Group 39 Project Report

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Abstract

In this report, we study the proposal of a new global contrast enhancement algorithm using the histograms of color and depth images given by Seung-Won Jung(Department of Multimedia Engineering, Dongguk University, Korea) . On the basis of the histogram-modification framework, the color and depth image histograms are first partitioned into sub-intervals using the Gaussian mixture model. The positions partitioning the color histogram are then adjusted such that spatially neighboring pixels with the similar intensity and depth values can be grouped into the same sub-interval. By estimating the mapping curve of the contrast enhancement for each sub-interval, the global image contrast can be improved without over-enhancing the local image contrast. Experimental results demonstrate the effectiveness of the proposed algorithm.

1 Introduction

Color image segmentation is a very emerging research topic in the area of color image analysis and pattern recognition. Many state-of-the-art algorithms have been developed for this purpose. But, often the segmentation results of these algorithms seem to be suffering from miss-classifications and over-segmentation. The reasons behind these are the degradation of image quality during the acquisition, transmission and color space conversion. So, here arises the need of an efficient image enhancement technique which can remove the redundant pixels or noises from the color image before proceeding for final segmentation. In the paper we selected , we talk about using color and depth histograms to enhance image contrast. The contrast of the image is increased with out a large amount of change in the color of the image. The depth image is constructed from the left and right view of the same image. The histogram of the low contrast image and depth image is used to improve the contrast of the image. The histograms were compared to find where the low intensities has been located. GMM is used to estimate the identified changes in the histogram by finding the Distribution function. The identified histogram difference is added to the image producing an enhanced color image.

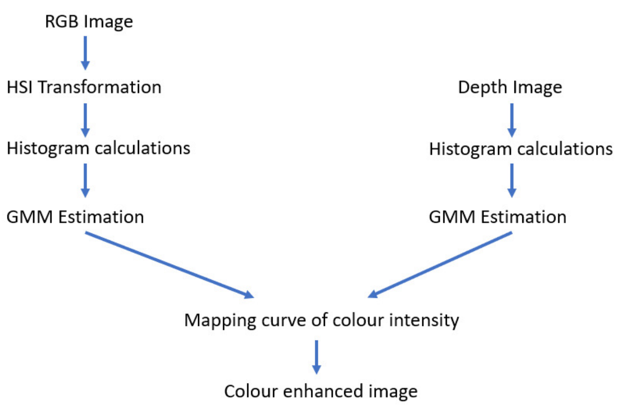

Figure 1: Test Image 1

2 Histogram Equalisation

Histogram is the graphical representation of the tonal distribution of the image. The histogram value of the input image and the depth image is calculated. The histogram values were compared and the positions where the histogram values were changing is identified and the points were located. If a single mapping derived from the image is used then it is a global method; if1the neighborhood of1each pixel is used to obtain a local mapping function then it is a local method. Histogram equalization is the technique by which the dynamic range of the histogram of an image is increased. HE assigns the intensity values of pixels in the input image such that the output image contains a uniform distribution of intensities. Through this adjustment, the intensities can be better distributed on the histogram. This allows for areas of lower local contrast to gain a higher contrast without affecting the global contrast. it can also be used on color images by applying the same method separately to the Red, Green and Blue components of the RGB color values of the image.

