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A Comprehensive Survey on Diverse Image Contrast Enhancement Mechanisms

[1]Vijay Kumar CN, [2]Dr. Amit Kumar
[1] Associate Professor, Dept. of TCE, SJCIT, Chikkballapur, Karnataka, India
[2] Professor, Department of ECE, CSJM University, Kanpur, Uttar Pradesh, India

Abstract: Image processing is a vast area of research. Many optimization and enhancement mechanisms are employed to improvise the quality of image. Image enhancement, usually, is performed on an image to make it more suitable for particular applications. It drastically improvises the clarity and makes better visualization of images for various computing applications. Contrast enhancement can augment any image's pixels intensity to make cent percent utilization of most possible bins. But the same time due to its property of diminishing brightness in images in course of enhancement, there is a need of research in this field to find good mechanisms which practically can provide best solution for the contrast enhancement while maintaining original image brightness. We did survey on various mechanisms and reviewed diverse image contrast augmentation mechanisms in this paper. Some of the popular techniques reviewed are Histogram equalization (HE), Brightness Bi-Histogram Equalization (BBHE), Dualistic Sub Image Histogram Equalization (DSIHE), Minimum Mean Brightness Error Bi-Histogram Equalization (MMBEBHE), Recursive Mean Separate Histogram Equalization (RMSHE), Multi Histogram Equalization (MHE), Brightness Preserving Dynamic Histogram Equalization (BPDHE), Recursive Separated and Weighted Histogram Equalization (RSWHE), Global Transformation Histogram Equalization (GHE) and Local Transformation Histogram Equalization (LHE). We compare these methods with regard to local and global enhancement mechanisms. Also we propose a solution that can be applied as an add-on the enhancement mechanisms to improvise the results. There is a huge possibility of image augmentation by using this mechanism in the areas such as medical image processing and X-Rays processing, microscopic imaging , HDTV, hyper spectral image processing, remote sensing, etc.

Keywords: Image Contrast Enhancement, Image Processing, Histogram Equalization.

I. INTRODUCTION

Various methods that help to develop the visual appearance of an image or to transfer the image to a well matched augmented image for examination by a person or instruments is called image improvisation. To attain perfection in an image look by rising superiority of several aspects or by reducing uncertainty among various parts of the image is known as image enhancement. The outcome derived from the image development is highly appropriate for particular applications compared to the actual image by the procedure of an image enhancement. Image augmentation is one among the most exciting fields of research in the domain of image processing. Image enhancement is widely bifurcated into 2 forms i.e. spatial domain methods & frequency domain methods. The image plane & method on this group are based on the direct process on pixels of an images that is called as spatial domain method, on other hand acclimatization of fourier transform of an image is called frequency domain methods

In digital image processing, one of the most important methods is image improvement and it plays vital role in several areas, for examples medical image process, remote sensing, high definition television (HDTV), industrial X-ray image processing, hyper spectral image processing, microscopic imaging etc. The image development is applying on image with the purpose of to create perfection for particular applications. The main aim of image enhancement usage is for develop the visual effects & the proper visible of the image, or to create the actual image will helpful for system to proceed. Normally, because of inferior quality of imaging devices or at the time of acquirement the unhelpful outside provisions, the image may have low active.

In image improvement techniques, one of the standard utilized methods is difference augmentation method. Several techniques in image diversity improvement are expected & it is wildly classified into 2 kinds of techniques, i.e. direct and indirect techniques. Between the indirect methods histogram alteration method have been broadly applied because it's easy to use & understand, in that one of the most regularly utilized method is histogram equalization (HE).

To create the histogram of the improved image fairly accurate to a standardized allocation, so that the active sort of the image can be completely utilized, this is the basic rule of histogram equalization. To use utmost probable bins so the contrast improvement altering the pixels strength of the input image and this improvement is consist of 5 methods for examples global, local, bright, partial and dark contrast

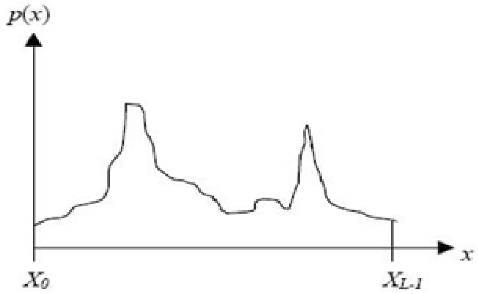
This thesis is prepared as follows: Part II explains the several contrast development methods; Part III illustrates the outcome & argument; Part IV makes explanation of issues; Part V describes our future results; Part VI provides the prospect job; Part VII concludes the thesis.

