Comparative Study of Iris Databases and UBIRIS Database for Iris Recognition Methods for Non-Cooperative Environment

Rishabh Parashar
Rajasthan Technical University, Kota, INDIA

Sandeep Joshi
Rajasthan Technical University, Kota, INDIA

Abstract

Iris recognition is one of the most secure biometric approach as it is non-invasive and stable throughout life. For the purpose of research and development of Iris recognition technology there are few public and freely available databases to have sample images. These iris databases contributes rich amount of iris images which were taken in different environments. In this paper we will discuss and compare the main characteristics of the public and freely available iris image databases to find the suitable one to test feature extraction method of iris recognition in non-cooperative environment. We also illustrate the types of noise that images from each database contain. Based on the analysis of these noise factors, we present the main motivations that led us to the construction of UBIRIS database and highlight the main factors in the comparison with the remaining ones.
Keywords: Biometric, Iris recognition, Databases.

1. Introduction.

The biometrics research and development demands the analysis of human data. Obviously, it is unrealistic to perform the test of algorithms in data captured on-the-fly, due to the enormous uneasiness that this would imply. Moreover, the fair comparison between recognition methods demands similar input data to valorise and contextualize their results. Therefore, when it comes to the test of recognition methods, standard biometric databases assume high relevance and become indispensable to the development process. Regarding the iris biometrics compass, there are presently, apart from the UBIRIS, five public and freely available iris image databases. In the following subsections we describe the main characteristics of their images and turn our attention to the analysis of the noise factors we considered the analysis of these noise factors and the images heterogeneity as the most important parameters, concerning the terms and purposes of our work. Through illustration, we exemplify some of the most common types of noise that each database contains.

2. Available Databases.

2.1 BATH Database

The University of Bath (BATH) iris image database is constantly growing and at present contains over 16000 iris images taken from 800 eyes of 400 subjects. It results of a project which aims to build a "high quality iris image resource" [1]. The majority of the database comprises images taken from students and staff of the University of Bath the images are of very high quality, taken with a professional machine vision camera, mounted on a height-adjustable camera-stand. The illumination was provided through an array of infrared LEDs, positioned below the camera and set at an angle such that reflections were restricted to the pupil. Further, an infrared pass filter was used in order to cut out the daylight and other environmental light reflections on the irises region. So, this framework increases the images quality, while turned it less appropriate for the testing of iris recognition method.

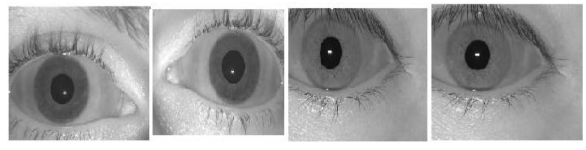

Figure 2.1 Examples of Iris Images from the BATH Database

2.2 CASIA Database

Iris recognition has been an active research topic of the Institute of Automation from the Chinese Academy of Sciences. Having concluded about a lack of iris data for algorithm testing, they developed the CASIA image database. CASIA iris image database [2][3] (version 1.0, the only one that we had access to) includes 756 iris images from 108 eyes, hence 108 classes. For each eye, 7 images are captured in two sessions, where three samples are collected in the first and four in the second session. Similarly to the above described database, its images were captured within a highly constrained capturing environment, which conditioned the characteristics of the resultant images. They present very close and homogeneous characteristics and their noise factors are exclusively related with iris obstructions by eyelids and eyelashes. Moreover, the post process of the images filled the pupil regions with black pixels, which some authors used to facilitate the segmentation task. So, this significantly decreased the utility of the database in the evaluation of robust iris recognition methods.

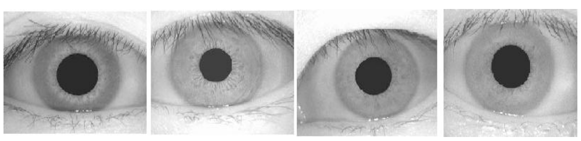

Figure 2.2 Examples of Iris Images from the CASIA Database

2.3 ICE Database

The Iris Challenge Evaluation (ICE) is a contest designed to measure the accuracy of the underlying technology that makes iris recognition possible. It is divided into two stages: first, it was asked to researchers and developers to participate in "iris recognition challenge problems" that might improve their recognition algorithms. Later, an opportunity to participate in a large-scale and independent evaluation will be given, through a new iris data set and a proper evaluation framework.

The ICE [3] database is comprised of 2954 images, with a variable number of images per subject. Similarly to the remaining public iris databases, its images were captured having quality as the main concern and clearly simulate the users' cooperation in the image capturing. Therefore, the noise factors that the ICE database contains are almost exclusively related with iris obstructions and poor focused images. Interestingly, there are some images that were deliberately rotated.Also, some irises were partially captured.

