Improve the image discontinuous problem by using color temperature mapping method

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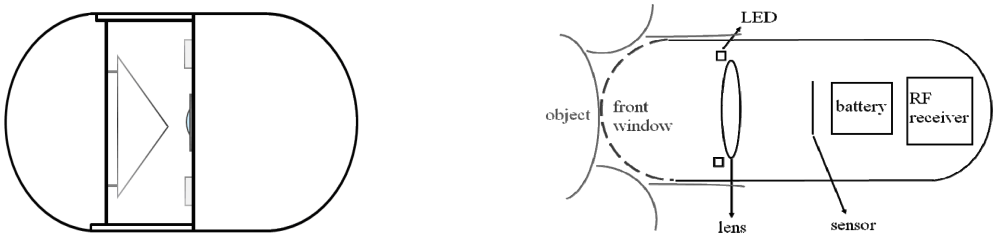
ABSTRACT

This article mainly focuses on image processing of radial imaging capsule endoscope (RICE). First, it used the radial imaging capsule endoscope (RICE) to take the images, the experimental used a piggy to get the intestines and captured the images, but the images captured by RICE were blurred due to the RICE has aberration problems in the image center and lower light uniformity affect the image quality. To solve the problems, image processing can use to improve it. Therefore, the images captured by different time can use Person correlation coefficient algorithm to connect all the images, and using the color temperature mapping way to improve the discontinuous problem in the connection region.

1. INTRODUCTION

Gastrointestinal diseases troubled human in the current society, because of the busy work people do not have enough time to eat, so diet is not normal, leading to gastrointestinal diseases and has been increased significantly. Gastrointestinal organs in the body is winds and rough, it is difficult to use medical equipment in-depth treatment. At present, more commonly used medical equipment for the colonoscopy and endoscopy, but it's still hardly push into the intestines of this medical equipment, so some points can not effectively distinguish symptoms, resulting in treatment negligence. In order to effectively solve this problem, many countries began to develop a new generation of endoscope, which can swallow into the body, the instrument is known as capsule endoscopy, there are many development unit such as Given image, RF lab, Olympus, Intelligent Micro -system center in Korea, China and Taiwan [1,2]. Unfortunately, this capsule endoscopy promised some shortcomings, such as the capsule can only take front image, so the larger the object distance longer need depth of field. For small lens, design to achieve long depth of field is very difficult, while due to intestine wrinkling, so there will exist dead space when take photos, this is because the symptoms point will be hidden inside, producing dead angle of the capsule endoscope, this is very important issue because it can not effectively determine the symptoms. As the capsule endoscopy can just take the front images, so there is no correlation between each image, the images are difficult to rebuild, and can not determine the capsule's speed. In order to improve the problem of the capsule endoscopy of, this article proposed a new generation of radial imaging capsule endoscope (RICE), the advantage is using cone mirror to take the side images, the purpose of takes the side images can be effectively softened the intestinal wall to solve the traditional problem of capsule endoscopy, the dead space are no longer produced. As the objects are contact on the capsule shell, resulting in shorten the object distance, thus it's only require a smaller depth of field, and thus solve the DOF problem. However, because the images are captured with radial direction, so each image have strong correlation, so the image stitching technology can be used to reconstruct image, and also can determine the speed of capsule endoscope. The difference between the two capsule endoscope as shown in Figure 1 [3].



