iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** IV **Month of publication:** April 2018

DOI: http://doi.org/10.22214/ijraset.2018.4054

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue IV, April 2018- Available at www.ijraset.com

A Survey on Spatial Domain Image Enhancement Techniques

B.Rupa[1], G.Karuna[2], G. Venkata Rami Reddy[3]
[1, 2] *Department of Computer Science and Engineering, GRIET, Hyderabad*
[3] *School of Information Technology, JNTUH, Hyderabad*

Abstract: ***Image Enhancement is one of the challenging issues in computer vision and image processing. The major goal of image enhancement is to increase the quality of image with respect to contrast and visual appearance or structural appearance without any degradation in the input image. The enhancement techniques mainly used for the identification of important features more easier by eliminating noise and other artifacts in an image. There are many image enhancement techniques existed which are mainly based on spatial and frequency domains. The spatial domain enhancement techniques basically deal with image intensity values or pixels and in second domain an image is transformed into frequency domain using fourier transforms, etc. This paper mainly explores various special domain image enhancement techniques which provides better contrast, visual appearance and further leads to improvement of image quality. Especially histogram equalization is a prominent enhancement method which is used for contrast adjustment using histograms so that quality of image has been improved.***
Keywords: Image Enhancement, Spatial domain, Frequency domain, Histogram

I. INTRODUCTION

Image Processing is a processing of an image so that it takes image as an input and the output of processed image may be either an image or set of image characteristics. Image processing is a method used to enhance original images captured through camera or sensor and improves the quality using various techniques [1]. These techniques are image segmentation, image enhancement, elimination of noise, image restoration, object or feature detection, image compression, etc. Mostly the digital images are always suffered by blurring, noise, less contrast and invalid color balance and lack of visual appearance. In general the digital images that can be formed through various scanners, digital cameras, video cameras, webcam and so on can be widely suffered from such above said problems which cause low quality digital images.

Image enhancement methods are useful to reduce the effects of various degradation problems and increases contrast [2]. There are large number of image enhancement methods proposed especially, an enhancement of color digital image is to process the luminance and color information to shape an image with sharp details, more color compatibility and better visual appearance without any distorting or shifting of color. The image enhancement is to process a digital image and the resultant image is more suitable than the original image for a precise application. Image enhancement methods are used for various applications like satellite images, medical images, remote sensing images and many real time images. The objective is to improve contrast and other characteristics of an image so that a clear and noiseless image has been produced [3].

Image enhancement is a method which enhances raw original image captured from video/ digital cameras, various sensors that are placed in artificial satellites, drones, space probes, the artifacts and many real time natural images. The basic steps involved in processing an image are image scanning, storing image, image enhancing and interpretation. The image scanner-digitizer diagram is given in below fig1. There are two methods for image processing. They are analog and digital image processing.

A. Analog Image Processing

Analog Image Processing mainly represents the modification of image in terms of electrical and the common example is the television image. The television signal is a voltage level which varies in amplitude to represent brightness through the image. By electrically varying the signal, the displayed image appearance is altered [4].

B. Digital Image Processing

In digital image processing the digital computers are used to process an image. Here the captured image will be transformed to digital form using a scanner – digitizer and it is processed. It is defined as the subjecting numerical representations of objects to a series of operations in order to obtain a desired result. It starts with one image and produces a modified version of the same. It is therefore a process that takes an image into another.

©IJRASET (UGC Approved Journal): All Rights are Reserved

Digital image processing involves the processing of a 2D-image by a digital computer. In a broader context, it implies digital processing of any two-dimensional data. The major benefit of digital image processing is its versatility and information is preserved for original image [5].

