A Review on Image Contrast Enhancement Techniques

Ramandeep Kaur kaler

M.Tech(Student),CSE Deptt. BBSBEC,Fatehgarh Sahib

Email:ramankaler52@gamil.com

Baljit Singh Khehra

Computer Science Department BBSBEC,Fatehgarh Sahib

Email:hod_cse@bbsbec.ac.in

*Abstract***:** *Image enhancement focuses on improving the excellence of the input image that may be captured by a camera or other electronics product for making the output image looks better. Contrast enhancement is one of the known and famous important considerations of digital image processing. Contrast enhancement has an important role in the improvement of visual quality for computer vision and the processing of digital images. It correspondingly enhances visual quality standard by enlarging the dynamic range of gray levels of the input image. In this paper, a survey has been conducted on the approaches to make a contrast enhancement on the images.*

Keywords: Image enhancement; Contrast enhancement; visual quality; computer vision.

1. INTRODUCTION

Image enhancement is one of the most important considerations of digital image processing. Image enhancement focuses on improving the excellence of the input image that may be captured by a camera or other electronics device to make the image looks better. The enhancement methods do not add the extra details in an image, instead they focus on specific features in the image. Contrast enhancement is one of the known and famous techniques for image enhancement. It enhances or increases quality by increasing the dynamic range of gray level values of the input image. contrast enhancement methods are used for the providing better improvement to contrast of image(dimmed images). It is an important technique for the improvement of enhancing video or images details in digital processing.HE(Histogram Equalization) is a commonly known method for enhancing contrast of an image. HE performs a uniform distribution of the gray values for an image but then also it is not suitable for consumer electronics products as it contains loss of naturalness of an image, lossof

image details and excessive changes in the brightness as well as excessive contrast enhancement etc. So to make it reliable for consumer and reducing the above problems some operations has to be done on it and these processes makes the HE process to be more good for giving the very good quality to the image .One of the known and famous technique. HE techniques which improve contrast in images (low contrast) images is called as AHE(Adaptive

Histogram Equalization). It is quite different from other HE techniques generates many histograms and each of those histogram replies to a different part of the original image which further need them to redistribute the brightness level in the image. for the representation of whole image it needs a single histogram which can be evolved by ordinary HE technique. Thus, AHE is observed and follow for the better results and improvement in local contrast enhancement and for the maintenance of the number of details on the entire image. But it can also generate noise in an image.

This technique is more advanced form of adaptive histogram equalization. Basically it is designed for giving results which are related to noise problems. It works on the small tiles that are very small regions in an image and does not take the whole image like other methods. Therefore each tile has contrast enhancement in that sense so that the histograms generated at the output will matches exactly as that is mentioned in the parameter i.e 'Distribution' parameter. With addition, adjacent tiles are combined together using a method that is bilinear interpolation for removing unnecessary local boundaries .At first, BBHE(Bi Histogram Equalization) broke an input image into two sub images which is based on the mean brightness of the image(input image). Out of two One of the sub images has set , which is less than or equal to 2, the mean and the other one is the set that has samples greater than the mean. Then the BBHE equalizes the sub images histograms with the technique that the samples in that

are in set(formal set) are mapped into the range between the minimum gray level and the input mean and the sample that are in the other set are mapped into the range between the mean and the maximum gray level. In this method input mean brightness value is shown by separation intensity. As a output, the mean brightness can be acquired because of the reason that original mean brightness is retained.

2. LITERATURE SURVEY

Huang *et.al*.[1] proposed a method to modify histograms and enhance contrast in digital images..In this there is a transformation technique that improves brightness of dimmed images via gamma correction and probability distribution of luminance pixels. Experimental results shows that this method produces enhanced images of higher quality than those produced using other methods. This method enhance the overall image.

Kim[2] proposed a method in which 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 stretch from mean to maximum gray values.

Wang *et.al*.[3] discussed a method, which 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 focus on those, who have wider area with similar distribution of gray level. For ex- images contains very dark or light backgrounds with smaller objects.

Wang and Ye[4] explained a new approach which use 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) and Mean Absolute Mean Brightness Error abbreviated as (MAMBE) and entropy are needed to process this phenomenon.

Kim and Chung [5] explained that 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 abbreviated as (Recursively Separated and Weighted Histogram Equalization). it undergoes in 3 steps :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 .Histogram weighting stage: The resultant histograms obtained from previous stage are further modified by normalized power law function according to the histogram weighting process. 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.

