HCTL Open Int. J. of Technology Innovations and Research
HCTL Open IJTIR, Volume 5, September 2013
e-ISSN: 2321-1814
ISBN (Print): 978-1-62840-986-4

# A Review of Image Enhancement Techniques in Image Processing

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## Abstract

**Image enhancement is usually classified into many different methods. Histogram equalization (HE) is amongst the effective and simple method of improving image quality. However, the standard histogram equalization methods usually lead to excessive contrast enhancement/improvements. Other equally important methods such as adaptive histogram equalization (AHE), histogram equalization (HE), decorrelation stretch (DRS), image adjust (IA) and image noise (IN) are classified as the important ones. Adaptive Histogram Equalization (AHE) is primarily utilized in image processing techniques and it's helpful to increase the contrast within the images. Histogram Equalization (HE) is usually a contrast adjustment when using the image histogram; it does usually enhance the global contrast of each and every pixel of the images. Decorrelation stretch (DRS) is applied to the multi channel image enhancement. Images**

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**adjust (IA) is primarily concentrate on adjusting the contrast and the quality of the entire image. Image noise (IN) is utilized to incorporate the noise within the image. The goal of image enhancement is usually to improve interpretability or perception of info available within the images, making it suitable for human vision, as well as to provide improved input to the other automated image processing techniques. This paper presents a histogram based approaches for image contrast enhancement. The most important differences of the several possible methods is the criteria employed to divide the input histogram.**

### Keywords

Image Enhancement, Contrast Enhancement, Histogram Equalization, Image Processing, Contrast Stretching.

## Introduction

The main objective connected with Image enhancement is to process an image so that result might be more suitable than first image for specific application. Electric image enhancement techniques provide a multitude associated with choices for improving this particular visual quality of photographs.

Image enhancement is basically improving the actual Interpretability or perception of information in images for human viewers and providing greater input for other hard-wired image processing techniques. There exist many techniques that can enhance an electronic image without spoiling it. These types of enhancement methods can broadly often be divided in to the two of these categories:

1. Spatial Methods for Image Enhancement,
2. Frequency Domain Methods for Image Enhancement.

In spatial domain techniques, we directly deal with all the image pixels. The pixel cost is manipulated to attain wanted enhancement. In frequency domain techniques, the image is first transferred straight into frequency domain. It means that, the Fourier Transform from the image is computed first. Every one of the enhancement operations are performed for the Fourier transform of the specific image and then the Reverse Fourier transform is performed to get the concomitant image.

Image enhancement is applied in just about every field where images are ought to be tacit and analysed.

## Real-time Applications of Image Enhancement Techniques

Image enhancement techniques have contributed to exploration advancement in a various fields. Some of the areas where Image Processing has wide application are as follows:

1. In forensics, For instance is used for designation, evidence gathering and monitoring. Images obtained from finger-mark detection, security videos analytic thinking and crime scene inspections are enhanced to help out with identification of culprits along with protection of victims.

2. In atmospheric sciences, For example is used to slow up the effects of haze, fog, mist and turbulent weather conditions for meteorological observations. It can help in detecting shape and also structure of remote physical objects in environment sensing. An artificial image from satellites requires image restoration, enhancement and other filtering methods to remove noise.

3. Astrophotography faces challenges on account of light and noise contamination that can be lessened by IE. For real-time sharpening and contrast enhancement several cameras have throughout-built IE functions. Furthermore, numerous software, allow editing such images to offer better and vivid final results.

4. In oceanography the study of images reveals interesting highlights of water flow, sediment density, geomorphology and bathymetric behaviour to name a couple of. These features are to a greater extent clearly observable in graphics that are digitally boosted to overcome the issue of moving targets, scarcity of light and obscure surround.

5. Medical imaging uses image processing techniques for noise reduction in addition to sharpening the visual representation and details of an image. Since minute details perform a critical role inward diagnosis and treatment involving disease, it is vital to highlight important features spell displaying medical images. This this way image processing techniques becomes an important aiding tool for MRI, echography and x-rays images.

A number of other fields including law enforcement, microbiology, biomedicine, bacteriology, etc., reap the benefits of various IE methods. This article provides

e-ISSN: 2321-1814
ISBN (Print): 978-1-62840-986-4

a survey of various concepts popular and/or derived being an outcome of recent research in the field of image enhancement. The focus would be on spatial domain techniques for image enhancement, with particular reference to help point processing methods including histogram processing technique.