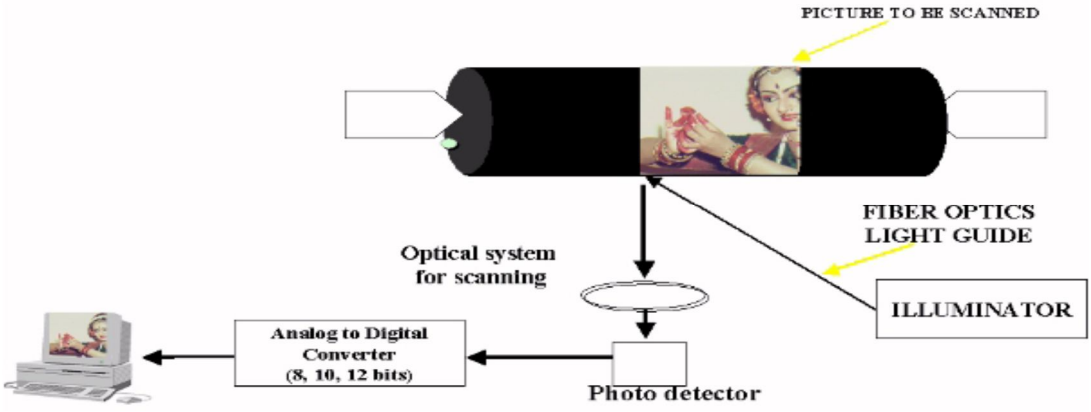


Fig 1. Image scanner-digitizer diagram

The rest of this paper is organized as follows. In Section II, we present image enhancement and its techniques. In Section III, we introduce various image enhancement techniques in spatial domain. Then, a brief conclusion is presented in section IV.

II. IMAGE ENHANCEMENT

Image enhancement methods can be broadly categorized into following two methods shown in Fig 2: Spatial Domain Enhancing Methods and Frequency Domain Enhancing Methods. The spatial domain enhancing techniques will directly operate on the pixels of digital image. The intensity values of images are manipulated in order to achieve required enhancement. The spatial based domain methods are easy to understand and conceptually simple so that complexity has been reduced [6]. However these techniques have not easy to providing ample robustness and imperceptibility requirements. The frequency domain methods are mainly used for transforming image into frequency domain.

Initially the Fourier transform of the image is computed. Then the resultant Fourier transform is multiplied with an appropriate filter to transfer function. Finally the inverse Fourier transform is applied for obtaining resultant image. This is basically used to illustrate the examine the mathematical functions and signals based on its frequency and perform directly on the transform coefficients of the image, such as Fourier transform, discrete wavelet transform (DWT), and discrete cosine transform (DCT). The benefits of frequency domain enhancement methods are, low computational complexity, managing the frequency composition of the image [7] and the limitations are, unable to enhance all the portions of image concurrently in better way and there is a complexity in using this process. Image enhancement is applied in most of the fields where digital images are affected with noise and contrast problems so that quality is not achieved. To understood and analyzed image enhancement, variety of image enhancement techniques existed and described in literature [8].

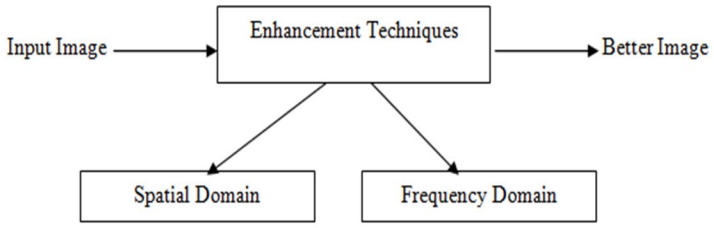


Fig2. Image Enhancement techniques

A. Spatial Domain Enhancement Method

Spatial Domain enhancement techniques are mainly used to represent the techniques that perform manipulation operation on individual pixels of given image [9]. It actually includes point arithmetic operations and neighbourhood enhancement algorithms for manipulation of pixels.

©IJRASET (UGC Approved Journal): All Rights are Reserved

Point arithmetic operations involved the histogram equalization and gray-level transformation. Gray-level transformation consists of linear, logarithmic and power-law transformation. The linear Transformation may result in detection or Negative transformation of an image. Logarithmic transformation may enlarge the darker pixels of an image and higher values are compressed which yields an enhanced image. Power law transformation may include n-th root or n-th power transformation. The degree of enhancement may be adjusted depending on the value of n.

Histogram equalization may ensure the uniform distribution of gray levels, but major drawback is that it cannot highlight the edges of the image and cannot be applied to detection Applications. Neighbourhood enhancement algorithms comprises of image sharpening and image smoothing methods. To avoid noise image smoothing technique is used and image sharpening concentrates on the edges, but eliminates the contrast of the Image.

