Effective Scale-Invariant Feature Transform Based Iris Matching Technology for Identity Identification

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***Abstract* — In this work, the effective scale-invariant feature transform (SIFT) based iris matching method is developed for identity identification. To avoid the eyelid and eyelash interferences, the retrieved iris region in the proposed design only locates near the pupil around the ring area for the recognition. The iris features are enhanced by the Contrast Limited Adaptive Histogram Equalization (CLAHE) and Gabor filtering processes. Then the SIFT-based method is applied for iris features matching. The SIFT method uses the local features of images, and it keeps the feature invariance for the changes of rotation, scaling, and brightness. Finally, the Random Sample Consensus (RANSAC) skill is used to increase the matching efficiency. In experimental results, the accuracy of iris recognition is up to 96%. Compared with the other methods by using the same iris database and the SIFT-based technology, the recognition accuracy of the proposed design is suitable for the consumer identity identification application.**

I. INTRODUCTION

Biometrics has been applied to the personal recognition popularly and it becomes more important. The iris recognition is one of the biometric identification methods, and the technology provides the accurate personal recognition. For example, by the iris scan identification, the iris information can be linked to the passport data database, and the personal identity is functional. In recent years [1-2], the iris identification is used widely and increasingly in personal identifications. Even the mobile phone also begins to use the iris identification system, and the importance of biometrics gains more and more attention. The traditional iris recognition technology [1] transforms the iris features region into a square matrix by the polar coordinate method, and the square matrix is transformed to the feature codes, and then the signature is used to the features matching.

In [4], the SIFT method uses the local features of images, and it keeps the feature invariance for the changes of rotation, scaling, and brightness. Besides, the SIFT skill also maintains a certain degree of stability for the change of perspective affine transformation and noise. Therefore, the SIFT technology is suitable to be applied for iris features matching. By using the SIFT-based enhancement technologies, the effective iris matching method is proposed for identity identification. The rest of this paper is discussed as follows.

II. PROPOSED IRIS-BASED IDENTITY IDENTIFICATION SYSTEM

The proposed design includes five stages, which are the pupil location, the iris location, the extraction of iris region, the features enhancement, and the features matching. Fig. 1 shows the proposed processing flow, and the detailed functions are depicted as:

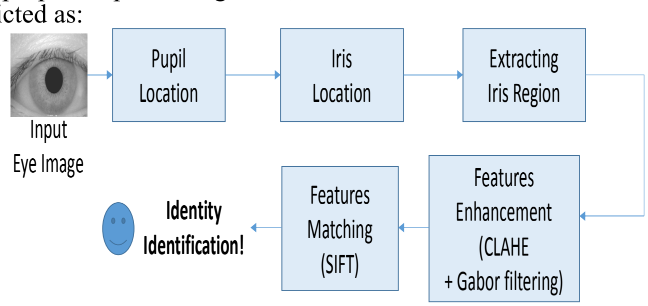


Fig. 1 The proposed processing flow for iris-based identity identification

2.1 Pupil Location

Firstly, the Canny boundary of pupil is detected, and the gradient of the first-order derivative of edges is obtained by using the Sobel filtering. Next, the circle-based Hough transform is used to convert the boundary points into a circle shape, and the system gets some circular boundaries that may be a circle, and then goes to the Gaussian blur process, where the Gaussian blur process is used to find the circle more accurately. After the Gaussian blur operation, the non-pupil circle boundary is filtered out. The Gaussian blur process is only used when the system searches a pupil circle, and it will not affect the texture of iris images. Finally, by the Hough-gradient method, the system finds the pupil circle and completes the pupil location. Fig. 2 illustrates the result of Hough-gradient pupil location.

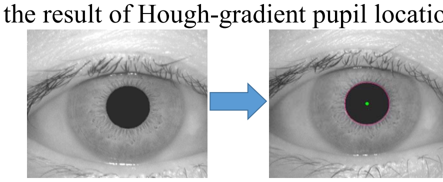


Fig. 2 The result of pupil location

2.2 Extracting Iris Region

The most abundant and dense iris texture information is distributed around the pupil. To avoid the upper and lower eyelids and eyelashes interfere with the iris area, when the pupil circle is found, the system locates a larger circle whose radius is 1.7 times of the pupil circle. Then the circular ring region between the pupil circle and the outer circle is the iris area of interests, as shown in Fig. 3.

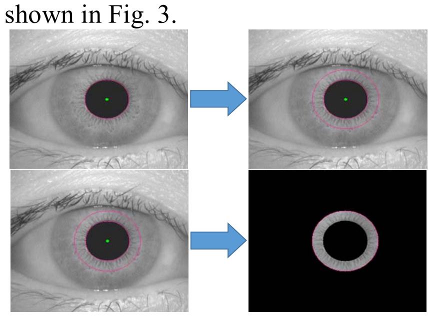


Fig. 3 The result of iris region extraction

2.3 *Features Enhancement*

Stage 1: The CLAHE process

The Contrast Limits Contrast Adaptive Histogram Equalization (CLAHE) [3] is applied to the features enhancement at the Stage 1. The CLAHE method is different from the normal adaptive histogram equalization in contrast clipping. The CLAHE method distributes the clipping beyond the histogram limit to other sections, and it enhances the iris texture efficiently. In CLAHE, each sub-region is processed by the contrast clipping to overcome the over-equalization problem, which happens in the traditional histogram method. After the CLAHE process, the enhanced texture features are more obvious, and the result is shown in Fig. 4.

