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Image Contrast Enhancement using AGCWD with Region Based Enhancement

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Abstract

Image enhancement is a technique which is responsible for refining the image quality for better visibility. It is a process of altering the certain amount of image features by human interpretation to obtain enhanced image at the output. Basically, the images taken in low light can cause poor contrast which makes object and background non-differentiable and there is also a chance of involving noise in it. So, it becomes an important parameter to rectify these problems. Therefore many techniques have been developed. But most of these techniques are failed to preserve the brightness and naturalness of the image which results into washed out appearance with loss of information. Now, a new technique has been proposed to resolve these problems. In this technique, an image is divided into blocks and then passes through high pass filter as well as adaptive gamma correction weighted distribution method for preserving brightness without losing details.

Keywords: Image Enhancement, Contrast Enhancement, Histogram Equalization, Adaptive Gamma Correction Weighted Distribution, Brightness Preservation

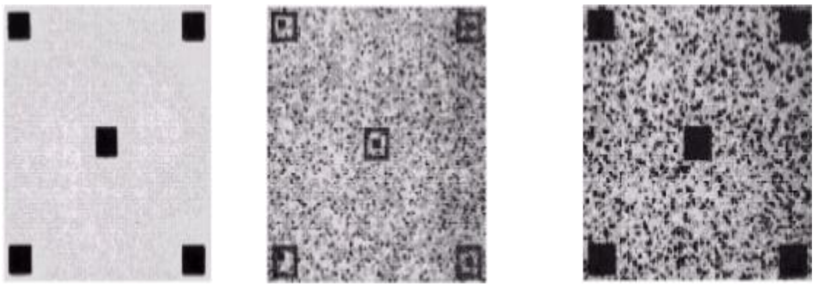
Introduction

Digital image processing is an area of vast research work that deals with enhancing the image details and pertaining to achieve the high visibility and clarity of it. Generally, sight is the most powerful sense than hearing, touch, smell and taste. As this is the medium for perceiving the environment around us and human brain processed it with the help of images in its visual cortex. Image enhancement is an effective and efficient appealing field among various digital image processing techniques. The principle objective of this technique is to bring out the necessary details which get hidden in an image or to improve contrast in a poor contrast image. It is a general phenomenon that if an image gets converted from one form to another like digitizing of an image, it tends to degradation at the output. It is not necessary that image enhancement algorithm [1] which works perfectly for one class of images will also perform similar for other class of images. It is varied among several applications according to the high and low frequency of the image. Enhancement also leads to restoration of an image that suffered due to worse weather conditions, lens-optics or electronics equipment error [2]. The idea which leads to enhancement process is also responsible for carrying out the details which get obscured. It is the way through which an image can be utilized by any other applications in future. It is achieved by varying the parameters of attributes of an image. While performing this process, it is not necessary that only specific attributes get altered. Sometimes, it results into some unnecessary changes of some other attributes which results into an unpleasant look or having non-uniformity than original image [3]. Digital image processing techniques have a number of ways to improve the visibility of an image but appropriate choices of those techniques depend on the conditions related to the class of the image. Contrast of an image plays an important role in rebuilding the visible structure of the image. Contrast can be defined as a series of the intensity range varying from maximum to minimum pixel values for an image. Sometimes, only the fraction of grayscale range is characterized as the relatively measuring range in digital images. So contrast is the way through which an object can be differentiated from its background and make it visible for human perception. There are lots of contrast enhancement techniques but histogram equalization (HE) is very popular one and known for its effective and simple algorithm to enhance the image [4]. In HE, there is a stretching of the gray level range according to the probability distribution of the input gray level. During this process, the overall dynamic range gets mapped and stretched with flattened histogram.

But, HE is not considering directly for consumer electronics as it has some undesirable effects. Basically, HE characterized as two types: Global HE and Local HE. In Global HE, the details of overall histogram of the entire image are used. This process is accomplished by normalizing the pixel value distribution pervaded with its cumulative distribution function so that it turned into uniform distribution of pixel values. Nevertheless, this process not gets succeeded to maintain the brightness of the input image. Furthermore, gray levels of those images that are composed of high frequencies are authoritative to lower frequencies. This phenomenon generates or stretched gray levels on basis of gray level frequencies. As a result, authoritative frequencies possessed with larger image histogram tend to limited contrast mapping with performing overall histogram equalization. In LHE, every part is chosen in sequential way for performing HE and this process is done by the help of sliding window. As the window slides over every pixel, the area lies under it considered for HE. Later on, enhancement for the central pixel is considered for gray level transformation. It is the way through which local information of an image is considered for its best use. Sometimes, this technique results into over enhancement as well as affected by noise too and possesses high computational cost. Another approach is considered for enhancing the image is gamma transform. This techniques does not result into saturation of the image because of its non- linearity. It is given by:-

$$Y = c.x^{\gamma} \tag{1}$$

where Y is considered as output variable, x is an input variable, c is the scale constant and γ is the real-number variable.