B. Frequency Domain Enhancement method:

In frequency Domain the Fourier transform of an image is computed and then multiply the result by using a filter. Now apply the Inverse Fourier transform to get the original Enhanced image. The frequency domain method includes low-pass filtering, high-pass filtering and homomorphic filtering. In Low pass-filtering high frequency components are eliminated and low frequency components are retained [10]. Typical filters are Butterworth low pass filters which can remove the sharp transitions associated with noise and thus may denoise the image and preserve the information. Similarly high pass filters may remove low frequency components and preserve the high frequency components and homomorphic filters may be used to extract illumination and reflectance components from the image. However in the case of medical images, the above specified methods process whole image, and may hide both partial and specific information and thus can be interfered by the noise easily. Therefore, it cannot meets the requirements of the medical image processing.

Image enhancement will play an important role into different fields such as medical, industrial, military and scientific applications. In addition to these applications, image enhancement is increasingly being used in consumer electronics [11]. Internet Web users, not only rely on built-in image processing protocols such as Joint Photographic Expert Group(JPEG) and interpolation, but the users equipped with dominant yet inexpensive software such as Photoshop. Users retrieve digital images not only from the Web but they are now able to obtain their own by use of digital cameras. Image enhancement is an essential tool for researchers in a wide variety of fields:

1) Image enhancement is used in forensics for identification, proof gathering and surveillance. Images taken from the analysis of security video clips, face detection, finger impression detection, and crime scene investigations are usually enhanced to help in order to identify the culprits and protection of victims.

2) To minimize the effects of fog, mist, haze and other unstable weather conditions for meteorological observations in atmospheric sciences image enhancement is generally used. It is useful to identify shape and structure of the objects in an environment. Satellite images go through image restoration and enhancement to remove noise.

3) Image enhancement is used in astrophotography, it faces challenges due to light, noise and pollution that can be minimized. Most of the cameras in real time are in-built with sharpening and contrast image enhancement functions. Moreover, several software allow for editing such images to provide better and bright results.

4) Many interesting features of images are discovered in water flow which remains attention on geomorphology and bathymetric patterns by the study of oceanography. These interesting features are obviously identifiable in most of the images which are enhanced digitally to overcome the limitation of moving targets, deficiency of light and ambiguous surroundings.

5) Image enhancement methods related to images / pictures and videos are useful for visually impair in reading little print, using computers and television and face recognition. Several studies have been conducted that emphasize the need and value of using enhancement for the visually impaired.

6) Image enhancement technique is frequently employed by virtual restoration of historic paintings and artifacts in order to reduce stains and crevices. Using sharpening, color contrast enhancement, and brightening are various techniques used to make the images clear and bright. Image enhancement is a dominant tool for restorers who can inform decisions by viewing the results of restoring a painting in advance it is evenly useful in discriminating text from worn-out historic documents.

7) Image enhancement is used in the field of e-learning also to clarify the contents of chalkboard as viewed on streamed video. It improves the content readability and helps students to focus on the text. Similarly, association through the whiteboard is facilitated by enhancing the shared data and diminishing artifacts like shadows and blemishes.

8) Image enhancement is used in the field of medical for reducing noise and sharpening details to improve the visual sign of the image. Since small details play a significant role in diagnosis and treatment of disease, it is essential to show up important

©IJRASET (UGC Approved Journal): All Rights are Reserved

features while displaying medical images. This makes enhancement is required aiding tool for viewing anatomic areas in MRI, ultrasound and x-rays.

Image enhancement techniques used in several other fields including law enforcement, microbiology, biomedicine, bacteriology, climatology, meteorology, etc.,

III. IMAGE ENCHANCEMENT TECHNIQUES IN SPATIAL DOMAIN

A. Histogram Equalization (HE)

Histogram equalization is a popular image enhancement technique for better contrast and appearance of images. Suppose we have an image which is predominantly dark. Then its histogram would be skewed towards the lower end of the grey scale and all the image detail is compressed into the dark end of the histogram [12]. Image becomes clear by draw out the grey levels at the dark end to generate a more uniformly distributed histogram. Histogram equalization generates image with a consistent histogram by finding a grey scale transformation function. The sample output of HE is shown in fig 3.

