International Journal of Scientific Research in Computer Science, Engineering and Information Technology
 | Volume 2 | Issue 5 | ISSN : 2456-3307

Wavefront Coding for Iris Recognition

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ABSTRACT

Iris recognition can offer high-accuracy person identification, particularly when the acquired iris image is well focused. Iris identification is one of the most eye-catching approaches due to its nature of randomness, texture stability over a life time, high entropy density and non-invasive acquisition. While the performance of iris identification on high quality image is well investigated, not too many studies addressed that how iris recognition performs subject to non-ideal image data, especially when the data is acquired in challenging conditions, such as long working distance, dynamical movement of subjects, uncontrolled illumination conditions and so on. This presents the overview of several of Wave front Coding for Iris Recognition.
Keywords : Randomness, Entropy Density, Illumination.

I. INTRODUCTION

The usage of biometric features for identity recognition has been practiced for centuries. Basically, the personal attributes used for a biometric identification system can be classified into two categories: the first one is based on physiological attributes, such as DNA, facial features, retinal vasculature, fingerprint, palm print, hand geometry and iris texture; the other one is dependent on behavioral attributes, like signature, keystroke, voice and gait style.

II. IRIS RECOGNITION

Iris recognition is an automated method of biometric identification that uses mathematical pattern-recognition techniques on video images of one or both of the irises of an individual's eyes, whose complex patterns are unique, stable, and can be seen from some distance.

Iris is the circular ring part located between the black pupil and the white sclera, it contains a lot of overlapping spots, filaments, coronary, stripes and other such detail features. By comparing the similarity between the iris image characteristics, iris recognition technology can be used to determine people's identity. Its core technology is to use pattern recognition, image processing to describe, match and classify iris characteristics, so as to realize automatic identification.

In many applications, biometrics recognition has become a key technology for identity management systems. Among these features, iris recognition is the most attractive one due to its nature of random and stable texture, high entropy density and noninvasive assessment.

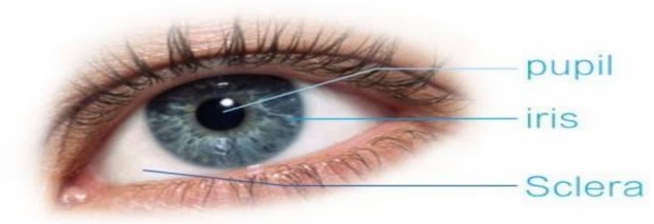

Figure 1: Eye Structure

The iris is an annular membrane between pupil and sclera in the eye. According to Daugman's algorithm, the probability of false identification is of the order of 10-10, which means the probability is smaller than 1 by two iris codes have the same each other in the world. Iris recognition system consists of four major parts,

Iris image acquisition, b) Iris image processing, c) Feature Extraction and d)Recognition

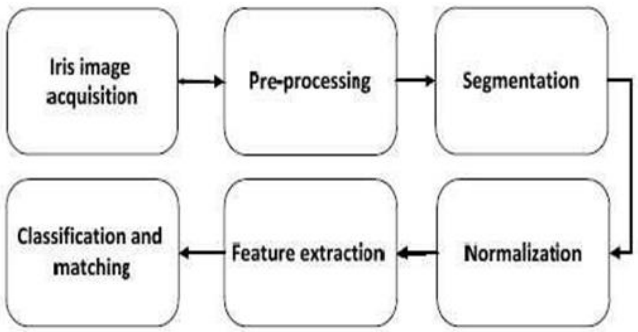

Figure 2 : Iris recognition system methodology

A. Image acquisition: The first step of the iris recognition system is image acquisition. This step is very complicated because the size and color of iris of every person is different. It is very difficult to capture clear images using the standard CCD camera in different environmental conditions. Usually, the acquisition distance for average capturing is 2 to 3 feet and the average time is 1 to 2 seconds. Sometimes the acquisition process produces different results for the same person due to the different lighting effect, positioning and different separation of distance.Recently, high-speed iris capturing devices have become available on the market. These devices are capable of capturing iris images of both eyes in less than three seconds per person. One example of a high-speed system is the Iris-On-the-Move (IOM) system, manufactured by Sarnoff Corporation. IOM has the capability of taking a video of subjects as they are walking through the portal. The subjects do not need to stop at any point during the acquisition process. All he/she has to do is to walk through the portal while looking straight ahead. The cameras inside the cabinet will automatically capture the iris images

B. Pre-processing: involving edge detection, contrast adjustment and multiplier.

C. **Segmentation:** including localization of iris inner and outer boundaries and localization of boundary between iris and eyelids.

D. Normalization: involving transformation from polar to Cartesian coordinates and normalization of iris image.

E. Feature extraction: including noise removal from iris image and generating iris code.

Classification and matching: involving comparing and matching of iris code with the codes already saved in database.

III. Wavefront Biometric Technologies (WBT)

Wavefront has patents in various jurisdictions that cover most aspects of the cornea and key features of the eye in visible light. Wavefront has developed a unique use of the features of the eye not previously commercially adopted. The combination of the cornea and iris provides a new biometric in visible light. The biometric is strengthened by the fact that the features measured are uncorrelated. Wavefront plans to add features to its existing patent portfolio as further intellectual property is identified.

Liveness is an important feature for biometrics and provides a mechanism to detect spoofing or fraud by confirming that the images are generated from a live person in real time. Wavefront's technology has a number of liveness measures within its biometric capability, providing an even stronger biometric for the authentication of identity.

