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A NOVEL IMAGE ENHANCEMENT APPROACH FOR THE HISTOGRAM IMAGE

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ABSTRACT

The development and progress of modern video imaging technology is not only limited to imaging itself. It has also led to the development of panel display technology with the resolution of electronic devices becoming more and more detailed, with an increasingly wider color gamut and color accuracy becoming higher and higher. Hence the requirement for details of the color image information has increased. However, due to the improper use of image processing technology or a lack of detailed calculation, these often cause the loss of detailed image or color information. The main purpose of this paper is to provide a new algorithm which can repair the gradation of the image when detailed information is lost by calculations; re-patching the missing color information so that the color information of the image can be recovered with as much detail as possible. The experimental results validate that images improved by proposed algorithm are easier with other techniques of image enhancement.

Keywords: Image processing, RGB, Histogram, Color image algorithm

1. INTRODUCTION

The current technology of video imaging has been developed dozens of years in Taiwan, these technologies in the past have been widely used in daily life, such as photographs, posters, books, advertising, television, movies, and so on. However, due to the diversity type of image processing technology and the complexity of different image processing results and quality may differ. Generally, it can be classified into two types, lossy compression and lossless compression [B. Xiao, et al. (2016); L. Wang, et al. (2016); Y. Nian, et al. (2015); A. Said, et al. (1996)]. The quality of the image won't have significant impact by using lossless compression, but if it is lossy compression, the damage to the image quality will be varied and it will entirely depend on the calculation of the algorithm.

Damage to the image quality will not necessarily be visible, but because the development of panel display technology, modern screen has been used for electronic devices and the resolution has become more and more detailed; the quality of color reproduction is also getting higher and higher. The low images to the modern, the quality of the shortcomings of the damage may be amplified, and cause adverse visual effects.

When process image for brightness, contrast, or color scale adjustment, if used process algorithm is not comprehensive, the information of image color level will be lost. Hence this paper will target the RGB color space of an image. First analysis the distribution of color level and process the loss of color level achieve the final goal of recovering the image.

2. LITERATURE REVIEW

In the literature review, the theory of digital image display representation, color spaces and histogram fault defects will be discussed. In the other methods which are been used to achieved the similar effect. Discuss each as follows:

2.1 Digital Image Representation Method

Digital image which is stored in computer digitally recorded. Normally, it represented as flat two dimensional image arrays. Each array will have multiple rows and columns representing the pixels, each pixel will contain colors to describe the image

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detail. When accessing a particular point of the image, it will be represented using axis x and y. In the field of computer for image processing means processing the color and position of pixels and the outcome will be human seeable display such as image, photo and so on. Although there are three dimensional or four dimensional representation of digital imaging, it is not in the scope of this research. In this paper, a two dimensional image will be the research target [J. Mostafa, 1994].

2.2 RGB Color Space

In image processing and photography, a color histogram is a representation of the distribution of colors in an image. In image processing, RGB color space is a common color space. It consists of three colors light; red, blue and green. Red, blue and green are primary colors of light, hence it is called RGB color model. The concept of this model is to use three color component light mixed with different intensity to create any color as figure 1 show [G. Ruiz-Ruiz et al., 2009]:

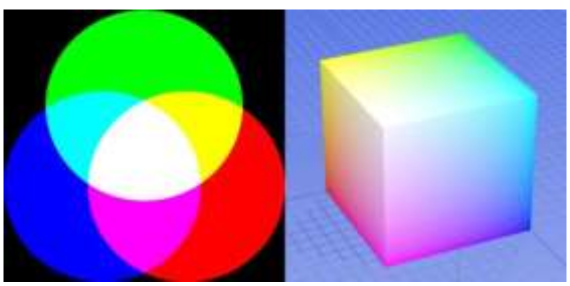

Figure 1: Primary colors of lights and RGB color model

RGB in computer are stored as 8bits for each color light. Hence its range is 00000000~11111111, which is 0~255 in decimal and 00-FF in hexadecimal, representing layered color between black and white.

2.3 Phenomenon of Histogram Fault

The RGB-based Image can extract color out, and then form a histogram graph showing each pixel's brightness from dark to bright. Reviewing image histogram is a method to quickly understand the exposure status of image [B. Yang, and S. Chen, 2013]. If exposure is too dark or too bright, software can be used targeting the histogram to tweak the exposure to meet the satisfy image exposure effect.