## Review of Existing Literature on Image Enhancement Techniques

Image enhancement being one of the favourite areas of interest for researchers working in Digital Image Processing [1]. A lot of research has been conducted and a large number of research articles have been documented within image enhancement techniques [2, 3, 4, 5, 6, 7, 8].

The following image enhancement techniques were studied and documented as follows:

### Adaptive Histogram Equalization

Adaptive histogram equalization (AHE) is a computing machine image processing technique employed to improve contrast in images. It differs from ordinary histogram equalization in the respect the adaptive method computes several histograms, each corresponding to a distinct section of the simulacrum, and uses them in order to redistribute the lightness prices of the image. Hence, it is suitable for improving your neighbourhood contrast of an effigy and bringing out far more detail [9]. HE is just not suitable for consumer electronics because it could develop most of problems [10]. Root Mean Separation can be a brightness preservation technique. Your preservation ranging is from 0 to 100%. This Dynamic Range value is modified at the output and also the output is based on the picture quality. Here dissimilar images having to green goods different results. Frequency ought to be low when the uniform histogram distribution. It offers low frequency. Computation complexity is appreciably reduced. Finally the DRSHE could utilize inch consumer electronics like Live view screen and Plasma Display Instrument panel (PDP) TV.

### Histogram Equalization

Histogram equalization is a method in image processing of contrast adjustment while using the image's histogram. This process usually improves the global contrast of countless images, especially when the usable data with the image is represented by close contrast values. Through this adjustment, the intensities is

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usually better distributed within the histogram. This gives for elements of lower local contrast to get an increased contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values [11].

### Brightness Preserving Bi-Histogram Equalization (BBHE)

This technique [12] divides the whole picture histogram into two parts. Within this method, the separation intensity is presented from the input mean brightness value, which can be the standard power of all pixels that construct the input image. Then separation processes, both of these histograms are independently equalized. Using this method, the mean brightness on the resultant image will lie between input mean along with the middle gray level. The histogram with vary from 0 to L-1 is split into two parts, with separating intensity. This separation produces two histograms. The 1st histogram provides the variety of 0 to, as the second histogram has the selection of to L-1.

### Dualistic Sub-Image Histogram Equalization (DSIHE)

Dualistic Sub-Image Histogram Equalization (DSIHE) [13] follows identical basic idea of BBHE method. It decomposes the original image in to two sub-images and so equalizes the histograms of the sub-photos separately. Instead of decomposing the image depending on its mean gray degree, The input image is definitely decomposed into two sub-images, being one coloured and one bright, improving the equal area house (i.e., the images has the same amount of pixels). In , it is definitely shown that the illumination of the output effigy O produced by the actual DSIHE method is the standard of the equal region level of the photograph I and the midst gray level of the look, i.e., L / a couple of. The authors claim that this brightness of the production image generated by your DSIHE method does not necessarily present a significant transfer of relation to the brightness level of the input image, especially for the prominent area of the simulacrum with the same gray-levels (represented by smaller areas in histograms with great concentration associated with gray levels), for example, images with small physical objects regarding to great dark or brighter backgrounds.

### Minimum Mean Brightness Error Bi-HE Method (MMBEBHE)

It also follows the same basic principle of decomposing an image and then applying the HE method to equalize the resulting sub-images independently. The main difference between these technique [14] is that previous consider only the input image to perform the decomposition while the MMBEBHE searches

e-ISSN: 2321-1814
ISBN (Print): 978-1-62840-986-4

for a threshold level that decomposes the image IM into two sub-images IM [0, A] and I [A+1, L1], such that the minimum brightness difference between the input image and the output image is achieved, that is called as Absolute Mean Brightness Error (AMBE), AMBE = $|E(X) - E(Y)|$ X and Y denote the input and output image, respectively. Lower AMBE indicates that the brightness is better preserved. Once the input image is decomposed by the threshold level A, each of the two sub-images IM[0, A], and IM[A+1,L-1] has its histogram equalized by the classical HE process, generating the output image. MMBEBHE is formally defined by the following procedures:

1. Calculate the AMBE for every possible level of the threshold.
2. Find the threshold level, XT that yield minimum AMBE.
3. Separate the input histogram into two based on the XT found in Step 2 and equalizes them independently as in BBHE.

