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Iris recognition based on human interpretable features

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ABSTRACT

The human iris is used for human recognition in various applications. However, deployment of iris recognition in forensic applications has not been reported. A primary reason is the lack of human-friendly techniques for iris comparison. The usage of iris recognition can be increased by visualizing the similarity between irises. Scientist Shen proposed a human-in-the-loop method for detecting and matching iris crypts. Thus with the help of this, we proposed a new approach for automatic detection and matching of crypts. This detection method is able to capture iris crypts of various sizes. This matching scheme is designed to handle potential topological changes in the detection of the same crypt in different images. In particular, this approach achieves over 22% higher rank one hit rate in the identification, and over 51% lower equal error rate in verification. In addition, the benefit of this approach on Multi-enrollment is experimentally demonstrated.

Keywords: *Iris, Biometric, Forensic, Human-in-the-loop, Iris crypts.*

1. INTRODUCTION

A Biometric system provides automatic apperception of a person predicted on some from far nothing like it points or quality of had by the person. Biometric systems have been undergone growth predicted on dactylograms of the face points, voice, hand geometry, hand writing, the retina, and the one presented in this thesis, the iris. Biometric systems work by first taking the example of the point, such as recording a by numbers, an electronic sound sign put out for voice apperception, or taking a by numbers, the electronic color image for face apperception. The example is then greatly changed putting to use some a little more mathematical purpose, use into of biometric example copy. The biometric example copy will give a normalized, good at producing an effect of and highly judging things well pictures of the point, which can be then uncolored by feeling or opinion made a comparison of with other example copies in order to make a decision about the mind and physical qualities. A good biometric is represented by the use of a point that is highly nothing like it so that the chance of any two people having the same quality will be the least, hard to move so that the point does not change over time.

2. EXISTING METHOD

The first accurate algorithm for iris biometrics was introduced in 1993 by John Daugman. Daugman provides an algorithm to locate the iris region in an image, segment it, and produce a template that can be used for comparisons to quickly and accurately determine identity. Since its introduction, Daugman has made numerous improvements to the original algorithm, and to this date, Daugman's system remains the basis of almost all deployed iris biometric systems.

Iris recognition systems based on the original Daugman work generally detect the iris boundaries by searching for circles, using an integrodifferential operator. However, since the boundaries are not perfectly circular, alternative techniques have been implemented to segment the iris region based on ellipses or active contours.

After segmentation, the iris region is unwrapped, changing the geometry from that of an annulus to that of a rectangle. The unwrapped iris region is then sampled a set number of times such that each (x; y) sample is translated to a polar coordinate, (r ;). This sampling interpolates the original iris segment and forces the output to be of known dimensions. This process of \unwrapping" the iris accounts for differences in pupil dilation so that each image is translated to equal-sized bands. Figure 2.6 shows an example of an original iris image, the resulting segmented image after the acquisition, segmentation, and normalization, iris texture features are extracted through the use of a complex filter. Daugman suggests a two-dimensional log-Gabor lter, which maps each pixel in the unwrapped image to a coordinate lo-cation in the complex plane. The quadrant of the complex plane that each pixel falls into is used to produce a binary iris code. Pixels that were masked out in the segmentation step are not included in the lter response.

After all, processing is completed, an iris image is denied by its iris code and a corresponding mask, and is ready for matching. In matching two iris codes, Daugman's approach computes a fractional Hamming distance between iris codes.

3. PROPOSED METHOD

IRIS recognition is one of the most reliable techniques in biometrics for human identification. The Daugman algorithm can achieve a false match rate of less than 1 in 200 billion. Iris recognition techniques have been used widely by governments, such as the Aadhaar project in India.

However, the iris is still under assessment as a biometric trait in law enforcement applications. One reason that hinders the forensic deployment of the iris is that iris recognition results are not easily interpretable to examiners. As discussed I, “Iris Examiner Workstation” may be built analogously to the “Ten print Examiner Workstation”, which has been used in forensics. In fingerprint recognition, a human examiner bases a decision on the number of matched minutiae on two fingerprints.

