An Intelligence System for Image Enhancement with Local and Global Enhancement for Dark Images

Pawan Kumar Shukla, Akhilesh Pandey

Abstract—**Image enhancement is a key factor in the area of image analysis, feature extraction and any further higher level processing of the image. The quality of the processed image cannot be scarified at any cause and contrast is always appreciated in higher level processing. The purpose of image contrast enhancement is to improve the features of an image. Contrast Enhancement plays a vital role in different kinds of images such as Natural, Medical and Microscopic for quality improvement. However, contrast enhancement may not be necessary for all images as processing of high contrast images costs time and computations. Hence, an automatic algorithm is required to classify the images as low contrast and high contrast to improve the quality of the images.**

Global image contrast enhancement is one of the most commonly used techniques to enhance the quality of an image, but it has some disadvantages with the fact that it does not consider the local details of an image. Local details of an image are very important for diagnosing a particular ailment. When either local contrast enhancement or global contrast enhancement is used alone, there is loss of brightness of the image. , a new method is presented in this work that uses both local and global enhancement methods with ANN on the same image.This enhancement method is simulated in MATLAB and results are verified on the parameters of image quality.

Index Terms—Local and Global enhancement, ANN, Image Contract, Image Quality

I. INTRODUCTION

Digital image processing is a technique used to analysis the required particular part of the images which comprises two levels of processing. Low level methods usually use very little knowledge about content of images. These methods often include image compression, pre-processing methods for noise filtering, edge extraction and image sharpening. High-level processing is based on knowledge, goals and plans of how to achieve those goals, and artificial intelligence methods are widely applicable.

Low-level processing helps to enhance high-level processing. These image processing techniques help to transfer the image from one form to another form. The input image may undergo a wide range of enhancement processes such as filters, contrast stretching, brightness, colour adjustments, etc., to extract the required information from the image. The direct human visualization of the images may lead to providing better analysis of high visual images. In the case of poor visual images those who have poor contrast and poor brightness it is difficult to analysis specific parts of the images. Enhancement of these images provides more flexibility in handling the images. In the case of poor visual images poor contrast and brightness images make more difficult to review the particular part of the image. Enhancement of images provides more flexibility in handling the images. Enhancement techniques are widely used in real time applications such as consumer electronics, medical image and disease analysis, cloud image analysis, space image analysis, defect detection in the processing industries, biometric security authentications and various other applications.

The local information of an image are very important if the image is of medical or astronomical applications for analyzing and extracting the information of that image and proper diagnosing of the ailments based upon the image of a cell. So with the advancement of science and technology, especially in the field of signal processing, the quality of an image can be enhanced so that it gives clear and detailed information about the image. [1]The global method of contrast stretching is very common in image enhancement, it gives a satisfactorily good quality of an image for viewing purpose but it lacks the local details of the image as it mainly focused on the global details of the image that is overall information of the image and neglects the local details of an image. The local method enhances the local details of the image that is the slight variation of the image is addressed and provides the minute details of the image. It lacks from the overall information of the image pixel enhancement. In this combined algorithm, one's discrepancy is addressed by another. The minute details of the image are addressed by the local method which is not addressed in the global method.The equalization of the histogram of an image for enhancement of the image is very common and effective. Histogram equalization based contrast enhancement techniques was presented in [2] for preserving brightness. In [3], each and every peak of the histogram is equalized separately. It is a technique of spatial domain of an image. Spatial domain means processing of image is done directly on the image pixel, not on the other transformed domain. One single technique cannot be used as a universal technique that can be applied to all types of images.

Various contrast stretching methods have been proposed to enhance the image of leukemia, a medical image in [4]. When a dark stretch is performed, the bright portions of the image or the bright pixels are more brightened. A better way to address such problem is to enhance the dark regions by keeping the bright regions untouched [5], these have shown the effects of various contrast stretching techniques like global stretching, local contrast stretching, partial contrast stretching etc. The problems of a blurred image, which is caused by the motion of the object while taking the image, and how to avoid is presented in [6]. It also used local edge detection to deblur the original image. In [7], the effect of application of both global and local contrast enhancement is studied on gray scale image and only the brightness parameter of the image has been observed. This method is being used in this work on the dark color image and image enhancement parameters like mean and measure of enhancement factor with artificial neural network is calculated and the output image is compared with the existing image enhancement techniques.Enhancement of images

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II. Literature Review

Literature survey interprets old information and generates a combination of new information with old information. So, in this section there is a brief description of various research papers and occurrence of summary and synthesis of research papers.

