Eye Detection for Eyeglass Wearers in Iris Recognition

Yujin Jung, Dongik Kim, and Jaihie Kim
School of Electrical and Electronic Engineering, Yonsei University
Seoul, Republic of Korea
{yjeclat, godsknight15, jhkim}@yonsei.ac.kr

***Abstract*—An eye detection method for eyeglass wearers in iris recognition is proposed. The eye detection method consists of two steps; eye candidate detection and eye validation. In eye candidate detection, eye candidates are searched by employing a mask with 2x3 sub-blocks on a near infrared eye image to compute the intensity difference between the iris region and the surrounding regions. In eye validation, an eye is verified by searching a pupil region in the eye candidates by employing a mask with 3x3 sub-blocks to compute the intensity difference between the pupil region and its surrounding regions. The experiment result shows that the eye detection rate is higher when a 2x3 mask is employed than when a 3x3 mask is employed in the eye candidate detection for eyeglass wearers.**

Keywords— iris recognition; eye detection; pupil detection; eye localization; eyeglasses;

I. INTRODUCTION

Iris recognition is one of biometric technology which are increasingly used for security purpose such as authentication[1]. In iris recognition, eye detection is a critical task, since an iris region has to be extracted properly from an eye image in advance of iris recognition[2]. However, since a lot of people wear eyeglasses, the frame of eyeglasses in the eye image might disturb the exact localization of the eye.

Previous works have suggested methods for eye detection. B. Kim et al.[3] proposed a method which employs a mask with 3x3 sub-blocks to compute the intensity difference between the iris region and the surrounding regions. Valenti and Gevers[4] proposed a method for eye center location using circular symmetry based on isophote properties. Z. Zhe and Q. Ji.[5] suggested a pupil detection technique which combines appearance-based object recognition and object tracking with active IR illumination. These approaches, however, are not specialized in eye detection for eyeglass wearers. Even thick eyeglasses frame in eye images should be considered since they might degrade the performance of eye detection algorithms.

In this paper, we propose an eye detection method which considers eyeglasses in an eye image. In eye candidate detection, eye candidates are searched by employing a mask with 2x3 sub-blocks on an eye image to compute the intensity difference between the iris region and the surrounding regions. In eye validation, an eye is verified by searching a pupil from eye candidates using a mask with 3x3 sub-blocks.

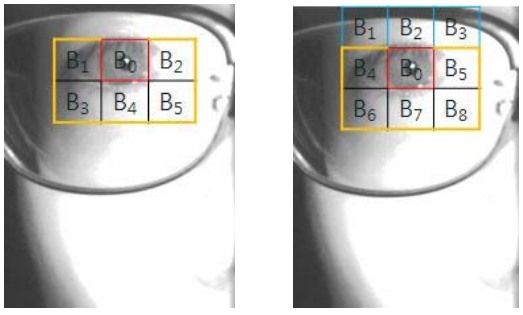
II. EYE DETECTION

A. Eye Candidate Detection

In order to extract eye candidates from an eye image, a mask with 2x3 sub-blocks is employed on an eye image to compute the intensity difference between the iris region (B_0) and its surrounding regions as defined in Fig. 1.(a). The intensity difference between the iris region (B_0) and its surrounding regions in a 3x3 mask is defined in Fig. 1.(b). Generally the iris region (B_0) has lower average intensity than its surrounding regions. If a 3x3 mask is employed, eyeglasses frame in the eye image can disturb the exact eye localization, because the intensity of the sub-blocks containing the eyeglasses frame(B_1~B_3) would be lower than the intensity of the sub-blocks without the eyeglasses frame. Therefore, by employing a 2x3 mask instead of a 3x3 mask, error caused by an eyeglasses frame could be prevented. The intensity differences between the iris region and its surrounding regions are computed as (1).

$$mask\ value = \sum_{i=1}^{5} (C_i - C_0) > \theta \qquad (1)$$

C_i : average intensity of block B_i



(a) (b)

Fig. 1. Illustrations of masks with sub-blocks that are used for eye candidate search: (a) 2x3 mask; (b) 3x3 mask.

