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Various Methods of Enhancement in Colored Images: A Review

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***Abstract*—** Image Enhancement is a technique to enhance images for many applications such as medical diagnosis and analysis, satellite images, agriculture etc. This paper is a review paper which focused on recent methods used by the authors such as soft computing for enhancing images, result of the methods used and also its limitation over the images. The main aim of this paper is to analyse the different proposed methods and to identify research problem.

***Keywords*—** Enhancement, Color Image Processing, Histograms.

I. INTRODUCTION

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. Nowadays, image processing is among rapidly growing technologies. It forms core research area within engineering and computer science disciplines too. Image processing basically includes the following three steps: first, importing the image via image acquisition tools; second, analysing and manipulating the image; and next, output in which result can be altered image or report that is based on image analysis. There are two types of methods used for image processing namely, analogue and digital image processing. Analogue image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques. Digital image processing techniques help in manipulation of the digital images by using computers. The three general phases that all types of data have to undergo while using digital technique are pre-processing, enhancement, and display, information extraction. Image enhancement techniques are explained here in this paper, which are widely used in most medical imaging domains, biological community to biological imaging applications. Image enhancement is one of the most important issues in image processing which can produce more suitable results than its original version for further image analysis and understanding.

II. LITERATURE REVIEW

Various literature are available for enhancement of images in recent trends. Histogram equalization method is used particularly to enhancement for grey level image as well as colored images. The author proposed a direct 3D histogram equalization method by which it gives out a uniform histogram of the colored values [3]. Many author work on color denoising to improve the color image visibility, as author work on the color image enhancement via chroma diffusion. In segmentation it is quite useful as coupling of chromacity and brightness in color images.[4] Many methods fond to be most suitable to different test images for enhancement of low contrast and low intensity color images and it was found by the authors that index of fuzziness and the 'entropy' decreases with enhancement [5]. As soon as technology grows on, many techniques have been arrived by many researchers to recount the research on capturing real life scenes, authors includes different alterations of the original approach by including different recent models of human vision and gamut mapping applications [6]. In another paper author proposed a Gaussian membership function to fuzzify the image information in spatial domain. For the desired appearance of images author define fuzzy contrast-based quality factor and entropy-based quality factor and the corresponding visual factors, which is most fitted for under exposed images [7]. By initial to the recent Retinex by Land and McCann, numerous additional perceptually motivated color correction models have been developed with many different goals, e.g., reproduction of color sensation, robust features recognition, and enhancement of color images. Author says that investigation of RACE make us to put in evidence a common drawback of differential models, to decrease this defect, author devised a local and global

contrast-based and image-driven regulation mechanism which may have a common applicability to perceptually inspired color correction algorithms [8]. In the next edge of technology, author proposed a new technique for natural rendering of color Image based on Retinex. Here, the word "natural" means that the ambience of image should not be changed after enhancement through motivated by Retinex theory and histogram rescaling techniques, the proposed method tries to realize natural rendering of image with respect to the constraints listed above. According to author there were still need to be improvement in the empirical formulas of global mapping and the design of reference map [9]. Furthermore the another author proposed a new algorithm of natural enhancement of color image which is motivated by multi scale Retinex model. In this work, it is believed that image enhancement should avoid dramatic modifications to image such as light condition changes, color temperature alteration, or additional artefacts introduced or amplified. Disregarding light conditions of the scene usually leads to extraordinarily sharpened images or dramatic white balance changes. In the proposed method, the ambience of image is maintain after enhancement, and no additional light sources are added to the scene, and no halo effect and blocking effect are amplified due to over enhancement. It realizes a natural enhancement of color image [10]

Many work has been carried out in the field of image processing for the sake of enhancement for color images to improve the quality and visibility of the images. Table 1 shows the dramatically evaluation of the image enhancement techniques with recent trends. It shows the study of different techniques used for image enhancement by utilizing different areas. It also displayed the limitation of the methods used for enhancement: author Zhu Ronga, Zhu Lib, Li Dong-nan, used the histogram equalization technique on colored image to improve the contrast of the color heritage Image and try to give the dramatic improvement in Image and its structural details. There is not much improvement have been done for different images [14]. Different authors have given their different approaches to make enhancement in color images on domains by using different area of specialisation like artificial intelligence, neural networks vice versa.

