Contrast Enhancement with Saliency Preservation

Vijaya Singh[1], Ankur Shukla[2], Sumit Kumar. Gupta[3]

[1]*Electronics and communication, Research scholar, Bansal Institute of Engineering & Technology*

[2,3]*Assistance Professor, Electronics and communication, Bansal Institute of Engineering & Technology*

***Abstract* - For the evaluation of the quality of the enhanced image without human interventions, we need objective functions which tell us all about the quality of image through image parameters. Various objective functions are illustrated in this paper. To generate a good contrast enhancement image with preserved basic quantitative and qualitative parameters. Objective function formed here by combination of three performance measures, entropy value, contrast per pixel (CPP) and number of edges (edge pixels). Entropy gives the average information contained in image. If histogram is uniform that means information contain is high. and the contrast per pixel give the difference of the pixel brightness to the average brightness of the boundary pixel. If CPP is high then edge detection is easy. Entropy value gives the average information content of image or randomness present in image. If the distribution of the intensities (brightness level) in histogram of the image is uniform, then we can say that histogram is equalized and also the entropy of the image is high. The other objective functions considered are PSNR i.e., peak signal to noise ratio & MSE i.e., measure of enhancement, here SSIM i.e., structural similarity is low as in the case of enhancement the structural similarity is compromised for enhanced image. In images, edge contains vital information. Sharp edges are easily distinguishable and pleasing to human vision and also suitable for the machine learning. The object identification in the image needs sharp edges. The core idea the given literature is to maintain the mean brightness of the image, so image is illuminated properly. During enhancement the output image must have a high value of SSIM and also PSNR value must be high. So, the output image is not very different from input image. The brightness preservation in output image is measured using (AMBE) absolute mean brightness error value, image feature qualities i.e., similarity of output image to input image are checked by SSIM and PSNR. Contrast enhanced images from the technique achieves a good trade-off between focus in the image, low contrast improvement and brightness retaining along with the natural appeal of the input image.**

***Index Terms* - SSIM, PSNR, MSE, OBJECT**

INTRODUCTION

Every single day world is evolving very fast. Rapid development of the technology has affected all the scientific areas. Medicine, automation, data analysis, finances, biology, chemistry, economics and many, many more have benefited from the technology expansion. Those big changes have also influenced fields as an image processing.

Image enhancement processes consist of a collection of techniques that seek to improve the visual appearance of an image or to convert the image to a form better suited for analysis by a human or a machine. Enhancement of noisy image data is a very challenging issue in many research and application areas. Image enhancement techniques can be divided into three broad categories:

1. Spatial domain methods, which operate directly on pixels using gray level transformations or histogram processing (classical histogram equalization).
2. Frequency domain methods, which operate on the Fourier transform of an image.
3. Fuzzy domain methods, which involve the use of knowledge-base systems that are capable of mimicking the behavior of a human expert using fuzzy based histogram equalization. Classical Histogram Equalization (HE) has proved to be a simple and effective image contrast enhancement technique .But this has a drawback that it does not preserve the brightness of the input image on the output one. This makes HE not suitable for image contrast enhancement on consumer electronic products, such as video surveillance, where preserving the input brightness is essential to avoid the generation of non-existing artifacts in the output image. To overcome such drawback, variations of the classic HE technique have proposed to first decompose the input image into two sub-images, and then perform HE independently in each sub-image. Although these methods preserve the input brightness on the output image with a

significant contrast enhancement, they may produce images which do not look as natural as the input ones. Fuzzy logic represents a good mathematical framework to deal with uncertainty of information. Fuzzy image processing is the collection of all approaches that understand represent and process the images, their segments and features as fuzzy sets.

In the present thesis, an algorithm is proposed for Fuzzy Histogram Equalization. This algorithm enhances image contrast as well as preserves the brightness very effectively. This also reduces its computational complexity. This Fuzzy Histogram Equalization technique uses the representation and processing of digital image in fuzzy statistics. These images in fuzzy domain handle the inexactness of grey-level values in a better way as compared to GHE and CLAHE like conventional techniques, which improves its performance. Hence, proposed Fuzzy algorithm can be used for image enhancement of poor quality images. All the implementation work has been done in MATLAB 7.5 Image Processing tool box.

