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# Image Enhancement Techniques for Grey Scale and Colour Images: A Survey

**A. H. Jadhav*, Dr. P. N. Chatur**
*Dept. of Computer Science & Engineering,*
*S.G.B. Amravati University, India*

***Abstract*—The main aim of image enhancement is to improve the interpretability or perception of information in images for human viewers, or to provide better input for other automated image processing techniques. Many techniques for enhancement of grey scale images such as histogram equalization, contrast stretching etc. can be found in the literature. But those methods are not directly applicable to the colour images due to the presence of colour information as well as grey-level information. In this paper various image enhancement techniques for grey scale and colour images are overviewed.***

***Keywords*— Grey scale image, Luminance, Contrast, Enhancement, human perception**

## I. INTRODUCTION

The image acquired from natural environment with high dynamic range includes both dark and bright regions. Due to exceed in dynamic range of human eyes sensing, those image are difficult to perceive by human eyes. Image enhancement is a common approach to improve the quality of those images in terms of human visual perception. Enhancement techniques can be divided into two categories namely: spatial domain and transform domain methods. Spatial domain technique enhances an image by directly dealing with the intensity value in an image. Transform domain enhancement techniques involve transforming the image intensity data into a specific domain by using methods such as DFT, DCT, etc. and the image is enhanced by altering the frequency content of the image. Many techniques for enhancement of grey level images such as histogram equalization, contrast stretching etc. can be found in the literature. But those methods are not directly applicable to the colour images because due to the presence of colour information as well as grey-level information. For the purpose of enhancing a color image, it is to be seen that hue should not change for any pixel. If hue is changed then the color gets changed, thereby distorting the image. One needs to improve the visual quality of an image without distorting it for image enhancement

## II. TECHNIQUES FOR GREY SCALE IMAGES

### *A. Histogram equalization*

Histogram equalization (HE) is a very popular technique for enhancing the contrast of an image [1]. Its basic idea lies on mapping the grey levels based on the probability distribution of the input grey levels. HE is a scheme that maps the input image into the entire dynamic range, by using the cumulative density function as a transform function.

It flattens and stretches the dynamics range of the image's histogram and resulting in overall contrast improvement. HE has been applied in various fields such as medical image processing and radar image processing [2]. Nevertheless, HE is not commonly used in consumer electronics such as TV because it may significantly change the brightness of an input image and cause undesirable artifacts. The fundamental reason behind such limitation of the HE is that HE does not take the mean brightness of an image into account. In theory, it can be shown that the mean brightness of the histogram-equalized image is always the middle grey level regardless of the input mean. This is not a desirable property in some applications where brightness preservation is necessary [4].

### *B. Brightness preserving bi histogram equalization*

Brightness preserving bi histogram equalization (BBHE) firstly separate the input image's histogram into two based on its mean; one having range from minimum grey level to mean and the other ranges from mean to the maximum grey level. Next, it equalizes the two histograms independently. It has been analysed both mathematically and experimentally that this technique is capable to preserve the original brightness to a certain extend but cannot handle cases that requires higher degree of preservation. [4]

### *C. Equal area dualistic sub-image histogram equalization*

Equal area dualistic sub image histogram equalization (DSIHE) is similar to BBHE except that DSIHE choose to separate the histogram based on grey level with cumulative probability density equal to 0.5 instead of the mean as in BBHE. The theory behind is that this would yield maximum entropy for the output image. Nevertheless, there are still cases that are not handled well by both the BBHE and DSIHE. These images require higher degree of brightness preservation to avoid annoying artifacts. It Enhances image information effectively and constrain original image luminance from great shift. But this method is not scalable to different images [4].

 

*D. Recursive mean-separate histogram equalization*

This method is a generalization of BBHE to overcome limitation and provide not only better but also scalable brightness preservation. BBHE separates the input image's histogram into two based on its mean before equalizing them independently. While the separation is done only once in BBHE, this method proposes to perform the separation recursively; separate each new histogram further based on their respective means.

It has been analysed mathematically that the output image's mean brightness would converge to the input image's mean brightness as the number of recursive mean separations increases. Besides, its recursive nature also implies scalable preservation, which is very useful in consumer electronic products. This method provides Better and Scalable brightness preservation and natural enhancement. But this method cannot be automated easily [4].

*E. Spatially adaptive Histogram equalization with temporal filtering*

This method proposed a block-overlapped histogram equalization algorithm for spatially adaptive contrast enhancement, and also proposed an efficient filtering method for suppressing over-amplified noise. The non-overlapped block adaptive histogram equalization technique that based on other properties of the pixel intensities in a neighbourhood can enhance details over small areas. These techniques, however results in blocking artifact at the cost of saving in computation and storage. The major objective of the proposed contrast enhancement system is twofold; locally adaptive histogram equalization and reduction of undesired artifacts such as noise and blocking artifact. More specifically, local adaptivity is incorporated by block-based processing, blocking artifact is reduced by overlapping adjacent blocks, and noise is suppressed by spatio-temporally adaptive filtering.