(a)Radial imagimg capsule endoscope (b)Typical capsule endoscope

Figure 1. Two kinds of capsule endoscope

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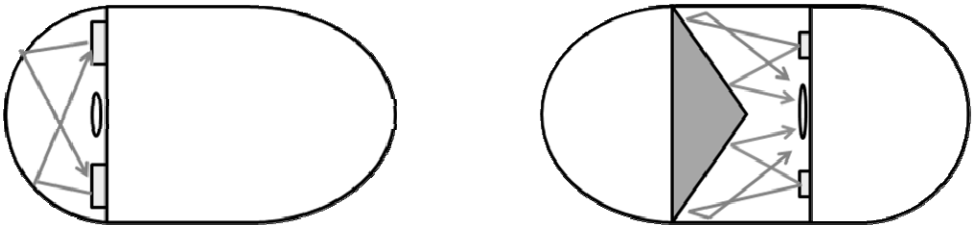
However, unlike the typical capsule endoscope the LEDs can be put on the focal plane of the elliptical dome, so there will be a serious problem of lighting in RICE system, there are over blooming and light scattering problem as shown in Figure 2. This issue will be a isssue that each image take at different times has non-uniform lighting, it cause image discontinious problem after stitching the images together as shown in Figure 3. Therefore, this article using the method of color temperature calibration point, the discontinious problem of images can be treat as color distortion, so color calibration can be using in the issue, then the problem can be solved by transforming into the same color temprature, so decrease the problem and improve image quality.



(a)Illumination of typical capsule (b) Illumination of radial imaging capsule endoscope

Figure 2. Illumination methods of capsule endoscope

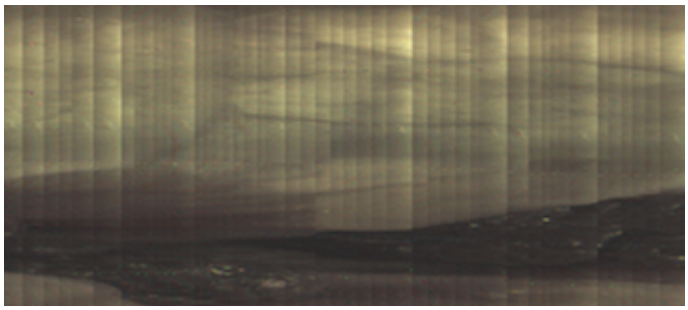


Figure 3. Image discontinious problem after image stitching

2. METHOD

This paper uses color temperature calibration method to solve the gap problems, the method is shown in Figure 4, assume there are two image points that has different color in the chromaticity coordinate, so this article treat this issue as a discontinuity point of different color on both sides, resulting in a different color temperature points . The processing procedure shown in Figure 4, assuming both sides have different color points C_1 and C_2 respectively. the relative distribution in the chromaticity diagram of color point is different, so it uses color point correction that move C_1 and C_2 into to the same point, solve the color mismatch issues, eliminating the gap of the discontinuity.