a) Original image b) Global Histogram Equalization c) Local Histogram Equalization

Figure 1: Effect of Global Histogram Equalization and Local Histogram Equalization [5]

The real-number variable γ specifies the curvature of transform function. However, before generates the transformation function there will be a normalization of input and output levels. If the value of γ is less than 1, the contrast of the bright regions gets compressed and contrast of the dark regions gets stretched. Moreover, if γ is greater than 1 then in that case contrast of the bright region gets enhanced. So, according to the dependability of γ there will be an enhancing of the contrast in the dark regions by sacrificing the visibility in the bright regions and vice-versa.

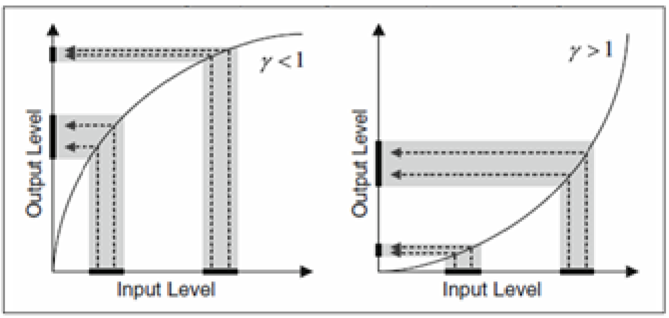


Figure 2: Gamma transforms functions depending on gamma variables [6]

Significance of Image Enhancement Techniques

There are many practical uses of image enhancement techniques among variety of miscellaneous fields, some of them are:

1. In atmospheric sciences and climatology, Image Enhancement Techniques are applied for monitoring the fog, cloudy and stormy weather situations. It is also used for locating remote physical objects in earth's atmosphere and processing satellite images.
2. In astrophotography, Image Enhancement Techniques played a vital role on analyzing light content and removing noise contents from recorded images of astronomical objects like Moon, sun, planets, stars, nebulae and galaxies.
3. In oceanography, Image Enhancement Techniques are used for studying various highlights of underwater behavior, plate tectonics, geology of the sea floor, chemical and physical properties of the ocean and underwater moving objects including marine life and ecosystem.
4. In forensic Science**,** Image Enhancement Techniques needed for collection of evidences like fingerprint detection, other samples of body parts and analyzing face detection of culprits.
5. In medical sciences, Image Enhancement Techniques brings a new era in the history of mankind. It plays a critical role in diagnosis of health related problems as well as provides treatment for it. With the use of MRI, X-rays, CT scan there is an ease in treatment of diseases.

Literature Survey

Brightness Preserving Bi-Histogram Equalization [7] (BBHE)
In this technique, input image is segregated into two sub images on basis of mean of the original image. Out of two sub images, first one contains the samples less than or equal to the mean and remaining one contains samples greater than the mean. Later on, sub images are equalized separately according to their corresponding histograms based on a fact that samples contained in the first set are stretched from minimum gray level values to the input mean and samples in the second set are stretched from mean to maximum gray level values.

Dualistic Sub-Image Histogram Equalization Method [8] (DSIHE)
This technique segregates histogram according to cumulative probability density of gray level having value 0.5 rather than mean method like in BBHE. Therefore, two sub histograms $H_L(X)$ and $H_U(X)$ generated from H(X) are emphasized by median X_D. Afterwards, two sub histograms $H_L(X)$ and $H_U(X)$ generated from H(X) are equalized separately. The overall phenomenon responsible for this cause is that it would achieve the maximum entropy for the resultant image. This technique does not lead to sufficient shift as it is co-related with brightness of the original image. Basically, it is focused for those who have larger area with similar distribution of gray level. For ex-images contains very dark or light backgrounds with smaller objects.