Park *et.al*.[6] proposed a technique, in 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 color. Difference 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 electronic products.

Wang and Ward[7] proposed a technique, 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 Automatic Histogram Separation module: In this module, input image is segregated according to the combination of weighting mean function. 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.

Wadud *et.al.*[8] proposed a method, this method is followed by DRSHE (Dynamic Range Separate Histogram Equalization)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.

3. CONTRAST ENHANCEMENT TECHNIQUES

Contrast enhancement has an important role in improving the visual quality for computer vision and the processing of digital image. It is widely used for medical image processing and as a preprocessing and in image/video processing applications .Different methods have already been developed for this purpose. Contrast enhancement techniques are widely used for improving visual quality of low contrast images. bad contrast in video or images can result from many situations like lack of operator expertise and inadequacy of image capturing, then the details of the image and video features

will be obscured. Therefore there exist various contrast enhancement methods which are used for better improvement of contrast.

3.1 Histogram Equalization

HE is the most commonly used technique because of its simplicity and better performance on almost all types of images. HE calculate the operation through remapping the gray levels values of the image on the base of probability distribution of the input gray levels. The image's histogram is reshaped on the basis of the image's original gray level distribution into a other one within uniform distribution technique for increasing or enhancing the contrast. The essentiality of histogram equalization has to reduce the number of gray level values so contrast of the image can be raised. In the procedure of equalizing , the neighboring gray levels which has light probabilistic density are combined together into only one gray level and the gap between neighbor two gray levels with heavy probabilistic density is enlarged. Therefore the image (processed image) have a uniform gray distribution property and it is obvious that the gray levels that have heavy probabilistic density occupied a large values of the gray dynamic range after the process of equalization, **so** the image contrast is enhanced in the whole sense. HE has a problem of mean-shift, which is, the mean brightness of the input image is totally changed or different from that of the output image. This mean-shift problem is nuisance for electronics products where preservation of the input brightness is required to avoid unnecessary visual deterioration. histogram of a image with gray level values in the range [0, *L*-1] is called a frequency distribution function defined as overall intensity distribution of an image.

$$h(X_K) = n_K \qquad (1)$$

(1)for $k = 0, 1, 2,…, L − 1$, where *X*k is the *k*th gray level of input and here *nk* is considered as the no. of the pixels in the image which is having gray level *Xk*. *P*(*Xk*) is the Probability Density Function (PDF).

$$P (X_K) = \frac{n_k}{n} \qquad (2)$$

for $k = 0, 1, 2,…, L − 1$, where n considered as the total no. of the pixels containing in the image.

Therefore, Histogram equalization,equation is given below

$$S = T(r) = (L − 1) \sum_{J=0}^{K} P(r) \qquad (3)$$

Here T(r) is considered as increasing function which is in the interval $0 \le r \le L-1$.

Advantages of HE

- Most popular and commonly used technique because of its simplicity .
- Calculation is easy and simple.
- image quality can be improved with alteration of histogram.
- Contrast is enhanced in the overall sense by using HE.

Disadvantages of HE

- This technique is not suitable for electronics products as it has loss of naturalness in image, loss of image information, washed out appearance of images.
- One of the drawback of the histogram equalization can be based on the fact that the brightness of an image after histogram can be changed ,that is due to propertyof flattening of the histogram equalization.

3.2 Dynamic Range Separate Histogram Equalization

Dynamic Range Separate Histogram Equalization (DRSHE) is technique that is used for preservation of naturalness of images and this technique used for improving images and also keeps contrast of images good. In electronics such as Flat Panel Display,HE is rarely applied direct because of its changes in brightness. DRSHE detects the start and the end position of dynamic range by adaptive end-in search method. Then DRSHE separates the dynamic range of histogram into k parts. The grayscale ranges for each sub-histogram are resized by its area ratio. At last, redistribution of the intensity values in sub-histogram is performed in resized grayscale range. The adaptive scale factor is used for scalable dynamic range preservation. In DRSHE and more detailed and moderate histogram is obtained by using the weighted average of absolute color difference.. 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 take help of Weighted Average of Absolute colour Difference (WAAD) to highlight the edges of the images as well as averaging the histogram variations successfully. WAAD is defined as the weighted average of the absolute color difference between the center pixel.

$$WAAD = I(x,y) + \frac{1}{8} \sum_{i=-1}^{1} \sum_{j=-1}^{1} | I(x i + y j) - I(x,y) | \qquad (4)$$

Where $I(x, y)$ represents a pixel value, and i and j shows horizontal coordinates and vertical coordinates resp. of pixels(adjacent pixels), respectively. To calculate WAAD, we use the filter which is modified homogeneous sharpening filter whose size is considered as3 X 3 on the original image. The pixels which are related to the edge have more weights than original one. 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 ,it is suitable for consumer electronic products.

