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Non-Linear Multi-Layer Neighbourhood Estimation Technique for Quality Enhancement of Color Images

S. Abdul Saleem[1] and Dr. T. Abdul Razak[2]

[1] *Jamal Mohamed College,*
Tiruchirappalli, Tamil Nadu, India
saleemnts@gmail.com
[2] *Jamal Mohamed College,*
Tiruchirappalli, Tamil Nadu, India
abdul1964@gmail.com

Abstract

Image enhancement is the process of adjusting the digital images so that the results are more appropriate for further analysis. Most of the image enhancement techniques suffer with the problem of feature retaining due to different noises and other disturbances. To solve this problem, we propose a multi layered approach which estimates the possible value of pixel by using the neighbourhood values. The proposed method splits the given color image into three layers like red, green and blue. At each layer, we apply the median filter to remove the noisy pixels from the interested pixels. The method estimates the likelihood of the pixel from the bottom layer of the pixel. If the first layer pixel has a specific feature then the rest of the layers feature could be used to estimate the intensity values to be stored. We compute the multi layered neighbourhood pixel value based on all three layers of the image. For each layered pixel, first the neighbour pixel of the bottom layer is analyzed and if they are similar then, we estimate the regional value of each layer to estimate the value to which the pixel has to be set. The proposed method enhances the image quality in efficient manner and reduces the processing time than other competent methods.

Key Words and Phrases: Multi Layer Approach, Region Based Estimation, Noise Removal, Adaptive Filter, Image Parameters, Image Enhancement

1 Introduction

Color images play a vital role in various circumstances and the quality of the image in intensity is more important and used to perform various tasks. The color images are used in various domains such as medical, forensic, weather forecasting, medias, space research etc. for performing various classification works. In general, color images have noise which spoil the visibility of the image and reduce the perception of the processing task. To improve the image quality and increase the visible perception of the images, the quality of the image has to be improved. The quality improvement of the image is basically of increasing the contrast and reducing the noise ratio of the image being given.

There are many noise removal approaches available and each has its own merits and demerits. These noise removal approaches are multi layered or one pass filter but the quality depends on the noise factors being used and how well the features of the image being retained, and so on. The color image has three layers namely red, green and blue. The blue pixel or the black layer represents the original feature of the image and the green and red layers values decide the contrast or intensity value of the pixel. So, in order to improve the quality of the image, all three layer pixel values have to be used and the quality of the image could be improved by that.

The multi layered approach is one which considers all the three layers above discussed and estimates the feature of the pixel according to the neighbour values of that particular layer. While improving the contrast or intensity value of the pixel, the popular histogram equalization method simply performs equalization of the pixel based on cumulative values of red , green and blue. But, we focused on equalization and estimation of distinct layer properties which could provide more enhanced result in the quality improvement of the color images.

Region based estimation is the technique of computing the approximated pixel values in each region at different layers. For example, the green values of the region may be specific and all the pixels in the region may have similar green values which decide the intensity also. Similarly the region based estimation technique could be used to identify and decide the pixel value of resultant image and helps to improve the quality of the image.

2 Related Works

Abramova et al., proposed a mixed noise parameter estimation for image enhancement via denoising [1], addresses a question of required accuracy of such estimation. Analysis is carried out for color images processed by a filter based on discrete cosine transform. The influence of errors in mixed noise parameters estimation is studied in terms of filtering efficiency. This efficiency is characterized by the conventional criterion peak signal-to-noise ratio (PSNR) and two visual quality metrics, PSNR human visual system masking (PSNR-HVS-M) and multi-scale structural similarity (MSSIM). If a reduction of filtering efficiency exceeds 0.5 dB (in terms of PSNR and PSNR-HVS-M) or 0.005 (in terms of MSSIM), mixed noise parameters estimation is assumed to be unacceptable.

Hanumantharaju et al., proposed a natural color image enhancement based on modified multiscale retinex algorithm and performance evaluation using wavelet energy [9], presents a new color image enhancement technique based on modified modified Multi Scale Retinex (MSR) algorithm and visual quality of the enhanced images are evaluated using a new metric, namely, Wavelet Energy (WE). The color image enhancement is achieved by down sampling the value component of HSV color space converted image into three scales (normal, medium and fine) following the contrast stretching operation. These down sampled value components are enhanced using the MSR algorithm. The value component is reconstructed by averaging each pixels of the lower scale image with that of the upper scale image subsequent to up sampling the lower scale image. This process replaces dark pixel by the average pixels of both the lower scale and upper scale, while retaining the bright pixels. The quality of the reconstructed images in the proposed method is found to be good and far better than the other researchers method.

Li-fang Zhan et al., proposed a scalability tower multi-scale DR image enhancement algorithm based on human visual characteristics [10], uses an improved laplace pyramid structure in image decomposition processing. Secondly, the high frequency part can be enhanced by the local nonlinear adaptive contrast enhancement method, the low frequency part of the improved method of histogram equalization combined with human visual characteristics. Lastly, original image will be reconstructed through the repeated extension of image and the results.

