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BOOSTING DARK IMAGES USING CONTENT-AWARE ALGORITHM THROUGH CHANNEL DIVISION

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ABSTRACT

Artifacts, over-enhancement and unnatural effects are rarely produced by current dark image boosting algorithm. These problems are solved by content – aware algorithm which boost dark images, sharpens edges, exposes textured details and conserves flat region smoothness and also gives *ad-hoc* transformation for each image. We analyze the image contrast of boundary and textured regions, and group the information of common characteristics from extracted transformation functions. The outputs are adaptively mixed by Human Vision System (HVS) characteristics, to boost the Image details. Results proves that the algorithm can automatically process a shadow and dark areas, indoor and outdoor lighting and face images.

Key words: Channel Division, HVS, Contrast pairs, dark image enhancement.

1. INTRODUCTION

Enhancing the contrast of images is one of the major issues in image processing, especially backlit images. Contrast enhancement can be achieved by stretching the dynamic range of important objects in an image. Dark image enhancement is essential to improve the substandard images which are captured in poor illumination conditions such as shadow and dark areas that give low contrast images which produce low dynamic range in shadow regions. Image enhancement which rises the quality of images for human viewing. Eradicating blurring and noise, rising contrast, and illuminating details are examples of enhancement operations. The original image might have very high and low intensity areas, which mask details.

Transformation of one image to another is called Image enhancement which improves look and feel of an image for machine analysis or visual perception of human beings. For gray scale image enhancement, the best popular method is histogram equalization in gray scale image enhancement, which is based on the hypothesis that the best visual contrast is achieved by a uniformly distributed gray scale histogram. However, color image enhancement by gray scale image enhancement is not a trivial job. Selection of a color model, characteristics of the human visual system, and color contrast sensitivity are the factors which must be measured for color image enhancement. The main goal of image enhancement is to process the image that can be more accurate than original image. There are two different approaches to attain this goal. First, the displayed image must be in clear form so that it maximize the conveyed information. Positively, Desired information will be extracted by human (or computer). Second, the image can be processed to retain the informative part and to avoid the rest. Image enhancement methods may be divided into two broad classes: transform domain methods and spatial domain methods.

(a)Transform domain methods: Transform the image to its frequency representation. Ex: Fourier Transform,
(b)Spatial domain methods: Manipulating an image representing an object in space to enhance image for given use. Ex: Smoothing and Unsharp Masking.

The existing work will be discussed in the Section II, and Channel Division method in Section III, the results comparison with existing systems in Section IV and finally we conclude the paper in Section V.

II. RELATED WORK

A. Histogram Equalization

The most widely used method is Histogram Equalization (HE) which is a technique for adjusting image intensities to enhance contrast whose procedure is

1. Find the sum of histogram values.
2. Normalize the sum values by dividing the total number of pixels.
3. Multiply the normalized values by maximum gray level and round off to the nearest integer value.
4. Map the gray level values using a one to one mapping.

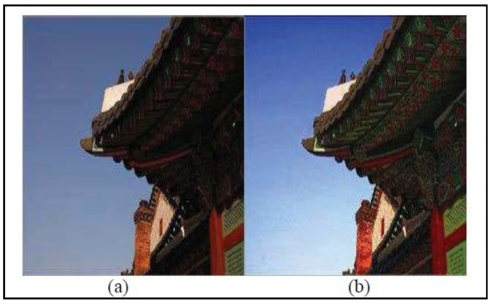

Figure – 1: (a). Original Image (b) After HE

The Conventional histogram based contrast enhancement technique is restricted in real time applications because of its large computation and storage and also degrades the image quality[1].Histogram equalization can be categorized into two methods: global and local histogram equalization [2]. Global histogram equalization uses the histogram information of the whole input image as its transformation function. This transformation function stretches the contrast of the high histogram region and compresses the contrast of the low histogram region. In general, the contrast of lesser and narrower histogram region. Ex: background is lost and overstate noise effect[3]. To overcome this limitation, a local histogram equalization method has been developed, which can also be named block-overlapped histogram equalization

B. HE Related Method Discussions

Partially overlapped sub-block histogram equalization (POSHE) which is a derivation of local histogram and spent more expense for calculation complexity.

Adaptive Histogram Equalization (AHE) which plot the gray values using local histogram relationships. It needs intensive computation even though improves image contrast[4].

Three new methods of transform histograms are logarithmic transform histogram mapping, logarithmic transform histogram shifting, and logarithmic transform histogram shaping. These methods needs less computational complicated techniques and used only in spatial domain.

Histogram mapping, a more generalized version of histogram equalization, permits us to alter the data so that the resulting histogram equals some desired curve. This is also known as histogram matching and histogram specification [5].

