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Simple image artifact removal technique for more accurate iris diagnosis

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Abstract

Iris diagnosis based on the color and texture information is one of a novel approach which can represent the current state of a certain organ inside body or the health condition of a person. In analysis of the iris images, there are critical image artifacts which can prevent of use interpretation of the iris textures on images. Here, we developed the iris diagnosis system based on a hand-held typed imaging probe which consists of a single camera sensor module with 8M pixels, two pairs of 400~700 nm LED, and a guide beam. Two original images with different light noise pattern were successively acquired in turns, and the light noise-free image was finally reconstructed and demonstrated by the proposed artifact removal approach.

Keywords: *Iris diagnosis, Image Artifact removal, Image reconstruction, Hand-held probe, Light noise*

1. Introduction

Medical analysis of a human eye has been widely used to detect specific diseases. Iris diagnosis using a color and texture information is one of a novel approach which can represent the current state of a certain organ inside body or the health condition of a person [1,2]. It can play an important role for prevention and treatment of illness, for maintaining a good health condition before the illness comes to the breakout. The Iris diagnosis (Iridology) has set up in many countries as a complementary-medicine discipline. With decades of scientific observation and comparative studies, it is known that the iris is the only externally visible organ that can reflect metabolic disorders like diabetes, a condition of pancreas and liver organs as a map of body [1,3,4]. In addition, several scientific studies have reported that the iris features correlates with the personality, the personal behavior, and the depressive illnesses [5,6]. Therefore, the iris analysis can substantially influence on the area of medicine and sociology as well. In reality, the iris recognition technology has been remarkably developed in the area of the security for the personal identification up to date [7]. However, the iris diagnosis requires more accurate resolution and evaluation approaches compared over the conventional iris recognition technologies.

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In analysis of the iris images, there are critical image artifacts which can reduce the performance of both the iris recognition and diagnosis systems such as a light reflection of an optical source on a cornea surface as shown in Fig. 1 [7,8]. Those artifacts prevent of use interpretation of the iris textures on images due to a shadow region under a light reflection. Hence, for exact texture information the image processing techniques are essential to remove those image artifacts.

In this study, we developed the simple iris diagnosis system with the removal algorithm of the light reflection artifact. The system is based on a hand-held typed probe which consists of a camera sensor, two pairs of LED, and a guide beam to acquire the human iris images in real time. Two original images with the different light reflection positions are acquired successively and, as a result, we reconstructed the final iris image without a light artifact through several steps of the image processing: gray scaling, pre-masking, range setting, matrix dilation, and reconstruction.

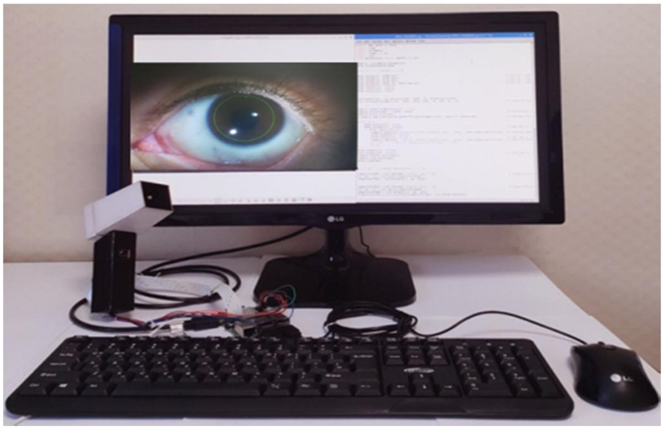

Figure 1. Image artifact induced by an optical source of a system

2. Experimental setup

We developed the iris diagnosis system based a hand-held typed imaging probe which consists of a single camera sensor module with 8M pixels (RPI camera V2 module), two pairs of LED with a broadband visible range of 400 ~ 700 nm, and a guide beam to fix the iris position of a human eye ball physically. For synchronization of an optical source and a camera sensor, and for image preprocessing, we employed the Raspberry Pi 3 compute tool kit as a core engine and the running software based on Python 2.7.13. Figure 3 represents the entire system configuration for the light artifact-free iris image.

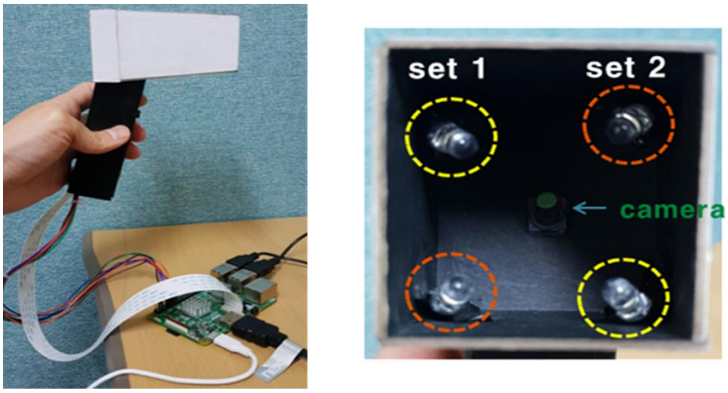

Figure 2. Developed iris imaging system (left), imaging probe configuration (right)

