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Analysis of Quality Metrics and Techniques Applied in Iris Recognition

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Abstract

Biometrics recognition is the use of physiological and behavioral traits to identify an individual. Many biometric traits have been developed and are being used to authenticate the person's identity. Iris recognition system is widely used and has been proved to be efficient at individual recognition with high accuracy and nearly perfect matching. The Iris feature of two eyes of same person are not similar making it more secured way of authentication compared to other Biometric recognition systems. In this paper, we describe the techniques, metrics, image compression and applications that are developed to create an Iris Recognition System.

1. INTRODUCTION

Biometrics is the reliable, secure authentication tool for systems where controlled access to physical assets is provided by recognizing the individual either based on physiological or behavioral characteristics [1]. The physiological characteristics are Iris, fingerprint, face and hand geometry while behavioral characteristics include voice, signature, and ECG, gait and keystroke dynamics. Biometric recognition methods are based on properties which cannot be forgotten, stolen, disclosed or lost unlike traditional authentication such as passwords or PIN's.

Iris is a thin, circular structure in the eye which is protected internal organ thus it is not affected by environmental condition [2]. Amongst all the biometric recognition systems Iris is the promising solution because of its uniqueness, reliability and stability over the lifetime. Even the genetically identical twins have different Iris textures [3].

The Iris recognition system has wide applications in variety of fields such as premise access control (home, office, laboratory), secure financial transactions, internet security, credit card authentication, secure access to bank accounts, anti-terrorism (e.g. security screening at airports) and many more [4].

Iris recognition system acquires the image of eye; extracting the Iris region from the image to determine the unique texture for individual identification during the verification phase and matches it with the database created in enrolment process. Thus identifying the individual's identity in a convenient, faster, precise and more reliable manner.

Though a biometric trait cannot satisfy all of these, some of them must be satisfied to make a characteristic a biometric trait. Table 1 shows a comparison of various biometric traits against the factors.

Table 1. Biometric Trait vs. Factors

Universality	Uniqueness	Permanence	Measurability	Performance	Acceptability	Circumvention
H	L	M	H	L	H	H
M	H	H	M	H	M	M
H	H	H	M	H	L	L
H	H	M	L	H	L	L
H	H	H	L	H	L	L
M	L	L	M	L	H	H
M	M	H	M	M	H	M

Basic principles of operations of an iris recognition technique are as follows:

1. Image acquisition or data capture;
2. Preprocessing and Iris Segmentation;
3. Normalization;
4. Feature extraction;

Match generation or comparison of templates against enrolled data for recognition or authentication purpose.

This paper presents a collective study which is formatted as follows: Section 2 provides a survey on frequently cited iris recognition techniques and Section 3 includes applications and finally with conclusion and future scope of iris.

2. IRIS RECOGNITION TECHNIQUES

Iris recognition is a method of identifying people based on unique patterns within the ring-shaped region surrounding the pupil of the eye. The iris usually has a brown, blue, gray, or greenish color, with complex patterns that are visible upon close inspection. The main body of this survey is organized into the following sections:

2.1 Iris Image Acquisition

2.2 Non-Ideal Images and Quality Metrics

2.3 Image Compression

2.4 Iris Region Segmentation

2.5 Texture Coding and Matching

2.1 IRIS IMAGE ACQUISITION

There are major research issues in the area of iris image acquisition. One issue involves imaging the iris with a sensor system that allows the person to be more "at a distance" and "on the move". Various acquisition issues including the wavelength of light used, the type of light source, the amount of light reflected by the iris back to the sensor, required characteristics of the lens, signal to noise ratio, eye safety, and image quality are discussed[4]. J. G. Daugman. [5] discuss the design of a system to image the iris "at a distance", allowing a standoff of 3 meters. Although current commercial iris biometrics systems all use near-infrared (NIR) illumination, and most research assumes NIR imaging similar to that used in current commercial sensors,

2.2 NON-IDEAL IMAGES AND QUALITY METRICS

Another issue of image quality is important and complex. For our purposes, "non-ideal" means something more than just the presence of specular highlights or occlusion by eyelashes or eyelids. While it is not part of the image acquisition step per se, iris biometric systems typically evaluate the focus quality, and possibly other factors, of each candidate image in order to select usable images. There are several approaches to evaluating image focus quality that involve finding the iris region before computing the focus value. While iris biometric systems select images based in part on focus quality, there are few publications dealing with deblurring of iris images. Most of them investigate image deblurring algorithms that exploit context specific to iris imagery.