II. METHODOLOGY

Image Contrast augmentation methods:

A. Histogram Equalization (HE)

Histogram equalization is broadly utilized for contrast augmentation in a different range of applications because of its service and usefulness. It works by destruct the histogram & extends the active range of the gray levels by utilizing the increasing density function of the image. The clarity of the image is modifies after the histogram equalization this is one issues of the histogram equalization, therefore this is not appropriate for customer electronic goods, where protecting the actual clarity & improving contrast are necessary to keep away from annoying objects.



$X_0 - X_{L-1}$ → 0 to 255 Gray levels
P(x) →No. of pixels

Fig. 1 Basic Histogram

The HE is utilized for directions to the input image into the complete active range, (X_o, X_{L-1}) through utilizing the increasing density activities as a converting function, and it is clearly illustrates in above mentioned image one. Histogram equalization has a result of enlarging the active variety of provided histogram because histogram equalization compresses the density allocation of the range.

B. Brightness Bi-Histogram Equalization (BBHE)

With the purpose of coming up from the disadvantage set up by the histogram equalization techniques explained in the earlier sub clause and clarity protecting Bi-HE (BBHE) techniques was projected.

Figure two illustrated that BBHE system is utilized to decompose the actual image into 2 sub-images, through utilizing the image mean gray-level, & then use the histogram equalization technique on all of the sub-images.

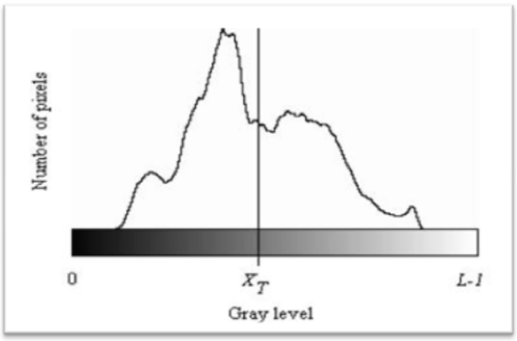


Fig. 2 Bi – histogram equalization

The BBHE technique creates an output image with the value of clarity (gray-level) situated in the center signify of the input image. The Brightness Bi-Histogram Equalization method is a hybrid technique between notice the clarity protecting of HE technique with the brief histogram equalization system. This method can improve the images without generating unwanted object.

C. Dualistic Sub Image Histogram Equalization (DSIHE)

Dualistic sub-image histogram equalization is also dividing the input histogram into 2 sub parts. Together Brightness Bi-histogram equalization & dualistic sub-image histogram equalization are parallel with the exception of that DSIHE prefers to divided the histogram based on gray level with growing possibility density is similar to 0.5 as a replacement for indicate as in BBHE, i.e. instead of decomposing the image based on its indicated gray level, the dualistic sub image histogram equalization technique decomposes the images focusing at the maximization of the Shannon's entropy of the resulted image. The aggregation of the actual image's gray level likelihood allocation is decomposed. The outcome of the DSIHE is achieved after the 2 equalized sub images are composed into 1 image.

D. Minimum Mean Brightness Error Bi-Histogram Equalization (MMBEBHE)

The fundamental rule of the Brightness Bi-histogram equalization & dualistic sub-image histogram equalization techniques of decomposing an image & then using the CHE technique to balance the out coming sub-images separately, anticipated the least involve of clearness error of Bi-HE (MMBEBHE) techniques. The main dissimilarity among the BBHE & DSIHE techniques and the MMBEBHE one is that the world seeks for a threshold stage that decomposes the image into 2 sub-images, such that the lowest amount of clarity variation among the input image & the output image is reached, while the previous techniques believes simply the input image to execute the decomposition.