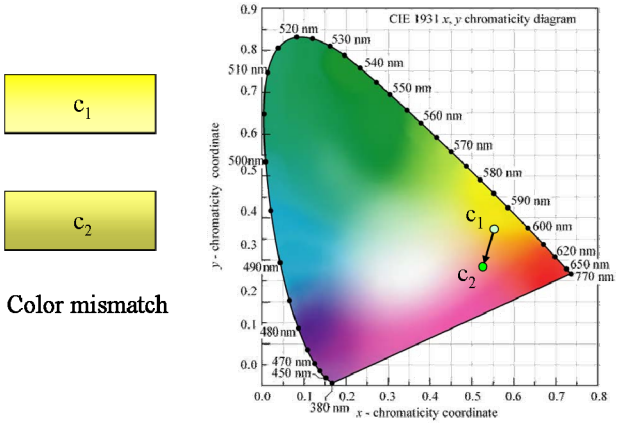


Figure. 4. Color temperature mapping method

3. EXPERIMENT AND RESULTS

The RICE system has entered the stage of living animal experiments, and animal is a pig which the age is about two months, that was raised in a clean room to avoid bacterial infection. The experimental procedure is cutting open the pig belly and pulled out some of the small intestine, then push the RICE into the intestine, the pig is live so that the RICE was moved naturally by the intestines wriggle and capture frequency is two images per seconds, the entire total of 50 photos were taken, as shown in Figure 5 and Figure 6. And the figure 7 shows the image which stitching all the images together but without do any color calibration, we can see the problem that there is obviously exist image discontinuous, so the color temperature calibration method can be used to solve this problem, the results shown in Figure 8. From figure 8 that the color temperature correction method can indeed improve the discontinuities, the image becomes smoother, but the image still can be improved. For example, the image has some color distortion so that is not close to the true color of this RICE in the intestine due to the light uniformity is poor, may lead to different brightness of the object being photographed, thus affecting the color rendering. Therefore, the next goal will be to use color correction method, the RICE system of color correction to the real color gamut volume, improve the color distortion phenomenon.