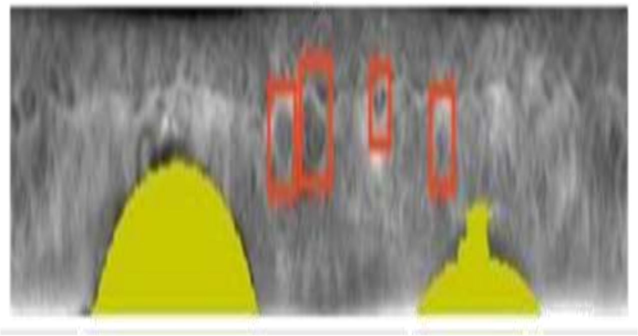

Figure 1-Demonstration of the characteristics of iris crypts

In this scenario, the whole procedure appears as a black-box to an examiner without the knowledge of image processing. Experiments have shown that human examiners can perform well in identity verification using iris images. The certainty was rated from 1 to 5. The decision was made based on human perception of the overall texture. Analogous to fingerprints, one way to further promote the development of iris recognition in law enforcement applications is to make the similarity between irises interpretable so that the whole process can be supervised and verified by human experts. Namely, the judgment should be made based on the quantitative matching of visible features in iris image relevant to forensics includes the recognition of iris captured in visible wavelength or non-ideal conditions, such as on the move or at a distance. There are very few results on investigating iris recognition using human-friendly features. Known feature based iris recognition methods, such as ordinal features, SIFT descriptors, and pseudo-structures, are neither easily interpretable nor corresponding to any physically visible features.

3.1 IRIS CRYPTS AND THE HUMAN-IN-THE-LOOP SYSTEM OVERVIEW

Recently, Shen developed a new human-in-the-loop iris biometric system which performs iris recognition by detecting and matching crypts in iris images. Iris crypts are certain relatively thin areas of iris tissue, which may appear near the collarette or in the periphery of the iris. The overtness of iris crypts stems from their relationship with the pigmentation and structure of the iris. In iris images captured under near-infrared (NIR) illumination, the appearance of iris crypts has the following characteristics (see Figure 1):

- The interior has a relatively homogeneous intensity that is lower than that of the neighboring pixels in the exterior.
- The boundary exhibits stronger edge evidence than either the interior or the exterior. Comparing to fingerprint recognition, iris crypts may serve as the “minutiae of the iris”.

Thus, iris apperception was formulated as the quandary of detecting and matching iris crypts. Following the ACE-V methodology (Analysis, Comparison, Evaluation, and Verification) commonly utilized in dactylogram apperception, a notional human-in-the-loop iris apperception system would employ the following steps as a scientific method:

1) Analysis (A): Features (iris crypts) are detected on the iris image under investigation, by a computer program or by trained examiners.

2) Comparison (C): A similarity (or dissimilarity) score is computed by comparing detected features with the feature patterns in the database using a rigorous process.

3) Evaluation (E): the Preliminary conclusion is formed according to the score(s).

4) Verification (V): Different trained examiners do independent manual inspections of the preliminary conclusion, in order to make creditable decisions.

Anterior experiments have demonstrated that human perception of iris crypts is consistent across different examiners, even without full training. A recent approach aimed to automate the A, C, and E steps. As a consequence, an integrated human-in-the-loop iris recognition system was established. Below, we briefly summarize how the system works in the identification and verification scenarios. For a completed description of the system and graphical interfaces for human inspection and annotation, we refer readers to. For identification, the probe image under investigation is first processed by the system to detect visible features automatically (the Analysis step). A dissimilarity score between the probe image and each gallery image is computed (the Comparison step). The system will retrieve candidate images from the gallery whose features have the most similar patterns to the probe image, i.e., the smallest dissimilarity score (the Evaluation step). In practice, m is a small integer, such as 10 or 20. Finally, human examiners will manually compare the candidate images against the probe image with the human-interpretable features labeled and the similarity between the features in the probe image and different candidate images presented, so as to make the conclusion on the identity of the probe image.

In verification applications, the system processes the probe image to detect features first (Analysis). The dissimilarity score between the probe image and the gallery image(s) of the identity that the probe image claims to be is computed (Comparison). The system will present the results to human examiners, only if the dissimilarity score is lower than a threshold (Evaluation). The human examiners will inspect the results, with the aid of detected features and similarity between corresponding features, to accept or reject that the probe image has the claimed identity.

4. SOFTWARE MATLAB

MATLAB is a high-performance language for technical computing. The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects. Today, MATLAB uses software developed by the LAPACK and ARPACK projects, which together represent the state-of-the-art software for matrix computation.

MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis.

MATLAB features a family of application-specific solutions called toolboxes. Very important to most users of MATLAB, toolboxes allow you to learn and apply specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems.

4.1 The MATLAB SYSTEM

The MATLAB system consists of five main parts:

DEVELOPMENT ENVIRONMENT: This is the set of tools and facilities that help you use MATLAB functions and files. Many of these tools are graphical user interfaces. It includes the MATLAB desktop and Command Window, a command history, and browsers for viewing help, the workspace, files, and the search path.

THE MATLAB MATHEMATICAL FUNCTION LIBRARY: This is a vast collection of computational algorithms ranging from elementary functions like sum, sine, cosine, and complex arithmetic, to more sophisticated functions like matrix inverse, matrix eigenvalues, Bessel functions, and fast Fourier transforms.

