A Review of Image Enhancement Algorithms for Low-contrast, Infra-red and Night Image

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***Abstract*— This work presents reviews of various image enhancement techniques and methods used by researchers, to bring out the ideas to overcome the drawbacks by using combinations of algorithms which is efficient and cost-effective. To obtain a best quality Image, it is important to device an algorithm that combines more than one algorithm. The main objective of this paper is to use the algorithm which is efficient and cost-effective. So it is important to obtain a best quality image, it is best to construct an algorithm that gives a enhanced image from an original image of any type like low contrast image, infrared image and also night image.**

***Keywords*— Histogram equalization, Affine Scale invariant Feature Transform (ASIFT), scale invariant Feature Transform (SIFT), AHE, Automatic colour exchange (ACE), RETINEX.**

I. INTRODUCTION

Image processing is a method to get an enhanced image from an image by performing some operations on an image to extract some useful information from it. One of rapidly growing technology is image processing. Two important components of digital image processing are image enhancement and information extraction. Visibility of any portion or feature of an image can be improved with the help of image enhancement techniques by suppressing the information on other part of an image statically information about any part or feature of an image.

The digital image is given as an input to a computer and it is programmed using a series of equations, or an equation to manipulate the given image and computation for each pixel which is known as pixel element is stored as results of computation. A new digital image is formed which is recorded or displayed un pictorial format or manipulated further by some additional programs. But possible formats of the manipulation of a digital image are literally infinite. To enhance fine features in an image data and to eliminate noise, the digital image is submitted to many images processing operation. Figure below depicts the importance of image enhancement.[1]

Fig.1 a.Original Image b.Enhanced Image

II. TYPES OF CATEGORIES IMAGE PROCESSING METHODS AND TECHNIQUES

Three functional categories of image –processing methods may be grouped as:

1. Image Restoration
2. Image Enhancement
3. Information Extraction

A. Image Restoration

During the playback operations, recording and scanning, data errors, noise and geometric distortions are introduced which is compensated by Image Restoration. Techniques used in Image Restoration methods are

- Restoring periodic line dropouts
- Restoring periodic line striping
- Filtering of random noise
- Correcting for atmospheric scattering
- Correcting geometric distortions

B. Image Enhancement

Altering the visual impact of an image which has on the interpreter in a fashion which improves the information content.[2] Techniques used in Image enhancement are

i. Contrast enhancement
ii. Intensity, hue and saturation transformations
iii. Density slicing
iv. Edge enhancement
v. Making digital mosaics
vi. Producing synthetic stereo images.

C. Information Extraction

To classify and recognize the pixels on the basis of their digital signatures, the decision-making capability of the computer is utilized by information extraction. The techniques used in Image extraction are:

i. Producing principal-component images.
ii. Producing ratio images
iii. Multispectral classification
iv. Producing change-detection image.

III. IMAGE ENHANCEMENT TECHNIQUES

Modification of an image to alter impact on the audience is Enhancement. Normally the original digital values are distorted by enhancement. So only after restoration process done, enhancement is done completed. Basically there are two types of image enhancement techniques.

i. Spatial Domain technique
ii. Frequency Domain Technique

A. Spatial Domain technique

Method concerned with pixels of input digital images is known as spatial domain Method[2]. Logarithm transforms, histogram equalization and power law are belonged to spatial domain techniques are based on direct manipulation of the range of pixels. Spatial domain techniques are useful for changing the gray level values and the contrast of whole image. But it makes unusual results. The pixel values of the computed image depend on the values of an original image. Expression is given by the $g(x ,y) = T[f(x ,y)]$, T is a gray level in transformation.[4]

B. Frequency Domain Technique

Frequency domain techniques content of depends on the orthogonal transform of an image instead of image itself. Two components of orthogonal transform are magnitude and phase. Magnitude components based on frequency content of an image and phase components is used restore the image to the spatial domain. Frequency domain techniques make use of Hartley Transform, Fourier transform etc. The operation on the content of frequency of poor contrast image done by transform domain. Subtle knowledge and edges can be enhanced by high frequency content. The General look off an image over smooth areas is controlled by low frequency contents in Fourier transform. Enhancement of an image $f(x ,y)$ is on frequency domain based (DFT) is an enhanced image is given by $g(x ,y) = h(x ,y)*f(x ,y)$.[4]

C. Histogram Equalization

Gray levels of an image are measured using Histogram. Histogram can be denoted by discrete function on an image. Histograms are used to take decision about an image whether it is light image or dark image or low contrast or high contrast image. He is used to increase or enhance visual appearance of an image [3]. Dynamic range of pixels are grown for the image appearance, Histogram equalization technique is used**.** Useful for homogeneous image. Figure 2 below depicts this.