Tae Keun Kim et al (1998) proposed a block-overlapped histogram equalization system for enhancing contrast of image sequences. The proposed system has various applications such as video door phone, security video cameras in addition to the original target video camcorders. A new approach for text images to compensate uneven illumination distribution with a high degree of text recognition was explained by Kuo-Nan Chen et al (2012). The proposed scheme was implemented by enhancing the contrast of the scanned documents and generated an edge map from the contrast-enhanced image for locating text area. With the information of the text location, a light distribution image (background) was created to assist the formulation of the final light balanced image.

A log-based histogram modification scheme which deals with developing a power consumption model and the objective function is formulated by Chulwoo Lee et al (2012). The contrast enhancement and power saving is obtained by minimizing an objective function using convex optimization theory. Andrea Polesel et al (2000) studied and developed a new method for unsharp masking for contrast enhancement of images. This work employed an adaptive filter that controls the contribution of the sharpening path in such a way that contrast enhancement occurs in high detail areas, and little or no image sharpening occurs in smooth areas.

Wavelet transform is used to decompose the image and modifies the coefficients by employing the proposed method to perform contrast enhancement. Cheng et al (2010) analyzed a novel approach to automatically select wavelet bases and parameters which are important and essential issue for implementing wavelet algorithms.

The problems like un-natural look and brightness preservation of histogram equalization had been addressed by contrast enhancement method based on genetic algorithm was proposed by Sara Hashemi (2010) and the resulted images were suitable for consumer electronic products. A hybrid algorithm including Genetic Algorithm (GA), Ant Colony Optimisation (ACO) and Simulated Annealing (SA) meta heuristics for increasing contrast of images was proposed by PouryaHoseini&MahrokhShayesteh (2013). Ming-SuenShyu& Jin-Jang Leou (1998) explained a genetic algorithm determining the optimal set of generalized transforms with largest fitness function value and also improved the image quality or enhances the fine details by using genetic algorithm approach. It is formulated as an optimization problem.

Enhancement of color images using the fuzzy logic technique that used power-law operator to improve the overexposed region of the image and to recover the lost information in the over exposed region was discussed by MadasuHanmandlu et al (2009).

Yu-Ren Lai et al (2012) presented a novel mean-shift based histogram equalization method called the MSHE method with textured region obtained by mean shift approach as the basis of histogram equalization and suppress the smoother regions. A new cost function was presented to balance the image quality and contrast enhancement effect for search termination in the proposed algorithm.

A new automatic contrast enhancement method selectively groups and ungrouped histogram components to achieve specific application purposes such as eliminating background noise, enhancing a particular segment of the histogram was explained by ZhiYu Chen et al (2016).

Jeyong et al (2015) formulated as an optimization problem to preserve localities of the histogram for performing image CE. The locality preserving property makes the histogram shape of the enhanced image to be similar to that of the original image.

A new contrast enhancement approach presented by Bhandari et al (2014) which is based on Cuckoo Search (CS) algorithm and DWT-SVD, reconstructed the enhanced image by applying IDWT for quality improvement of the low contrast satellite images. Agaian et al (2007) discussed about the logarithmic transform domain histogram which gives a better relation between stimulus and perception of image, that in turn help in better enhancement quality and computation efficiency.

Jinshan Tang et al (2003) used an image enhancement algorithm with low computation complexity for compressed images. The algorithm is based on a contrast measure defined within the discrete cosine transform (DCT) domain.

III. Local Enhancement of the Image

The local enhancement is employed to get the minute details of an image. It enhances the local details in terms of the gradient of the image which gives useful information to the analyzer of the image. It addresses those pixels which would be ignored by the global method. The local enhancement method employed here is un-sharp masking [8]. In this method the image is sharpened by subtracting an un-sharp image that is a blurred or smoothed from the original image, so the name Un-sharp masking is derived. In this method the following steps are involved:

1. Blurring of the image.
2. Subtracting the blurred image from the original image to make the mask.
3. Adding the mask to the original image.