### Recursive Mean-Separate HE Method (RMSHE)

Recursive Mean-Separate HE Method is an improved version of the Brightness Preserving Bi-Histogram Equalization method. The style of BBHE [12] indicates that performing mean-separation before the equalization process does preserve a photo's original brightness. In RMSHE [15] rather than decomposing the image one time, it perform image decomposition recursively to increase preserve the initial brightness approximately scale A. HE could be the same as RMSHE level 0 (A = 0). BBHE is equivalent to RMSHE with A = 1. The brightness with the output image is best preserved as scale A increases.

### Mean brightness preserving histogram equalization (MBPHE)

The mean brightness preserving histogram equalization (MBPHE) [15] methods basically may be divided into two principal groups, which are bisections MBPHE, and multi-sections MBPHE. Bisections MBPHE group is the easiest of MBPHE techniques. Generally, these methods separate this input histogram into two sections. These two histograms are further equalized separately. However, bisections MBPHE can maintain the mean brightness just to a certain extent. Withal, some cases do demand higher degree of conservation to avoid unpleasant items. Furthermore, bisections MBPHE is able to preserve the original necessarily mean brightness if and on condition that the input histogram has a quasi-shaped distribution around its isolating point. But, most from the input histograms do not have this kind of property. This condition causes the failure of bisections MBPHE in safe guarding the mean intensity in the real world applications. Multi-sections MBPHE group has a better mean brightness preservation compared to the group of bisections MBPHE. In variable-sections MBPHE, the insight histogram is divided into Radius sub-histograms, where R is any kind of positive integer value. Each and every sub-histogram is then equalized alone. The creation of this sub-histograms can be carried out recursively (e.g. when using the mean or median chroma value), or based for the shape of the suggestions histogram itself (e.g. when using the locations of local uttermost or local minimum). Still, in these methods, the actual detection of the removing points process normally involves complicated algorithms, which and then associated with relatively large computational time. Furthermore, they usually increase the computer hardware requirement in the implementations for consumer electronic digital products. In addition, these methods put to a lot constrain on keeping the mean intensity value. Consequently, not much enhancement may very well be obtained from most of such methods.

### Dynamic Histogram Equalization

The Dynamic Histogram Equalization (DHE) technique [16] takes control over the effect associated with traditional HE so it performs the enhancement of image without making virtually any loss of details inside it. DHE divides the stimulant histogram into number of subwoofer-histograms until it ensures in which no dominating portion occurs in any of this newly created sub-histograms. Then each sub histogram is allotted a active gray level (GL) which usually further can be mapped by HE. This is performed by distributing total obtainable dynamic range of dull levels among the sub-histograms based on their moral force range in input graphic and cumulative distribution (CDF) of histogram values. This allotment involving stretching range of distinction prevents small features from the input image from getting dominated and washed away, and ensures a average contrast enhancement of every portion of the total image. At last, for each sub-histogram a separate transformation perform is calculated based for the traditional HE method in addition to gray levels of stimulation image are mapped for the output image accordingly. The complete technique can be portioned in three parts sectionalized histogram, allocating GL ranges for every single sub histogram and applying HE along each of them.

### Brightness Preserving Dynamic Histogram Equalization

The brightness preserving vibrant histogram equalization (BPDHE) [16], which is extra time to HE, fulfils the advantages of maintaining the mean settings of the image, simply by producing the output photograph with the mean high

HCTL Open Int. J. of Technology Innovations and Research
HCTL Open IJTIR, Volume 5, September 2013
e-ISSN: 2321-1814
ISBN (Print): 978-1-62840-986-4

intensity almost equal to this mean intensity of your input. This method is in fact an extension to both equally MPHEBP and DHE. Much like MPHEBP, the method dividers the histogram based on the topical aesthetic maximums of the smoothened histogram. However, before the histogram equalization taking place, the procedure will map each partitioning to a new dynamical range, similar to DHE. Since the change in the dynamical range will cause the progress in mean brightness, the ultimate step of this approach involves the normalization on the output intensity. So, the average intensity of the consequent image will be just like the input. With this specific criterion, BPDHE will green goods better enhancement compared using MPHEBP, and better inside preserving the mean perfection compared with DHE.