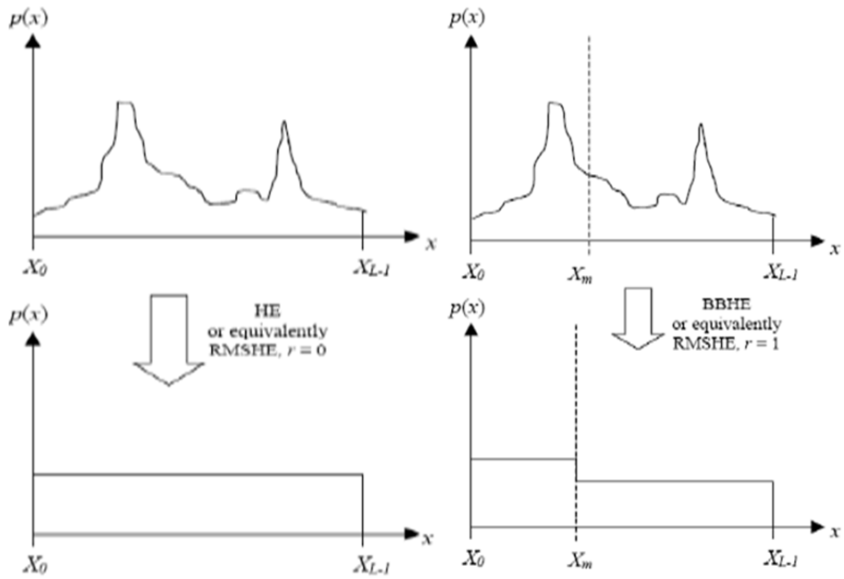
Formerly the input image is decomposed by the threshold stage, all of the two sub-images has its histogram similarised through the traditional HE procedures, creating the resulted image. In several time suppositions & exploitation for discovering the threshold stage is very difficult.

Without creating the output image for all applicant threshold level, this kind of policy permits us to acquire the clearness of the resulted image & its goal is to generate a technique is apt able for real time applications. Minimum Mean Brightness Error Bi-Histogram Equalization methods include of below mentioned 3 parts are:

1. All of the threshold level AMBE will compute.
2. Discover the threshold level, XT that surrender the least amount of MBE.
3. Divided the input of histogram into 2 depend on the XT originate in step 2 & balanced them separately as in Brightness Bi-Histogram Equalization.

E. Recursive Mean Separate Histogram Equalization (RMSHE):

The decomposing the image is merely once in Recursive mean-separate histogram equalization (RMSHE) technique, Figure three (a) & (b) explains that Histogram previous & behind histogram equalizations or consistently RMSHE, r=0 and r=1 correspondingly to execute image decomposition recursively, up to a scale r, creating 2r sub-images. After that, every one of these sub-images is alone enhanced utilizing the HE technique. When r = 0 (no sub-images are created) & r =1, the RMSHE technique is similar to the histogram equalizations & Brightness Bi-Histogram Equalization technique, correspondingly. The protection of the resulted image rises as r (independent stage) rises in this technique,



(a) (b)

Fig. 3 (a) Histogram prior to & subsequently HE or consistently RMSHE, r = (b) Histogram prior to & subsequently HE or equally RMSHE, r = 1

To achieve the division of recursively take apart from every fresh histogram auxiliary based on their individual represent. It is examined accurately that the output image's stand for clarity will meet to the input image's mean brightness as the amount of recursive mean separation will rises. As well, the recursive character of RMSHE also permits scalable clarity protection, which is more helpful in customer electronics.

F. Multi Histogram Equalization (MHE)

In this method, decompose the image into various sub-images, such that the image contrast improvement given through the histogram equalizations in every sub image is low strength, leading the output image to have a high natural appearance. The beginning of such techniques occurs 2 queries. The 1st query is how to decompose the input image. The image decomposition procedure is depend on the histogram of the image, so the histogram equalizations are the focal point of the work, The histogram is determined by threshold stages and is divided into classes, where every histogram class symbolizes a sub-image. The decomposition procedures are visible on image sectors procedures and it performs by multi-threshold part. The 2nd query is in how many sub-images an image should be decomposed on. This volume based on how the image is decomposed, & so this query is straight connected with the 1st query.