If the blurred image is denoted as b (i,j) and the image as p (i,j) then the mask m (i,j) is given according to equation (1).

$$m(i, j) = p(i, j) - b(i, j) \quad (1)$$

The weighted portion of the mask is added to the original image to get the sharpened images (i,j) given by equation (2).

$$s(i, j) = p(i, j) + w * m(i, j) \quad (2)$$

Where ‘w’ is the weight, generally greater than zero. When the weight is equal to 1, it is the un-sharp masking and when greater than 1 then it is called high boost filtering. This sharpened image is given as input to the global contrast enhancement process for further improvement in the image quality or to improve the visual quality of the image.

IV. Global Enhancement of the Image

The global enhancement of the image is used to increase the contrast of the image. In this process each pixel of the image is adjusted so that it gives a better visualization of the image. In spatial contrast enhancement, the operation is performed directly on the pixel. The pixels are arranged in such a way that it is distributed throughout the range of desired intensity level. Global contrast stretching method is used as global method of enhancing the image. There are many global techniques like histogram equalization (HE), contrast limited adaptive histogram equalization and many other transformation methods like discrete cosine transform (DCT), discrete shearlet transform (DST), adaptive inverse hyperbolic tangent function transformation, etc. Among these, HE is the one used widely as global method [8].

Any of the method can be used to enhance the image globally. In all the global methods they did not consider the local details of the image and look for the global information of the image. So we first apply the local enhancement in order to verify the algorithm, the simple HE is used. It is not mandatory to use only this method; different methods can be used to improve the image quality. For the discrete image, the probabilities of the pixel value are taken in HE. To take the probabilities, first the corresponding number of pixels should have particular pixel intensity value; it is calculated and divided by the total number of the pixels present in the image. The probability of occurrence of pixel intensity level 'k' in the digital image is stated by equation (2).

$$p(r_k) = \frac{n_k}{N*M} \quad (3)$$

Where N*M is the total number of pixels in the image and n_k is the total number of pixels having intensity level"k". The pixels are transformed according to the following transformation equation in discrete form [8].

$$t_k = L(r_k) = (G-1)\sum_{i=1}^{k} p(r_i) = \frac{G-1}{N*M}\sum_{i=0}^{k} n_i \quad (4)$$

Where 'G' is the highest intensity level or value, L (r_k) is the transform function and k = 0, 1, 2, 3, ..., G-1. So the output image pixel is obtained by mapping each input pixel r_i to the new transformed value tk. The processed output value may have fractional value so a rounding function to the nearest integer value is needed. While doing so some of the image pixels may go to the new value and some of the intensity pixel values may not be present in the transformed image.

V. Artificial Neural Network (ANN)

The inputs to the ANN are the utilization of the entire network element. The output of Base ANN is the temperatures of the cores, switches and links. The Base ANN output is compared to the threshold producing a single bit output. This output signifies. The element has crossed the threshold or not. The trained ANN is a concatenation of three subdivided ANN streams. The subdivided ANN streams are Core streams, Link stream and Switch stream. The inputs to all the streams remain the same, i.e. the utilization of all the network elements and time to be predicted.

This structure of ANN results in better accuracy and decreases the number of connections between hidden layer and output layer i.e. the fully connected neurons exists only between the hidden neurons of cores and output neurons of the cores. The reduced number of connections between the hidden neurons and the output neurons decreases the latency of prediction. The ANN tool box of MATLAB is used to train.

VI. Proposed Image Enhancement Method

Figure 1 shows the proposed method to be incorporated in order to get a good quality image by combining both local enhancement and global enhancement of a color image. It mainly consists of the following five steps.

Step 1: Get the color image and convert it into hue, saturation and value (HSV) color space and take the luminance of that image.

Step 2: Apply Artificial Neural Network.

Step 3: Apply the local enhancement method to enhance the local details of image.

Step 4: The local output is again given as global input and perform global image enhancement.

Step 5: Recombine the components and reconvert it back to color image.