Advantages of DRSHE

- DRSHE ignores unnecessary changes in brightness and It also helps for preserving naturalness of the original image
- Improve overall contrast by using Weighted Average of Absolute color Difference to makes original image have more uniform histogram distribution.
- DRSHE does not use logarithm and exponential computation.

Disadvantages of DRSHE

- In this technique, when histogram is broke, it may results in uneven contrast enhancement.
- This technique involve more computation step, therefore it is time consuming technique and complex.

3.3 Advanced Gamma Correction With Weighting Distribution

Adaptive gamma Correction technique with Weighting Distribution (AGCWD) method provide efficient contrast enhancement. AGCWD proposes a method to modify histograms and enhance contrast in digital images. In this the transformation technique that improves brightness of dimmed images via gamma correction and probability distribution of luminance pixels. Experimental results shows that this

method produces enhanced images of higher quality than those produced using other methods. This method enhance the overall image. Here the intensities of histogram are considered to form a probability density function which in turns will give a new weighted value of cdf (Commulative Density Function).Gamma correction function is used to correct image's luminance. First, the histogram analysis gives the spatial information of a only image that is based on probability and based on statistical inference. In the next step(second step), for smoothing the weighting distribution method is used for the fluctuant phenomenon and thus ignores generation of unfavorable artifacts. In the third and final step, gamma correction phenomenon automatically enhance the image contrast through use of a smoothing curve. Formula for AGCWD method is given below

$$T(l) = l_{max}(l/l_{max})^\gamma = l_{max}(l/l_{max})^{1-cdf(l)} \qquad (5)$$

Where, $l_{max}$is the maximum gray scale level in a grayscale image, l is the value of the current pixel and *cdf(l)* is the cumulative distribution value.
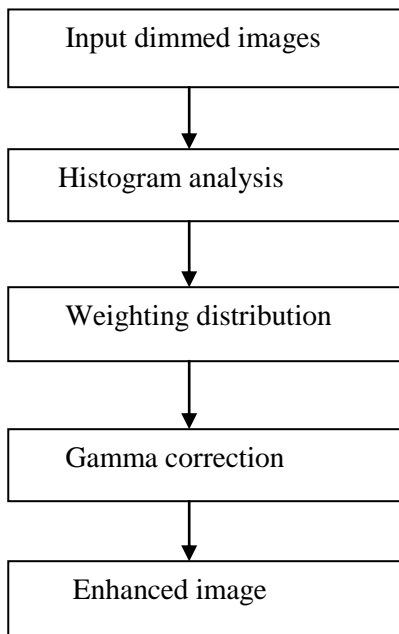

Fig.1. Flow Chart of AGCWD

Advantages of AGCWD

- Transformation technique improves and give better quality of brightness of images(dimmed) with help

of the gamma correction and also improve probability distribution of luminance pixel
- Method produces enhanced images of higher quality with comparison to other methods.
- Efficient method to modify histograms and enhance contrast in digital images

Disadvantages of AGCWD

- It works on whole image ,sometimes enhancement is required only on certain part of image.

4. COMPARISON TABLE FOR ENHANCEMENT TECHNIQUES

In Table 1,it is clearly observe the purpose and conclusion of different techniques.

TABLE 1 Comparing Different Techniques

Technique	Purpose	Conclusions
HE	Contrast enhancement.	Contrast is enhanced in the whole sense
DRSHE	To preserve naturalness of images and to improve entire contrast	Prevent excessive enhancement in contrast&preserve naturalness of image.
AGCWD	Improve brightness and provide efficient contrast enhancement	Produces enhanced images of higher quality

5. CONCLUSION

A large number of enhancement have been proposed in recent past years.. Still there is lot of work to be done and research is continued. Existed methods enhances the image but the issue is that these methods works average on the complete image whereas each region in an image requires variable enhancement in terms of contrast .A method must be developed to create an equal balance between the low computational costs and high levels of visual quality.. Therefore, a new region wise method needed to be adopted for image enhancement.

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