THE MATLAB LANGUAGE: This is a high-level matrix/array language with control flow statements, functions, data structures, input/output, and object-oriented programming features. It allows both "programming in the small" to rapidly create quick and dirty throw-away programs, and "programming in the large" to create complete large and complex application programs.

HANDLE GRAPHICS®. This is the MATLAB graphics system. It includes high-level commands for two-dimensional and three-dimensional data visualization, image processing, animation, and presentation graphics. It also includes low-level commands that allow you to fully customize the appearance of graphics as well as to build complete graphical user interfaces on your MATLAB applications.

THE MATLAB APPLICATION PROGRAM INTERFACE (API). This is a library that allows you to write C and FORTRAN programs that interact with MATLAB. It includes facilities for calling routines from MATLAB (dynamic linking), calling MATLAB as a computational engine, and for reading and writing MAT-files.

Some of the functions, like sqrt and sin, are built-in. They are part of the MATLAB core so they are very efficient, but the computational details are not readily accessible. Other functions, like gamma and sinh, are implemented in M-files. You can see the code and even modify it if you want. Several special functions provide values of useful constants.

5. RESULTS

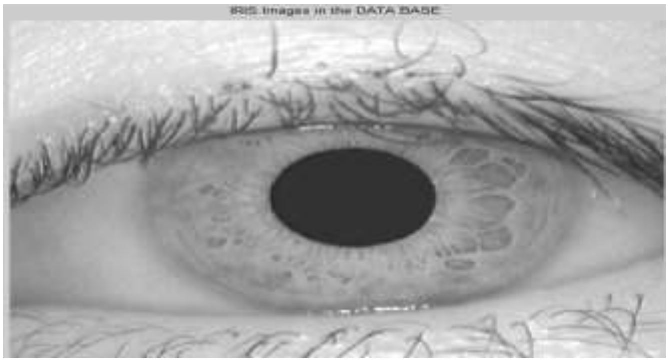

Figure 2: Original Iris image in the Data base

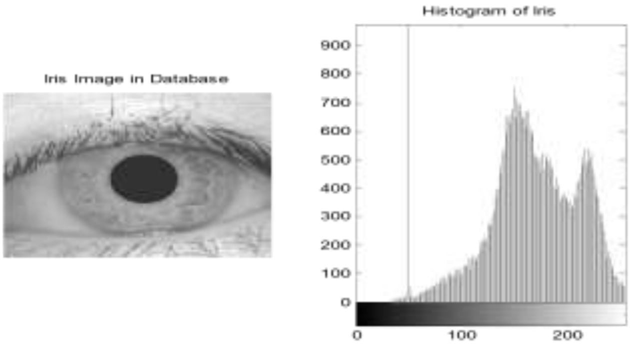

Figure 3: Histogram of the Iris image in the Data Base

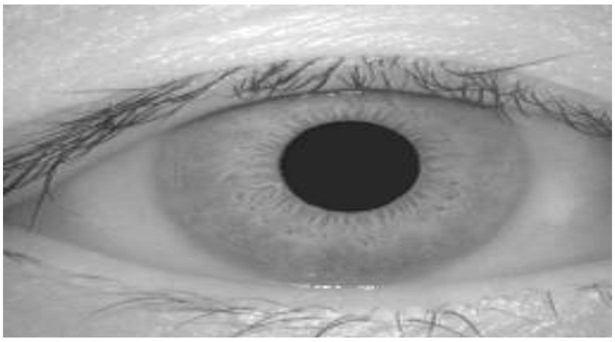

Figure 4: Target iris to be patched

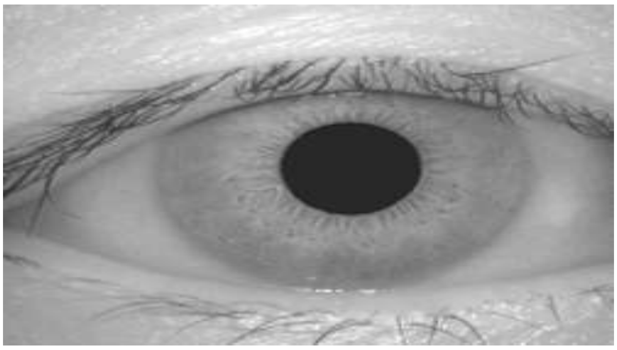

Figure 5: Enhanced Target Iris image

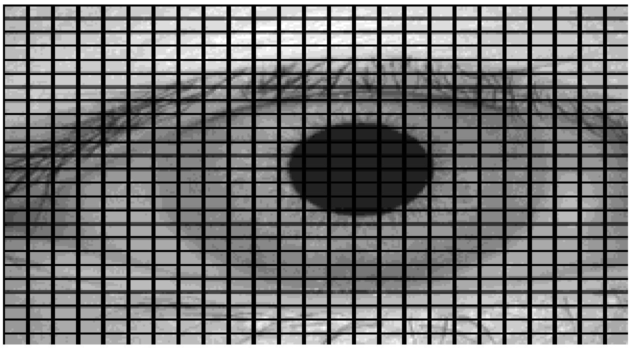

Figure 6: Patched target Iris image

Figure 7: In-depth Patched target Iris image

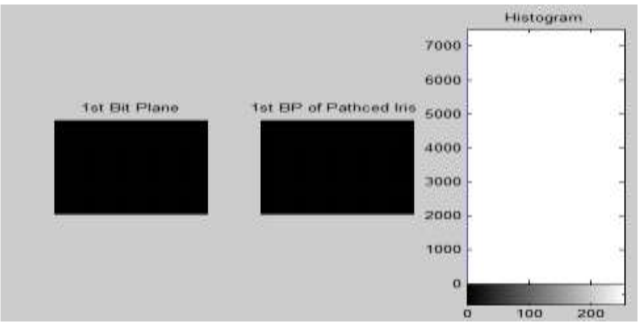

Figure 8: Histogram of Iris image using the local binary patterns

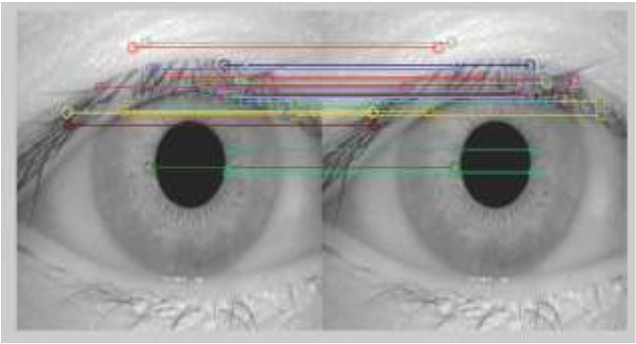

Figure 9: Target and Recognized Iris images

Figure 10: Recognized Iris image

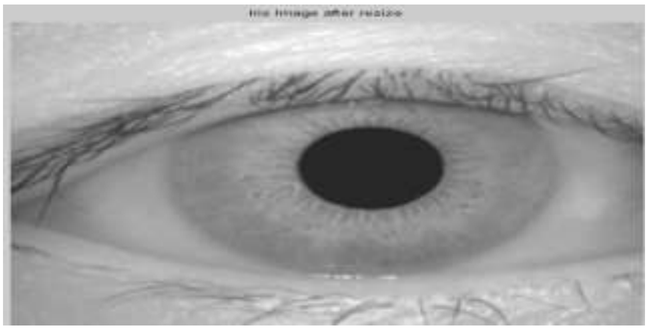

Figure 11: Recognized Iris image after resize