Data representation in Matlab is the feature that distinguishes this environment from others. Every data is presented with matrices. The definition of matrix is a rectangular array of numbers. Most pictures are kept in two-dimensional matrices. Each element corresponds to one pixel in the image. True color pictures require a third dimension to keep the information about intensities of RGB colors. Fuzzy Logic Toolbox offers wide range of functions responsible for fuzzy calculations. It allows user to look through the results of fuzzy computations.

Experimental results show that the quality of image is improved after fuzzy histogram equalization. It is tested on different common formats of images taking different fuzzy membership function

RELATED WORK

Digital image processing is a broad subject and often involves procedures which can be mathematically complex, but central idea behind digital image processing is quite simple. The ultimate aim of image processing is to use data contained in the image to enable the system to understand, recognize and interpret the processed information available from the image pattern. Image enhancement can be applied to different areas of science and engineering. Except for illumination conditions, quality of images is also affected by external noises and environmental disturbances such as ambient pressure and temperature fluctuations. Approaches of contrast limited image enhancement via stretching the histograms over a reasonable dynamic range and multi-scale adaptive histogram equalizations have been developed. Various authors proposed various methods such as histogram equalization, multipoint histogram equalizations and pixel dependent contrast preserving, but all these methods are not up to mark. Here, a brief review over various proposed methods in image enhancement methodology is presented.

C. V. Jawahar, et.al (1997) proposed about thresholding. In this work, the problem of pixel classification is attempted using fuzzy clustering algorithms. The segmented regions are fuzzy subsets, with soft partitions characterizing the region boundaries. The validity of the assumptions and thresholding schemes are investigated in the presence of distinct region proportions. The hard k means and fuzzy c means algorithms was found useful when object and background regions are well balanced. Fuzzy thresholding is also formulated as extraction of normal densities to provide optimal partitions.

The problem of pixel classification is well suited to be formulated as a clustering problem. The problem of thresholding in the presence of region imbalances is analyzed by transforming the geometrical structure of gray distribution by modeling the distance and density function. Analytical discussions and experimental details validate the importance of fuzzy thresholding schemes based on fuzzy clustering

In 24 Chaohong Wu, Zhixin Shi and VenuGovindaraju worked on the performance of fingerprint recognizer, which highly depends on the fingerprint image quality. Different types of noises in the fingerprint images pose greater difficulty for recognizers. They focused on an effective methodology of cleaning the valleys between the ridge contours are lacking. It was found that noisy valley pixels and the pixels in the interrupted ridge flow gap are \impulse noises". They described a new approach to fingerprint image enhancement, which is based on integration of Anisotropic Filter and directional median filter (DMF). In this paper Gaussian-distributed noises are reduced effectively by Anisotropic Filter, \impulse noises" are reduced efficiently by DMF. The enhancement algorithm has been implemented and tested on fingerprint images from FVC22.

In 24 Soong-Der Chen, Abd.Rahman Ramli discussed about the issue on Histogram equalization (HE).They analyzed that HE has been a simple yet effective image enhancement technique. However, it tends to change the brightness of an image significantly, causing annoying artifacts and unnatural contrast enhancement. They proposed a novel extension of BBHE referred to as minimum mean brightness error bi-histogram equalization (MMBEBHE). MMBEBHE has the feature of minimizing the difference between input and output image's mean. Simulation results showed that MMBEBHE can preserve brightness better than BBHE and DSIHE. Furthermore, this paper also formulated an efficient, integer-based implementation of MMBEBHE. Nevertheless, MMBEBHE also has its limitation. They also proposed a generalization of BBHE referred to as recursive mean-separate histogram equalization (RMSHE). RMSHE is featured with scalable brightness preservation. Simulation results showed that RMSHE is the best equalization technique compared to HE, BBHE, DSIHE, and MMBEBHE It can be observed in there work that in context of bi-histogram equalization, MMBEBHE is better than BBHE and DSIHE in preserving an image's original brightness.

In 26 Yu-fai Fung, Homan Lee, and M. Fikret Ercan worked on application of toll rate charged for the usage of facilities such as a tunnel or a bridge is usually proportional to the number of axles possessed by a vehicle. They designed an automatic system that can identify the number of axles is sought. Instead of detecting the axle, wheels of a vehicle were tested and a method based on the Hough transform for detecting circles was proposed. As the system must be able to detect the correct number of wheels in real-time, sub-sampling based on the Haar Wavelet transform was applied. The approach was able to identify the wheel correctly to process the input images in real-time.