Fig 3. Original Image & Output Image for HE

B. Brightness Preserving Bi-Histogram Equalization (BBHE)

BBHE technique is used for preserving brightness of an image. One of the most important characteristics of an image is brightness preservation. This method divides the image's histogram into independently two equalized parts. So the intensities are arranged equal as well. The major limitation of histogram equalization is the brightness of given image has been changed because of flattening property of histogram equalization [13]. So that histogram equalization is hardly utilized in applications such as consumer electronic products Television and other products where preserving the original brightness may be necessary to reduce unnecessary visual corrosion.

Fig 4. Original Image & Output Image for BBHE

To overcome this limitation of histogram equalization of the Brightness Preserving Bi-Histogram Equalization is proposed [14]. This algorithm mainly utilizes histogram equalizations independently over two sub images obtained by decomposing the input image based on its mean with a constriction that the resulting equalized sub images are bounded by each other around the input mean. It is represented that the proposed BBHE algorithm preserves the mean intensity or brightness of a given image considerably best compared to histogram equalization while enhancing the contrast and provides a typical enhancement that can be used in consumer electronic products. The output of BBHE is shown in fig 4.

C. Adaptive Histogram Equalization (AHE)

Adaptive Histogram Equalization is used for improving contrast in images. It differs from Histogram Equalization by adaptive method that computes several histograms and each histogram corresponding to a distinct section of an image. An image, contrast region will not adequately enhanced by Histogram Equalization [15]. AHE improves this enhancement by transforming each pixel with a transformation function derived from a neighbourhood region. It is used to overcome some limitations of global linear

©IJRASET (UGC Approved Journal): All Rights are Reserved

minmax windowing method. Thus it reduces the amount of noise in regions of the image. And also AHE have the ability for improving the contrast of grayscale and color image. The results of AHE is shown in fig 5.

Fig 5. Original Image Output Image for AHE

D. Contrast-Limited Adaptive Histogram Equalization (CLAHE)

Contrast-limited adaptive histogram equalization (CLAHE) is the technique used for enhancing the contrast in the grayscale image. This technique applies on small regions in the image, called tiles, instead of the entire image [16]. Each tile's contrast is enhanced, there by the histogram of the output region roughly matches the histogram which is specified by the distribution parameter. The neighbouring tiles are finally combined by using bilinear interpolation in order to eliminate artificially induced boundaries. Particularly in homogeneous areas, the contrast of the image can be restricted to circumvent amplifying any noise. The sample output of this technique is shown in fig 6.

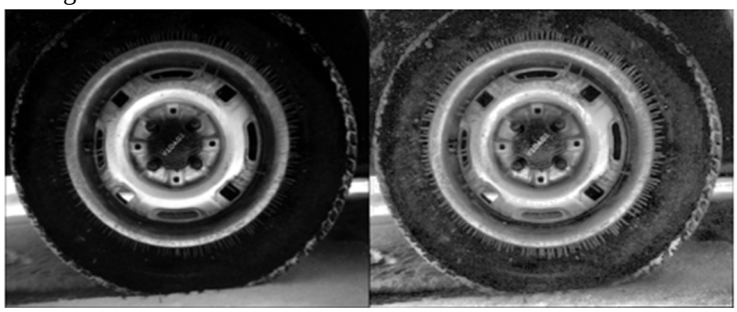


Fig6. Original Image Output Image for CLAHE

E. Contrast Enhancement (CE)

Image enhancement techniques play an important role in many applications of digital image processing where the quality of images in terms of contrast and visual appearance is essential for human interpretation. Contrast is one of the important factors in any kind of subjective valuation of digital image quality. The feature contrast is created by taking the variance in luminance reflected from two adjacent surfaces. In other words, contrast is the variance in the visual factors or properties that makes an object separable from other objects and the background. The contrast in visual perception, is determined by the difference in brightness, colour and of the object with other objects. Human visual system is more sensitive to contrast than the absolute luminance; so that, human can perceive the world similarly regardless of the considerable changes in illumination conditions. Most of the algorithms for obtaining contrast enhancement have been proposed and developed, they are applied to the problems in image processing. This technique automatically increases the brightness of digital images which appear as dark, poor in clarity. Apply appropriate tone correction to deliver improved quality and clarity [17]. This technique plays an important role for most of the medical applications. The result of CE is shown in below fig 7.