The estimation between the user distances from the sensor in order to estimate the appropriate point spread function (PSF) for image restoration. They measure the distance between two specular highlights on the iris. Using this information, plus knowledge about the positions of the two infrared LEDs, they get the user's distance from the camera without using a special distance sensor. The knowledge of the distance from the sensor is used in estimating the PSF. They combine percent occlusion, percent dilation, and "feature information" to create an iris image quality metric. To compute "feature information", they calculate the relative entropy of the iris texture when compared with a uniform distribution. To fuse the three types of information into a single score, they first compute an exponential function of occlusion and an exponential function of dilation. The final quality score is the product of the three measures are the number of image quality factors, including percent occlusion, defocus, motion blur, gaze deviation, amount of specular reflection on the iris, lighting variation on the iris, and total pixel count on the iris.

2.3. IMAGE COMPRESSION

Daugman[6] present a detailed study of the effects of compression of the original iris image on the performance of iris biometrics. They present schemes that combine isolation of the iris region with JPEG and JPEG 2000 compression, evaluate their approach on images from the Iris Challenge Evaluation (ICE) 2005 dataset and conclude that it is "possible to compress iris images to as little as 2000 bytes with minimal impact on recognition performance." Many of them compress iris data without degrading matching results.

They use JPEG compression on unwrapped polar iris images. They design and compare different quantization tables to use with the JPEG compression. Two of their tested Q-tables are designed to preserve more angular iris texture than radial iris texture (i.e. the horizontal texture in the unwrapped image). The other two Qtables are derived from the first two through genetic optimization. There is no clear winner among their tested Q-tables, and they conclude that custom Q-tables for iris recognition should be optimized to a specific target bitrate for best performance.

2.4 IRIS REGION SEGMENTATION

Publications related to segmenting the iris region constitute a significant fraction of the published work in iris biometrics [7]. Many of these publications can be grouped as tackling similar versions of the traditional iris segmentation problem; e.g., given one still image, find the pupillary and limbic boundaries. However, there are also a variety of approaches being explored to find occlusion by specular highlights and eyelashes, to segment the iris using less-constrained boundaries, and to refine initial segmentation boundaries. Iris segmentation algorithms that assume circular boundaries for the iris region continue to appear in some conferences.

The current frontier in iris segmentation is generally now focused on removing the assumption of circular boundaries and on refining the segmentation to account for various occlusions and distortions of the iris texture. This is because the images have been edited to have a circular region of constant intensity value for the region of each iris. Therefore, any segmentation algorithm built around the assumption of a circular region of constant dark intensity value should naturally meet with great success on this dataset, even though these conditions are generally not present in the iris region of real images.

2.5 TEXTURE CODING AND MATCHING

Performing texture analysis to produce a representation of the iris texture, and the matching of such representations, is at the core of any iris biometric system. A large fraction of the publications in iris biometrics deal with this area. It is not necessarily straightforward to organize these publications into well-defined and meaningful categories. They are grouped in a way intended to represent important common themes.

3. APPLICATIONS

Iris recognition, like facial recognition, is most often used for security-related applications. Some countries have implemented iris-recognition systems in airports, points of entry or exit, and government buildings. The technology has also been used to prevent unauthorized access of personal computers and mobile devices. A small, portable iris-scanning

device is available for consumer use, bypassing the need for cumbersome password entry. Iris recognition applications are also available for the iPhone and other smartphones.

4. CONCLUSION AND FUTURE SCOPE

This paper discusses background information's of the anatomy of an iris, a detailed history of how iris has been started to be treated as a biometric trait and a general framework of iris recognition system which are currently being used. The main aim of this work is to provide a timeline view of various iris recognition techniques. Based on this view it is concluded that most of the works carried on iris recognition is more or less similar but the focus was mainly made into 4 major areas namely iris segmentation, normalization which includes noise removal, feature extraction and classification of iris templates. The term "multi-biometric" is used to refer to techniques that use more than one biometric sample in making a decision. Often the samples are from different sites on the body; for example, iris and fingerprint Using multi-biometrics we can (a) increase the fraction of the population for which some usable sample can be obtained, and / or (b) increase recognition accuracy, and / or (c) make it more difficult to spoof a biometric system.

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