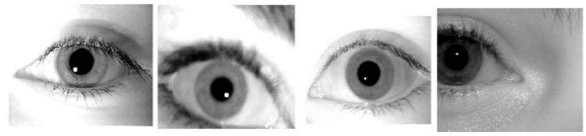

Figure 2.3 Examples of Iris Images from the ICE Database

2.4 MMU Database

The Multimedia University has developed a small data set of 450 iris images (MMU) [4][7].They was captured through one of the most common iris recognition cameras presently functioning (LG Iris Access 2200). This is a semi-automated camera that operates at the range of 7-25 cm. Further, a new data set (MMU2) comprised of 995 iris images has been released and another common iris recognition camera (Panasonic BM-ET100US Authenticam) was used. The iris images are from 100 volunteers with different ages and nationalities. They come from Asia, Middle East, Africa and Europe and each of them contributed with five iris images from each eye. Obviously, the images are highly homogeneous and their noise factors are exclusively related with small iris obstructions by eyelids and eyelashes. As can be seen in figure 2.4.

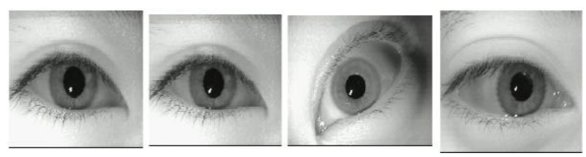

Figure 2.4 Examples of Iris Images from the MMU Database

2.5 UPOL Database

The UPOL [2] iris image database was built within the University of Palack´eho and Olomouc. Its images have the singularity of being captured through an optometric framework (TOPCON TRC50IA) and, due to this, are of extremely high quality and suitable for the evaluation of iris recognition in completely noise-free environments. The database contains 384 images extracted from both eyes of 64 subjects (three images per eye). As can be seen in figure 2.5, its images have maximum homogeneity and inclusively the iris segmentation is facilitated by the dark circle that surrounds the region corresponding to the iris[6]. Obviously, these characteristics make this database the less appropriate for the non-cooperative iris recognition research.

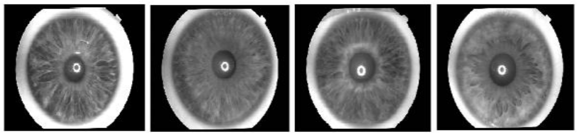

Figure 2.5 Examples of Iris Images from the UPOL Database

2.6 WVU Database

The West Virginia University 5 developed an iris image database (WVU) [6] comprised of 1852 images from 380 different eyes. The number of acquisitions from each eye ranges between three and six and an OKI IrisPass-H hand-held device was used. Images of the WVU database were captured with less constraining imaging conditions and, due to this, incorporate several types of noise, such as iris obstructions, poor focused and off-angle iris images. However, there are few iris images with significant regions affected by specular and lighting reflections, which we believe to be the most common type of noise resultant of natural light imaging environments. As can be seen in figure 2.6. We stress that this was one of the major motivations that led us to decide about the need of a new and noisier iris image database, that later originated the UBIRIS database.

Figure 2.6 Examples of Iris Images from the WVU Database

3.1 UBIRIS Database

After studying the above described iris databases, we concluded that none of them was suitable for the evaluation of robust iris recognition methods, those where noise identification and handling assumes higher relevance[10]. Apart from the WVU database, that contains some noise factors but significantly lacks iris secular and lighting reflections, all the remaining databases were constructed within cooperative environments. This makes them more suitable for the preliminary evaluation of iris segmentation, feature extraction or comparison strategies, when the noise factors constitute an a priori obstacle to conclude about their merits.

Based on this, we decided to build a new public and freely available iris images database - UBIRIS [7] - with a fundamental characteristic that distinguished it from the remaining ones: it is a ”noisy iris image database” and the noise factors are not only avoided but rather induced, in order to simulate the non-cooperative image capturing. UBIRIS database is comprised of 1877 images collected from 241 subjects within the University of Beira Interior 6 in two distinct sessions and constituted, at its release date, the world’s largest public and free iris database for biometric purposes.

3.2 Image Capturing

We used a Nikon E5700 camera with software version E5700v1.0, 71mm focal length, 4.2 F-Number, 1/30 sec. exposure time, RGB color representation and ISO-200 ISO speed. Images dimensions were 2560 × 1704 pixels (width × height) with 300 dpi horizontal and vertical resolution and 24 bit depth. They were saved in TIFF format. For the first image capture session, where the enrolment was simulated, we tried to minimize all possible noise factors, especially those related with reflections, obstructions, focus, motion, luminosity and contrast. The used image capturing framework is given in Figure No 3.1 and was installed inside a dark room.