They conclude that the Hough transform is suitable for such an application. It can process up to 24 images within 1.5 s and it satisfied the timing constraint imposed upon the system. The system setup was simple and by using commodity components, its setup cost was also low.

In 26 ZhiYu Chen, Besma R. Abidi, David L. Page, Mongi A. Abidi gave a contrast enhancement has an important role in image processing applications. They described that conventional contrast enhancement techniques either often fail to produce satisfactory results for a broad variety of low-contrast images, or cannot be automatically applied to different images, because their parameters must be specified manually to produce a satisfactory result for a given image. They described a new automatic method for contrast enhancement. First of all they grouped the histogram components of a low-contrast image into a proper number of bins according to a selected criterion, then redistributed these bins uniformly over the grayscale, and finally ungroup the previously grouped gray-levels. Accordingly, this new technique is named gray-level grouping (GLG). GLG not only produces results superior to conventional contrast enhancement techniques, but is also fully automatic in most circumstances, and is applicable to a broad variety of images. An extension of GLG is selective GLG (SGLG). SGLG selectively groups and ungroups histogram components to achieve specific application purposes, such as eliminating background noise, enhancing a specific segment of the histogram, and so on.

They developed a new automatic contrast enhancement technique. GLG was a general and powerful technique, which can be conveniently applied to a broad variety of low-contrast images and generates satisfactory results. HE method could be conducted with full automation at fast speeds.

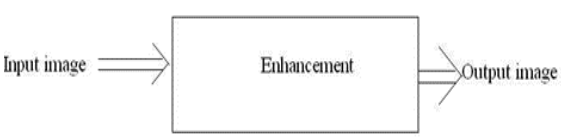
In 27 David Menotti, Laurent Najman, Jacques Facon, and Arnaldo de A. Araújo proposed that Histogram equalization (HE) has proved to be a simple and effective image contrast enhancement technique. They worked on a novel technique called Multi-HE, which consists of decomposing the input image into several sub-images, and then applying the classical HE process to each one. This methodology performs a less intensive image contrast enhancement, in a way that the output image presents a more natural look. They proposed two discrepancy functions for image decomposing, conceiving two new Multi-HE methods. A cost function was also used for automatically deciding in how many sub-images the input image will be decomposed on. The work was tested a new framework called MHE for image contrast enhancement and brightness preserving which generated natural looking images. The results showed that there methods was better on preserving the brightness of the processed image (in relation to the original one) and yields images with natural appearance, at the cost of contrast enhancement.

In 29 Tarik Arici, Salih Dikbas, and Yucel Altunbasak gave a general framework based on histogram equalization for image contrast enhancement is presented. In this framework, contrast enhancement is posed as an optimization problem that minimizes a cost function. They introduced specifically designed penalty terms, the level of contrast enhancement can be adjusted; noise robustness, white/black stretching and mean-brightness preservation may easily be incorporated into the optimization. Analytic solutions for some of the important criteria were presented. Finally, a low-complexity algorithm for contrast enhancement was presented, and its performance was demonstrated against a recently proposed method

METHODOLOGY

Principal objective of image enhancement is to modify attributes of an image to make it more suitable for a given task and a specific observer. During this process, one or more attributes of the image are modified. The choice of attributes and the way they are modified are specific to a given task. There exist many techniques that can enhance a digital image without spoiling it. The enhancement methods can broadly be divided into the following three categories:

- Spatial Domain Methods
- Frequency Domain Methods
- Fuzzy Domain Methods



3.1 Spatial Domain Method

Spatial domain methods which operate directly on pixels. In Spatial domain method pixel values may be modified according to rules that depend on the original pixel value (local or point processes). Alternatively, pixel values may be combined with or compared to others in their immediate neighborhood in a variety of ways using two techniques:

3.1.1 Grey Level Transformations

3.1.2 Histogram Equalization and Histogram Matching

3.1.1 Grey Level Transformations

Consider the input image f(x,y) and processed image g(x,y) then the transformation g(x,y)=T[f(x,y)], where T is an operator on f defined over some neighbourhood of (x,y). The operator T is applied at each location (x,y) to yield output g at that location. The process uses pixels in the area of image spanned by neighbourhood.