Fig.2 a. Original Image b. After Histogram Equalization

This method is useful only for homogeneous images. When this method is applied to non-homogeneous images the results are not satisfied. The Figure 3 shows this transparently.

Fig. 3 a. Original Image b. After Histogram Equalization

D. Adaptive Histogram Equalization

Superior images are produced by AHE when compared with interactive contrast enhancement. It is proved that if the original image has more dark regions, better image quality image is produced. Not only that many variations in the gray level of an image, that adaptive histogram equalization doesn't give good results. It also proved that in AHE not only images enhanced but also noise in the image also enhanced. AHE [5] is suitable for improving the local contrast of an image and doesn't bringing out more detail of night image. Adaptive histogram equalization is used to remove the noise or suppresses the noise. A Figure below depicts the image enhancement using Adaptive Histogram Equalization.

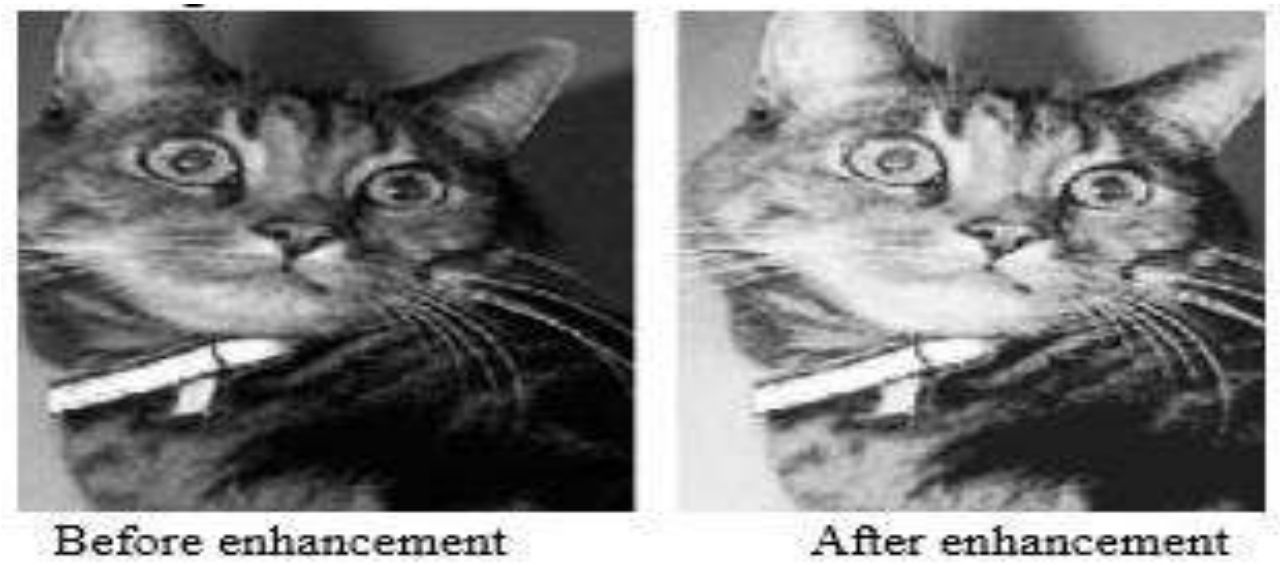

Fig. 4 Adaptive Histogram Equalization

AHE [5] is quite computationally expensive for night image which is depicted pictorially below.

Fig. 5 a. Original Image b. After Adaptive Histogram Equalization

E. Contrast-Limited Adaptive Histogram Equalization (CLAHE)

Serious problem to infra-red images is low contrast and signal-to-noise ratio (SNR) because of effect of atmosphere and character of infra-red detectors. Contrast-Limited Adaptive histogram equalization algorithm[6] is the combination of limited contrast approach with adaptive. CLAHE algorithm is used to enhance an image for better quality and to remove the noise. It provides the expensive computation complexity for night image. The Figure below explains the image enhancement using CLAHE.

Fig.6 Original Image and Enhanced Image by CLAHE

It is advantageous not to discard the part of the histogram that exceeds clip limit but to redistribute it equally among all histogram bins which is illustrated by the Figure below.

Fig.7 Original Image and Enhanced Image of Night Image by CLAHE

F. RETINEX

RETINEX is a simple method of the HVS quantity called "lightness" which is associated to the object not to the changes in the illumination or in the position of the objects. The lighten information is estimated by calculating sequential ratios between values at adjacent points. RETINEX is suitable for enhancement of night image. The Figure below describes the image enhancement by RETINEX method. The below figure depicts the enhanced night image by RETINEX method where we can Number plate of the car during night.