Brightness Preserving Histogram Equalization With Maximum Entropy [9] (BPHEME)

This technique uses a variant approach to calculate the desired histogram which is followed up by mean brightness preservation limit based on maximum differential entropy and afterwards, required histogram obtained by analyzing histogram specification. As a result, histogram transformation is done for preserving maximum brightness so that entropy of histogram gets maximized below the limit of brightness. Afterwards, gray levels resolved in smaller interval for the input image and needs stretching of gray levels in larger area for the output image so that they form similar discrete entropy. Moreover, enhanced result is obtained at the output because of its greater dynamic range as compared with the input. Basically, Absolute Mean Brightness Error (AMBE), Mean Absolute Mean Brightness Error (MAMBE) and Entropy are needed to process this phenomenon.

Recursively Separated and Weighted Histogram Equalization [10] (RSWHE)

In this technique, histograms are segregated into two or more sub histograms on basis of recursively segmentation. Histograms obtained will be further modified by weighting process and HE is performed separately on the modified histograms. The enhancement rate decreases by the rate of recursion level increases. However, this is a great disadvantage in RSWHE. Basically, it undergoes in 3 steps:

1. Histogram segmentation stage: In this stage, histograms are generated for the input image. Thereafter, numbers of sub histograms are calculated from input histogram on basis of their mean and median value.
2. Histogram weighting stage: The resultant histograms obtained from previous stage are further modified by normalized power law function according to the histogram weighting process.
3. Histogram Equalization stage: In this stage, each sub histograms undergoes HE separately for achieving desired contrast level. As a result, enhanced image is obtained at the output.

Dynamic Range Separate Histogram Equalization [11] (DRSHE)

This technique segregates the histogram dynamically such that it forms sub histogram into K parts and thereafter, mapping of the gray scale range is processed according to its area ratio. Pixel values are re-arranged uniformly in gray scale intensity range on basis of the processed histograms. This technique uses Weighted Average of Absolute colour Difference (WAAD) to highlight the edges of the images as well as averaging the histogram variations successfully. It also uses linear adaptive scale factor to reduce the over enhancement of the images. So, this process helps in maintaining the brightness of the original image and increases the clarity of the output image without any prior emphasizing upon the edges of the details in the image. Therefore, it is suitable for consumer electronic products. This technique also uses linear equations so that there is an ease in software and hardware implementation.

Automatic Weighting Mean-Separated Histogram Equalization [12] (AWMHE)

This technique is considered as an elegant image enhancement approach as it overcomes the drawbacks from previous enhancement techniques. This technique is carried out in two modules:

a) Automatic Histogram Separation module: In this module, input image is segregated according to the combination of weighting mean function.
b) Piecewise Transform Function module: In this module, each sub histograms are individually equalized with minor details for obtaining better enhanced image without any loss of information.

This technique has a drawback that it can't be use for color images. It only process gray scale images.

Adaptive Contrast Enhancement Using Regional Dynamic Histogram Equalization [13] (ARDHE)

This technique if followed by DRSHE technique. This technique also includes regional image contrast enhancement for better enhancement process. Therefore, input image undergoes block- wise segregation and then it followed DRSHE technique. Later on, gray scale range is re-mapped with elegant adaptive scale factor for maintaining perfect brightness level and minimizing over enhancement level. Gray scale range remapped according to the area ratio of sub histograms and executed in every block of the image. Densities of the mean value will decide the enhancement rate. Low mean values containing blocks will undergo for weaker enhancement and high mean values containing blocks will suffer strong enhancement. As a result, background of the image follows weaker enhancement and high frequency parts including edges will form strong enhancement.

Efficient Contrast Enhancement Using Adaptive Gamma Correction With Weighting Distribution [14] (AGCWD)

In this technique, faded or dimmed images gets enlighten by gamma correction technique and form better enhanced image with increase in brightness level. This gamma technique works with luminance pixel values to obtain the brighten image. It is followed by RSWHE technique as it modifies each sub histograms by normalized gamma function. But due to loss of statistical details in RSWHE, AGCWD is applied. In AGCWD, it uses cdf directly with normalized gamma function to reform curve transformations unaccompanied by any loss of histogram details. It results in reconstructing intensity level as per desired level and form more significant brightness. However, weighting distribution is also required for reforming the histogram slightly so that it can overcome the adverse effects evolved during this phenomenon.