Figure 2: Test Image 1

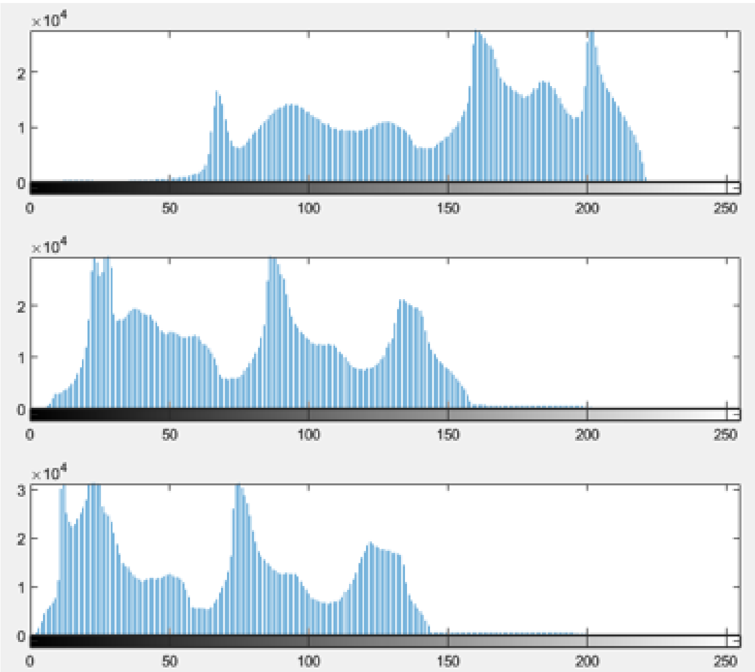

Figure 3: Histogram in RGB Plane respectively

3 EM and GMM Model

3.1 Intro

Any arbitrary image can be assumed to be composed of individual meaningful regions occupying near-homogeneous areas of the image. Each region in natural images has a Gaussian-shaped histogram where the means of the Gaussian histograms indicate their corresponding average intensity levels and the variance corresponding to their texture details. These Gaussians are separated by their mean values and spread out with their variances, thus forming the global histogram. On the basis of the fact that low-contrast images have narrow histograms, if one departs the important means from each other, the contrasts of individual areas are enhanced and the visual quality of the image is improved.

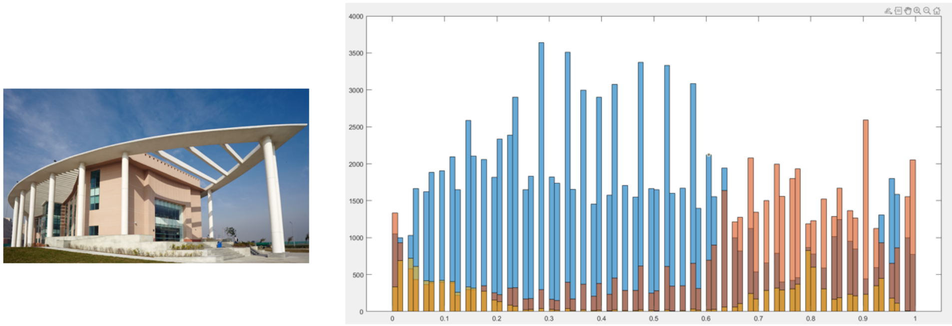

Figure 4: Test Image 3 and Gaussian Mixture

3.2 Formula

Let and represent the color image and the depth image, respectively. The histograms of **c** and **d** are assumed to be divided into **N** and **M** sub-intervals, respectively, and the intersection points **c** and **d**between the **i-th** and **i+1-th** sub-intervals of **c** and **d** are denoted as l_i^o and m_i^o , respectively.
Using the intersection points, **c** and **d** can be decomposed into multiple layers as

$$S_{\mathbf{l}^o}(k) = \{(i,j)|l_{k-1}^o \leq \mathbf{c}(i,j) < l_k^o\}, k = 1, \dots, N,$$
$$S_{\mathbf{m}^o}(k) = \{(i,j)|m_{k-1}^o \leq \mathbf{d}(i,j) < m_k^o\}, k = 1, \dots, M.$$

where (i,j) represents a pixel coordinate, and $S_l(k)$ and $S_m(k)$ are the sets of pixels in the k-th layer of **c** and **d**, respectively. l_O^o and l_N^o are the start and end positions corresponding to the first and last sub-intervals, respectively, and m_O^o and m_M^o are defined similarly.

3.3 Optimisation

For optimisation, we might use the Expectation Maximisation (EM) algorithm (like almost all other GMM-based optimisation problems) which is an iterative approach to estimate the latent variables of a statistical model. Although EM has proven to be a very accurate solution for GMM-based problems, it has short falls that make it 'not the best approach' for some conditions. The main drawback of EM is its complexity and inability of implementation for real-time applications. For example, if the application is auto contrast in digital video recorders , it is not feasible to apply EM for every single frame. Moreover, EM-based methods are highly dependent on the starting points. Choosing a bad set of starting points might cause the solution to diverge, which is the case in histogram representation, especially in the presence of abnormal local peaks in the histogram.

3.4 Experimental Results

To demonstrate the performance of the algorithm proposed, few public domain image were used for example, our campus

For this comparative study, we will first use the same method of histogram segmentation and mapping curve generation , by which the effectiveness of the proposed algorithm can be evaluated by comparing the results obtained with and without changing the histogram sub-intervals.We will find the depth image of our original image and then enhance the image via the proposed algorithm. Then we will compare the results and thereby come to the conclusion that which enhancement technique will be more suitable for color image segmentation.