## Decorrelation Stretch

A decorrelation stretch (DCS) is a method to maximize the difference concerning different bands of data. By using eigen vectors and a covariance matrix, the details are "rotated" in to a whole new space where the values are then maximized as well as returned to the master copy space [17]. Another method [18] suggests a practical implementation approach shot of decor relation as well as linear contrast image enhancement technology in image processing. The main goal is to extend the medical imaging for optical interpretation such as cerebral. Proposes two pre-processing techniques are implemented. [19] Equally two methods are largely used to improve the actual classification accuracy. Main purpose of this method is to enhance the interrupted images as well as improve the classification effects.

## Local Enhancement

Other methods like histogram equalizations and histogram matching are global enhancement techniques. So, local enhancement [20] is used. Determine square or rectangular town (mask) and move the guts from pixel to pixel. For each neighborhood, calculate histogram of the points within the neighborhood. Obtain histogram equalization/specification function. Map gray level of pixel centered in neighborhood. It might use new pixel values and previous histogram to calculate next histogram.

## Contrast Stretching

[21, 22] To expand the collection of brightness values in an incredible image the contrast enhancement techniques are used, so the image can be efficiently shown in a manner desirable to the analyst. The quantity of contrast in an image

e-ISSN: 2321-1814
ISBN (Print): 978-1-62840-986-4

may vary due for you to poor illumination or unacceptable setting in the swap sensor device. Therefore, you will find there's need to manipulate the particular contrast of an image in order to catch up on difficulties in image acquisition. The idea drive contrast stretching is to increase the dynamic range on the gray levels in the image being processed. The method is to modify the actual dynamic range of the specific grey-levels in your current image. Linear Contrast Stretch is the simplest form a contrast stretch protocol that stretches this pixel value of a miserable-contrast image or high-contrast image by extending the dynamic range across the full image spectrum from 0 (L-1).

## Image Adjust

[23] Proposed method is dependent on extensive experiment. This composition novel extension of ageing scheme is extracted along with the automatic age is for being identified. Human age is estimated based on your genes. The face images patches at different the degree of intensity. Future work is suggested to improve the accuracy and reliability. [23] Proposes a unexampled image enhancement method with it is founded on the Non-sub Sampled Contour let Transform (NSCT). The proposed algorithmic program enhances the dynamic choice of the image. We have proposed the novel algorithm for multiple-scale image enhancement based on the NSCT and also this algorithm can be put on gray-scale and the two color images.

## Image Noise

[25] Related work on this paper is related to be able to partial differential equation based mostly schemes for image processing may be easily incorporated in our model. [26] Film-screen mammography has been the most frequent and effective technique with the disease for breast malignant neoplastic disease. Full-Field Digital Mammography (FFDM) is important to increase the sensitiveness of mammography. In the point of view the particular proposed methods of this particular paper is to lessen and avoid alcohol, exercise every day and also take the supplements daily. Then alone(p) you avoid the cancer of the breast. [27] This paper is principally focus on canny sharpness detector and it is easily the most popular edge detection technique and also it may be the one of the prosperous edge detector. Future work is recommended to investigate this computing that parameter applying property of image such as histogram. New step is as well used to increase this computational time. Incorporate fellow group and neighbour mathematical group consideration can be used to improve edge detection performance. [28] Proposes an ample algorithm is used to raise

the quality of weak illumination image.

## Conclusion

In this paper different image enhancement methods are discussed and processes have been studied. Image Enhancement methods primarily applied intended for contrast the images. Image enhancement algorithms offer a wide selection of approaches for modifying photographs to achieve visually appropriate images. The choice connected with such techniques is a function with the specific task, image content, observer characteristics, along with viewing conditions. The place processing methods are many primitive, yet essential image processing operations and are utilized primarily for contrast enhancement. Image Negative is suited for maximizing white detail embedded throughout dark regions and features applications in medical imagery. Power-law transformations are useful for general-purpose line manipulation. For a dark image, an expansion of grayish levels is accomplished employing a power-law transformation with a fractional advocator. Log Transformation is Useful for maximizing details in the richer regions of the image at the expense associated with detail in the brighter regions with the higher-degree values. Comparatively, histogram equalization provides better result regarding image contrasts. Histogram equalization is used in are Cumulative Distributive Function (CDF).

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