Image Contrast Enhancement Using Color and Depth Histogram

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Abstract- We propose a new global contrast enhancement algorithm by using the histogram of color and depth images. Based on the histogram-modification framework, the color and depth image histograms are first divided into sub-intervals using the Gaussian mixture model. The positions partitioned color histogram are adjusted such that 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.

Keywords *- Contrast enhancement, depth image, histogram modification, Histogram partitioning.*

I. INTRODUCTION

Image contrast enhancement techniques have been studied in the past decades. There are various contrast enhancement methods are there. Among those, histogram modification methods have received the greatest attention because of their simplicity and effectiveness. Since global histogram equalization over-enhance the image details, an alternative to this, the approaches of dividing an image histogram into several sub-intervals and modifying each sub-interval separately. The effectiveness of these sub-histogram based methods is dependent on how the image histogram is divided. The histogram of a image is obtained by using the Gaussian mixture model (GMM) and divides the histogram using the intersection points of the Gaussian components. The divided sub-histograms are then separately stretched using the estimated Gaussian parameters. Now a days technic of the color image enhancement have been found using depth [4]–[6] or stereo [7]–[9] as side information. Stereo matching algorithms and depth sensors are providing accurate depth images, and thus the use of the depth image for the color image enhancement becomes an important issue.so In this project, we propose a new contrast enhancement algorithm that exploits the histograms of both color and depth images.

The histograms of color and depth histograms are first divided into subintervals by using gaussion mixture model. Then the histograms of color histograms are adjusted with the similar intensity and depth values of depth image

Fig. 1. (a) The color image $Teddy$ and (b) its depth image obtained by [10].

II. PROPOSED ALGORITHM

A pair of color and depth images are given as input, as shown in Fig. 1. By using Gaussian mixture model we obtain the histograms of input images. Then the algorithm modifies the histogram of the color image using the histogram of the depth image as side in-formation. . The histogram of the color image, is transformed from the RGB space to the hue saturation intensity space. Histogram modification is then applied to the intensity channel, and then resultant color image is obtained by transforming the HIS to RGB. Figs. 2(a) and (b) show the histograms of the color and depth images with their Gaussian mixture models. Figs. 2(a) and (b)) are used to divide the histogram into sub-intervals. Let $\mathbf{c}$ and $\mathbf{d}$ represent the color image and the depth image, respectively. The histograms of $\mathbf{c}$ and $\mathbf{d}$ are assumed to be divided into N and M sub-intervals, respectively, and the intersection points between the i-th and $i+1$ -th sub-intervals of $\mathbf{c}$ and $\mathbf{d}$ are denoted as l_o and m_o , respectively. Using the intersection points, $\mathbf{c}$ and $\mathbf{d}$ can be decomposed into multiple layers.

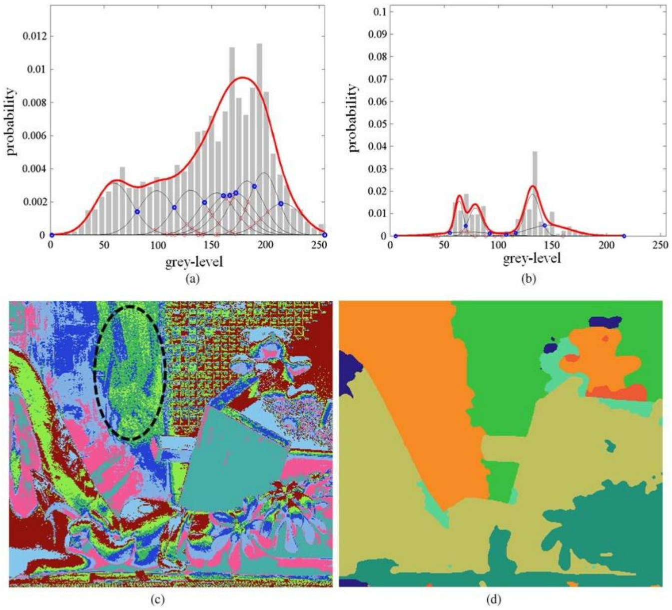

Fig. 2. (a) - (b) Histogram and layer partitioning results of Figs. 1(a) and (b), respectively. (c) - (d) Layer labeling results of Figs. 1(a) and (b).