When tweaking histogram's curve, if expand the original narrow histogram range, then the pixel within the expanded range will have to be increased by ration to adapt to the new distribution of the range. However, the increase ratio is not an integer [V. Indira et al., 2011], which will cause a histogram fault. In contrast, if compress the original large range of histogram will prevent the histogram fault, it will only superposition number of colors. The previous method of tweaking histogram's curve will cause more serious damage, because the loss of color level can be seen as a lossy compression. The damage to image will depend case by case, sometimes when it is very serious can break color gradation continues of color causing bad image effect. Figure 3 is one of example of histogram fault:

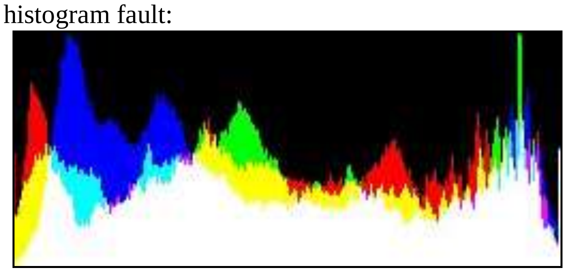

Figure 2: Color histogram of showing a smooth distribution

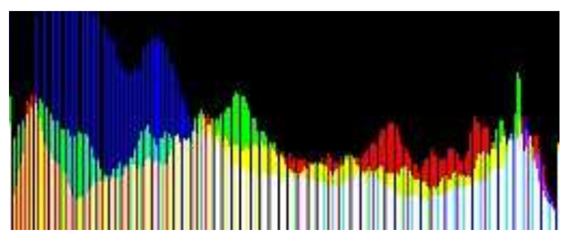

Figure 3: Example showing Color histogram fault

2.4 RGB to LAB to RGB Amendment Method

In this paper, we proposed a method which it can be used to amend histogram faults as "RGB to LAB to RGB amendment method". The concept of this method is to turn the original image from RGB color space to LAB color space, then back to RGB color space [J. Zhao et al., 2012]. Below Fig. 4 shows the comparison of color scale before and after applying this method. The LAB color space has larger color gamut than RGB color space, therefore when image is converted to LAB will increase its color's display space. Also, LAB require higher color precision, therefore the file size of the image will become large. When convert back to RGB again, it will decrease the expanded color space back to the same size as RGB color space, concept similar to color level adjustment,

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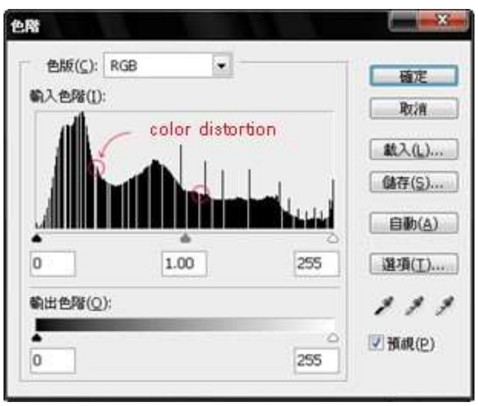
the part where it is truncated in the original RGB will be preserved by LAB, and when it is converted to RGB, it will be recalculated allowing the color level back to nearly original places. The problem with this method is during conversion process, it will cause color distortion as Fig. 4 (a). The more it is converted, the more distorted it will be. The other side effect of this method is that it is targeted using for full image [Michael W. et al., 1987]. The histogram of the original image is smooth illustrated in Fig. 4 (b), when converted will cause unnecessary distortion. This unnecessary distortion can be avoided by this paper's algorithm; the smooth part will not be treated by the algorithm, avoid causing unnecessarily distortion. Unlike
"RGB to LAB to RGB amendment method" method, quality of image will not be affected by the number of times this research's algorithm applies on it.



(a) Color distortion happen during conversion process

(b) Using research's algorithm avoid causing unnecessarily distortion

Figure 4: Image showing the result before and after applying the RGB to LAB to RGB amendment method, (a) shows before and (b) show after; histogram curve shape change can be noticed.

3. RESEARCH METHOD

In this section, we use RGB histogram as base, write program targeting histogram to perform defect correction. The algorithm can be broken down and described as four step as follow:

Step 1. Initiate three two-dimensional arrays; storing images' three color channel of R, G and B. These three two-dimensional array will represent the original color info of the image.