Tong Zhao et al., proposed an image enhancement based on quotient space [11] uses the quotient space, which is an effective approach that can partitions the original problem in different granularity spaces. In this method, different quotient spaces are combined and the final granularity space is generated using granularity synthesis algorithm. The gray levels in each interval are mapped to the appropriate output gray-level interval.

Long Chen et al., proposed a fast image enhancement algorithm using bright channel [12], addresses a new image speedy algorithm with detailed illumination component information. Its combined illumination imaging model with target reflection features on RGB color channel, raised a new bright channel concept, and obtained computation method of illumination components by analysis. Then, illumination components were gained precisely through image bright channel gray-scale close computation and fast joint bilateral filtering. Consequently, target reflection components on RGB channel could be solved by illumination/reflection imaging model. The proposed algorithm can get excellent edge details through simple and quick computation. After being removed from the illuminative effects, the images gained are natural-colored, highly visible, and with no halo artifacts. This paper also resolved color casting problem. Compared with NASA method based on multi-scale Retinex, the proposed algorithm improved computation speed, received vivid colors and natural enhancement result.

Zhigang Zhou et al., proposed a parallel nonlinear adaptive enhancement algorithm for low or high intensity color images [13], addresses the problem of color image enhancement for images with low or high intensity and poor contrast (LIPC or HIPC). A parallel nonlinear adaptive enhancement (PNAE) algorithm using information from local neighbourhood is presented to resolve the problem in parallel. The PNAE algorithm consists of three steps. First, a red-green-blue (RGB) color image is converted to an intensity image, then an adaptive intensity adjustment with local contrast enhancement is parallelly performed, and finally, colors are restored. The PNAE algorithm can be adjusted to control the level of enhancement on the overall lightness and the contrast achieved at the output separately. Most of the parameters used in PNAE are robust for LIPC and HIPC color image enhancement.

Melkamu Hunegnaw Asmare et al., proposed an image enhancement based on contourlet transform [14], uses a new image enhancement algorithm using the important features of the contourlet transform. A new transformation function is developed based on the existing sigmoid function and the tanh functions which have very interesting properties in enhancing images which are suffering from low illuminations or non-uniform lighting conditions. Literature dictates that contourlet transform has better performance in representing the image salient features such as edges, lines, curves, and contours than wavelets for its anisotropy and directionality and is therefore well suited for multi-scale edge-based image enhancement. The algorithm works for gray scale and color images. For a color image, it is first converted from RGB (red, green, and blue) to HSI (hue, saturation, and intensity) color model. Then, the intensity component of the HSI color space is adjusted the preserving the original color using a new nonlinear transformation function.

All the above discussed approaches have the problem of enhancing the quality of image in efficient manner and they produce distortion of retaining the features of the image.

3 Proposed Method

The proposed method has various stages of image enhancement namely, pre-processing, low level gray co-estimation, multi-layer neighbour estimation based image enhancement and so on. Figure 1 shows the proposed system architecture and the functional components. We discuss each of the functional components in detail in this section.

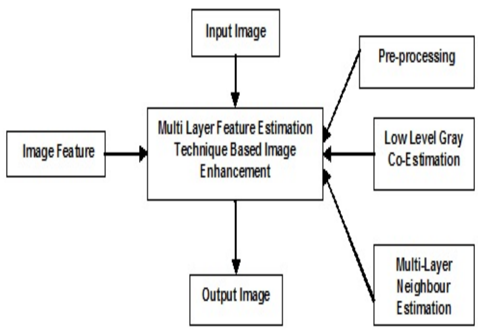

Figure 1: Proposed System Architecture

4 Pre-procesing

At the pre-processing stage, the input RGB image is split into three different layered pixels of red,green and blue. Each layer is applied with efficient fuzzy logic decision based adaptive filtering technique [15], which removes unnecessary noise and blur from the image.

The RGB image is also convert into gray scale image. The pre-processed image is then applied with the rest of the process to improve the quality of the image.

Algorithm

Input: RGB Image Img
Output: Multi Layer Feature, Gray Scale image GI.
Step1: start
Step2: convert rgb image into gray scale image.
GI = Rgb2Gray(Img).
Step3: Split RGB image into multi layer feature.
$MLF = \int Red(Img) + Green(Img) + Blue(Img)$
Step4: for each layer Li from MLF, MLF(i) = FDBEAMF(MLF(i)).
Step5: stop.

5 Low Level Gray Co-Estimation Technique

The LGET method estimates the gray level co-efficient of each pixel according to the neighbor pixels. For each pixel of the image, the method selects the neighbour pixels and estimate the similarity or closeness of the gray value of neighbour pixels. Then we select set of neighbour pixels which are more similar with the gray value of the source pixel. According to the selected pixel, we compute the gray co estimation value and a set of neighbour pixels which can be used to perform multi layer neighbour estimation technique. The selected pixels will be given to the next phase of the image enhancement technique.

