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Recent Trends Towards Improved Image Enhancement Techniques

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Abstract— Image enhancement process includes a couple of techniques that seek to improve the visual appearance of a graphic or to convert the image to an application better fitted to analysis by an individual or machine. The fundamental reason of image enhancement is to bring out detail that is hidden in an image that is covered up in a picture or to expand contrast in a low contrast picture .This paper presents a literature review on some of the image Enhancement techniques for improving images like CLAHE, DBLA, Mix-CLAHE, Histogram Equalization, Adaptive Histogram Equalization etc. This paper ends up with the suitable future directions to enhance the DBLA algorithm further.

Keywords— Image Enhancement, DBLA, Histogram Equalization, Adaptive Histogram Equalization, DBLA.

I. INTRODUCTION

Image enhancement plays a fundamental role in lots of image processing applications. Image enhancement process includes a couple of techniques that seek to improve the visual appearance of a graphic or to convert the image to an application better fitted to analysis by an individual or machine. The principal objective of image enhancement is to change attributes of a graphic to make it more ideal for confirmed task and to a certain observer.

Fig : 1 a) Input Image b) Enhanced Image

During this method, one or more attributes of the image are modified. Digital Image enhancement techniques provide numerous choices for improving the visual quality of images.

II. IMAGE ENHANCEMENT TECHNIQUES

A. Histogram Equalization

Histogram equalization makes the histogram to expand between all the ranges (0,255) and gets more smooth transitions between the pixels of the image[3]. The algorithm average time is 0.1590 seconds for a 240x320 image. It is quite fast because we can process more than 6 images per second.

Algorithm to find histogram[3]:-

1. Compute a scaling factor x=255/number of pixels
2. Calculate histogram using following
a. Create an array histogram with 2b element
b. For all grey levels , I do Histogram[i]=0
c. For all pixel coordinate, x and y, do Increment histogram[f(x ,y)] by 1
3. c[0]=a* histogram[0]
4. For all remaining grey levels, I do c[i]=c[i-1]+a* histogram[i] End for
5. For all pixel coordinates x and y, do g(x, y)=c[f(x , y)]
6. This transformation affect to the histogram as it is showing in the output it has pixels.

Values in all the grayscale range. However in the input histogram the level goes from 0 to 200, so the output image has increase its dynamic range in 50 values. The histogram of a digital image with gray levels from 0 to L-1 is a discrete function

$h(r_k)=n_k$

Where:

r_k is the kth gray level

n_k is the number of pixels in the image with that gray level n is the total number of pixels in the image

k = 0, 1, 2, …, L-1

It gives a quantify of how likely is for a pixel to have certain Intensity. That is, it gives the probability of occurrence the intensity.

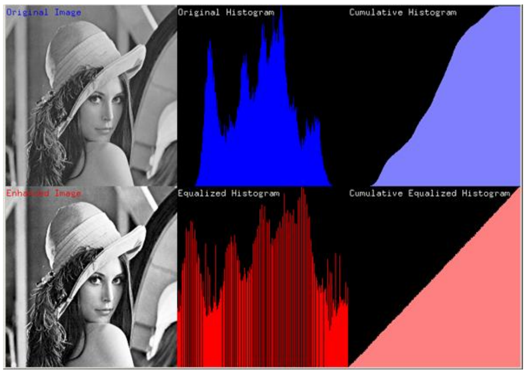

Fig 2: Histogram Equalizations

The sum of the normalized histogram function over the range of all intensities is 1.

Algorithm :

Let rk, k = 1,2,...,m be the intensities of the image, and let p(rk) be its normalized histogram function.

That is, we add the values of the normalized histogram function from 1 to k to find where the intensity rk will be mapped. The range of the equalized image is the interval [0,1].

B. Adaptive Histogram Equalization

Adaptive histogram equalization (AHE) is a computer image processing technique used to improve contrast in images. It differs from ordinary histogram equalization in the respect that the adaptive method computes several histograms, each corresponding to a distinct section of the image, and uses them to redistribute the lightness values of the image. It is therefore suitable for improving the local contrast of an image and bringing out more detail.

However, AHE has a tendency to over amplify noise in relatively homogeneous regions of an image. A variant of adaptive histogram equalization called CLAHE prevents this by limiting the amplification.