Proposed Methodology

To discuss the limitations of the current method (ARDHE), a method must have developed to create an equal balance between the low computational costs and high levels of visual quality. A combination of block implementation of Adaptive Gamma

Correction with Weighing Distribution is proposed. It is indicated that in description of RSWHE method, a gamma function has used to modify each sub-histogram to involve the multi-equalizations with the brightness preservation. Although the updated sub-histograms may lose little statistical information therefore reduces the effect of enhancement. It is inspired by the RSWHE schemes that directly utilized the cdf and apply a gamma function to change the curve transformation without getting the available histogram of the statistics. Particularly, the gamma parameter creates more significant adjustment. The observation has led us to assign a compensated cdf as adaptive parameter that changes the intensity of progressive increment with its original trend. The adaptive gamma correction has been formulated as follows:

$$T(l) = l_{max}(l/l_{max})^{\gamma} = l_{max}(l/l_{max})^{1-cdf(l)} \quad (2)$$

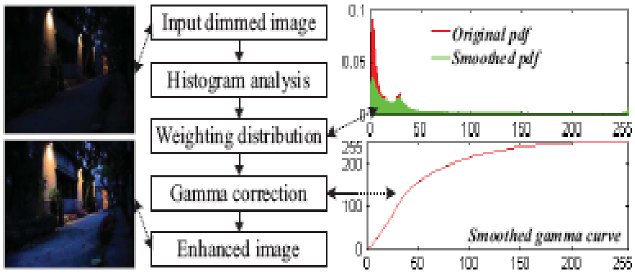


Figure 3: Flowchart of AGCWD method [14]

This AGC technique can progressively prolong the less intensity avoiding the decrement of high intensity.

Moreover, the weighting distribution function has been applied slightly to change the statistical histogram and generates adverse effects. The WD function has been formulated as:

$$Pdf_w(l) = pdf_{max}(pdf(l) - pdf_{min}/pdf_{max} - pdf_{min})^{\alpha} \quad (3)$$

where α is a adjusted parameter, pdf_{max} is a maximum pdf of the statistical histogram, pdf_{min} as the minimum pdf. Based on modified *cdf*, which is estimated by

$$Cdf_w(l) = \sum_{l=0}^{l_{max}} pdf_w(l) / \sum pdf_w \quad (4)$$

where sum of pdf_w has calculated as follows:

$$\sum pdf_w = \sum_{l=0}^{l_{max}} pdf_w \quad (5)$$

In the end, the gamma parameter has based on the *cdf* of modified Equation as follows:

$$\gamma = 1 - cdf_w(l) \quad (6)$$

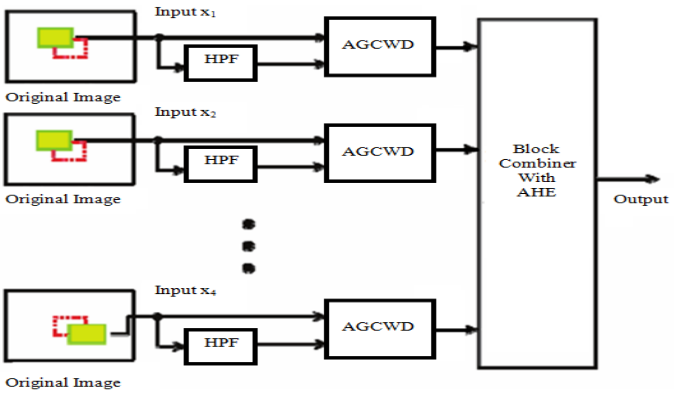


Figure 4: Block diagram of proposed system

Results

(a)

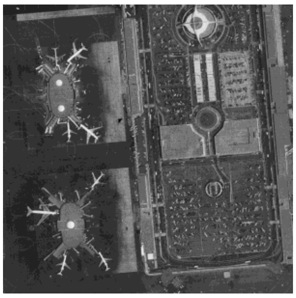
 

(b) (c)

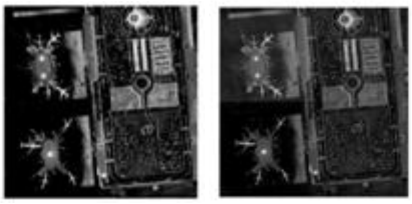
 

(d) (e)

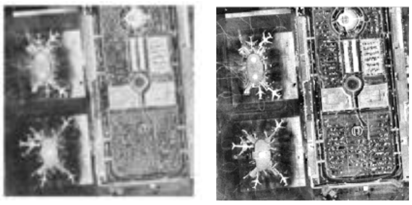
Figure 5: (a) Original image, (b) DRSHE, (c) ARDHE, (d) AGCWD, (e) IAGCWD (proposed work)



(a)