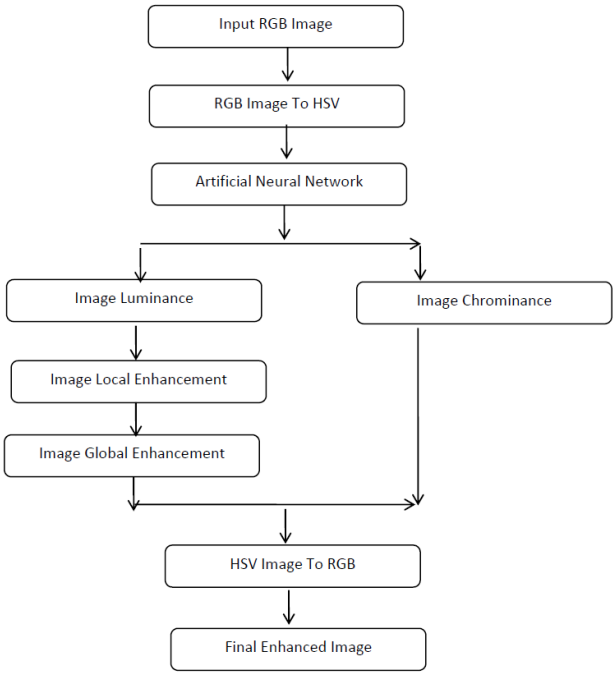


Figure 1: Flow graph of the proposed image enhancement

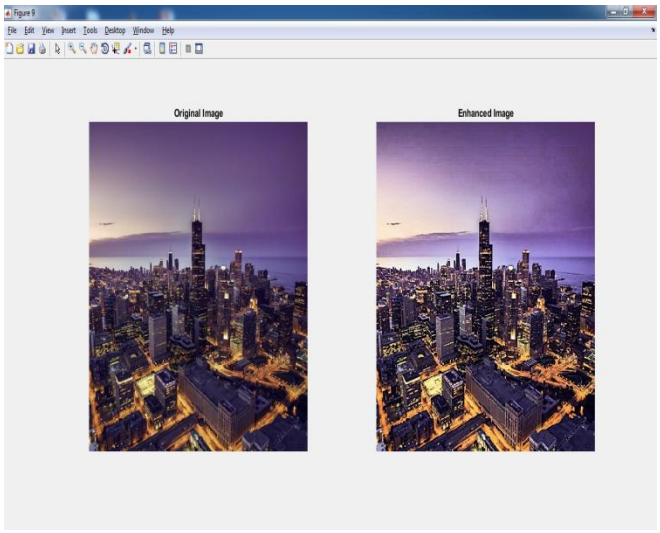
In order to enhance the local gradients or the local details, an existing local enhancement method has been used. Here the un-sharp masking is used as local details enhancement method. As the name suggests it uses the blurred image to make the mask and enhances the local details in the form of edge sharpening. The sharpened image is used as the input to the global enhancement method. The global enhancement method uses one of the global contrast stretching methods.

The image enhancement is performed only in the luminance plane of the image. The local details of an image can be accessed or addressed through the luminance only. There is effect of hue and saturation also in the contrast but the effect is less compared to luminance of an image. The luminance portion is responsible for the local radiance of the image. The luminance is enhanced by applying the proposed algorithm and it is combined with the chrominance and converted back to color image. Generally the global method is very fast in processing.

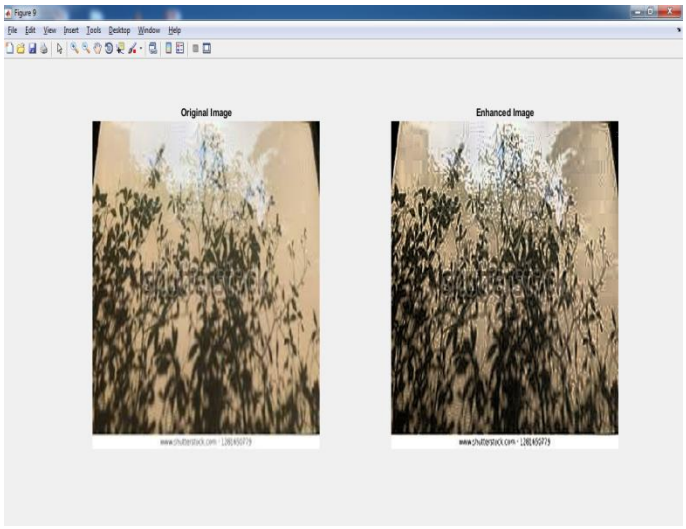
VII. Result and Analysis

To see the effect of the combination of local and global enhancement methods of an image, the above mentioned algorithm is applied. The color image or digital color image to be enhanced is taken and converted to the HSV color space in order to apply the algorithm. The image plane slicing is performed and the image is divided into three different planes each of hue, saturation and value. The hue and saturation is the chrominance of the image and the value is the luminance. The luminance is mainly responsible for the radiance and brightness of the image. So the value image plane which is the third plane is taken for the enhancement and the other two planes of the image are kept as it is without altering the pixel intensities.