Fig.8 Original Image and Enhanced Image of Night Image by RETINEX

G. Automatic colour Enhancement(ACE)

ACE means automatic color enhancement is a simplified model of the human visual system. The enhancement process is consistent with perception. Better enhancement of night image is achieved through ACE by the concept of obtaining a global white balance. In this method enhanced night image appears natural because the input image is adjusted in a manner consistent with perception. The Figure given below depicts enhanced Night Image by ACE method.

Fig.9 Original Image and Enhanced Image of Night Image by ACE

IV. LITERATURE SURVEY

Table 1: Study on Comparative Study of Existing Algorithms

Ref No.	Methods & Algorithms	Type Of Data	Results	Conclusion
KIM et.al[13]	Mean preserving bi-histogram equalization	Low Intensity image	conserve the mean intensity of an image	Mean intensity image is not enhanced.
SnehalO.Mundhadaet.al [12]	Spatial and Transformation Domain Techniques	Poor contrast image	Enhance the whole image in a uniform manner.	Produces undesirable results for images with different qualities of contrast and edge information
RakhiChanana et.al [21]	Spatial Domain based Image Enhancement	Scanned Electron Microscope (SEM) images	It helps in enhancing the details over small dark areas in an image.	Not useful for images having large darker area in an image.

ZaidAlbatainehet.al [14]	RobustICA based algorithm	Low Intensity Image, Poor Contrast Image, Under Water Image	To solve the frequency domain BSS problem for convolutive acoustic mixtures in several adverse conditions.	1.loss of infrequently distributed pixel intensities 2. Computing Complexity and Cost expensive.
Tae et al. [15]	Block-overlapped histogram equalization	Except night image	Exhibits quality upgradation by preserving infrequently distributed pixel intensities,.	Large computational and storage requirements.
Mithilesh Kumar et al.[3]	Contrast Limited Adaptive Histogram Equalization technique and Wiener filtering	Gray Scale Image	Yields perfect contrast enhancement by preserving the brightness of given image and sharpening of images .	1. Sharpness and Brightness makes image to loose the details of original image. 2.Impossible to implement Hardware and Consumer electronics
Fan et al. [6]	HE with Gaussian Filter	Multiple-Peak Images	Method out performs other algorithms on the aspects of simplicity and adaptability.	1.Good performance in the area of image enrichment. 2Requires large Storage and computing complexity.
Y. F. Liu et al. [18]	stratified parametric-oriented histogram equalization (SPOHE)	Integral Image	To provide a regional enhanced effect without visual artifacts	Significantly decreases the computational complexity and produced error-free results.
G. Lyu et al.[19]	visual perception enhancement algorithm	Night image	For high speed railway in the low light condition	Does not provide good quality for day image.
D. Wang et al.[20]	Piecewise-based contrast enhancement Algorithm	Low lighting image	Gives more important To background of an night image	Foreground detail of a Night image is not enhanced.

V. GAPS IN EARLIER WORK

This literature survey found the limitation of Histogram equalization method is used to pre-process the original image, pre-processed original image is used as input to ASIFT algorithm & SIFT algorithm to achieve the extraction and matching of Image feature points but it leads to more grains in quality of an image. Histogram specification has ability to adjust the colors and saturation of the image efficiently; so will produce better results but produced grains. To avoid the grains in an image, the S-curve algorithm is applied to enhance the image quality. Also no algorithm is constructed to get a better quality image of any type of image. .However as nonlinear image enhancement has produced accurate results for intensity, so we can apply histogram specification only for H and S. The quality of the image will be improved can be assured.by combining any of two or more algorithms from the algorithms which are discussed above, better quality image of any type of image like infrared or night image can be achieved.

VI.CONCLUSION & FUTURE WORK

In digital image processing, the image enhancements techniques play a significant role. It is discussed in this survey paper that the HE (nonlinear image enhancement) can be used to improve the quality of a poor quality or blurred image by using the concept of the light source refinement. It has been found that the available technique does not provide better results by providing grain in image in multiple light sources since hue and saturation is not modified . As discussed earlier the image enhancement technique can be improved by modifying the hue and saturation along with the combination of two or more algorithms.. It will provide better results than the existing techniques. This work has focused on finding the possible solution for the limitation of the existing work.. In near future suitable algorithm will be constructed to implement the possible solution. From this review paper it is suggested that by combining the HE algorithm, CLAHE algorithm and by adjusting H component value and S component value in HSV space better quality image can be achieved. To get good effect for night, blurred and infrared image the proposed approach can be used which also reduces Computing complexity and cost.

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