Multi Histogram Equalization method include of t3 parts:

1. Multi histogram decomposition.
2. Automatic thresholding principle.
3. Discovering the best thresholds.

G. Brightness Preserving Dynamic Histogram Equalization (BPDHE)

In this technique as per their local maxima, the actual image is decomposed into manifold sub images then the active histogram equalization is used to every sub image & lastly, the sub Images are mixed. Depend on the local maxima the histogram will separate. The BPDHE generates the resulted image with the signify strength more or less similar to the signify strength of the input, therefore completes the needs of sustaining the indicated clarity of the image. This technique evens the input histograms with 1 dimensional Gaussian filter & then depends on its local maxima it separate the smoothed histogram. It allocates fresh active range to each division later. Then, the HE function is use separately to these partitions, depend on this fresh active range & the output image is standardize to the input signify the clarity.

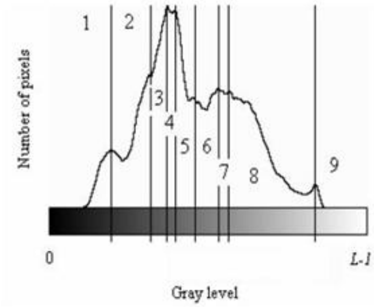


Fig. 4 Histogram of two or more sub sections

The Image's histogram prior to improvement usually does not engage with all the lively range of the gray level. Figure four demonstrates that if the histogram is divided into in excess of 2 sub parts, a few of the parts will have a awfully narrow range. Because of small range, these parts will be not improved importantly through histogram equalization.
Brightness Preserving Dynamic Histogram Equalization method includes of 5 parts:

1. Discovery of the position of local maximums from the smoothed histogram.
2. In map every division into a fresh active range.
3. Make equal for every division in separately.
4. Regularize the image clarity.
5. Level the histogram with Gaussian filters.

H. Recursive Separated and Weighted Histogram Equalization (RSWHE)

Recursive Separated and Weighted Histogram Equalization includes of 3 element, histogram segmentation, histogram weighting, & histogram equalization. Figure-5 explains that the histogram segmentation section prefer the input image X, calculates the input histogram H(X) and recursively separates the input histogram into 2 or more sub-histograms. Through utilizing a regularized energy law purpose the histogram weighting element alters the sub-histograms. Finally, the HE unit works separately more than all of the altered sub-histograms. Recursive Separated and Weighted Histogram Equalization method includes of 3 sections:

1. Histogram segmentation module: Depending on the significant & middle value the histogram segmentation module will divide the image into 2 or more histograms recursively.
2. Histogram equalization module: Finally match the weighted sub histogram separately.
3. Histogram weighting module: Depend on regularize law activities the histogram weighting module alter the sub histogram via weighting procedure.

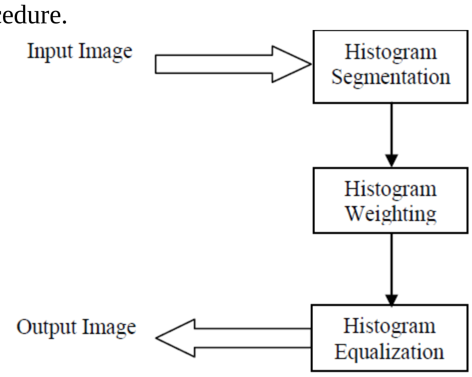


Fig. 5 Functional block diagram of RSWHE

I. Global Transformation Histogram Equalization (GHE)

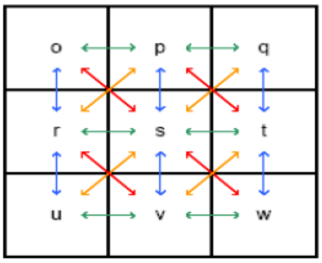
The universal conversion function remaps the concentration standards of the image in same way that it extended the active range of the image histogram; final outcome is normal contrast improvement. The RMSHE is utilized as a simplification of together GHE & BBHE that permits scalable clarity maintenance. The key plan is to split the input histogram into 2 sections and it is depend on the suggestion of the input histogram. After indicate the separating, the outcome is sub histogram part might be further split into more sub-histograms depend on their individual means based on the stage of recursion r. Consequential 2r histogram area are matched separately. Therefore, the universal conversion function is acquired as:

$$T(g)=g_{min}+(g_{max}-g_{min})*\frac{\sum_{x=gmin}^{g} h(x)}{\sum_{x=gmin}^{gmax} h(x)} \text{-----------------------} (1)$$

where g indicate the power value, g_{min} and g_{max} are the minor & higher bound of every histogram division, h(x) signifies the histogram count for strength value x, & T(g) is the universal conversion function. Depend on person choice the stage of recursion gives scalability to permit correction of the clarity stage

J. Local Transformation Histogram Equalization (LHE)

Global Transformation Histogram Equalization takes the universal data into record & cannot acclimatize to local glow situation. The Local Histogram Equalization achieves block overlapped histogram equalization. LHE defines a sub-block & recover its histogram data then HE is helpful for the center pixel utilizing the CDF of that sub block. Later, until the conclusion of the input image is attained the sub block is moved through 1 pixel & sub block HE is constant. While Local transformation histogram equalization cannot regulate to limited light data, still it more developed in few segment based on its mask size. On the other hand, choose of a best block size that improves every section of an image is not a simple job to achieve. The intensity pair allocation based technique develops the locality data of every pixel to create a universal concentration mapping activities. Generally, digital images enclose a 2D collection of power values, with locally unstable data that outcomes from a dissimilar mixture of unanticipated characters for examples boundaries & areas because dissimilar elements of the image have various numerical features that use the similar method of block wise to maintain home data for high successfully. Inside the every block, creates the group of power pairs from a pixel's eight linked locality. Figure six illustrate the intensity pairs from sample 3 x 3 neighbourhood windows.



(a)

$$\begin{Bmatrix} (o,p),(p,q),(o,r),(p,r),(r,s) \\ (o,s),(p,s),(q,s),(s,t),(p,t) \\ (q,t),(r,u),(s,u),(u,v),(r,v) \\ (s,v),(t,v),(v,w),(s,w),(t,w) \end{Bmatrix} \begin{Bmatrix} (a1,b1),(a2,b2), \\ \dots\dots\dots,(aj,bj), \\ \dots\dots\dots\dots\dots\dots\dots \\ \dots\dots,(am,bm) \end{Bmatrix}$$

(b)

Fig. 6 (a) 3 x 3 neighbourhood window (b) A group of intensity pairs

In an actual 2D image, several border pairs live close to the edges. So it will collect each increasing forces among the edge pairs. Because of the contrast enlargement, the smooth area intensity will also be enlarged so inside of the intensity range of the edge pairs, presently the smooth power pairs may recline. To keep away from such situation, divergent to growth forces are created inside of the intensity range of the smooth intensity pairs. Likewise, every divergent to extension forces are collected for those intensity pairs of the level area, & then deduct from the extension forces with a definite bang feature w to get the net growth force. The conflicting to extension force makes sure the efficiency for homogeneous areas in net-extension force.

$$G(g)=g+\sum_{gmin}^{g} f(x) \text{--------------------------} (2)$$

The local extension utility from the intensity-pair allocation. This local extension utility value is utilized to create last intensity mapping function.

K. Local and Global Contrast Stretching

The Local contrast stretching is a developed technique that executed an image for close by matching to the every picture components value to develop the ideas of organization in both dimmest and lightest part of the image at the similar duration. Local Contrast stretching is achieved through sliding windows across the image & regulating the main components as follows:

$$I_p(x, y) = 255 * [I_o(x, y) - min] / (max - min) \text{--------------} (3)$$

Where, I p(x, y) - is the colour level for the resulted pixel (x, y) after the contrast enlarging procedures.

Io(x, y) - is the colour level input for data the pixel (x, y).

max - is the highest value for colour level in the input image.

min - is the minimum value for colour level in the input image.

From the formula (x, y) are the coordinates of the center image components in the KERNEL & min and max are the minimum and maximum values of the image information in the chosen KERNEL.