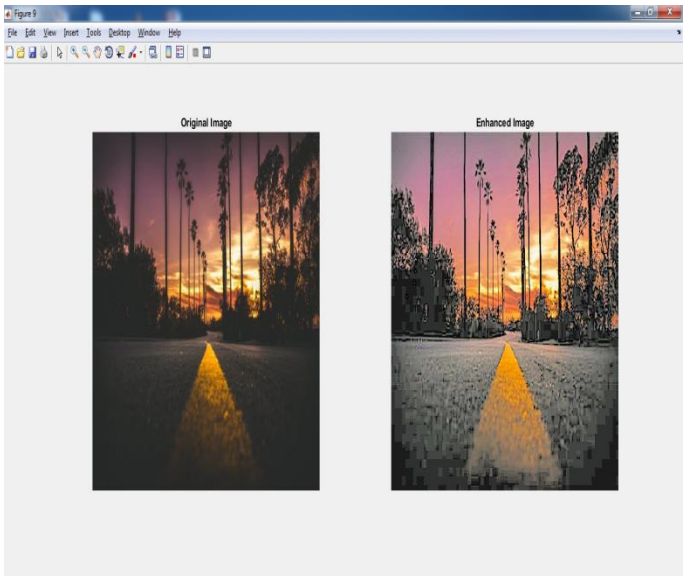
In order to enhance the edges which are considered as the local features of an image, the local contrast stretching process is applied. This is the first step in enhancement method. At the end of this step, a locally enhanced image is obtained. It gives a clear picture of the local information of the image but deficient in the overall brightness of the image. In order to address this discrepancy of local enhancement the global enhancement method is applied to the output of the first step. The global enhancement method employed here is histogram equalization explained above. The working of the algorithm can be verified with the help of image quality parameters. One of the very common parameter is the measure of enhancement and measure of enhancement factor (MEF). In order to find the MEF the measure of enhancement of the input and output has been calculated individually. MEF is the ratio of the measure of enhancement of output image to the measure of enhancement of the input image. A better value of MEF implies that the visual quality of the enhanced image is good. The mean of the input original image and enhanced output image is also calculated.