C. DBLA

This algorithm computes brightness adaptive intensity transfer functions using the Low - frequency luminance component in the wavelet domain and transforms intensity value s according to the transfer function. Firstly discrete wavelet transform (DWT) is performed on the input images and then using the log-average luminance the LL subband into low-, middle - , and high-intensity layers will be decomposed. Intensity transfer functions are adaptively estimated by using the knee transfer function and the gamma adjustment function based on the dominant brightness level of each layer. After that, the resulting enhanced image is obtained by using the inverse DWT. Although various histogram equalization approaches have been proposed in the literature, they tend to degrade the overall image quality by exhibiting saturation artifacts in both low-and high-intensity regions. The algorithm overcomes this problem using the adaptive intensity transfer function. The algorithm enhances the overall contrast and visibility of local details better than existing techniques. The method can effectively enhance any low-contrast images acquired by a satellite camera and are also suitable for other various imaging.

D. CLAHE

The CLAHE method [4] applies histogram equalization to sub-images. Every pixel of original image is in the focal point of the sub- image. The first histogram of the subpicture is cut and the cut pixels are redistributed to each gray level. The new histogram is not quite the same as the first histogram on the grounds that the intensity of every pixel is inhibited to a client determined maximum. Consequently, CLAHE can lessen the enhancement of noise.

The various steps of CLAHE method are divided as follows[4]:

Step 1: The original picture should be divided into subpictureses which are continuous and non-overlapping. The size of each sub-picture is M×N.

Step 2: The histograms of the sub-pictures are calculated.

Step 3: The histograms of the sub-pictures are clipped.

The number of pixels in the sub-picture is uniformly distributed to each gray level. Then the average number of pixels in each gray level is given as $avg = NSI{-}XP * NSI{-}YP\ Ngraylevel \ldots \ldots$ (1)

where $Navg$ is the average number of pixels, $Ngraylevel$ is the number of the gray levels in the sub-picture, $SI{-}XP$ is the number of pixels in the x dimension of the sub-picture, $NSI{-}YP$ is the number of pixels in the y dimension of the sub-picture.
Based on the Eq. (5), the actual clip-limit is calculated as

$$NC{-}L = Nc * Navg \ldots\ldots (2)$$

where$NC{-}L$ is actual clip-limit, Nc is the maximum multiple of average pixels in each gray level of the sub-image. In the original histogram, if the number of pixels is more than Nc then the pixels will be clipped. The number of pixels scattered averagely into each gray level Nd is defined by the total number of clipped pixels NTC as

$$Nd = NTC\ Ngrayscale \ldots \ldots (3)$$

$$If\ HSI > NC{-}L \ldots \ldots (4)$$

At the end of the above distribution, the lasting number of clipped pixels is expressed as NRP.
.

Figure 3: (a) input image(b) output image

E. MIX-CLAHE
Hitam et al. (2013) presented method to enhance undewater images using a mixture Contrast Limited Adaptive Histogram Equalization. The enhancement method effectively improves the visibility of underwater images and produces the lowest MSE and the highest PSNR values. Thus, it has shown that the mix-CLAHE based method is promising for classifying coral reefs especially when visual cues are visible.

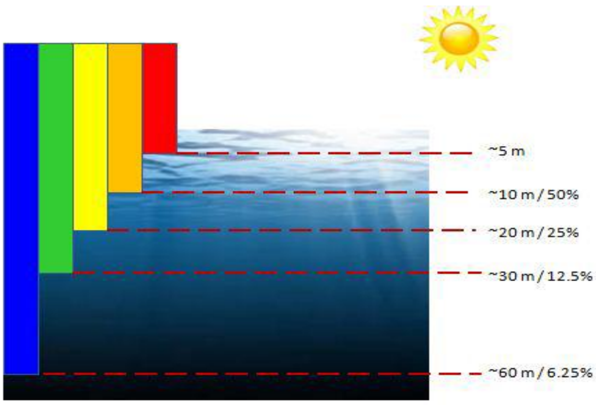

Figure 4: Absorption of light by water

Figure 4 shows an illustration about the absorption of light by water. For every 10m increase in depththe brightness of sunlight will drop by half. Nearly all red light is gone by 50% from the surface but blue continues to great depth. That is why most underwater images are dominated by blue-green coloration. CLAHE-Mix first normalizes the result of CLAHE-RGB.