Fig7. Original Image Output Image for CE

©IJRASET (UGC Approved Journal): All Rights are Reserved

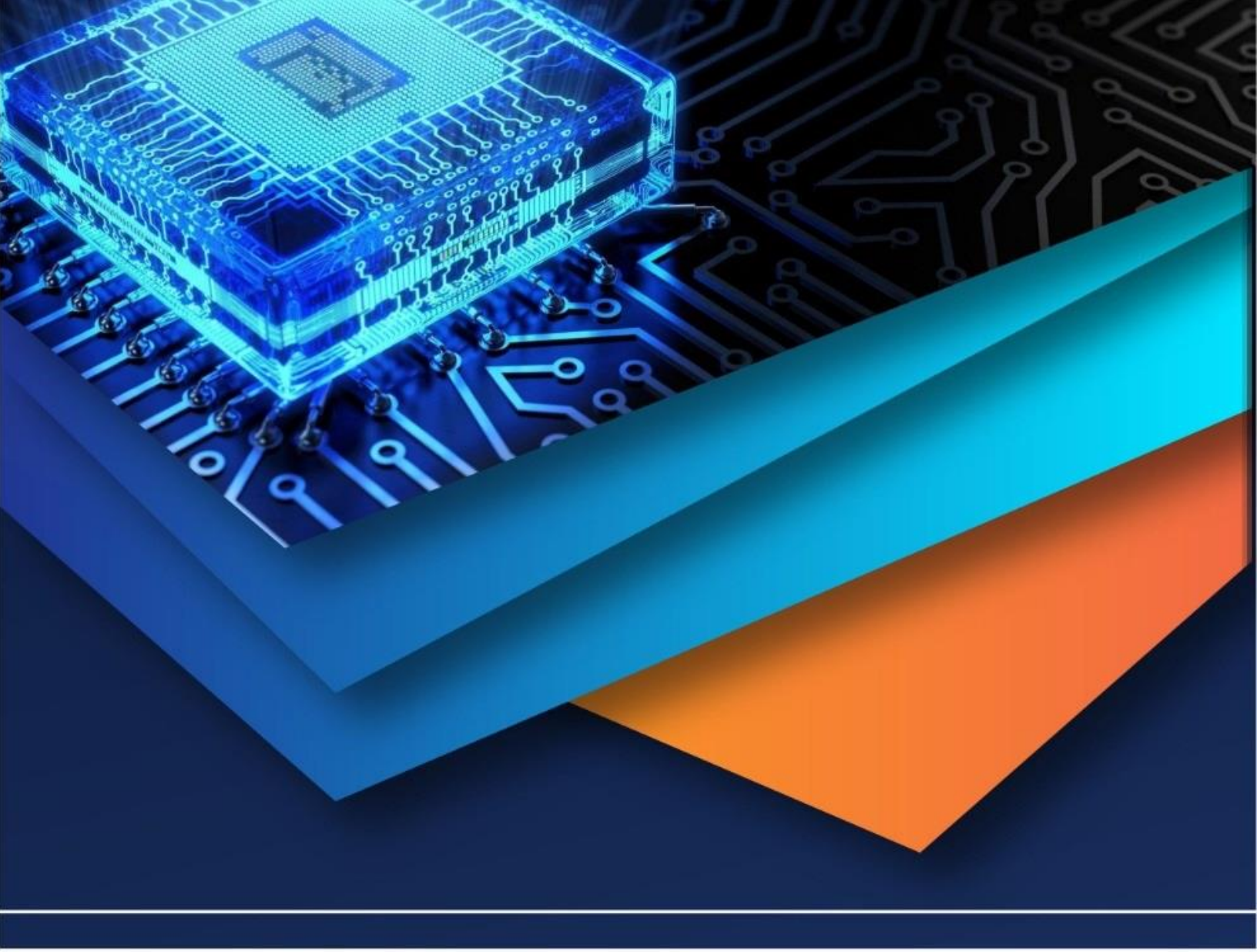
IV. CONCLUSION

Image enhancement is one of the challenging issues in the area of digital image processing and pattern recognition. Image enhancement deals a wide variety of techniques for modifying images in order to achieve contrast, brightness and visual appearance for given images. Image enhancement methods are broadly categorized into two types based on spatial and frequency domains. This paper mainly deals with underlying concepts of various enhancement techniques in spatial domain. The output of each technique presented as a result which reflects an improved image quality and better visual or structural appearance of given image. And these techniques also increased range of pixels dynamically with better contrast, improves the overall brightness and the preserved the edges of image without any degradation. Even though all the techniques produced good result, however the combined method of AHE and CLAHE produced better performance for remote sensing applications where Adaptive Histogram Equalization and Contrast-Limited Adaptive Histogram Equalization are combined. Because the AHE is contains low contrast with dark regions. The CLAHE technique better in contrast, especially in homogeneous areas, can be limited to avoid amplifying any noise that might be present in the image.