In histogram based contrast enhancement algorithms, the mapping function for each layer is estimated such that image details in each layer can be effectively enhanced. However, histogram partitioning using only the intensity channel can assign different labels to the neighboring pixels that have similar intensity and depth values.

The background region inside the dotted circle as shown in Fig. 2(c) has similar intensity and depth values as input image but different labels are cluttered in the region. Thus, if we use contrast enhancement on this background region which results unnatural images. So we propose an algorithm that adjusts the histogram partitioning such that a same label is enforced for the pixels with the similar intensity and depth values.

III. EXPERIMENTAL RESULTS

In order to evaluate the performance of the proposed algorithm, the Middlebury stereo test images [14] were used in our experiment. The depth images were obtained using the stereo matching algorithm [10] as shown in Fig. 3. The pixel values of the color images were then divided by 4 to simulate low-contrast input images. Using the same histogram partitioning and mapping curve generation methods in [2], the effectiveness of the proposed algorithm can be evaluated by comparing the results obtained with and without modifying the histogram sub-intervals, respectively. Fig. 4 shows that the layer labeling result S_{1*} became more spatially uniform as λ increased. We empirically found that $\lambda=1000$ performed well in enhancing the contrast of images. The results given hereafter were obtained using $\lambda=1$

Fig. 5. Experimental results corresponding to the input images in Fig. 3. (a) - (c) the resultant image obtained by [2], (d)-(f) the resultant image obtained by the proposed algorithm, (g), (i), (k): the magnified sub regions corresponding to (a)-(c), respectively, (h), (j), (l) the magnified sub regions corresponding to (d)-(f), respectively.

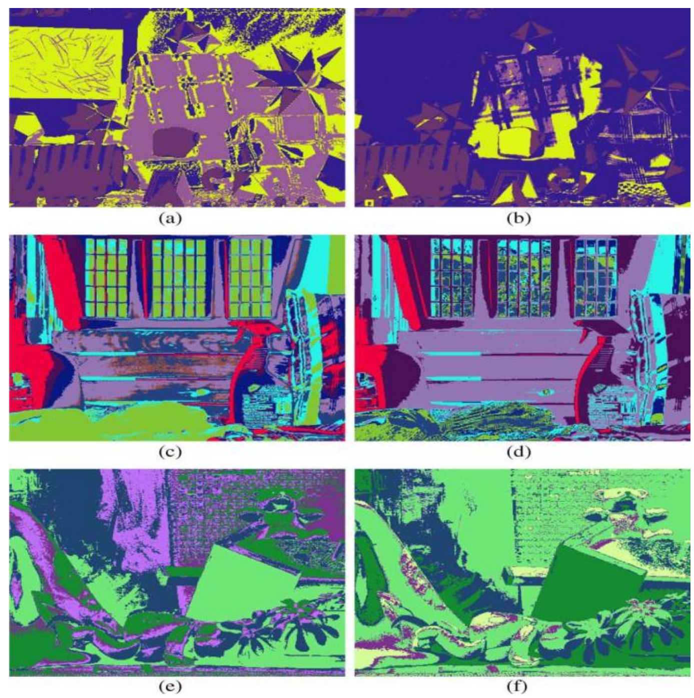

Fig. 6. Layer labeling results for the conventional method (first column) and the proposed method (second column)

Fig. 5 shows the experimental results obtained using the conventional [2] and proposed algorithms. Both algorithms successfully enhanced the global contrast of the input images shown in Fig. 3. However, the conventional method produced artifacts at some image regions as shown in Figs. 5(g), (i), and (k). This is because the image regions with the similar intensity and depth values were decomposed into different groups as shown in Figs. 6(a), (c), and (e). By using the proposed algo-rithm, such regions were merged into the same layer as shown Figs. 6(b), (d), and (f), and thus the over-enhancement was prevented.

IV. CONCLUSION

In this project, we proposed a new histogram-based image contrast enhancement algorithm using the histograms of color and depth images. The histograms of the 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 of the color histogram are adjusted such that the pixels with the similar intensity and depth values can be-long to the same layer. Therefore, while a global image contrast is stretched, a local image contrast is also consistently improved without the over -enhancement. We plan to extend our layer -based algorithm to a segment-based algorithm by using a joint color-depth segmentation method.

V. REFERENCES

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