III. IMAGE ENHANCEMENT TECHNIQUES

Image enhancement is mainly improving the visibility and quality of information in images or human viewers and giving best input for other automated image processing technique. There are different techniques that can make enhancement in a digital image without degrading it. The enhancement techniques can widely categorized in to the following two: 1. Spatial Domain Methods 2. Frequency Domain Methods. In spatial domain techniques, it directly deals with the image pixels. The pixel values are manipulated to achieve desired enhancement. In frequency domain methods, the image is first transferred in to frequency domain. It means that, the Fourier Transform of the image is computed first. All the enhancement operations are performed on the Fourier transform of the image and then the inverse Fourier transform is performed to get the resultant image. There are different methods are available to enhance the images which are described below

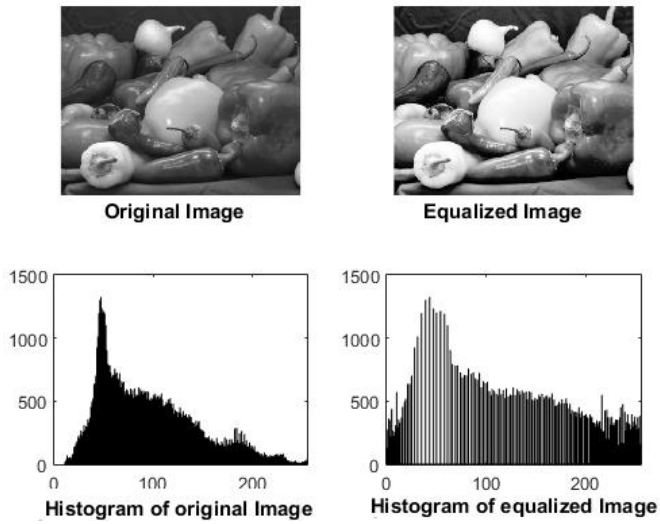

Figure 1.: Histogram Equalization

3.1 Contrast Stretching

Contrast stretching technique is used to stretch the dynamic range of an image. Dynamic range is the range between the minimum intensity value and the maximum intensity value of an image. This transformation will provide good visual representation of the original scene but some of the detail maybe loss due to saturation and clipping as well as due to poor visibility in under-exposure regions of the image.

Each pixel *P* is scaled using the following function:

$$P_{out} = (P_{in} - c) [(b-a) / (d-c)] + a$$

Where *a* and *b* are the lower and the upper limits respectively, and *c* and *d* are the lowest and highest pixel values currently present in the image.

1. 3.2 Histogram based Techniques

- **3.2.1 Histogram Equalization**

The main objective of the histogram equalization is to give out the grey levels of an image so that each grey level is equally occurring. This will enhance the brightness and contrast image of type dark and low. The transformation equation is given below for changing pixel value x to I(x) by which image can be enhanced.

The new intensity value of pixel x is calculated by the given expression below: I(x) = round[cdf(x)-min(cdf) x (L-1)/(1-min(cdf))]
There may be some cases were histogram equalization can be worse. In those cases the contrast is decreased. Output image after Histogram Equalization is given above in figure.

3.2.2 Adaptive Histogram Equalization

AHE (Adaptive Histogram Equalization) is a computer image processing technique used to improve contrast in images. It may vary from normal histogram equalization in the respect that the adaptive method covers number of histograms, each equivalent to altered section of the image, and used them to reorganize the brightness values of the image. It is fit for getting better the local contrast of an image and come out more picture detail. However, AHE technique has drawback that it results in amplify noise in comparatively homogeneous regions of an image It can be solved by using the modified technique called contrast limited adaptive histogram equalization (CLAHE) which avoid the amplification of noise by restricting the amplification process. Ordinary histogram equalization makes use of the same conversion derived from the image histogram to change all pixels. It works fit when the division of pixel values is similar all over the image. Output image after Adaptive histogram Equalization is given in figure 3.

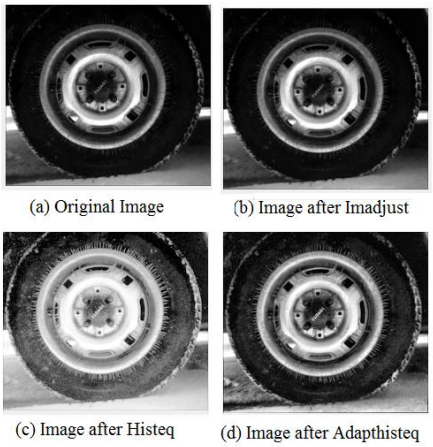

Figure-2: Adaptive Histogram Equalization

3.2.3 BI- Histogram Equalization (BBHE)

BBHE method categorized the image histogram into two parts. In this method, the partition intensity is represented by the input mean brightness value, which is the average intensity of all pixels that construct the input image. Then the BBHE equalizes the sub-images autonomously based on their relevant histograms with the limitation that the samples in the proper set are mapped into the range from the minimum gray level to the input mean and the samples in the latter set are mapped into the range from the mean of the maximum gray level. Thus, the resultant equalized sub-images are surrounded by each other around the input mean, which has an outcome of preserving mean brightness.