REFERENCES

[1] Rafael C Gonzalez and Richard E Woods, “Digital Image Processing”, third edition, Pearson Education, 2007.
[2] Ramkumar.M, Karthikeyan.B,” A Survey on Image Enhancement Methods”, International Journal of Engineering and Technology (IJET),Vol 5 No 2 Apr-May 2013, 960.
[3] A. Rosenfeld, A. Kak, Digital Picture Processing, NJ, Upper Saddle River:Prentice-Hall, 1982.
[4] D. T. Cobra, "Image histogram modification based on a new model of the visual system nonlinearity", J. Electron. Imag., vol. 7, no. 4, pp. 807-815, 1998.
[5] Er. Mandeep Kaur Er. Kiran Jain Er Virender Lather, “Study of Image Enhancement Techniques: A Review”, IJARCSSE, Volume 3, Issue 4, April 2013
[6] Raman Maini and Himanshu Aggarwal “A Comprehensive Review of Image Enhancement Techniques”, Journal of Computing, Volume 2, Issue 3, March 2010, pp.8-13.
[7] S.S. Bedi, Rati Khandelwal,” Various Image Enhancement Techniques- A Critical Review”, International Journal of Advanced Research in Computer and Communication Engineering, Vol. 2, Issue 3, March 2013.
[8] Sunita Dhariwal, “Comparative Analysis of Various Image Enhancement Techniques”, International Journal of Electronics & Communication Technology (IJECT), Vol. 2, Issue 3, pp. 91-95, Sept. 2011.
[9] Shanto Rahman,Md. Mostafijur Rahman,Khalid Hussain “Image enhancement in spatial domain: A comprehensive studuy”, Computer and Information Technology (ICCIT), 2014 17th International Conference on Dec 2014,IEEE Transactions
[10] Pinki Agrawal et al., “ A Comprehensive Studey of the Image Enhancement Techniques”, International Journal of Advance foundation and Research in Computer(IJAFRC), Vol.1,Issue 7, July 2014.
[11] Nancy, Er. Sumandeep Kaur, “Image Enhancement Techniques: A Selected Review”, IOSRJCE,Volume 9, Issue 6 (Mar. - Apr. 2013)
[12] Rajesh Garg, Bhawana Mittal, sheetal Garg, “ Histogram Equalization Techniques for Image enhancement”, IJECT,Vol 2, Issue 1, March 2011.
[13] Kim’s, Min Chung, “Recursively Separate and Weighted Histogram Equalization for Brightness Preservation and Contrast Enhancement”, IEEE Transaction on Communication, Networking and Broadcasting, Page: 1389-1397, Publication year: 2008.
[14] Kong.N.S.P, Ibrahim .H, “Color Image Enhancement using Brightness Preserving Dynamic Histogram Equalization”, IEEE Transaction on Communication, Networking and Broadcasting, Page: 1962-1968, Publication year: 2008.
[15] Ooi, chen Hee,Isa, Nor Ashidi Mat. Adaptive contrast enhancement methods with brightness preserving. IEEE Transactions on Consumer electronics, 2005.
[16] Reza AM, “Realization of The Contrast Limited Adaptive Histogram Equalization (Clahe) For RealTime Image Enhancement”, Journal of VLSI signal processing systems for signal, image and video technology, (2004), vol. 38, no. 1, pp. 35-44.
[17] Hassan, N. Y. and Aakamatsu, N., ”Contrast Enhancement technique of dark blurred Image”, International Journal of Computer Science and Network Security (IJCSNS), Vol. 6, No. 2, 2006, pp. 223- 226.

©IJRASET (UGC Approved Journal): All Rights are Reserved



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)