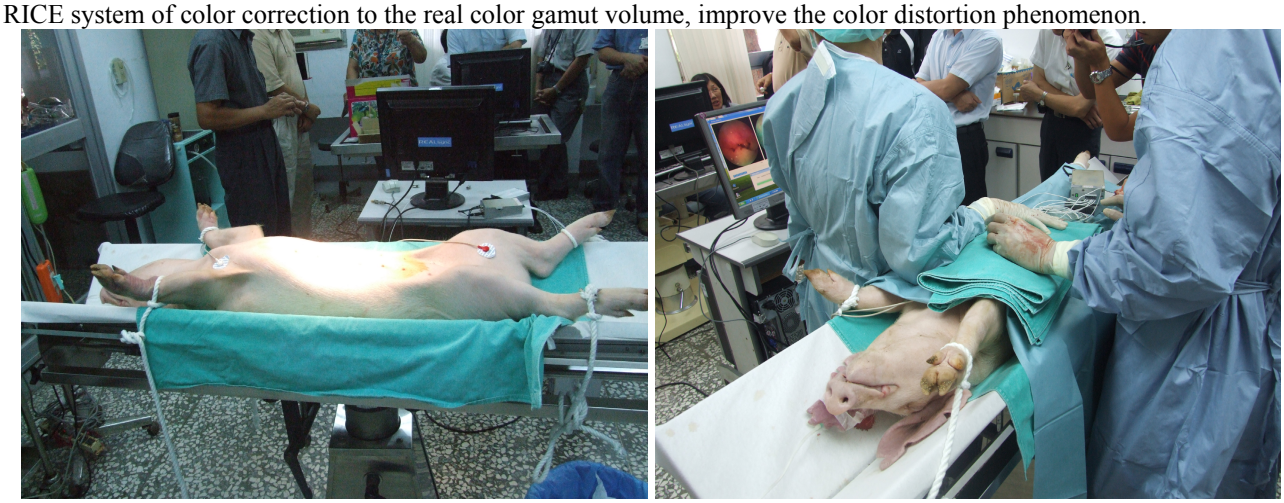


Figure. 5. Experimental environments

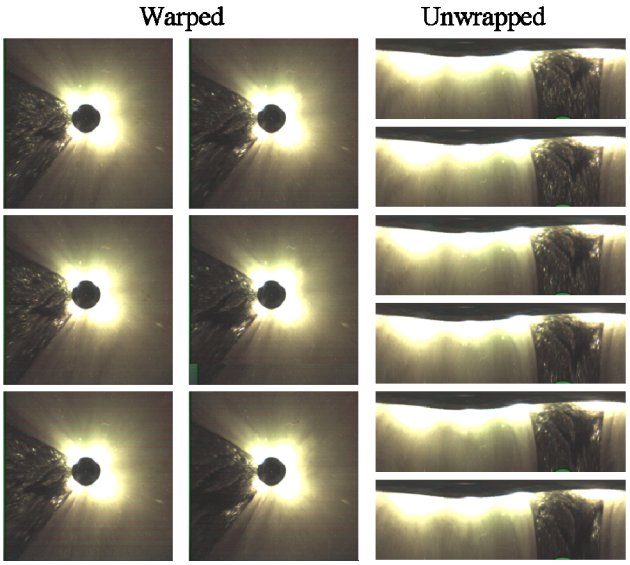


Figure. 6. The intestines images of warped and unwrapped

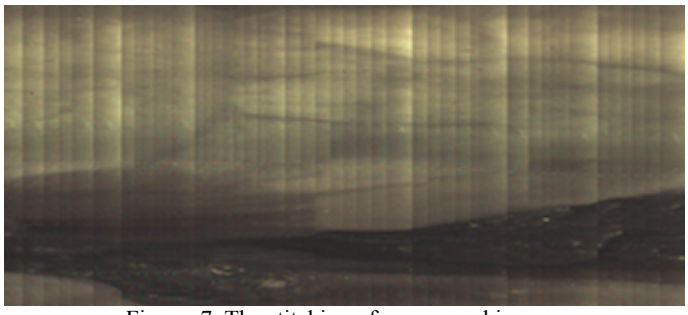


Figure. 7. The stitching of unwrapped images

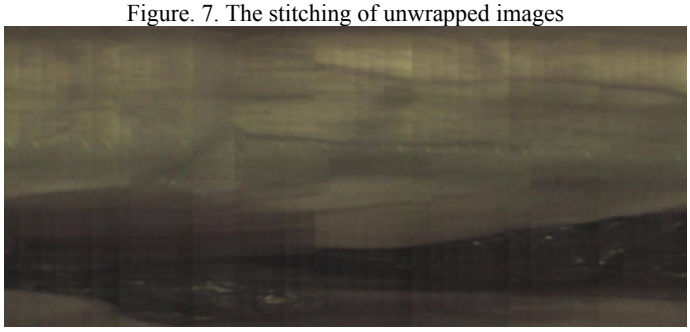


Figure. 8. The stitching of unwrapped images after color temperature mapping

4. CONCLESIONS AND DISCUSSION

This article first introduces a new generation of capsule endoscope which is called RICE, and then use of living animals experiments to take the real intestines images, and because of the light uniformity is not ideal in RICE, resulting in images will have discontinuous problems, so then use color temperature correction to improve the discontinuity of the gap problem, this point out that by using the color temperature calibration method it's clearly that this method can indeed improve the shortcomings of the gap is not continuous, making the image more smoother. Although the gap is not continuous problem has improved, but the overall image color has serious distortion issue, namely the system color distortion. Therefore, future work is the use of color correction technology, the system of the RGB color correction to the right point, and reverts to the true RGB CIE1931 spectrum, showing the true colors of the image [3-5].

5. ACKNOWLEDGEMENT

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REFERENCES

[1] A. Uehara and K. Hoshina, "Capsule endoscope NORIKA system," Minimally Invasive Therapy and Allied Technologies, 12 (5), 227-234 (2003).

[2] T. Nakamura and A. Teran, "Capsule endoscopy: past, present, and future," J. Gastroenterology, 43 (2), 93-99 (2008).M. Ou-Yang, S. W. Huang, H. H. Lee, Y. L. Chen, K. C. Huang, and Y. T. Kuo, "Multiple LEDs luminous system in capsule endoscope," Proc. SPIE 6430, 64300V-1-14, 2007.

[3] E. H. A. Langendijk, A. S. Hotz, and K. J. G. Hinnen, "Wide Gamut Color Mapping and Image Enhancement using Image Segmentation," in Seventeenth Color Imaging Conference - Color Science and Engineering Systems, Technologies, and Applications, 2009, pp. 181-185.

[4] J. W. Lee, R. H. Park, and S. Chang, "Tone Mapping Using Color Correction Function and Image Decomposition in High Dynamic Range Imaging," Ieee Transactions on Consumer Electronics, vol. 56, pp. 2772-2780, Nov.

[5] C. Yao, X. K. Yang, L. Chen, and J. A. Wang, "Color Transfer Via Local Binary Patterns Mapping," in 2010 IEEE International Conference on Image Processing, pp. 1825-1828.