(a) Low light image

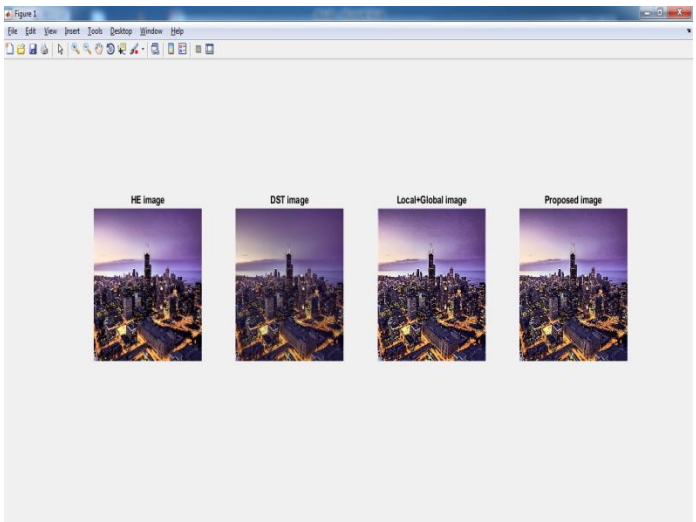


(b) Shadow afternoon image

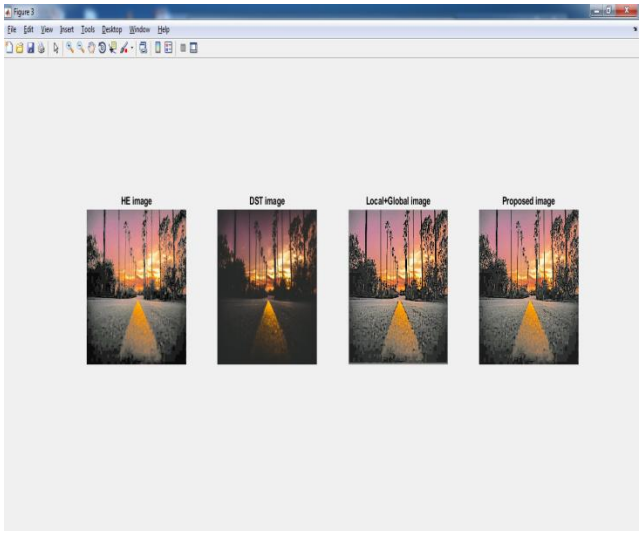


(c) Evening image

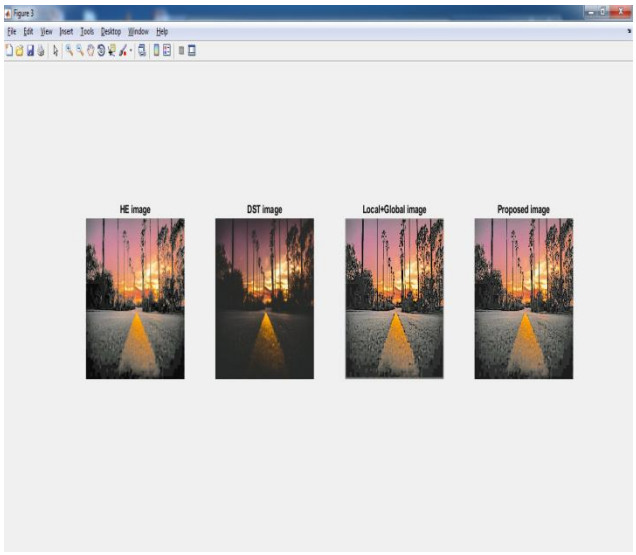
Figure 2: Input and enhanced output images of different images using proposed enhancement method.



(a) Low light image



(b) Shadow afternoon image



(c) Evening image

Figure 3: Comparison of enhanced images: (a) HE (b) DST (c) Local + Global (d) Proposed

The comparisons between input and output image is performed without Proposed Work shown in Table 1 and with Proposed Work shown in Table 2. The original images and its enhanced images by performing proposed algorithm are shown in Figure 2. It is also compared with some of the existing methods such as HE, DST, Local + Global and Proposed method as shown in Figure 3.

Table 1:comparison Between Input and Output Images without Proposed Work

S. No.	Image Name	Input Mean Value	Output Mean Value	MEF	MSE	PSNR	SNR
1	Low light image	0.3758	0.4446	1.1832	0.0143	18.4398	12.3446
2	Shadow afternoon image	0.4544	0.3866	0.8507	0.0149	18.2536	12.7736
3	Evening image	0.2179	0.3565	1.6361	0.0468	13.2979	6.9798

Table 2:comparison Between Input and Output Images with Proposed Work

S. No.	Image Name	Input Mean Value	Output Mean Value	MEF	MSE	PSNR	SNR
1	Low light image	0.3758	0.4454	1.1852	0.0139	18.58	12.496
2	Shadow afternoon image	0.4544	0.386	0.8495	0.0129	18.8955	13.3995
3	Evening image	0.2179	0.3555	1.6317	0.0455	13.4209	7.0881

VIII. CONCLUSION

The method is successfully carried out in MATLAB. Combination of both local and global contrast enhancement techniques are employed to improve the visual quality of an image with ANN, where a local enhancement method is applied first to enhance the local details of the image, which is not taken care and usually neglected in the global contrast enhancement.

The locally enhanced image is given to the input of global enhancement for better visual perceptions and increases the brightness to a level which gives pleasant sensation to the human eye. This method works fine in most of the dark images. It has more significance to those images where we need local minute gradient information such as the image of planetary and heavenly bodies, satellite images and medical images. The comparison is done with a couple of the existing methods. The different local and global methods with ANN have been used and tested their effectiveness of the different combinations of the local and global methods.

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