III. RELATED WORK

All Henan, Wu et al. [1] presented an enhancement algorithm predicated on multi-scale Retinex to be able to improve the potency of remote sensing image enhancement and which can make up the deficiency of traditional wavelet algorithm that losing part information when image enhancement. The principle and realization types of multi-scale Retinex and wavelet were calculated. The experiment of panchromatic and multicolor remote sensing image enhancement were carried out on the basis of the two methods, the end result showed that: the mean valve of enhanced image by this algorithm is all about 125, the entropy and definition may be increased by 5% and 25% in contrast to wavelet algorithm, and remote sensing images could get better enhancement quality, so multi-scale Retinex is a better method for sensing image enhancement. Ehsani, Seyed Pooya et al. [2] proposed an adaptive and iterative histogram matching (AIHM) algorithm for chromosome contrast enhancement especially in banding patterns. The reference histogram, with which the first image needs to be matched, was created predicated on some processes on the first image histogram. Usage of raw information in the histogram of initial image would result in more dependency to the input image and acquiring better contrast improvement. Moreover, the iteration procedure contributes to a gradual contrast enhancement and getting the very best result. The iteration steps can vary with regards to the image characteristics and histogram. To be able to assess the performance of the proposed algorithm in comparison with existing image enhancement techniques, Constant Gain Transform (CGT) and Local Standard Deviation Adaptive Contrast Enhancement (LSD-ACE), a quantitative measurement, the contrast improvement ratio (CIR), was utilized. The experimental results indicate that the proposed method shows the very best results in terms of the CIR measure and, as well as in visual perception. Gorai, Apurba et al. [3] proposed a PSO based hue preserving color image enhancement technique. The procedure can be as follows. Image enhancement is considered as an optimization problem and particle swarm optimization (PSO) can be used to solve it. The caliber of the intensity image is improved with a parameterized transformation function, where parameters are optimized by PSO predicated on an objective function. The intensity transformation function uses local and global information of the input image and the objective function considers the entropy and edge information to assess the image quality. The enhanced color image is then obtained by scaling, which sometimes contributes to gamut problem for few pixels. Rescaling is performed to the saturation component to remove the gamut problem. The algorithm is tested on several color images and email address details are in contrast to two other popular color image enhancement techniques like hue-preserving color image enhancement without gamut problem (HPCIE) and a genetic algorithm based method of color image enhancement (GACIE). Visual analysis, detail and background variance of the resultant images are reported. It has been discovered that the proposed method produces better results compared to other two methods. Panetta, Karen et al. [4] introduced a parameterized LIP (PLIP) model that spans both linear arithmetic and LIP operations and all scenarios between in just a single unified model. In addition they introduced both frequency- and spatial-domain PLIP-based image enhancement methods, such as the PLIP Lee's algorithm, PLIP bihistogram equalization, and the PLIP alpha rooting. Computer simulations and comparisons demonstrate that the new PLIP model allows the user to obtain improved enhancement performance by changing only the PLIP parameters, to yield better image fusion results by utilising the PLIP addition or image multiplication, to represent a larger span of cases compared to LIP and linear arithmetic cases by changing parameters, and to work with and illustrate the logarithmic exponential operation for image fusion and enhancement. Hasikin, Khairunnisa et al. [5]presented a fuzzy grayscale enhancement technique for low contrast image. The degradation of the low contrast image is principally caused by the inadequate lighting during image capturing and thus eventually triggered non-uniform illumination in the image. The majority of the developed contrast enhancement techniques improved image quality without thinking about the nonuniform lighting in the image. The fuzzy grayscale image enhancement technique is proposed by maximizing fuzzy measures contained in the image. The membership function is then modified to boost the image by utilizing power-law transformation and saturation operator. The qualitative and quantitative performances of the proposed method are in contrast to another methods. The proposed method produced better quality enhanced image and required minimum processing time compared to other methods. Juliastuti, E., et al. [6] evaluated the contrast quality of digital image that scanned using both mode based on statistic image characteristic. The outcomes showed that the quality of digitized image using transmission mode is preferable to using reflection mode. However, if direct digital imaging is employed as a gold standard, image enhancement on digitized image continues to be required. Four methods, i.e. contrast stretching, HE, AHE, and CLAHE are accustomed to attempt improve the product quality digitized image. Evaluation of the preference image quality is conducted based on objective criterion. The preference image quality for digitized panoramic image can be obtained by using image enhancement based on CLAHE-Rayleigh method, that indicated by the lowest value of mean, standard deviation, RMSE, and average difference and the larger value of NAE and SAE. Wang, Lung-Jen et al. [7] showed that nonlinear image enhancement may be used to boost the quality of a blurred image using the concept