The above mentioned methods are significantly improves the contrast of an image but not much appropriate results in dark images.

III. CHANNEL DIVISION METHOD

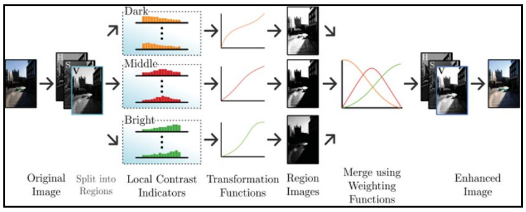

Figure 2: abstraction of Proposed Algorithm

The proposed algorithm makes an *ad hoc* transformation function based extracted image information while previous methods which use fixed transformations. we program contrast using *contrast pairs* that form contrast relation between the intensities of two neighboring pixels because of intensity pairs inspiration [6]. Thus, we accumulate the contrast pairs into *local contrast indicator* (LCI) functions, and merge such functions into *channels*, to reduce the artifact creation—a process that we termed *channel division*.

We introduce this process because the accumulation of mixed contrast pairs inaccurately spread the dynamic range of some intensities because of the contribution of intensities with different characteristics, such as bright intensities contributing to the separation of dark intensities. Then, we group the channels into *region channels*, which may simulate human visual characteristics, and create a set of transformation functions from their accumulated LCIs. Furthermore, we used a finer grain for the channel division, i.e., *intensity channels*, that allow us to control the interference and overlap of the contrast pairs. These intensity channels became the building block for the region channel function to enhance the specific characteristics of each image and merge the results of the process to reduce the artifacts and to ensure maximum enhancement. Figure .2 summarizes the entire algorithm.

To realize the suggested algorithm, we first transform the image to the hue – saturation – value color space. Then, we put the proposed algorithm to value (V) component only and at the same time, Hue(H) and Saturation(S) components from the original image are maintained constant and merge them with enhanced intensities to create final image. Our method uses the channel division and mixture process to adjust the final transformation, which thereby enhances the image instead of Anti-expansion force inclusion which produces no appreciable improvements[6].

A. Contrast Pair

The intensity difference between two pixels i.e. Contrast—in the image through contrast pairs, which can be made like previous method [6]. A contrast pair acts like a force that spreads apart the intensities that define it. We classify the contrast pairs of each image into two classes: *edge* and *smooth*. The former is found in the boundaries and texture regions, while the latter is found in the flat regions. To classify the pairs, we take the intensity difference between the pair's intensities. If it exceeds some defined threshold ε (in our experiments we used 10 intensity levels), then it is considered an edge contrast pair; otherwise it is considered a smooth contrast pair.To form transformation function, LCI from the contrast pairs is used.

Spatially, the contrast pairs are constructed from the image using the eight neighbors of each pixel. We define the set of contrast pairs for a pixel *(x, y)* as

$$P(x, y) = \left\{ \rho_{I(x,y)}^{I(x',y')} \middle| (x', y') \in \mathcal{N}(x, y) \right\} \quad \text{---(1)}$$

where $\rho_{I(x,y)}^{I(x',y')}$ is a contrast pairs which can be efficiently computed by scanning.

B. Intensity Channels

Already we said, the different intensity regions form contrast pairs. Thus, one accumulation of contrast pairs does not represent the intensity relations, and may separate the intensities that should stay together. To overcome this problem, we group the contrast pairs into *intensity channels*. Thereby, each contrast pair is accumulated into an intensity channel (LCI) that corresponds to each intensity, in order to isolate the contribution of the contrast pairs. Hence, our proposed transformations avoid the inclusion of LCIs that excessively spread the intensities of the group, and consequently, compress other intensities. The bright intensity is equally enhanced due to the equal number of pixels interacting in the boundary between the dark and bright intensities. Thereby, the local neighborhood contrast affects the final transformation. Therefore, our algorithm maintains the flat regions in the image and enhances the textured regions, which avoids the introduction of artifacts. The creation of intensity channels enhances the contrast of one image's area without introducing artifacts.

Figure 3: (a) synthetic images, with same global contrast but different local contrast, producing different and (b) enhanced images

C. Region Channels

Grouping the contrast pairs into intensity channels is not sufficient to produce the best enhancement, as there may be(intensity) channels with similar properties. We propose to mix the channels with similar characteristics into *region channels*. Consequently, a region channel is a mix of intensity channels that share some characteristics. Hence, an image may have *R* different region channels that are defined by

$$T_r = \frac{\sum_{i=I_{\min}^r}^{I_{\max}^r} T^i}{I_{\max}^r - I_{\min}^r + 1}, \quad 1 \le r \le R \quad \text{------------- (2)}$$

where ***Tr*** is the *r* th region channel transformation, ***Ti*** is the transformation function for each intensity channel *i*, and *I r*min and *I r*max are the lower and upper bound (intensities) for the r^{th} region channel [the *(r −* 1*)*th and the *(r* + 1*)*th channel may share their upper and lower bounds with the *r* th channel].