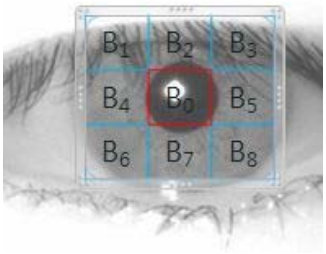


Fig. 2. Illustrations of a mask with sub-blocks that are used for eye validation: 3x3 mask

If the computed mask value of 2x3 mask is greater than the threshold, the center block (B_0) is considered as an eye candidate. The threshold is decided by experiments.

B. Eye Validation

Among eye candidates that are obtained from the eye candidate detection, there are eye candidates that are not an iris region. Eye validation is processed to select a genuine iris region from eye candidates. If the pupil is detected, that area is considered as the genuine iris region. A pupil is detected by employing a mask with 3x3 sub-blocks to compute the intensity difference between the pupil region and the surrounding regions. The pupil region and its surrounding regions are defined as in Fig. 2. Generally the pupil region has lower average intensity than its surrounding regions. The intensity differences between the pupil region and its surrounding regions are computed as (2).

$$mask\ value = \sum_{i=1}^{8} (C_i - C_0) > \theta \qquad (2)$$

C_i : average intensity of block B_i

If the computed mask value of 3x3 mask is greater than the threshold, the center block (B_0) is considered as a pupil region. Therefore, the location of an iris region is verified. The threshold is also decided by experiments.

III. EXPERIMENTAL RESULTS

In this paper, we created a database by using a mobile phone. Two 850nm LED illuminators is located 11 mm left of the front NIR (near infrared) camera. The stand-off distance is 15cm and the image resolution is 1280x960 pixels. Since the stand-off distance is fixed, the size of a sub-block of the mask in eye candidate detection is fixed to 180 pixels, which is the size of an iris region. The size of a sub-block of the mask in eye validation is fixed to 60 pixels, which is the size of a pupil region. We collected 1000 eye images from 20 subjects who wore eyeglasses. The methods using the 2x3 mask and the 3x3 mask in eye candidate detection was compared. The 3x3 mask was employed for both methods for eye validation. The comparison of the two methods is shown in Table 1. In eye candidate detection, the eye candidate detection method using the 2x3 mask succeeded 2.2% more than the method using the 3x3 mask in searching eye candidates which include the genuine iris region. In addition, there are 4.1% more samples which the genuine iris region is found in the first rank of eye candidate detection when the 2x3 mask is used than when the 3x3 mask is used. Finally, the rate of eye detection is 2.8% higher when the 2x3 mask is used than when the 3x3 mask is used.

TABLE I. COMPARISON OF THE PERFORMANCE OF EYE DETECTION METHODS USING DIFFERENT MASK

	Masks	
	3x3	***2x3***
Rate of eye candidate detection succeeded (%)	97.2	99.4
Rate of the genuine iris region detected in the first rank of eye candidate detection (%)	94.1	96.2
Rate of eye detection succeeded (%)	94.2	97.0

IV. CONCLUSION

An eye detection method which is robust for eye images of eyeglass wearers is presented. By employing a 2x3 mask in eye candidate detection, we could avoid errors caused by eyeglasses in the eye image. For eye validation, 3x3 mask is employed to detect a pupil from eye candidates. Consequently, employing the 2x3 mask in eye candidate is effective for eye images of eyeglass wearers.

REFERENCES

[1] A. K. Jain, Ruud M. Bolle, and Sharath Pankanti, Biometrics:Personal Identification in Networked Society, Boston: Kluwer Academic, 1999.

[2] G. O. Williams, "Iris recognition technology," IEEE AES Systems Magazine, pp. 23-29, April 1997.

[3] B. Kim, H. Lee and W. Kim, "Rapid eye detection method for non-glasses type 3D display on portable devices," IEEE Trans. on Consumer Electronics, Vol. 56, No. 4, pp. 2498-2505, November 2010.

[4] R. Valenti and T Gevers, "Accurate eye center location through invariant isocentric patterns," IEEE Trans. On Pattern and Analysis and Machine Intelligence, Vol. 34, No. 9, pp.1785-1798, September 2012.

[5] Z. Zhu and Q. Ji, "Robust real-time eye detection and tracking under variable lighting conditions and various face orientations," Computer Vision and Image Understanding, Vol. 98, No. 1, pp.123-154, April 2005.