Step 2. Initiate three one dimensional arrays; this will be used to store the histogram information of the three colors: R, G, and B

Step 3. Use for loop running from 1 to 254 against the initiated arrays detecting whether it contains information of color level. If it contains color level information, then it will not be processed. If it does not contain color level information, this means it could have been lost due to image processing, hence start the following process:

Step 4.

4.1 Histograms levels which are missing color level will need to use the color of its one level higher or lower color's for amend. Hence first get the higher or lower level of histogram and get one third of the target number.

4.2 Use a Do loop, start finding in the image's pixel which is similar to histogram. If found histogram is one level below the target histogram, then increase the found histogram by one level and store it in record. If found histogram is one level above than the target, then decrease found histogram by one level and restore back to record. Detect the number of time that the above process has been done, if it has reach the one third of the target number, then find the next level of histogram, else continue searching for the pixel histogram.

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The base of using one of thirds of target number is that we focus on histogram's one level above, one level below and its own level, meaning a total of three color levels.

The target histogram's middle level in this algorithm will be 0, and its one level above or one level below will be the base level used for amending. No matter what value the histogram is (it could also be 0, meaning the color level cannot be amended), say 1 for both above and below level, through mathematic we can get 1 + 0 + 1 = 2. This means putting averagely two histogram's information into three color level will mean averagely given two-thirds. This means the middle histogram will always be 0 meaning achieving two of thirds will need to add another two of thirds. The original histogram value of one level above and one level below is 1, to achieve two third; each has to be taken one-thirds. This is the theory base of taking one third of target number.

We will use a simple hypothesis as example. Say a color scale of three with value in order of 3, 0 and 6 a total of 9. The middle color level is 0 and will be the amendment target. One level below is 3 and value of one third is 2, taken value is 1. One level above is 6 and value of one third will get 4, taken value will be 2. Adding the taken value back to middle for amendment will be 3, hence the final result will be 2, 3 and 4. The total is still 9, but the original color level of middle which its value 0 has been amended.

Step 5. After process the three color level channel R, G and B, the original three two dimensional array will be updated, redrawn the record of the three array back to the image will complete the amendment of image.

4. AMENDMENT RESULT ANALYSIS

The focus of this section is to examine the effectiveness of the amendment process. To compare and contrast the ability of the algorithm at different situation, the sample will use two different photos as illustration. The two photos have applied process of brightness, contrast, level adjustment and Gamma, which will cause the loss of color scale. At the bottom will show the color level distribution diagram showing the loss of color level.

Figure 5: Prototype Program for demonstrating the algorithm

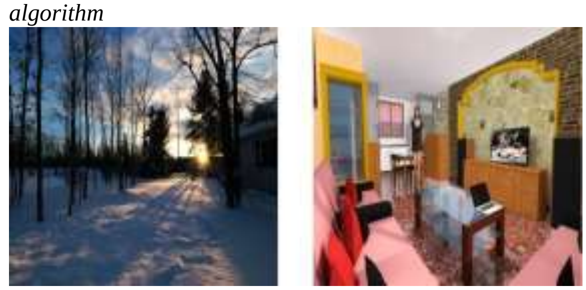

Figure 6: Two already been pre-processed by other image processing technique which caused loss of color level

4.1 Result of Photo 1 After Apply Amendment Process

In this section, the left photo of figure 6 will be used against applying the amendment algorithm. Below figure 7 shows photo before apply amendment on the left and after amendment on the right. It is hard to see the difference with naked eye.

Figure 7: Showing before and after apply amendment process of photo 1

We will use figure 8 to examine the color level distribution diagram of before and after applying the amendment process. The top showed before applying the amendment process, the bottom showed after applying the amendment process. The top showed loss of color level evenly distributed across, after applying the amendment process, the loss of color level gap has been amended, forming colorful distribution of color scale from dark to

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bright.