of opportunity cost with image classification. However, one observes from computer simulation that the values of clipping and scaling parameters are very different in image enhancement for various blurred images. Therefore, one aim of the paper is to produce a successful image classification technique to determine the very best mix of clipping and scaling parameters by the chance cost method for image enhancement. Experimental results showed that the proposed opportunity cost method with image classification for the nonlinear image enhancement achieves a much better subjective and objective image quality performance compared to method utilising the opportunity cost without image classification and other nonlinear image enhancement methods.Yaping, Li et al. [8] adopted stepwise refinement method attempts to fix the problem. The proposed method was based on three steps including image preprocessing, image recognition and enhancement. The experimental results show the method can be quite good to deal with such issues. The investigation result shows that the image recognition and image enhancement continues to be not simple process. Therefore, they imagined that image recognition for complex real scene image also isn't simple issues. But the investigation concept of stepwise refinement which will be proposed in the paper supplies a methodological reference for complex image recognition. Peng, Zhang et al. [9] proposed a multi-scales nonlinear enhancement method of THz image. The THz image has lower contrast and bigger noise because the THz radiant power is small, for the purpose of improving the image definition. The THz image is decomposed into multi-scales detail coefficients and approximation coefficients by using the wavelet transform. The detail coefficients are taken to denoise and histogram equalization to be able to enhance this is of image edge and image detail. The approximation coefficients are taken to nonlinear transform to be able to suppress the backdrop noise and enhance target information. The experiment takes the 0.2 THz image for instance to validate the algorithm. The outcomes of experiments and theory analyzing demonstrate that proposed method could boost up the prospective information of THz image and take away the noise of THz image at the same time. Accordingly the brand new method could increase the THz image definition, and avoids the phenomenon that the histogram equalization not just enhances the prospective information but additionally enhances noise. Theory analysis and experiment show that the brand new method is reasonable and efficient, and the THz image enhancement effect is more matching the character of human eye. Sun, Yaqiu et al. [10] **proposed** a novel optical transfer function-based micro image enhancement algorithm. In this algorithm, the point spread function was acquired according the incoherent illuminate in the optical system firstly. Secondly, the optical transfer function(OTF) was obtained and the high-pass filter based on optical property was constructed through the microscopic OTF. Finally, micro image could be processed using the compensating filter. Consequently, the clear and non-obvious Ringing effect micro image was gained. Further more, the micro image enhancement algorithm based on OTF was weighed against image enhancement algorithm based on Butterworth high-pass filter. Experimental results show that the optical transfer function-based micro image enhancement algorithm can produce a better micro image enhancement effect. Teng, Yanwen et al. [11] described the essential tenets of the Laplacian pyramid decomposition, and analysis using user-defined threshold values to tell apart involving the image detail and edges of the disadvantages, and propose to utilize the global information directly to obtain the threshold value method. In the basis of the obtained accomplishment, the limit remapping layers that not just able to cut back time and cost, and can reduce the cost of unnecessary calculations. As they demonstrated, their method produced consistently high-quality results in the act of image detail enhancement. Nercessian, Shahan C. et al. [12] presented a multi-scale image enhancement algorithm centered on a new parametric contrast measure. The parametric contrast measure incorporates not only the luminance masking characteristic, but additionally the contrast masking characteristic of the human visual system. The formulation of the contrast measure could be adapted for just about any multi-resolution decomposition scheme in order to yield new human visual system-inspired multi-scale transforms. In this information, it is exemplified utilising the Laplacian pyramid, discrete wavelet transform, stationary wavelet transform, and dual-tree complex wavelet transform. Consequently, the proposed enhancement procedure is developed. The features of the proposed method include: the integration of both the luminance and contrast masking phenomena; the extension of non-linear mapping schemes to human visual system inspired multi-scale contrast coefficients; the extension of human visual system-based image enhancement approaches to the stationary and dual-tree complex wavelet transforms, and an immediate means of; adjusting overall brightness; and achieving dynamic range compression for image enhancement within a direct multi-scale enhancement framework. Experimental results demonstrate the power of the proposed algorithm to accomplish simultaneous local and global enhancements. Verma, A., et al. [13] proposed a technique that is dependant on genetic algorithm. This process enhances an image with natural contrast. In local contrast enhancement image could be enhanced using four parameters `a ', `b ', `c'and `k ', where `a ', `b ', `c'and `k'are constants. They proposed a technique in that the goal of contrast enhancement is achieved using these parameters with the new extension in their range. Local contrast enhancement advances the gray level of original