Algorithm

Input: Gray Scale image Img.
Output: Gray Co matrix GCM.
Step1: start
Step2: generate gray scale image.
Gimg = GrayScale(Img).
Step3: for each pixel Pi from Gimg
Identify set of neighbour pixel.
$Np = \int_{i=1}^{size(Gimg)} \sum_{j=1}^{8} Gimg(i)Pi$
End
Step4: for each pixel pi
For each pixel ki from Np
Compute similarity of gray scale value.
$Gss = \int_{i=1}^{size(Np)} Dist(Pi, ki)$
If $Gss \leq STh$ //Similarity threshold
Add pixel to Equalization Set.
$ES = \sum_{i=1}^{size(Ess)} Ess(i) + Ki$
End
End
Step5: Stop

6 Multi Layer Neighbour Estimation

The multi layer neighbour estimation is performed using the original RGB image and with the equalization set generated at the previous stage of image enhancement. For each pixel from the equalization set, there exist set of neighbour pixels mentioned with that. Using these details, at the three layers of the image RGB, we collect all the pixels which has participated in the equalization set of the particular pixel. The collected pixels and the RGB values of the neighbour pixels will be used to compute the probable RGB value of the current pixel. For each layer, we perform equalization of the pixel value and the set the current pixel value at particular layer with that. This will be iterated for the all three layers and will be done for all the pixels of the image. This method increases the image quality and enhances the contrast of the image also.

Algorithm

Input: Input image Img, Equalization set ES
Output: Enhanced ImageRimg.
Step1: start
Step2: Convert image img into three layers RGB
Step3: for each pixel Pi from Es
ESS = Es(Pi).
For each layer L from RGB
Identify the neighbors of Pi with Ess
$PixelsetPs = \int \sum Ki(R|(|G|)|B)Ess$
Compute Mean of $R = (\sum R(Ps))/(size(Ps))$
Compute Mean of $G = (\sum G(Ps))/(size(Ps))$
Compute Mean of $B = (\sum B(Ps))/(size(Ps))$
Restore the pixel Pi with computed RGB values.
$ResultantimageR_{img} = \int_{i=1}^{size(Es)} R, G, B$
End
End
Step4: stop

7 Results and Discussion

The proposed multi layered median neighbourhood feature estimation technique based image enhancement has been implemented and tested for its efficiency with various image sets using MATLAB image processing tool. The quantitative measures Peak Signal-to-Noise Ratio (PSNR) and Contrast Improvement Index (CII) were computed from output images for obtaining accuracy of the different image enhancement methods. The multi-layer estimation technique gives the better results than other competent techniques. In this proposed approach, we focused only on enhancing RGB images but still the approach is more effective one with all types of color images The Figure 2, shows the comparison of image enhancement accuracy produced by different methods. It shows clearly that the proposed method has produced efficient accuracy than other methods.

The Figure 3 shows the distortion ratio produced by different methods and it shows that the proposed method has produced less distortion than other methods. The Figure 4, shows the comparison of processing time of proposed approach with other competent

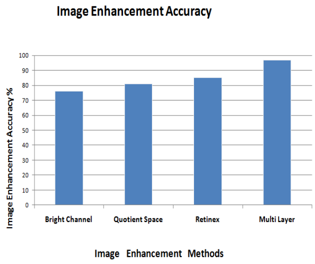

Figure 2: Comparison of image enhancement accuracy

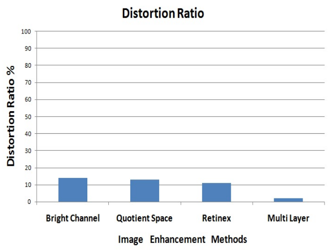

Figure 3: Comparison of distortion ratio

image enhancement methods and it shows clearly that the proposed method has produced less processing time than other methods.

8 Conclusion

A new non-linear multi layer neighbourhood feature estimation technique is proposed for quality enhancement of color images. The proposed method converts the RGB image into three different layers and at each layer we apply the fuzzy based adaptive median filter to remove the noises. The RGB image is converted into gray scale to estimate the gray level co-estimation which identifies similar pixel of concern pixel. With the gray level co-estimation technique and input image, the multi layer feature estimation is computed using which the value of the pixel will be restored. The proposed approach has produced efficient enhancement results with improved quality and also minimises the processing time. This technique can be used in all[the real-time domains for improving the quality of the color images.

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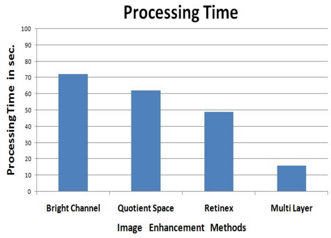

Figure 4: : Comparison of processing time

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