The hand-held typed imaging probe was designed to have the proper imaging working distance so that it can visualize the iris image clearly, appropriately on the monitor in real time display. Each pair of LED is irradiated onto an eye with an angle of 45 degree. In addition, we used a guide beam with a visible range wavelength of a 632.8 nm to fix the iris position physically on images since it is difficult to place the light reflection pattern on the same position due to movement of a human eye ball. Even if we employed an additional guide beam, the total optical power in front of the cornea is within ~1mW which meets the safety requirements set by the American National Standards Institute (ANSI) Z136.1 limits [9].

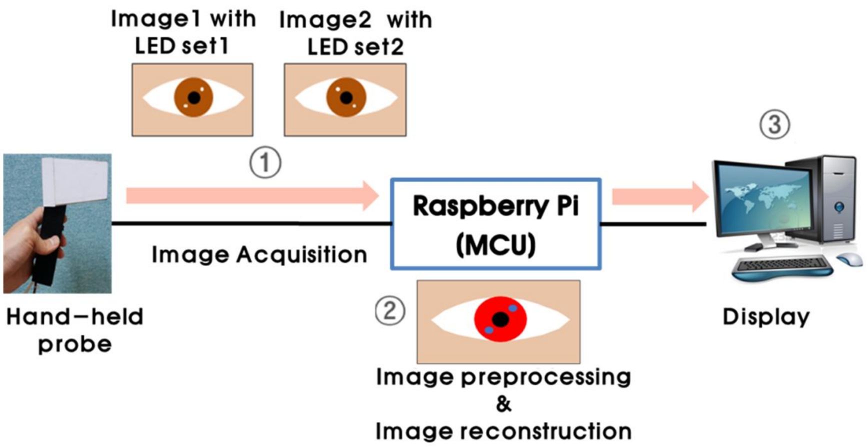

Figure 3. Schematic of the iris system with the artifact removal

3. Results & discussion

The light reflection artifacts removal approach can be explained briefly as shown in Fig. 4. Two original color images with two different light reflection patterns of two sets of LED (set1 with the yellow circle mark and set2 with the red circle mark as shown in Fig. 2.) are obtained successively in turns.

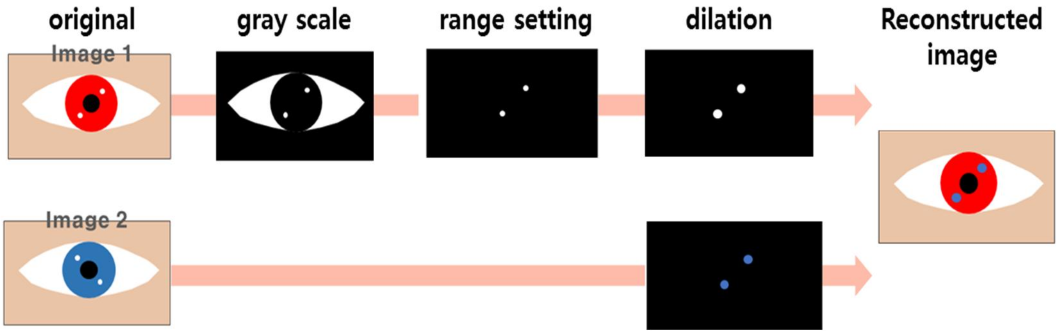

Figure 4. Image processing algorithm for artifact-free final images

Firstly, image1 is converted into a gray scale format with a threshold value. The histogram is a discrete function corresponding to the number of pixels in the image which have a similar intensity value. The histogram of a normalized iris image shows the distribution of pixels over their intensity value. Based on our observation, a threshold value can be determined as (a +b) / 2, a is a value beginning to recognize the light noise on the image, b is a value beginning not to recognize the light noise on the image. The final threshold value was determined to be 175 after averaging all threshold values extracted from the acquired images of 10 subjects. Secondly, the light noise of two LEDs can be selected by pre-masking based range setting steps. Pre-masking circle size smaller than the whole iris includes the pupil all the time, and all the light artifact patter induced by two LED sets are including within this pre-masking circle due to a guide beam. Pre-mask can be set up to have the proper circle size parameter as a green circle shown in Fig. 5 (a). Thirdly, to minimize the light noise sufficiently, the light noise removal region can be expanded as the dilation step by using a matrix parameter adjustment of the conventional kernel filter. This matrix parameter provided by Python library can be determined to be 82 after averaging all the values extracted from the acquired images of 10 subjects. If there is not the dilation step, the resultant image can have additional blurred mask noise on the image. The selected light noise region on the image1 can be replaced with the corresponding region from the image2 because of the different light noise. The image acquisition speed is much fast than it of the eye movement so that the imaging region of both the image1 and image2 is always the same because they are acquired successively in real time display at 60 Hz.

