A Survey on Contrast Enhancement in images Using Adaptive Gamma Correction

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Abstract- *Contrast enhancement is the famous and important considerations of digital image processing. Contrast enhancement has an important role in the improvement of visual quality for computer vision and also improve quality of digital images. It improves and enhances visual quality 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 using adaptive gamma correction.*

Keywords- Contrast enhancement, visual quality, computer vision, gamma correction.

I. INTRODUCTION

Contrast enhancement is one of famous techniques for image enhancement. It increases quality by increasing the dynamic range of gray level values of the input image. contrast enhancement methods are used for the providing better quality to contrast of image, images that are dimmed images. It is famous technique for the improvement of of digital images and enhancing images details Contrast is defined as the difference in colour , responsible for making an object (or its representation in the image) distinguishable. In real world in visual perception, contrast is defined as the difference between the color and brightness of the object and other type of objects which are of the same field of view. The human visual system is considered as much sensitive to contrast rather than absolute luminance, the world can perceive similarly by us regardless of the changes in illumination over the day and from place to place. The maximum contrast of the image is known as the contrast ratio or dynamic range. Contrast enhancement is one of the known techniques for image enhancement. It enhance the quality standard by increasing the dynamic range of gray levels of the input image. It is a necessary method for the improvement of enhancement of video or images in imaging processing. Contrast enhancement has very wider range of areas and applications in image processing for both human and computer vision. 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, loss of 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.

II. PREVIOUS WORK

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 HL(X) and HU(X) generated from H(X) are emphasized by median XD. Afterwards, two sub histograms HL(X) and HU(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.

III.EXPERIMENT AND RESULTS

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.

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

for $k = 0, 1, 2,\ldots, L-1$, where Xk is the kth 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

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

for $k = 0, 1, 2,\ldots, L-1$, 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 $0 \le r \le L-1$.

One of the drawback of the histogram equalization can be based on the fact that the brightness of an image can be changed after histogram equalization, that is mainly due to property of flattening of the histogram equalization. Because of this problem it is rare utilized in consumer electronic products such as TV where preserving original input brightness property is necessary in order not to introduce unwanted visual deterioration. The work of the algorithm is the utilization of histogram equalizations that are independent differently on the two images which are sub images obtained by decomposing the input image that is on the basis of its mean with a limitation that the resulting output equalized sub images are bounded by one each other around the input mean. Mathematically, it is shown that the proposed algorithm preserves the mean brightness of a given image significantly compared to histogram equalization when increasing the contrast and, thus, provides more better natural enhancement that can be utilize electronic products..

Adaptive gamma Correction technique with Weighting Distribution (AGCWD) method provide efficient contrast enhancement. Experimental results demonstrate that the proposed method produces enhanced images of comparable or higher quality than those produced using previous state-of-the-art methods**.** 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 . The new value of a pixel in an image is given by:

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

Where, $l_{max}$is the maximum gray scale level in a grayscale image, l is the value of the current pixel . CDF stands for cumulative distributive function. It is a function that calculates the cumulative sum of all the values that are calculated by PMF(Probability Density Function). It basically sums the previous one.CDF is calculated using a histogram. Here how it is done. Consider the histogram shown below which shows PMF.Since this histogram is not increasing monotonically , so make it grow monotonically. simply keep the first value as it is , and then in the 2nd value , and add the first one and so on. Here is the CDF of the above PMF function.

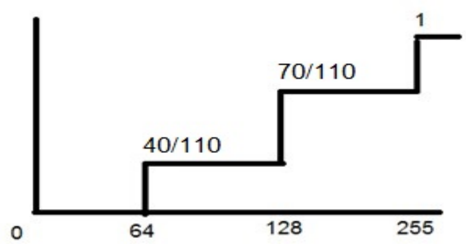

Fig. 1 Histogram Showing PMF

Now as seen from the graph above , that the first value of PMF remain as it is. The second value of PMF is added in the first value and placed over 128. The third value of PMF is added in the second value of CDF , that gives 110/110 which is equal to 1. And also now, the function is growing monotonically which is necessary condition for histogram equalization. In adaptive gamma approach

Step1:read the input image.

Step2*:* *pdf(l)=h(l)/N* ,where *h(l)* is the count for number of pixels at level *l*, *N* is the total number of pixels

Step3:Furthermore, the weighting distribution (WD) function is also applied to slightly modify the statistical histogram and lessen the generation of adverse effects. The WD function is formulated as:

$$pdf\_w\ (l) = pdf\_max\ (((pdf(l) - pdf\_min))\ /\ ((pdf\_max - pdf\_min))\hat{}\alpha\ )$$

where α is the adjusted parameter, *pd f* max is the maximum *pd f* of the statistical histogram, and *pd f* min is the minimum *pd f* . Based on Equation (6), the modified *cd f* is approximated by

$$cdfw=\left(\frac{\sum_{l=0}^{lmax} pdf_w(l)}{\sum pdf_w}\right)$$

Step4: Finally, the gamma parameter based on *cd f* of Equation (5) is modified as follows:

$$\gamma = 1 - cdf_w$$

Step 5: $T(l) = l_{max}(l/l_{max})^{\gamma}$
Repeat 1 to 5 for each pixel in the image

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

This method works average on the complete image whereas each region in an image requires variable enhancement in terms of contrast.

IV. CONCLUSION

Many researches have already been done on histogram equalization and many methods have already been proposed A large number of enhancement have been proposed in recent past years.. Still there is lot of work to be done and research must be 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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