Figure 12: Recognized Iris image after magnification.

6. CONCLUSION

In this paper, we present a new approach for detecting and matching iris crypts for the human-in-the-loop iris biometric system. Our proposed approach produces promising results on all the three tested datasets, in-house dataset, ICE2005, and CASIA-Iris-Interval. Comparing to the known method, our approach improves the iris recognition performance by at least 22% on the rank one hit rate in the context of human identification and by at least 51% on the equal error rate in terms of subject verification.

Also, the parameters used in our approach were trained on another small set of homemade data. The generality and effectiveness of our approach to diverse image data can be demonstrated. Furthermore, as far as we know, this work is so far the only evaluation of a human-interpretable iris feature matching approach using public datasets (ICE2005 and CASIA-Iris-Interval), which offers a direct comparison with traditional approaches such as Daugman’s framework.

To further increase the reliability of the human-in-the-loop iris biometric system, incorporating a quality measure for images enrolled in the system would be beneficial. This would allow evaluating whether the quality of each acquired image is good enough for visual feature matching. Based with respect to certain common factors, such as interlacing or moderate blurring. But, it may still be affected by other factors. Similar to the conventional approaches, high dilation in the pupil, off-angle iris, and severe blurring would be some of the important factors. In addition, heavy occlusion and bad illumination would have a more severe effect on our approach than the traditional iris code.

Specifically, huge occlusion may significantly reduce the number of visual features that can be used for matching. Poor illumination may result in low contrast so that fewer features can be detected than under normal illumination. Nevertheless, our approach under the human-in-the-loop iris recognition framework exhibits a promising application of the iris as a biometric trait in forensics.

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