Experimentally, we found that mixing our intensity channels into three regions (*R* equal 3), which may simulate the huma visual system, further improves the

resultant image. We approximate each region channel to accommodate dark, middle,
and bright intensities. This may be similar to the human visual system regions: De Vries-Rose, Weber, and Saturation [8-9].we build a transformation function for each region channel that will spread its intensities due to the interactions of that region's intensities. These functions produce different results which are then merged using weighting functions to create the final image. Because we are working with dark images, we give more importance to the dark intensities compared to the other intensities, to boost the enhancement of the dark intensities without compromising the result of the other two region channels.

In our method, each channel has a different weighting function which emphasizes its characteristics. Fig. 4(a) shows three weighting functions for the intensity region channels that emphasize the dark region channel to reduce the dark look of the images. The final weighting functions are shifted Gaussian functions that have been normalized. To construct them, we place their centers in the limits of the intensity range and in the center of the middle region channel. Note that the standard deviation of each Gaussian is proportional to each region in the image. We then normalize the three Gaussian functions so that the contribution of their weights sum to one, as shown in Fig. 4(b).

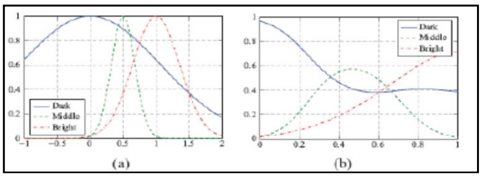

Figure .4: Set of weighting functions. We construct the weighting functions for the region channels from (a) a set of shifted Gaussians. The final functions are (b) those Gaussians normalized.

4. RESULTS

The performance of the proposed method compared to one of the most widely used method using JPEG image: Histogram Equalization (HE) which have ability to reveal the details in dark images. Yet, they cannot enhance mixed images and they produce artifacts in the final image. The proposed method was able to reveal the details near the building and maintain the details in other parts of the image because it created different transformation functions. The HE result revealed some details in the shadow, but it gave an odd look to the resulting image, as reflected by its structural index. In addition the HE result was over enhanced.

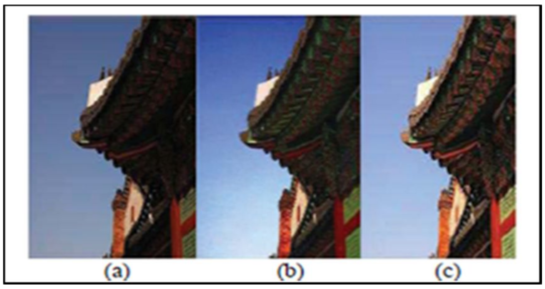

Figure 5: (a) Original Image, (b) after HE , (c) proposed method result

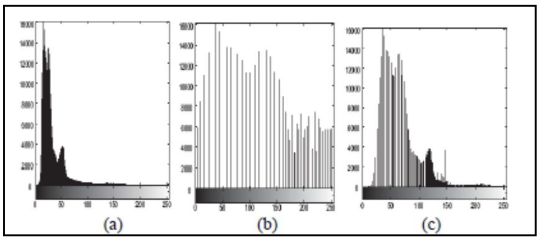

Figure 6: Histogram (a) Histogram of the dark image, with high accumulation in the dark intensities. (b) Histogram of the HE result, which is spread equally, thereby creating artifacts in the bright intensities. (c) Histogram of the result using the proposed method, where the dark intensities are spread and the shape is maintained, which reduces the artifacts.

Visually proposed method produced a better result compared
to the other methods, but this improvement was not reflected in the contrast pair metric because the means of the contrast pairs were more compact in the image and had small standard deviation compared to the over enhanced HE result. Although the proposed method was able to enhance a wide set of images, it remains limited in certain extreme cases.

Finally ,the enhanced image is obtained by grouping region channels. Final transformation £ is computed by

$$\mathcal{T}(i) = \sum_{r=1}^{R} w_r(i) \cdot T_r(i) \qquad \text{---- (3)}$$

The final weighting function are shifted Gaussian functions which is to be normalized. Three methods to evaluate by enhancement measure by entropy[8].

V. CONCLUSION

In this paper, we increased the efficiency by adjusting the weighting functions and also achieved the good picture quality during poor illumination conditions especially in dark images and shadow areas. This method is vigorous because of its error avoidance which mimics the human visual perception and increases quality of the image. This method reduces the RAM sizes and needs dual core computer and also achieved by C++ coding. In future work, we will try to reduce the RAM capacity to achieve this method.

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