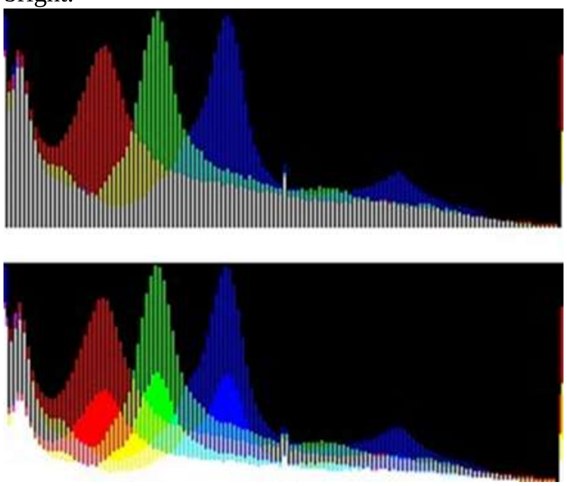

Figure 8: The color level distribution diagram of before and after apply amendment process

Finally, on the below Figure 9, the differential diagram showed because the color level loss is evenly distributed, hence when applying the amendment algorithm, the whole image has been amended. Only at place where the bright light is, meaning a white saturation area, are not affected by the amendment process. Other than that, the amendment process has been apply to whole image.

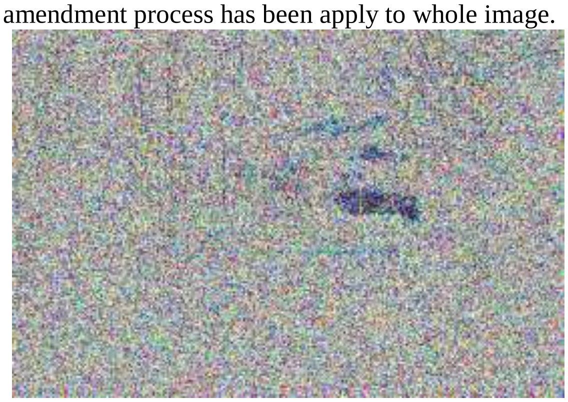

Figure 9: Differential diagram of photo 1 showing before and after apply amendment process

4.2 Result of Photo 2 After Apply Amendment Process

In this section, the right photo of figure 6 will be used against applying the amendment algorithm. Below figure 10 shows photo before apply amendment on the left and after amendment on the right. It is hard to see the difference with naked eye.

Figure 10: Showing before and after apply amendment process of photo 2s

We will use figure 11 to examine the color level distribution diagram of before and after applying the amendment process. The top image is before applying the amendment process, where bottom image is after applying the amendment process. From figure 11, it showed that this image's color level loss is not as serious as photo 1. This means the amendment process will only to certain part on the image.

Figure 12 will show the differential diagram of

before and apply amendment process. The distribution of loss color level for the image is around 80~128 and 160~216 these two areas, hence the amendment process only targeted these two part. On the top of the differential diagram is the floor and the right corner is the chair display as black, which means the area does not need amendment process, keeping it as original. Skipping color saturated area does not only help preserving the detail, it also optimizes the computing resource. This is also an important characteristic of this amendment algorithm.

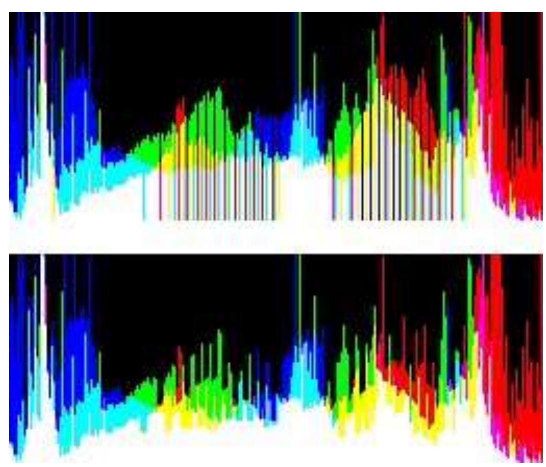

Figure 11: The color level distribution diagram of before and after apply amendment process for photo 2

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Figure 12: Differential diagram of photo 2 showing before and after apply amendment process

5. CONCLUSION

The image histogram amendment process algorithm proposed by this paper can deal the original image with minimal affect to achieve the goal of color level amendment. The result of before and after applying the process shown an obvious different at color level when examine using color level dictation program. However, it is hard to see by naked eye even when magnifying the image under eight times

The algorithm amended missing color level which is less than third-order of color level scale, and also added smooth effect of color level distribution. From the differential image analysis, when the original color level is saturated or contain too big gap, the algorithm will skip and not process that part. In other words, the algorithm will only process color level which is at less than the tolerate level. This has the benefit of not causing side effect to image, meaning this algorithm is very suitable to image which has been pre-processed on the brightness, contrast and color level. This means this process algorithm can help image processing relative technician. We hope in the future to optimize the speed and performance of this algorithm, and expand the research on pixel level more suitable area.

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