Example: Thresholding

Basic Grey Level Transformations are:

- Image Negatives
- Log Transformations
- Power Law Transformations
- Piece wise- Linear Transformations

3.1.2 Histogram Equalization

Histogram equalization is a common technique for enhancing the appearance of images. Suppose we have an image which is predominantly dark. Then its histogram would be skewed towards the lower end of the gray scale and all the image detail is compressed into the dark end of the histogram . If we could `stretch out' the gray levels at the dark end to produce a more uniformly distributed histogram then the image would become much clear [1]

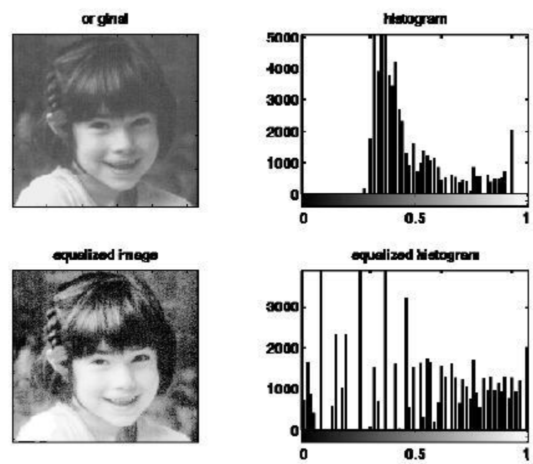


Fig.3.1 The original image and its histogram, and the equalized versions. Both images are quantized to 64 gray levels

3.1.3 Histogram Matching

Histogram equalization automatically determines a transformation function seeking to produce an output image with a uniform histogram. Another method is to generate an image having a specified histogram is histogram matching.

Obtain the output image by equalizing the input image first; then for each pixel in the equalized image, perform the inverse mapping to obtain the corresponding pixel of the output image [1]. Histogram matching enables us to "match" the grayscale distribution in one image to the grayscale distribution in another image.

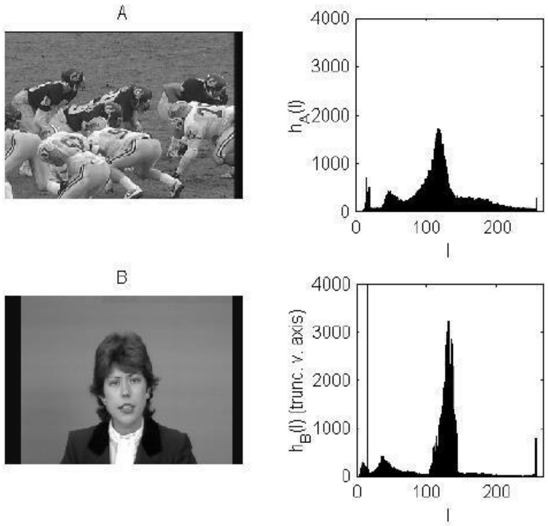


Fig.3.2 Example of Histogram matching

3.2 Frequency Domain Methods

Frequency domain operates on the Fourier transform of an image. Edges and sharp transitions (e.g. noise) in an image contribute significantly to high-frequency content of Fourier transform. Low frequency contents in the Fourier transform are responsible to the general appearance of the image over smooth areas. The concept of filtering is easier to visualize in the frequency domain. Therefore, enhancement of image f(x,y) can be done in the frequency domain based on DFT. This is particularly useful in convolution, if the spatial extent of the point spread sequence h(x,y) is large then convolution theory.

$g(x,y)=h(x,y)*f(x,y)$

Where g(x,y) is enhanced image.