In contrast to the existing global histogram equalization, block-based equalization generally over enhancing the contrast in the corresponding block due to reduced number of pixels. In the processed image, that over-enhancement results in variance or noise amplification. In order to enhance the current image contrast with suppressing undesired noise amplification, the spatio-temporal filter is proposed [3].

*F. Weighted threshold Histogram equalization*

This method proposed a fast global HE-based enhancement scheme, which provides images with well-enhanced contrast and considerably less artifacts than the traditional global HE based methods. The proposed enhancement method provides two parameters that allow convenient and effective control over the degree of enhancement. The proposed weighted thresholded (WTHE) enhancement method performs histogram equalization based on a modified histogram. Each original probability density value is replaced by a weighted and thresholded PDF value [5].

In this method the histogram of an image is modified by weighting & thresholding before equalization. It gives visually pleasant enhancement effects and adaptive to various types of images.

## III. TECHNIQUES FOR COLOUR IMAGES

*A. Hue-preserving colour image enhancement without gamut problem*

Though the various algorithms are interesting and effective for colour image enhancement, most of them do not effectively take care of the gamut problem – the case where the pixel values go out of bounds after processing. Due to the nonlinear nature of the uniform colour spaces, conversion from these spaces with modified intensity and saturation values to RGB space generates gamut problem. In general this problem is tackled either by clipping the out of boundary values to the bounds or by normalization. Clipping the values to the bounds creates undesired shift of hue. Normalization reduces some of the achieved intensity in the process of enhancement which is against its objective.

This method is a novel and effective way of tackling the gamut problem during the processing itself. It is not necessary to bring back the R, G, and B values to its bounds after the processing is over in this method. An algorithm proposed in this method does not reduce the achieved intensity by the enhancement process. The enhancement procedure is hue preserving. It generalizes the existing grey scale image enhancement techniques to colour images. The processing has been done in RGB space and the saturation and hue values of pixels are not needed for the processing. Scaling and shifting are hue preserving operations, using these two operations hue preserving contrast enhancement transformations are developed.

This is the scheme to generalize any grey scale image enhancement method to colour images without encountering gamut problem. The overall enhancement obtained by the proposed scheme is mainly dependent on the already existing different contrast enhancement functions for grey scale images. These contrast enhancement functions for grey scale images are generalized to enhance the intensity of the colour images, keeping the hue intact. A novel scheme is proposed to avoid gamut problem arising during the process of enhancement. This scheme is used to enhance the intensity of colour images using a general hue preserving contrast enhancement function [8].

*B. Adaptive and integrated neighbourhood dependent approach*

This method has two separate processes. Luminance enhancement is first applied to the image through a pixel intensity transformation that is implemented by using a nonlinear transfer function. This transfer function can be manually or automatically adjusted to achieve appropriate luminance enhancement. After luminance enhancement, the image is then treated by the contrast enhancement which, unlike the conventional techniques, is an adaptive process based on the intensity information of both the processed (centre) pixel and its surrounding neighbours. The luminance information of surrounding pixels is obtained by using 2D discrete spatial convolution with a Gaussian kernel. Therefore, pixels with the same luminance may have different outputs depending on their neighbourhood pixels. In this way, picture contrast and fine details can be optimally enhanced while dynamic range expansion can be controlled without degrading image quality [9].This method gives images having good quality, fine details and well balanced contrast. But here the shape of transfer function is same for all pixel i.e. High level locality is not considered.

### *C. Nonlinear Transfer Function-Based Local Approach for Color Image Enhancement*

Most of the image enhancement methods treats the input image globally by considering the global information. The main problem of such methods is that, after enhancement the image details are degraded. We know that the illumination all over the image is not same, some regions maybe dark and some may be bright. Thus the image locality is to be considered while enhancing the colour image. In order to achieve this goal this method first divide the value component image in HSV image space into smaller overlapping blocks and find the shape of the nonlinear transfer function for each pixel to enhance the luminance of the image. In contrast enhancement process, for each pixel the amount of enhancement is calculated depending upon the centre pixel itself and its surrounding pixel values [1].

This method for enhancing the colour images based on nonlinear transfer function and pixel neighbourhood by preserving details. In this method, the image enhancement is applied only on the V (luminance value) component of the HSV colour image and H and S component are kept unchanged to prevent the degradation of colour balance between HSV components. The V channel is enhanced in two steps. First the V component image is divided into smaller overlapping blocks and for each pixel inside the block the luminance enhancement is carried out using nonlinear transfer function. In the second step, each pixel is further enhanced for the adjustment of the image contrast depending upon the centre pixel value and its neighbourhood pixel values. Finally, original H and S component image and enhanced V component image are converted back to RGB image. The performance evaluation shows that this enhancement method yields better results without changing image original colour in Comparison with the conventional methods.

## IV. CONCLUSIONS

In this paper various techniques for image enhancement for grey scale and color images are overviewed. There are Many techniques for enhancement of grey scale images in the literature on the other hand, literature on the enhancement of color images is not as rich as grey scale image enhancement. Most of the image enhancement methods treats the input image globally but after enhancement the image details are degraded. So the image locality should be considered while enhancing the colour images.

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