LCS will believe each range of colour palate in the image (R, G and B). The range of each colour will be utilized for contrast enlarging procedure to symbolize each range of colour and it will provide each colour palate a group of min and max values. GCS believes every colour palate range now to establish the greatest and least for all RGB colour image. The combine of RGB colour will provide merely 1 value for most and least for RGB colour. Maximum and minimum value will be utilized for contrast enlarging procedures.

III. RESULT AND DISCUSSION

The HE method is not appropriate for electronic goods using customer because the clarity of the image is altered. The Brightness Bi-Histogram Equalization & Dualistic Sub Image Histogram Equalization technique divide the input histogram into 2 sub part depend on signify value and middle value correspondingly. The RMSHE, BPDHE and RSWHE methods separates histogram into 2 or more sub parts. In RMSHE methods separates histogram into several subsections based on local mean values. In BPDHE method splits the histogram into various sub parts & balances them separately, separation is depending on local maximums of input histogram. In RSWHE methods splits input histogram into 2 or many sub segments recursively, to alter sub histogram through means of weighting procedure based on standardize power law function. Evaluate to other contrast improvement method, The GHE & LHE techniques creates the greatest image contrast improvement as since these methods creates images without unwanted artifacts & sustains input indicate of clarity.

IV. PROBLEM DEFINITION

Usually in development of image contrast will decrees the clarity, the main goal of this new technique is to improve the contrast with protective actual visibility of the image, Sharpening details is in high contrasted way, protecting the entire shape of histogram, enlarging histogram equivalent to their bins, use of more bins through image histogram showing better improvement of image.

V. PROPOSED SOLUTION

We suggest 2 techniques in that 1st is *Local Feature Enhancement* for discovering local characters of image. 2nd is *Bidirectional Smooth Histogram Stretching* for universal improvement of image. Figure seven is explains the block diagram of planned technique. We mixed the outcome of both process through 2 modes. 1 is merging in weighted approach to obtain *Weighted of Local and Bidirectional Smooth Histogram Stretching* (WLBSHS) & next is firstly execute local improvement on actual image to acquire locally developed image. After that achieve BSHS on locally develop image to find *Local then Bidirectional Smooth Histogram Stretching*

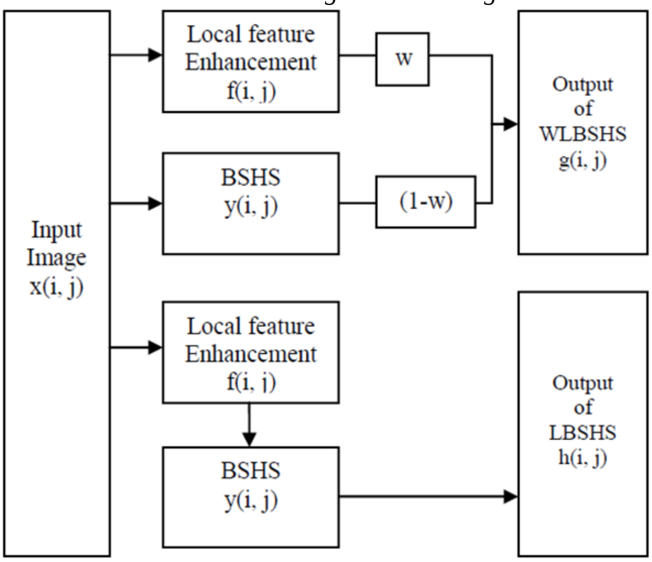


Fig. 7 Block diagram of anticipated technique

Under local augmentation, we analyze the local characteristics of image. x(i, j) symbolize a pixel value of image. f(i, j) indicate the developed value of x(i, j). w represent the weighting coefficient. g(i, j) and h(i, j) signifies the result of WLBSHS & LBSHS techniques correspondingly.

VI. CONCLUSION

In image augmentation the image contrast development plays a significant role. While conducting research survey, various image contrast improvement methods are examined and evaluated. Compared to the other mechanisms, combination of universal & local contrast improvement mechanism is advanced because these methods augment image's perfections & maintain brightness of the image while protecting its visual clarity. The main aim of image contrast improvement is to transform images into enhanced images without harsh side effects of image processing at the similar time preserving input mean clarity. Future works will be carried on to implement proposed mix of mechanisms.

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