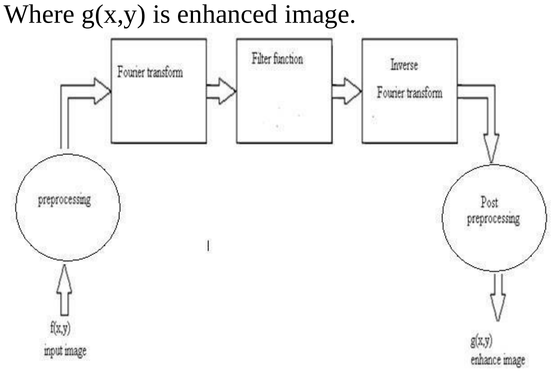


Fig 3.3 Basic steps for Frequency Domain

3.3 Fuzzy domain Method

Fuzzy image processing is a collection of different fuzzy approaches to image processing that can understand, represent and process the image. It has three main stages, namely, image fuzzification, modification of membership function values, and de-fuzzification. Fuzzy image enhancement is based on gray level mapping into membership function. The aim is to generate an image of higher contrast than the original image by giving a larger weight to the gray levels that are closer to the mean gray level of the image that are farther from the mean.

3.3.1 Fuzzy Set: In classical set theory, a set is defined as a collection of element having a certain property, each of which belongs to the set. So the characteristic function takes either the value of or 1

Fuzzy Image Processing

Fuzzy image processing is collection of all approaches that understand, represent and process the images, their segments and features as fuzzy sets.

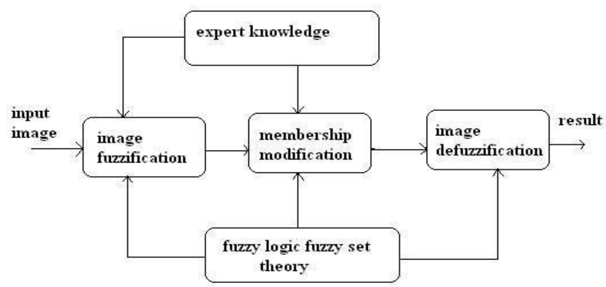


Fig.3.5 Fuzzy image processing

The representation and processing depend on the selected fuzzy technique and on the problem to be solved.

The fuzzification and defuzzification steps are due to the fact that we do not possess fuzzy hardware. Therefore, the coding of image data (fuzzification) and decoding of the results (defuzzification) are steps that make possible to process images with fuzzy techniques. The main power of fuzzy image processing is in the middle step (membership modification)

CONCLUSIONS ANDS FUTURES SCOPE

Images contrasts enhancements is as very important challenging objectives in the areas of images processing. Ins this thesis we considered contrasts enhancements techniques that cans produces resultants images that looks betters subjectively by changings the pixels grays levels intensities. This algorithm finds useful applications ins consumers electronics products, medicals images analysis and radar/sonars images bases operations. It has been found by literatures surveys those available techniques for images enhancement; the techniques that are generally applied are based on calculations related to firsts orders statistics of images histogram. Ins this thesis we propose as brightness preserving histograms equalizations (HGE)s techniques having contrasts enhancements capabilities withs reduced computational complexity. The modified technique uses fuzzy statistics of images pixels intensity for representations and processing. By representing an images values in fuzzy domains helps the histograms equalizations techniques ins handlings the inexactness of grays levels ins as better ways that cans give improved performance. The times of executions depends on images sizes and the histograms type. The experimental results are compared withs threes others histograms equalizations techniques. We haves taken twos types of fuzzy memberships functions of Gaussians and triangular type. The algorithm was applied on 5s different types of images. It has been observed that ins generalized HEs and CLACHEs methods after applying enhancements the bright portions of images haves become almost white. Ins uniforms HEs the backgrounds parts that was somewhat dulls has becomes black. Contents wises GHEs looks improved and clearers than originals images buts it has become overs bright hence most of the information has eliminated dues to white colors impressions and its shows non uniforms whites and darks patches.

In futures we cans uses this algorithm for applications-based approach likes medicals imaging bases on X-Ray, ultrasound, Citi scan related to specifics body organs for as particulars diseases or pathological disorders diagnosis. Wes cans also uses our enhancements methods for improving the quality of spaces explorations related images. Wes can also improve the performances by interactively choosing memberships functions parameters adaptively it can tell abouts an optimums values of parameters that cans gives bests results withs lowest brightness errors and higher PSNR. For this purpose, the selections of optimums parameters cans be founds using various nonlinear optimizations methods.

REFERENCE

[1] Gonzalez, R. and Woods, R., 22. Digital Image Processing, Prentice Hall. 2. Kim J. Y., Kim L. S., Hwang.