Gray Level Grouping (GLG)

The basic principle involved in this technique is as follows, in first step we assemble the histogram components into an appropriate number of gray level bins according to their amplitudes in order to initially trim down the number of gray bins. The main aim of this technique is to get a regular histogram for a low contrast color image. Previous histogram equalization outcome in under or over contrast image since it leaves too much blank space on the grayscale. The shortcoming of GLG is that it is not computationally capable compared to fuzzy-based methods.

3.3 CLAHE

CLAHE represents the Contrast limited adaptive histogram equalization. CALHE does not need any weather forecasted information for the processing of fogged image. Initially, the image clicked by the camera in foggy condition is converted from RGB (red, green and blue) color space is converted to HSV (hue, saturation and value) color space. The images are to be transformed because of the human sense colors similarly as HSV represent colors. And the value component is routed by CLAHE without effecting hue and saturation. As a contextual region, it uses histogram equalization. The original histogram is going to be cropped and the cropped pixels are again distributed to every gray-level. In this each pixel value is trim down to maxima of user selectable. And hence, the image carried out in HSV color space and is converted back to RGB color space. Output images after Clahe is given in figure 4.

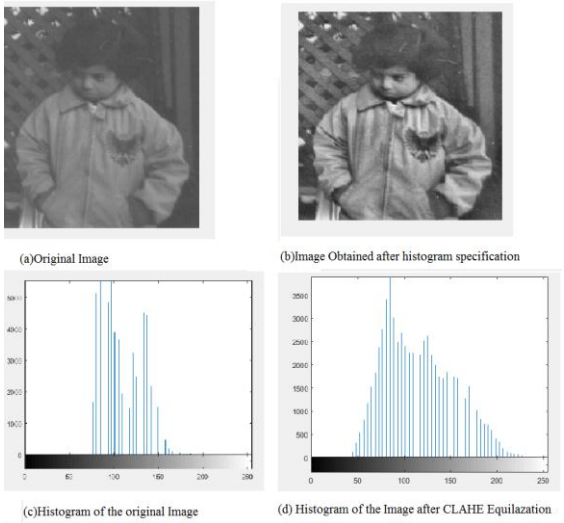

Figure-3: Enhancement using CLAHE Technique

IV. ANALYSIS OF ENHANCEMENT TECHNIQUES BY DIFFERENT AUTHORS

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values [3]. Many author work on color de-noising to improve the color image visibility, as author work on the color image enhancement via chroma diffusion. In segmentation it is quite useful as coupling of chromacity and brightness in color images [4]. Many methods fond to be most suitable to different test images for enhancement of low contrast and low intensity color images and it was found by the authors that index of fuzziness and the 'entropy' decreases with enhancement [5]. As soon as technology grows on, many techniques have been come into existence by many researchers to recount the research on capturing real life scenes, authors includes different alterations of the original approach by including different recent models of human vision and gamut mapping applications[6]. In another paper author proposed a Gaussian membership function to fuzzify the image information in spatial domain. For the desired appearance of images author define fuzzy contrast-based quality factor and entropy-based quality factor and the corresponding visual factors, which is most fitted for under exposed images [7]. By initial to the recent Retinex by Land and McCann, numerous additional perceptually motivated color correction models have been developed with many different goals, e.g., reproduction of color sensation, robust features recognition, and enhancement of color images. Author says that investigation of RACE make us to put in evidence a common drawback of differential models, to decrease this defect, author devised a local and global contrast-based and image-driven regulation mechanism which may have a common applicability to perceptually inspired color correction algorithms [8]. In the next edge of technology, author proposed a new technique for Natural Rendering of Color Image based on Retinex. Here, the word "natural" means that the ambience of image should not be changed after enhancement. Through, motivated by Retinex theory and histogram rescaling techniques, the proposed method tries to realize natural rendering of image with respect to the constraints listed above. According to author there were still need to be improvement in the empirical formulas of global mapping and the design of reference map [9]. Furthermore the author proposed a new algorithm of natural enhancement of Ccolor image which is motivated by multi scale Retinex model. In this work, it is believed that image enhancement should avoid dramatic modifications to image such as light condition changes, color temperature alteration, or additional artifacts introduced or amplified. Disregarding light conditions of the scene usually leads extraordinarily sharpened images or dramatic white balance changes. In this method, the ambience of image is maintain after enhancement, and no additional light sources are added to the scene, and no halo effect and blocking effect are amplified due to over enhancement. It realizes a natural enhancement of color image [10].

Many works has been carried out in the field of image processing for the sake of enhancement for color images to improve the quality and visibility of the images. Table 1 shows the dramatically evaluation of the image enhancement techniques with recent trends used are shown which show the study of different techniques used and the utilization of different areas with their limitations: author Zhu Ronga, Zhu Lib, Li Dong-nan, used the histogram Equalization technique on colored image to improve the contrast of the color heritage image and try to give the dramatic improvement in Image and its structural details. until unless there is not much improvement have been done before for different images [14]. Different authors have given their different approaches to make enhancement in color images in different application domains by using different area of specialisation like artificial intelligence, neural networks vice versa.