image on the bases of light and dark edges. This proposed method has applied on m×n size of an original gray scale image. The local mean and local standard deviation of entire image, minimum value and maximum value of the image are accustomed to statistically characterize digital image. Sree, V. Krishna et al. [14] addressed the implementation of image enhancement algorithms like brightness control, contrast adjustment and histogram equalization on FPGA that have become a competitive alternative for high-performance digital signal processing applications. With the advent of mobile embedded multimedia devices that are required to execute a variety of multimedia tasks, especially image processing tasks, the requirement to design efficient and powerful image processing systems in a quick time-to-market schedule must be addressed. Hence, the Image enhancement algorithms implemented in hardware have emerged as the absolute most viable solution for improving the performance of image processing systems. The proposed work provides implementation of efficient image enhancement algorithms on Field programmable gate array (FPGA) using Matlab Simulink. Imtiaz, Mohammad Shamim et al. [15] presented a simple and efficient color image enhancement method for endoscopic images. The proposed image enhancement method functions two interrelated steps: image enhancement at gray level and color reproduction. At, first, the captured RGB endoscopic image is converted into 2 dimensional gray level spectral images utilizing a well-known method called FICE (Fuji Intelligent Color Enhancement). In the next stage the image with maximum entropy is selected as the bottom image to be used for color reproduction. Maximum entropy value indicates the most enhanced image. In color reproduction, the whole chrominance map of a source image is transferred into the bottom image by matching luminance and texture information between two images. The distance between luminance the different parts of target (base image) and source images are calculated using 2-norm Euclidean distance. The proposed color image enhancement method is in contrast to popular narrow-band imaging on the scale of image quality, image enhancement, simulation speed and efficiency of color reproduction and distortion. The proposed method could be applied on any RGB images collected from any white light endoscopic devices. Is highlights the tissue characterization on the surface section of base endoscopic image that allows better diagnosis. Premkumar, S., et al. [16] proposed a novel method for image contrast enhancement based on Discrete Shearlet Transform (DST) for color images. To be able to obtain high contrast enhancement image, the RGB image is first changed into HSV (Hue, Saturation and Value) color space. The converted hue color channel is only taken in to the take into account DST decomposition. After that higher sub bands of hue component are eradicated and lower sub bands are just considered for reconstruction. Finally, high contrast image is obtained by utilizing reconstructed Hue for HSV colour space and convert this colour space into RGB color space. The performance of the proposed contrast image enhancement method is weighed against existing histogram equalization based image enhancement. The visualization based results show that the proposed contrast image enhancement system achieves satisfactory performance. Bhattacharya, Saumik et al. [17] proposed a fast algorithm to increase the contrast of a graphic locally using singular value decomposition (SVD) approach and attempt to define some parameters that may give clues related to the progress of the enhancement process. Negi, Shailendra Singh et al. [18] centered on Contrast Stretching and Image Sharpening techniques. In this paper, an approach that simultaneously adjusts contrast and enhances boundaries is presented. Histogram has been plotted to verify the result of various cases arising due to implementation of contrast stretching on image sharpening. The edges of the objects in the image may also be enhanced by this methodology. Many other edge enhancement techniques may also be available like Contrast Stretching on Adaptive Thresholding for enhancing edges of MRI knee images. The proposed methodology showed definitely better result compared to the one said above. Imtiaz, Mohammad Shamim et al. [19] presented an efficient color image enhancement method for endoscopic images. The enhancement is achieved in two parts: image enhancement at gray level followed by a shade reproduction. The captured RGB endoscopic images are first changed into three 2-D spectral images using a well-known method called FICE (Fuji Intelligent Color Enhancement). Then your image with the maximum entropy is selected as the bottom image to be used for color reproduction next stage. In color reproduction, the chrominance map of a source color image is included with the bottom image. This chrominance map is located by matching luminance and texture information between those two images based on neighborhood statistic method.

IV. CONCLUSIONS

In this paper, survey of various image enhancement techniques has been done. The principal objective of image enhancement is to alter attributes of an image to make it more suitable for a given task and a specific observer. During this process, one or more characteristics of a picture are changed. The choice of attributes and the way that they are modified are specific to a given task. From the survey it has been found that none of the technique performs better in terms of enhancement on images. In this paper the use of the image gradients has been neglected which has the ability to improve the edges of the enhanced images. So in near future we will use image gradients as post processing technique to improve the results. Further enhancement will also be considered by the hybridization of the modified DBLA with the fuzzy based image enhancement.

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