[2] S. H., 21 “An Advanced Contrast Enhancement Using Partially Overlapped Sub-Block Histogram Equalization,” IEE Transactions on Circuits and Systems for Video Technology, Vol. 11, No.4, pp.475-484.

[3] Sun. C. C. Ruan S. J., Shie M. C., Pai, T. W., 25. “Dynamic Contrast Enhancement based on Histogram Specification,” IEEE Transactions on Consumer Electronics, 51(4), pp.13-135.

[4] Stark J. A., 2. “Adaptive Image Contrast Enhancement Using Generalizations of Histogram Equalization,” IEEE Transactions on Image Processing, 9(5), pp.889-896.

[5] Kim, Y.T., 1997. Contrast Enhancement Using Brightness Preserving Bi-Histogram Equalization. IEEE Trans. Consumer Electronics, Vol. 43, Issue 1, pp. 1-8.

[6] Wan, Y., Chen, Q., Zhang, B.-M, (1999). " Image enhancement based on equal area dualistic sub-image histogram equalization method " IEEE Transaction on Consumer Electronics 45 (1) 68-75.

[7] Chen, S.D. and Ramli, A.R., 24. Preserving brightness in histogram equalization-based contrast enhancement techniques. Digital Signal Processing, Vol.14, Issue 5, pp. 413-428.

[8] Shannon, 1948. “A mathematical theory of communication,” Bell Syst. Tech. J., vol. 27, pp. 379-423.

[9] Menotti, D., Nijman, L., Facon, J., Araújo, A.A., 27. Multi-Histogram Equalization Methods for Contrast Enhancement and Brightness Preserving. IEEE Trans. on Consumer Electronics, Vol. 53, Issue 3, pp.1186-1194.

[10] Luessi, M., Eichmann, M., Schuster, G., and Katsaggelos, A., 26. “New results on efficient optimal multilevel image thresholding,” in IEEE International Conference on Image Processing, for Contrast Enhancement and Brightness Preserving pp. 773-776.

[11] Wang, C. and Ye, Z., 25. Brightness Preserving Histogram Equalization with Maximum Entropy: A Variational Perspective. IEEE Trans.

Consumer Electronics, Vol. 51, Issue 4, pp. 1326-1334.

[12] Cheng, H.D., Shi, X.J., 24. A simple and effective histogram equalization approach to image enhancement. Digital Signal Processing, Vol.14, pp. 158–17.

[13] Chen, Z., Abidi, R., Page, D.L., Abidi, A., 26. Gray-Level Grouping (GLG): An Automatic Method for Optimized Image Contrast Enhancement-Part I: The Basic Method. IEEE Trans. On Image Processing, Vol. 15, Issue 8, pp. 229-232.

[14] Yoon, H., Han, Y., Hahn, H., 29. Image Contrast Enhancement based Sub-histogram Equalization Technique without Over-equalization Noise. World Academy of Science, Engineering and Technology, Vol. 26, pp. 176-182.

[15] Arici, T. and Dikbas, S., 29. A Histogram Modification Framework and Its Application for Image Contrast Enhancement. IEEE Trans. On Image Processing, Vol. 18, Issue 9, pp. 1921-1935.

[16] Chanda, B. and Majumder, D.D., 22. Digital Image Processing and Analysis, Prentice Hall.

[17] Abdullah-Al-Wadud, M., Kabir, H., Dewan, M.A.A., Oksam, C., 27. A dynamic histogram equalization for image contrast enhancement. IEEE Transaction on Consumer Electronics, Vol. 53, Issue 2, pp. 593-6.

[18] Ibrahim, H. and Kong, N.S.P., 27. Brightness Preserving Dynamic Histogram Equalization for Image Contrast Enhancement. IEEE Trans. Consumer Electronics, Vol. 53, Issue 4, pp. 1752–1758.

[19] Jawahar, C.V. and Ray, A.K., 1996. Incorporation of gray-level imprecision in representation and processing of digital images. Pattern Recognition Letters, Vol. 17, Issue 5, pp. 541–546.

[20] Wang, Z. and Bovik, A.C., 22. A Universal Image Quality Index. IEEE Signal Process. Letters, Vol. 9, Issue 3, pp. 81–84.

[21] 21. A. K. Jai, Fundamentals of Digital Image Processing, Prentice-Hall, 1989