Table1: Analysis of Enhancement Techniques by Different Authors

SN	Technique	Àuthors'Name/Journal	Year	Objective	Output	Limitations
1.	Partial differential equations or diffusion flows	Bei Tang, Guillermo Sapiro/ IEEE Transactions On Image Processing	2001	Color Image Enhancement via Chromaticity Diffusion	proposed a algorithm by extracting the color data chomoticity and brightness	need to perform a complete analysis of the harmonic energy
2.	Natural Rendering based on Retinex	Shaohua Chen and Azeddine Beghdad/ IEEE Transactions in Image Processing,	2009	the ambience of image should not be changed after enhancement	proposed method tries to realize natural rendering of image with respect to the constraints	the proposed method works poorly with unnatural images.
3.	multi scale Retinex model	Shaohua Chen, Azeddine/ Springer, EURASIP Journal on Image and Video Processing	2010	To avoid dramatic modifications to image	the ambience of image is maintained after enhancement, and no additional light	For some unnatural scene images still need to be retrained for a better

					sources are added to the scene	performance
4.	Sub Image Histogram Equalization	Kuldeep Singh, Rajiv Kapoor/ Pattern Recognition Letters, Elsevier	2013	To use Histogram Equalization methods in terms of image visual quality, entropy preservation and better contrast enhancement	proved very effective technique for enhancing under exposed images. The histogram clipping technique is also combined with histogram equalization to provide control on over enhancement that leads to natural enhancement.	-
5.	Scale Invariant Feature Transforms algorithm on Wavelets	Kirti Khatkar, Dinesh Kumar/ Elsevier	2015	to present a method to enhance the biomedical images	A comparative study of the performance of different wavelets with the proposed method has been presented and it has been found that the proposed method provides better results than other wavelets.	Still required image quality improvement
6.	Histogram Equalization on Colored Image	Zhu Ronga, Zhu Lib, Li Dong-nan/ Elsevier	2015	To make improvement for the contrast of the color heritage image	Improvement in image contrast and enhanced structural details of heritage images.	-
7.	artificial bee colony algorithm	Jia Chena, Weiyu Yua, Jing Tianb,c,□, Li Chenb,c, Zhili Zhoud/ Elsevier	2017	to improve the contrast level of images, which are degraded during image acquisition.	develops a new objective image contrast fitness function by incorporating a new image contrast measure	
8.	improved adaptive gamma correction	Gang Cao, Lihui Huang ,Huawei Tian, Elsevier	2017	Contrast enhancement of brightness-distorted images	The contrast of both bright and dimmed input images is enhanced effectively and efficiently without incurring annoying artifacts	It is limited to dimmed and bright ones.
9.	hue-preserving color image enhancement	Hengjun Yu, Kohei Inoue, Kenji Hara, Kiichi Urahama ICT Express,	2017	to improve the saturation of colors during hue-preserving	proposed method increases the saturation of given color images	-

	methods.	Elsevier		color image enhancement without the gamut problem	better than do the conventional methods	
10.	improved histogram equalization and wavelet transform	Xi Qiao, Jianhua Bao, Hang Zhang, Lihua Zeng, Daoliang Li/ Information Processing In Agriculture, Elsevier	2017	to enhance the sea cucumber image quality	For sea cucumber underwater image-improves the contrast -reduces the noise -avoids the effect of under- and over-enhanced areas in the image output. -improve the quality and visualization	-

V. RECENT TRENDS IN THE ENHANCEMENTS OF COLORED IMAGES IN DIFFERENT APPLICATION AREAS

Some recent trends which are giving good result for enhancing the colored images. These are - Neural Network, an Artificial Bee Colony, Genetic Algorithm, Fuzzy techniques, Quantum Mechanics, Swarn Intelligence Techniques, Automatic Brain MRI Classification Modified Ant Colony System and Neural Network Classifier, An Adaptive Bacterial Foraging Algorithm, Hybrid Ant Colony Optimization, Genetic Algorithm, and Simulated Annealing for image contrast enhancement. A Novel Adaptive Cuckoo Search Algorithm, A New Adaptive Gamma Correction Based Algorithm, Entropy-Preserving Mapping Prior Hessian Matrix and STFT.

VI. CONCLUSIONS

We conclude that recent techniques used by authors gave a better result to improve the information in images for human vision. Some techniques are very effective for enhancing under exposed images. The histogram clipping technique is combined with histogram equalization to provide control on over enhancement that leads to natural enhancement. Artificial bee colony algorithm improved the contrast level of images, which are degraded during image acquisition.

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