Wavefront's system operates in the visible light spectrum. Most commercially available iris recognition systems utilize near-infra red (NIR) spectrum. NIR spectrum requires a specific illuminator. Standard mobile devices, such as tablets and mobile phones, provide illumination in the visible light spectrum.

Wavefront has initially focused on the mobile (self acquisition) market to demonstrate its technology. Wavefront has developed a prototype and completed internal performance tests of its multi-biometric system under laboratory conditions which demonstrated that Wavefront's multi-biometric system can operate on a mobile platform. Independent testing of the technology is currently being completed at Purdue University, one of the world's leading Biometric research facilities.

Wavefront considers its multi-modal biometric technology provides a unique solution to human biometric identification that has application to a range of identified industry sectors. Wavefront plans to build strategic partnerships with device manufacturers and software vendors while it builds out a product based portfolio of software applications into key targeted markets.

IV. Biometric iris image acquisition system with wavefront coding technology

Firstly, the optical system parameter, such as magnification and field of view, was optimally designed through the first-order optics. Secondly, the irradiance constraint was derived by optical conservation theorem. Through the relationship between the subject and the detector, and they estimate the limitation of working distance when the camera lens and CCD sensor were known. The working distance is set to 3m in our system with pupil diameter 86mm and CCD irradiance 0.3mW/cm2. Finally, they employed a hybrid scheme combining eye tracking with pan and tilt system, wavefront coding technology, filter optimization and post signal recognition to implement a robust iris recognition system in dynamic operation. The blurred image was restored to ensure recognition accuracy over 3m working distance with 400mm focal length and aperture F/6.3 optics. The simulation result as well as experiment validates the proposed code aperture imaging system, where the imaging volume was 2.57 times extended over the traditional optics, while keeping sufficient recognition accuracy.

Extending DoF with optical phase modulation is a very useful technique to enhance the usability for image acquisition devices. In this study, they implemented a telephoto imaging system to acquire iris images from three meters away, which is practically useful for many applications which require high turnover rate. The computational imaging scheme can greatly increases the DoF to be approximately three times the conventional imaging system, while keeping sufficient recognition accuracy.

V. Performance Evaluation of Wavefront Coding for Iris Recognition

Iris recognition using camera systems with a large depth of field is very desirable. One approach to achieve extended depth of field is to use a wavefront coding system as proposed by Dowski and Cathey which uses a cubic phase modulation mask. The conventional approach restores the iris images from the camera outputs and then applies iris recognition algorithms to the restored iris images. In this work we investigate the recognition performance of two different algorithms, iriscode and correlation filter based iris recognition, when the input images are unrestored images produced by the wavefront coding imaging system.

Iris recognition technology can achieve very high matching accuracy but still requires substantial user co-operation. To ease this requirement on the user, we require that the operational range of the iris acquisition system be larger than what it is today. Wavefront coding offers a solution to achieve this, but there have not been any large scale tests to quantify and confirm the increase in the depth of field that can be achieved. In this work we address this problem by using more than 1000 images for evaluation on both restored and unrestored wavefront-coded imagery. Using unrestored images is attractive in terms of reduced computational cost and also by the fact that the performance, both in terms of recognition accuracy and depth of field, is similar to the performance on restored images. However, this requires correct segmentation of the unrestored images which is very difficult with current segmentation techniques but can be achieved by improving the current iris segmentation algorithm.

Their experimental result shows that wavefront coding can help us achieve more than twice or thrice the depth of field of a conventional image acquisition system depending on the accuracy of the iris segmentation algorithm.

VI. Extended-Depth-of-Field Iris Recognition Using Unrestored Wavefront-Coded Imagery

Iris recognition using camera systems with a large depth of field is very desirable. One approach to achieve extended depth of field is to use a wavefront-coding system as proposed by Dowski and Cathey, which uses a phase modulation mask. The conventional approach when using a camera system with such a phase mask is to restore the raw images acquired from the camera before feeding them into the iris recognition module. In this paper, we investigate the feasibility of skipping the image restoration step with minimal degradation in recognition performance while still increasing the depth of field of the whole system compared to an imaging system without a phase mask. By using a simulated wavefront-coded imagery, we present the results of two different iris recognition algorithms, namely, Daugman's iris code and correlation-filter-based iris recognition, using more than 1000 iris images taken from the Iris Challenge Evaluation database.

Iris recognition technology can achieve very high matching accuracy but still requires substantial user cooperation. To ease this requirement on the user, we require that the operational range of the iris acquisition system be larger than what it is today. Wave front coding offers a solution to achieve this, but there have not been any large-scale tests to quantify and confirm the increase in the depth of field that can be achieved. In this paper, we have addressed this problem by using a very large set of simulated wavefront-coded images for evaluation. They have also carefully investigated the feasibility of using unrestored wavefront-coded images for recognition since this helps reduce the computational cost associated with image restoration and also by the fact that the recognition performance, both in terms of recognition accuracy and depth of field, is only slightly worse than the recognition performance on restored images.

VII. CONCLUSION

Iris recognition technology can achieve very high matching accuracy but still requires substantial user co-operation. To ease this requirement on the user, they require that the operational range of the iris acquisition system be larger than what it is today. Wavefront coding offers a solution to achieve this, but there have not been any large scale tests to quantify and confirm the increase in the depth of field that can be achieved. This work presents the various researches by using wavefront coding for Iris Recognition.

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