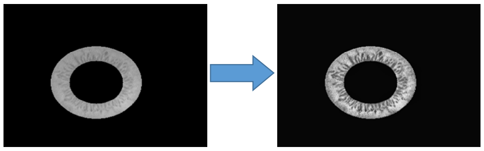


Fig. 4 The iris features enhancement by the CLAHE process

Stage 2: The Gabor filtering process

In order to re-strengthen the texture information, when the CLAHE process is done, the system runs the Gabor filtering continuously. Fig. 5 indicates the result after the CLAHE and Gabor filtering processes

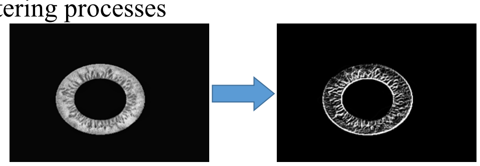
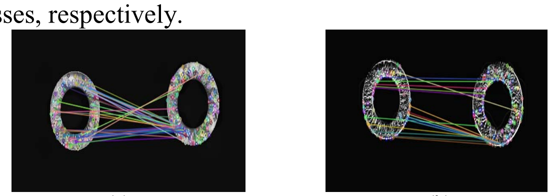


Fig. 5 The iris features enhancement by using both of the CLAHE and Gabor filtering processes

2.4 Features Matching

By the SIFT-based skill [4], the iris features are extracted, and then the features matching process will be done. Fig. 6(a) and Fig. 6(b) demonstrate the results of features matching by only using CLAHE, and both of the CLAHE and Gabor filtering processes, respectively.



(a) (b)

Fig. 6 Features matching results by (a) CLAHE and (b) CLAHE +Gabor filtering processes

By the RANSAC process [5], the proposed system can get the largest inner group, and can exclude the outer groups that do not fit the spatial correspondence. Thus, the system gets the best matching result and improves the matching efficiency. Fig. 7 illustrates the features matching results with/without the RANSAC process.

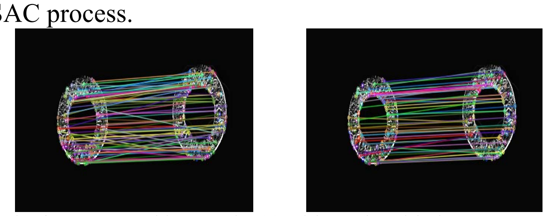


Fig. 7 The features matching results (a) without (b) with the RANASC process

III. Experimental Results and Comparisons

The tested iris databases are obtained from the Chinese Academy of Sciences (CASIA), i.e. CASIA-IrisV1 [6], and these iris images are captured by the NIR camera. In the iris database, 108 subjects are included, and each subject has 7 sub-images. A total of 756 iris images are contained with a resolution of 320x280 pixels. To evaluate the proposed C/C++ software-based design, a personal computer, which has the 32-bit operating system, 8GB memory, and a CPU by the 3.4GHz operational frequency, is used in the experiments.

Due to the interference of the upper/lower eyelids and eyelashes, the iris images with serious interference, as shown in Fig. 8, are not selected for our experiments, and only 651 iris images (93 subjects) are used for testing. In the experiments, the tested iris samples are classified into legal users and intruders. In general, the accuracy, the false rejection rate (FRR), and the false acceptance rate (FAR) are used for the assessment of the ability of the system to recognize the personal identity.

Fig. 8 The iris images with serious interferences [6]

In the process of the SIFT-based features matching, the same person's iris feature matching rate will be higher than that of different people's iris features. Therefore, by setting the appropriate threshold, the system can find the features of the same person to achieve the matching effect for identity recognition. In our experiments, after testing the features matching rate by iris images, the matching rate for different persons falls below about 0.25, and the matching rate for the same person mostly falls above 0.35. Thus, the system selects the threshold value, i.e. 0.28, to achieve the highest recognition accuracy. Table 1 lists the performance comparison among different SIFT-based designs. The accuracy of the proposed design is similar with that of the design in [2]. The FAR of this work is smaller than that of the other methods.

Table 1 Performance comparisons among different SIFT-based designs

	Accuracy	FAR(False Acceptance Rate)
Traditional SIFT [2]	85.19%	20.17%
Hunny, etc. [2]	97.95%	4.09%
Proposed	96.14%	1.90%

However, the value of false rejection rate (FRR) is high in our design, and the FRR represents the legal users who are rejected by the iris recognition system. In future works, the system needs to be improved to reduce the FRR value.

IV. Conclusion

To joint with the CLAHE and Gabor filtering and RANSAC technologies for raising the matching efficiency, the effective SIFT based iris matching method is proposed for identity identification. By experiments, the iris recognition accuracy is up to 96%. Compared with the previous SIFT-based methods, the recognition accuracy of the proposed design is suitable for the consumer electronics application.

Acknowledgment

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References

[1] J. Daugman, "How iris recognition works," IEEE Transactions on Circuits and Systems for Video Technology, vol. 14, no. 1, pp. 21-30, 2004.

[2] Mehrotra Hunny, Banshidhar Majhi, and Pankaj Kumar Sa "Unconstrained iris recognition using F-SIFT," IEEE 8th International Conference on Information, Communications and Signal Processing, pp.1-5, 2011.

[3] Garima Yadav, Saurabh Maheshwari, and Anjali Agarwal, "Contrast limited adaptive histogram equalization (CLAHE) based enhancement for real time video system," International Conference on Advances in Computing, Communications and Informatics, 2014.

[4] Yuji Nakashima and Yoshimitsu Kuroki, " SIFT feature point selection by using image segmentation," International Symposium on Intelligent Signal Processing and Communication Systems (ISPACS), pp.275-280, 2017.

[5] https://en.wikipedia.org/wiki/Random_sample_consensus

[6] Chinese Academy of Sciences Institute of Automation (CASIA) Iris Database, http://biometrics.idealtest.org/findTotalDbByMode.do?mode=Iris