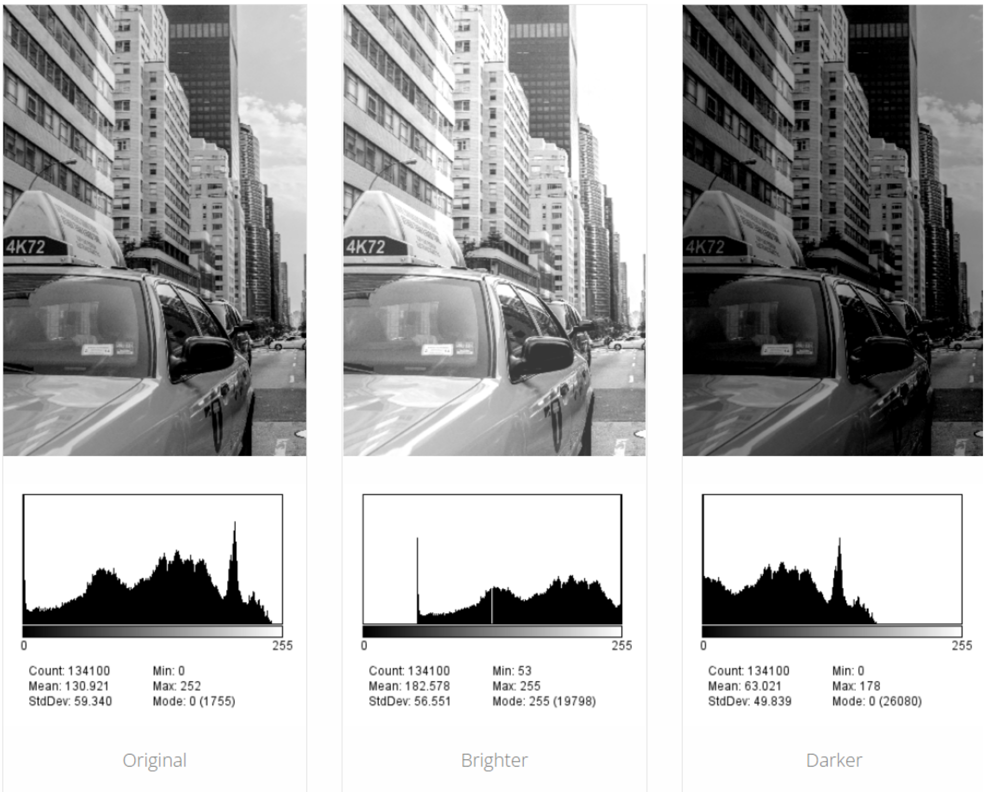

Figure 5: Demonstration 1

Figure 6: Test Image, Depth Image, Enhanced Image

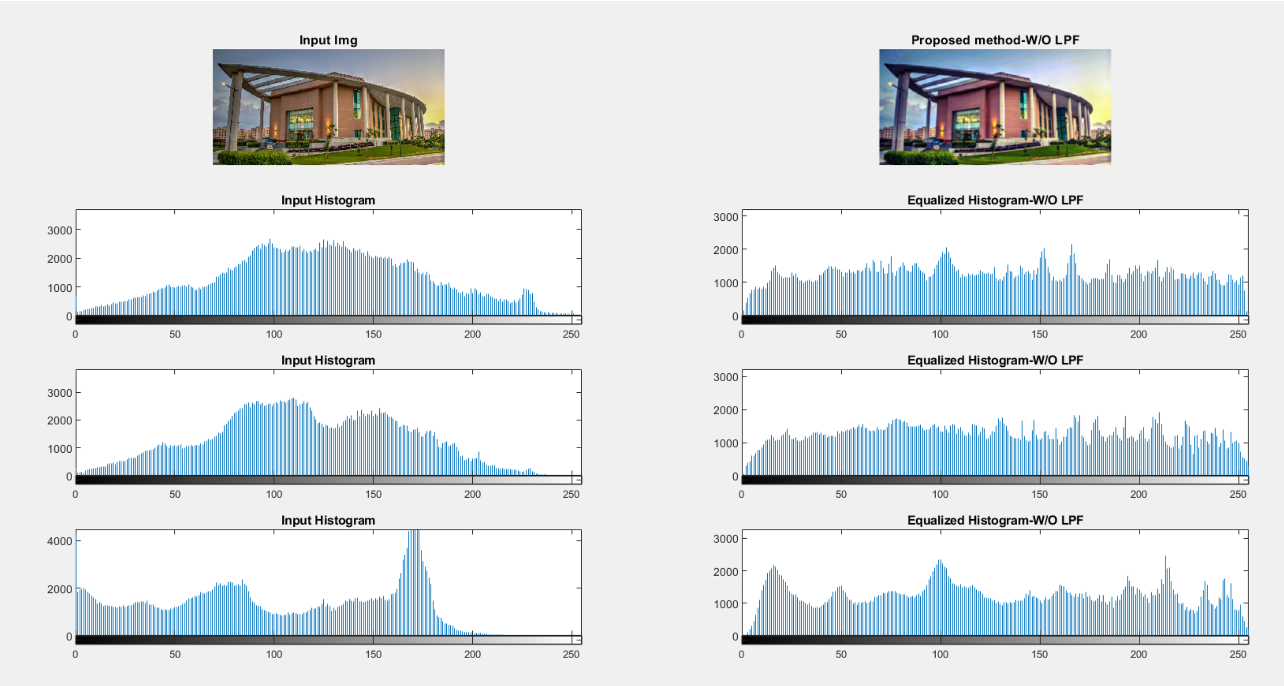

Figure 7: Demonstration 1

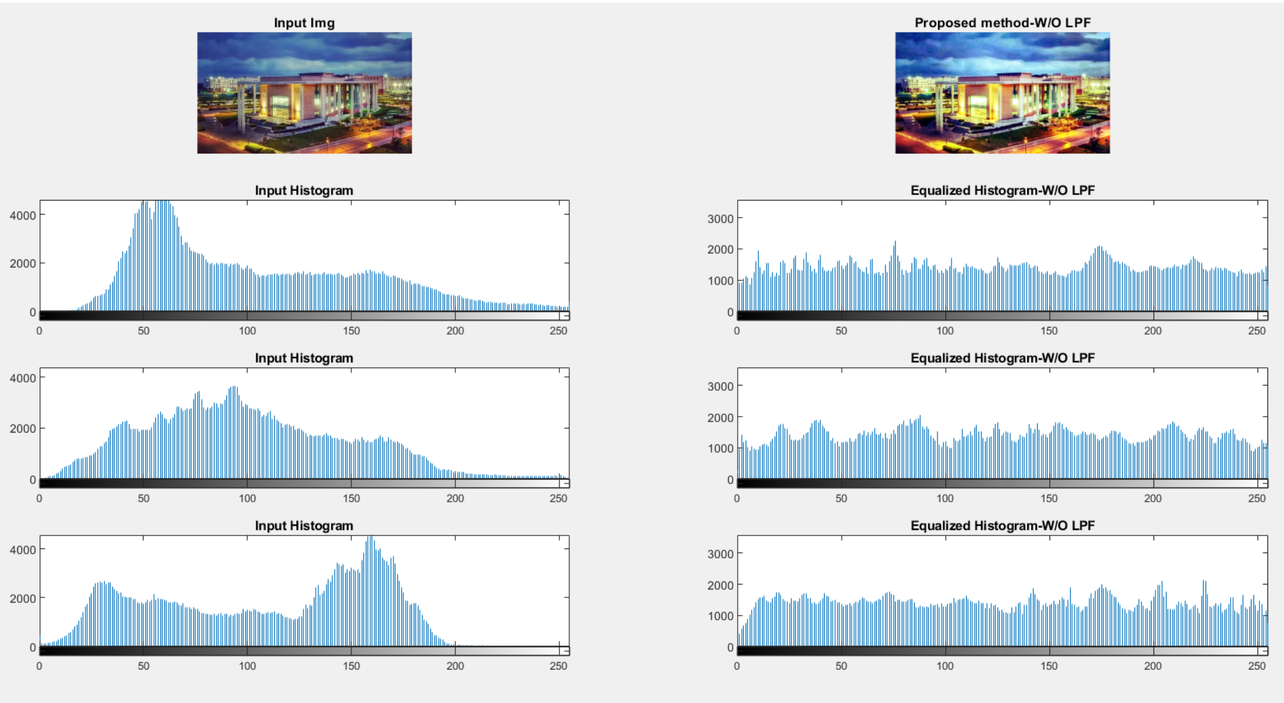

Figure 8: Demonstration 2

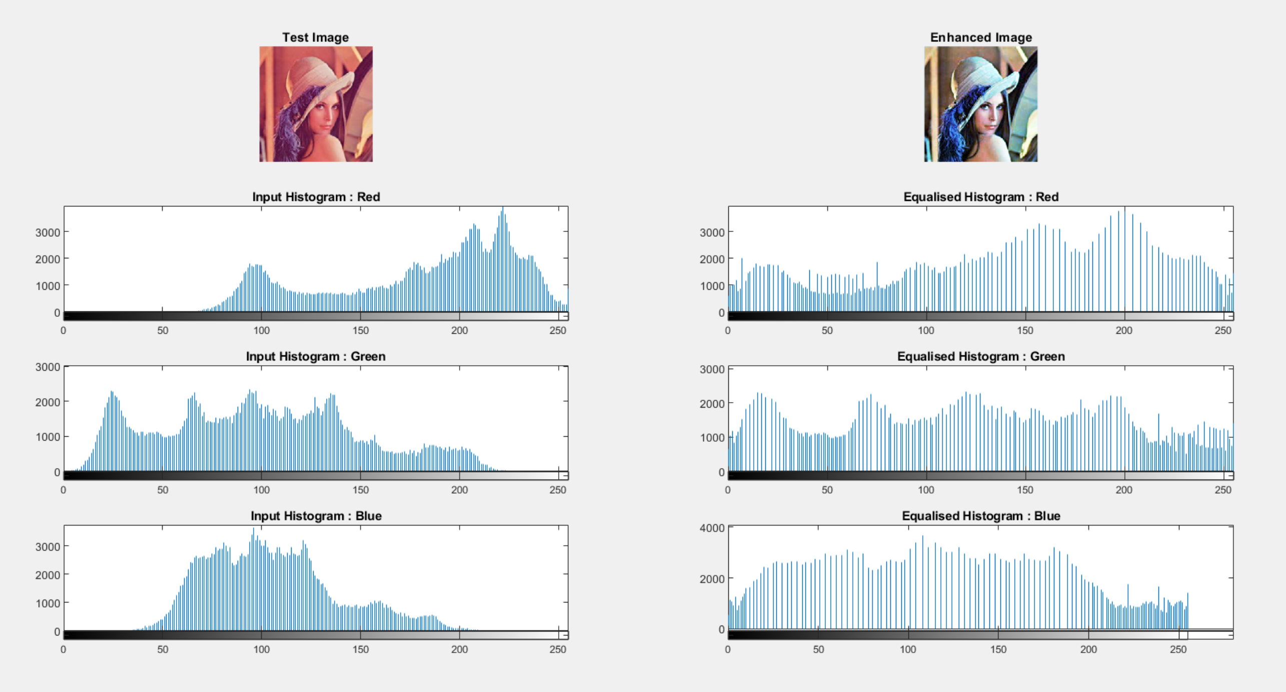

Figure 9: Demonstration 3

Figure 10: Final Result for Test Images

Figure 11: Final Results for SNU Test Images

4 Future Scope and Improvements

A step-by-step approach was followed in order to enhance the image, that is, locally equalising the histogram. With better local equalisation, better results can be obtained. Color Image Enhancement techniques involve more efforts than Gray image enhancement techniques because in the case of color images, we need to consider vectors instead of scalars.Also, for color images, the complexity of image perception is again a considerable fact. Different methods with a similar approach can be used, and we aim to apply at least two different methods to obtain and compare results, which includes TGC - Total Gamma Correction, based on which our image can be enhanced and the other method being the application of the EM model. These models are slightly demanding on the system and therefore we will approach these ideas on a higher-end system in order to obtain experimental results more efficiently in the future. In the case of color image processing, color image enhancement is the mostly concerned topic as distortion in the color image will impact the later analysis process like segmentation very negatively and hence this distortion should be removed through enhancement techniques as much as possible.

5 Conclusion

An approach had been presented in this paper that directly specifies a profile for histogram equalization based image contrast enhancement. A new histogram-based image contrast enhancement algorithm using the histograms of color and depth images are first partitioned into sub-intervals using the Gaussian mixture model. The partitioned histograms are then used to obtain the layer labeling results of the color and depth images. The sub-intervals of1the color histogram are adjusted such that the pixels with the similar intensity and depth values can belong to the same layer. Therefore, while a global image contrast is stretched, a local image contrast is also consistently improved. Experiments on a large data set of natural images reveals that although there is no single technique that can perform best in all performance criteria, results had shown that the technique developed in this work is able to provide color image enhancement that is both qualitatively and quantitatively satisfactory. From our study it is observed that work has already been done in this area, but there exists scope for further improvements.

References

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