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# A Review on Modified Image Enhancement Applications

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**Abstract**

*The aim of image enhancement is to or to provide 'better' input for other improve the interpretability or perception of information in images for human viewing automated image processing techniques. Various Histogram Equalization techniques like CHE, GHE, BBHE, DSIHE, RMSHE and Multi-HE techniques are used for processing the image input to enhance its output.*

*This paper provides a review over the modification of the brightness preserving dynamic histogram equalization technique to improve its brightness preserving and contrast enhancement abilities while reducing its computational complexity. There are many modified technique related to brightness preserving dynamic Histogram Equalization that uses statistics of digital images for their representation and processing are discussed here. Representation and processing of images in the spatial domain enables the technique to handle the inexactness of gray level values in a better way, resulting in improved performance. This algorithm enhances image contrast as well as preserves the brightness very effectively. Some images are not available to good quality, so these algorithms are used for image enhancement to improve the quality of the image.*

***Keywords:*** *image enhancement, image processing, histogram, fuzzy statistics, brightness preserving algorithm*

## 1. Introduction

Digital image processing is a broad subject and often involves procedures which can be mathematically complex, but central idea behind DIP is quite simple. The aim of image processing is to use data contained in the image to enable the system to understand, interpret and recognize 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.

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## 2. Image Enhancement by Histogram Equalization

A general framework based on histogram equalization for image contrast enhancement is presented in many literatures [1-3]. In this framework, contrast enhancement is posed as an optimization problem that minimizes a cost function. They introduced specifically designed penalty terms, the contrast enhancement level can be adjusted; white or black stretching, noise robustness and mean-brightness preservation may easily be incorporated into the optimization. Analytic solutions for some important criteria are presented along with a low-complexity algorithm for contrast enhancement was presented, and its performance was demonstrated against a recently proposed method.

These frameworks [6] employs carefully designed penalty terms to adjust the various aspects of contrast enhancement. Hence, the contrast of the image/video can be improved without introducing (Figure 2) visual artefacts that decrease the visual quality of an image and cause it to have an unnatural look.

**Figure 1. Original Image**

**Figure 2. Contrast Limited Adaptive Histogram Equalization**

To obtain a real-time implementable algorithm, the proposed methods avoid cumbersome calculations and memory-bandwidth consuming operations. Obtained results were visually pleasing, artefact free, and natural looking. The proposed algorithm feature was that it does not introduce flickering, which is crucial for video applications. This is principally due to the fact that the proposed method uses the input (conditional) histogram, which does not change in an expressive manner within the same scene. Then, the proposed method modifies it using linear operations resulting from different cost terms in the objective rather than making algorithmic hard decisions.

 

In 2004 [3] issue on Histogram equalization were analyzed and it was proposed that HE is simple yet effective image enhancement technique. However, it tends to alternation the brightness of an image in an expressive manner, causing annoying a unnatural and artifacts 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 moderate. Simulation to come out showed that MMBEBHE can preserve brightness better than BBHE and DSIHE. Furthermore, this work also formulated an effective, integer-based implementation of MMBEBHE. Nevertheless, MMBEBHE also has its restriction. There is also proposed generalization of BBHE referred to as recursive mean-separate histogram equalization (RMSHE). RMSHE is featured with scalable brightness preservation. Simulation results viewed that RMSHE is the best equalization technique compared to HE, BBHE, DSIHE, and MMBEBHE. It has been observed that the work in context of bi-histogram equalization, MMBEBHE is better than BBHE and DSIHE in preserving an image's original brightness.

**Figure 3. Local Histogram Equalization**

**Figure 4. Global Histogram Equalization**

In 2004 [3] it is found that image enhancement is one of the most important issues in low-level image processing. In some algorithm basically enhancement methods were classified into two classes: global and local methods. In such work the multi-peak generalized histogram equalization is proposed. The global HE is improved by using multi-peak histogram equalization combined with local information. These enhancement methods are based either on local information or on global information. Such approach used both local and global information to enhance image. This method adopts the traits of existing methods. It also makes the degree of the enhancement completely controllable. Experimental results show that it is very effective in enhancing images with low contrast, heedless of their brightness. Multi-peak GHE technique is very effective to enhance various kinds of images when the proper features (local information) can be extracted.

## 3. Extension to Histogram Equalization

In 2006 to 2012 many works supported the significance a contrast enhancement has an important role in image processing applications [6-9]. They described that conventional contrast enhancement technique either often fail to produce satisfactory results for a broad variety of low-contrast images. 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, these 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 incidents, and is suitable to a broad differences of images. An extension of GLG is selective GLG (SGLG). SGLG selectively groups and ungroup histogram components to achieve specific application purposes.

GLG was a general and powerful technique, which can be suitable manner, applied to a explicit variety of low-contrast images and generates satisfactory results. HE method could be conducted with full automation at fast speeds.

In 2007 a modified Histogram equalization (HE) has proved to be a simple and effective image contrast enhancement technique [8]. It worked on a novel technique called Multi-HE, which uniformly of decomposing the input image into various sub-images, and then devoting the classical HE process to each one. This scheme performs a less increase produce image contrast enhancement, in a way that the output image presents a more natural look. It proposed two discrepancy functions for image decomposing, imagining 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.