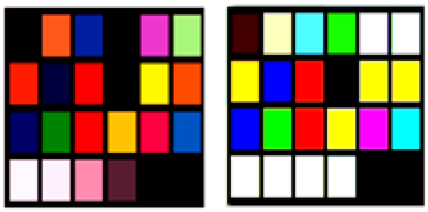
(b) (c)



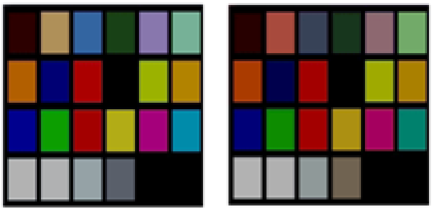
(d) (e)

Figure 6: (a) Original image, (b) DRSHE, (c) ARDHE, (d) AGCWD, (e) IAGCWD (proposed work)

(a)



(b) (c)



(d) (e)

Figure 7: (a) Original image, (b) DRSHE, (c) ARDHE, (d) AGCWD, (e) IAGCWD (proposed work)

The results are presented in Fig. 5 and Fig. 6 for the color and gray images respectively. Fig. 7 shows the Macbeth Color Checker image for computing the standard AMBE for different approaches.

Table 1: AMBE Comparison

DRSHE	ARDHE	AGCWD	IAGCWD
37.99	68.28	23.47	16.75

Conclusion

By the results presented above, it can be concluded that the proposed method is found to be more effective than existing image enhancement techniques. However, the approach is found to effective for the images having varying intensities throughout the space. Therefore future work is required to make this method more effective for other images with less spatial variation.

References

[1] T. Gulati, K. Gupta, D. Gupta, "Interpreting Low Resolution Images Using Edge Interpolation Techniques: A Comparative Analysis," International Journal of Applied Engineering Research, Vol. 10, pp. 7843-7855, 2015.

[2] A. Singhal and V. Mittal, "A Brief Review: Fingerprint Authentication System," International Journal of Applied Engineering Research, Vol. 7, pp. 1683-1686, 2012.

[3] A. Goel and V. Mittal, "Removal of Impulse Noise Using Fuzzy Techniques: A Survey," International Journal of Applied Engineering Research, Vol. 7, pp. 1850-1855, 2012.

[4] S. Das, T. Gulati and V. Mittal, "Histogram Equalization Techniques for Contrast Enhancement: A Review," International Journal of Computer Applications, Vol. 114, pp. 32-36, 2015.

[5] R. C. Gonzalez and R. E. Woods, “Digital image processing,” 2rd Edition, Prentice Hall, pp. 8-107, 2002.

[6] D.H. Kim and E.Y. Cha, “Intensity surface stretching technique for contrast enhancement of digital photography," Multidimensional Systems and Signal Processing, Vol. 20, pp. 81-95, 2009.

[7] Y.T. Kim, “Contrast enhancement using brightness preserving bi-histogram equalization,” IEEE Transactions on Consumer Electronics, Vol. 43, pp. 1-8, 1997.

[8] Y. Wang, Q. Chen and B. Zhang, “Image enhancement based on equal area dualistic sub-image histogram equalization method,” IEEE Transactions on Consumer Electronics, Vol. 45, pp. 68-75, 1999.

[9] C. Wang and Z. Ye, “Brightness preserving histogram equalization with maximum entropy: a variational perspective,” IEEE Transactions on Consumer Electronics, Vol. 51, pp. 1326-1334, 2005.

[10] M. Kim and M. G. Chung, “Recursively separated and weighted histogram equalization for brightness preservation and contrast enhancement,” IEEE Transactions on Consumer Electronics, Vol. 54, pp. 1389-1497, 2008.

[11] G.H. Park, H.H. Cho and M.R. Choi, “A contrast enhancement method using dynamic range separate histogram equalization,” IEEE Transactions on Consumer Electronics, Vol. 54, pp. 1981-1987, 2008.

[12] P.C. Wu, F.C. Cheng and Y.K. Chen, “A weighting mean-separated sub-histogram equalization for contrast enhancement,” IEEE International Conference on Biomedical Engineering and Computer Science, pp. 1-4, 2010.

[13] T. Iwanami, T. Goto, S. Hirano and M. Sakurai, “Adaptive contrast enhancement using regional dynamic histogram equalization,” IEEE International Conference on Consumer Electronics, pp. 719-722, 2012.

[14] S.C. Huang, F.C. Cheng and Y.S. Chiu, “Efficient contrast enhancement using adaptive gamma correction with weighting distribution,” IEEE Transactions on Image Processing, Vol. 22, pp. 1032-1041, 2013.