Figure 5 shows the images resulted from the proposed light artifact removal process. Acquired original image1 with the pre-mask (a green circle) shown in Fig. 5 (a) is converted into a gray scale format image with a suitable threshold value shown in Fig. 5 (b), Fig. 5 (c). Pre-mask circle with a green color includes the LED light noise all the time. Someone can use this system to obtain his iris image by himself because of the properly designed physical parameters of the system with consideration for the guide beam based pre-mask. The light noise free final image is reconstructed and demonstrated in Fig. 5 (d). The texture information under the LED light artifact is clearly visualized compared over it of Fig. 5 (a).

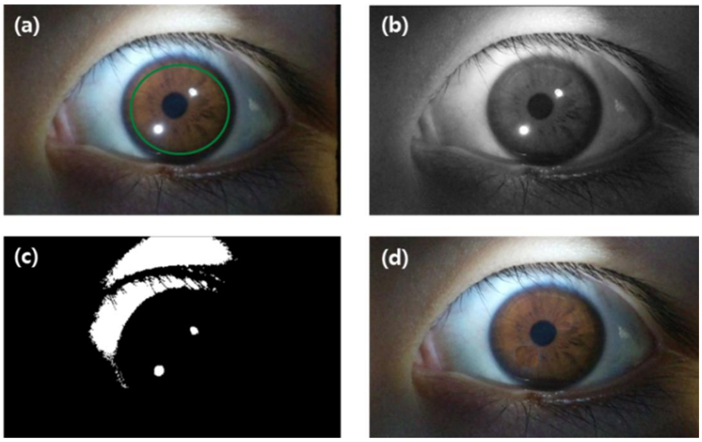

Figure 5. Acquired original image with a light noise (a), image with a gray scale (b), image with a gray scale and pre-masking processing (c), reconstructed artifact-free final image (d)

4. Conclusion

In this study, we developed the simple iris diagnosis system based on a hand-held typed imaging probe, which can enhance the flexibility and the usability of the system performance in various environmental conditions. The users can obtain their iris images by themselves. For more accurate and of use interpretation of the iris texture image, we removed the light artifact on the original images effectively, simply all through the proposed preprocessing approach including both hardware and software. All of the image processing parameters were determined from the iris images of 10 subjects. We demonstrated successfully the light artifact free final image reconstructed all through the proposed artifact removal approach, and the invisible texture information of the original image is clearly seen in the final image. However, the noise free final images can be reconstructed from successively acquired two images, so that the image acquisition speed can be decreased into a half the maximum camera speed.

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References

[1] D. Nivas and T. Manigandan, “Classification of Human Eye Image using Different Methods for Medical Applications”, International Journal of Advanced Research in Computer and Communication Engineering Vol. 4, No.4, 2015.
DOI: 10.17148/IJARCCE.2015.4435

[2] J. Prasad, D. Patel, M. Jadhav, and R. Deshmukh, “Iris based medical analysis by geometric deformation features”, International Research Journal of Engineering and Technology (IRJET), Vol. 3, No.4, 2016.
DOI: 10.1109/TITB.2012.2222655

[3] S.K. Bhatia, P. Atole, S. Kamble, and P. Telang, “Methodology for Detecting Diabetic Presence from Iris Image Analysis”, International Journal of Advanced Research in Computer Engineering & Technology (IJARCET),Vol. 4, No. 3, 2015.

[4] A.D. Wibawa, M.H. Purnomo, “Early Detection on the Condition of Pancreas Organ as the Cause of Diabetes Mellitus by Real Time Iris Image Processing”, 2006 IEEE Asia Pacific Conference on Circuits and Systems, pp. 1008-1010, Dec.4-7, 2006.
DOI: 10.1109/APCCAS.2006.342258

[5] M. Larsson, N.L. Pedersons, and H. Stattin, “Associations between the Irischaracteristics and personalities in adulthood”, Biological Psychology, Vol. 75, No 2, pp. 165-175, 2007.
DOI: 10.1016/j.biopsycho.2007.01.007

[6] M. Larsson., Human Iris Characteristics as Biomarkers for Personality, Ph.D. Thesis. Orebro University, Orebro, SWEDEN., 2007

[7] W.K Kong and D. Zhang, “Accurate iris segmentation based on novel reflection and eyelash detection model”, *in Proc. Int'l Symposium on Intelligent Multimedia on Video and Speech Processing,* pp. 263-266, May.2-4, 2001.
DOI: 10.1109/ISIMP.2001.925384

[8] W.-K. Kong and D. Zhang, “Detecting eyelash and reflection for accurate iris segmentation”, International Journal of Pattern Recognition and Artificial Intelligence, vol. 17, No. 6, pp. 1025–1034, 2003.
DOI: 10.1142/S0218001403002733

[9] ANSI Z 136.1, Safe Use of Lasers, (American National Standard Institute, 2007)