Similarly in [5] it was stated that the HE technique was not very well suited to be implemented in consumer electronics.

**Figure 5. Dualistic Sub-Image Histogram Equalization**

 

They discussed that one of the solutions to overcome this weakness is by preserving the mean brightness of the input image inside the output image.

They provided the modified dualistic sub image HE method which preserves the brightness of the image. They discussed results of first five methods that are available for contrast enhancement and brightness preservation such as conventional global HE, local HE, ADPHE, BBHE, DSIHE. The last method as MDSIHE gives better results than all other.

In 2009 a work was found [9] that in can enhance the contrast in the regions where the pixels have similar intensities, they presented a new histogram equalization scheme. Conventional global equalization schemes over-equalize these regions so that too bright or dark pixels are resulted and local equalization schemes produce unexpected discontinuities at the boundaries of the blocks. The proposed algorithm segments the original histogram into sub-histograms with reference to brightness level and equalizes each sub-histogram with the limited extents of equalization considering its mean and variance. The final image is determined as the weighted sum of the equalized images obtained by using the sub-histogram equalizations. By limiting the maximum and minimum ranges of equalization operations on individual sub-histograms, the over-equalization effect is eliminated.

## 4. Brightness Preserving Techniques Application in Image Enhancement

In [7] a novel local brightness preserving dynamic histogram equalization (LBPDHE) algorithm for contrast enhancement is provided. Previous contrast enhancement works have shown the benefits of histogram partitioning before histogram equalization to avoid over or under enhanced images. In addition, brightness preservation has been recognized as one of the most important properties for contrast enhancement schemes. Brightness preservation is important for reducing energy consumption in consumer electronic products, such as liquid crystal displays (LCD) and televisions. The main idea of that work was the observation that brightness preservation could be performed locally and independently for each partition, instead of globally over the whole histogram as in previous research proposals. Based on eighty test images, experimental results indicate that their proposed method can not only produce good contrast enhanced images, but also achieve the best mean brightness preservation when compared with the other state-of-the-art methods. It augments the DHE method with a simple, yet important local mean brightness preserving technique. Based on eighty test images, experimental results show that our proposed LBPDHE method not only has good contrast enhancement, but also achieves the best brightness preservation. Their proposed method has saved more power than the other contrast enhancement methods when implemented in consumer electronic products.

Chao Wang and Zhongfu Ye in 2005 [3] worked for preserving the original brightness to avoid annoying artifacts. This provided an extension of histogram equalization, really histogram detailed description, to overcome drawback of HE. To maximize the entropy is the essential idea of HE to make the histogram as flat as possible. Following that, the essence of the proposed algorithm, named Brightness Preserving Histogram Equalization with Maximum Entropy (BPHEME).They compared BPHEME to the existing methods including HE, Brightness preserving Bi-Histogram Equalization (BBHE), equal area Dualistic Sub-Image Histogram Equalization (DSIHE), and Minimum Mean Brightness Error Bi-Histogram Equalization (MMBEBHE), experimental results show that BPHEME can not only enhance the image effectively, but also preserve the original brightness perfectly well.

**Figure 6. Mean Brightness Preserve Histogram Equalization**

BPHEME used to find the optimal histogram (Figure 5), which has the maximum differential entropy under the mean brightness constraint, and then implements the histogram specification under the instruction of that desired histogram. Experimental results show that BPHEME can enhance the image quite well when preserving the mean brightness, which is very suitable for consumer electronics such as TV. It had potential applications considering the tolerant threshold for the human visual systems.

## 5. Fuzzy Statistics in Image Enhancement

In 1997 [1] 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 legality of the supposition 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 modelling the distance and density function. Analytical discussions and experimental details validate the importance of fuzzy thresholding schemes based on fuzzy clustering.

In 2010 gave a novel modification of the brightness preserving dynamic histogram equalization technique to improve its brightness preserving and contrast enhancement abilities while reducing its computational complexity. The modified technique, called Brightness Preserving Dynamic Fuzzy Histogram Equalization (BPDFHE1), uses fuzzy statistics of digital images for their representation and processing. Processing and representation of images in the fuzzy domain enables the technique to handle the inexactness of gray level values in a better way, resulting in improved performance. Execution time is depending on image size and histogram nature, however experimental results show it to be faster as compared to the techniques compared here.

## 6. Image Enhancement Application in Real Time

In 2004 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 ridges 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 newly approach to fingerprint image enhancement, which is based on integration of directional median filter (DMF) and Anisotropic Filter. 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 FVC2002. Images of changing quality have been used to evaluate the performance of their approach. They compared the proposed work with other methods in terms of missed minutiae, spurious minutiae, matched minutiae and flipped minutiae (between end points and bifurcation points). Results shown for their model can effectively reduce Gaussian-distributed noises (by anisotropic filter) and impulse noises along the direction of ridge flow (by DMF). This algorithm may fail when image regions are contaminated with heavy noises and orientation field in these regions can hardly be estimated.

In 2006 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 desired. Instead of axle discovering, 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 Hear 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.

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