron., vol. 54, no. 4, pp. 1803–1810, Nov. 2008.
[10]. Sathit Intajag , Vittaya Tipsuwanporn and Rungrat Chatthai," Retinal Image Enhancement in Multi-Mode Histogram". 2009 World Confress on Computer Science and Information Engineering.
[11]. Guo Xian Jiu, Jiang Feng Jiao, Li Xiang,"Image Enhancement Method Based on Fuzzy Set and Subdivision"@IEEE 2009
[12]. Raman Maini and Himanshu Aggarwal" A Comprehensive Review of Image Enhancement Techniques", JOURNAL OF COMPUTING, VOLUME 2, ISSUE 3, MARCH 2010, ISSN 2151-9617
[13]. Kota Murahira, Takashi Kawakami, & Akira Taguchi*),Member IEEE," Modified Histogram Equalization for Image Contrast Enhancement", 4th International Symposium on Communications, Control and Signal Processing, ISCCSP 2010, Limassol, Cyprus, 3-5 March 2010,
[14]. Zhengya Xu, Hong Ren Wu" Colour Image Enhancement by Virtual Histogram Approach" 2010 3rd International Congress on Image and Signal Processing
[15]. N. M. Kwok, Q. P. Ha, G. Fang, A. B. Rad and D. Wang," Color Image Contrast Enhancement using a Local Equalization and Weighted Sum Approach", 6th annual IEEE Conference on Automation Science and Engineering Marriott Eaton Centre Hotel Toronto, Ontario, Canada, August 21-24, 2010.