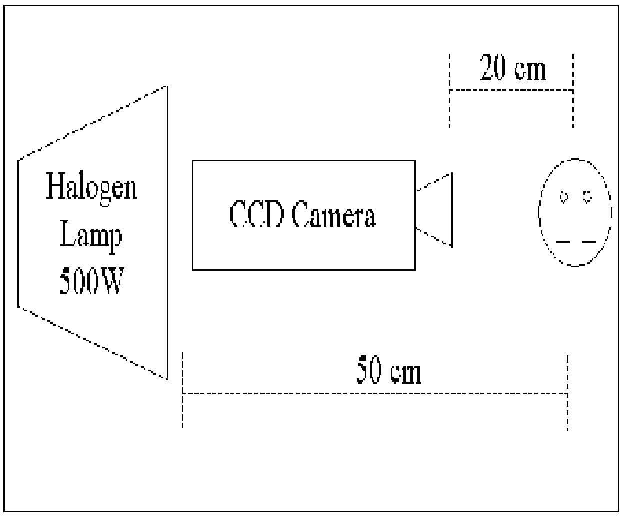

Figure 3.1 Image Capturing Frameworks of the UBIRIS Database of the First Session

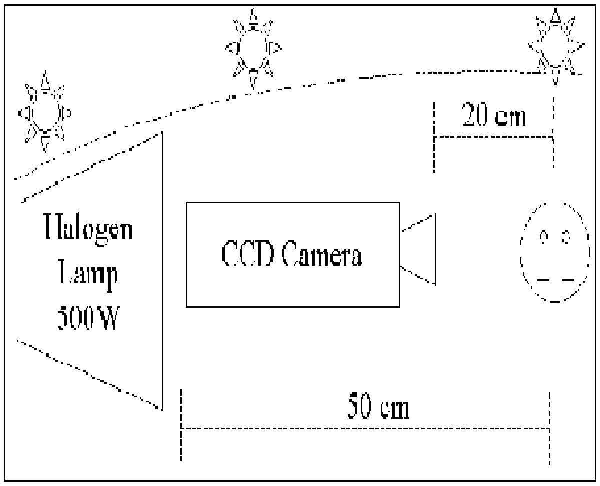

Figure 3.2 Image Capturing Frameworks of the UBIRIS Database of the Second Session

Further, in the second session and the location is changed and setup of the image capturing framework. The introduction of natural luminosity significantly increased the dynamics of the imaging conditions and enabled the appearance of highly heterogeneous images regarding iris reflections and obstructions, poor focused, and with highly heterogeneous characteristics (e.g. in terms of contrast or brightness). Here, our aim was to simulate the image capturing without or with minimal subject's cooperation.

The below figures illustrates some of the noise factors that images of the UBIRIS database contain. Within non-cooperative image capturing environments.

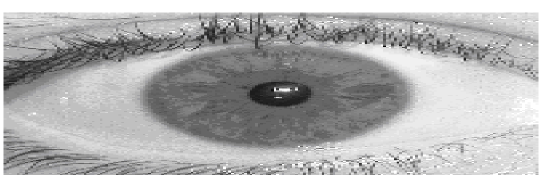

Figure 3.3 Good quality iris image

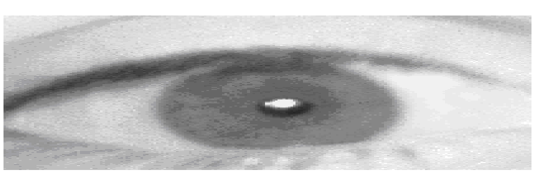

Figure 3.4 Poor focused iris

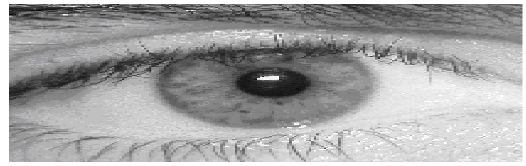

Figure 3.5 Eyelids and Eyelashes Obstruction

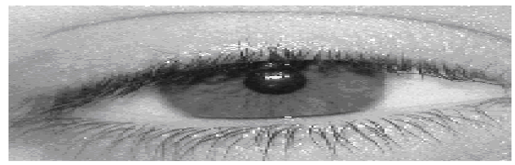

Figure 3.6 Extreme Eyelids Obstruction

3.3 Analysis of Database Noise Factors

In order to provide an overview of the main characteristics of each iris image database, Table No.3.1 summarizes the noise factors that images from the above described databases contain. Each column identifies a noise factor."X" denotes that the database contains images with the correspondent noise factor and"-" denotes the opposite.

The analysis of this table allowed us to conclude that the noisiest database is the UBIRIS database. Apart from not containing off-angle iris images, all the remaining noise factors that are expectable in the non-cooperative capturing setting are present in images of the UBIRIS database. Oppositely, all the remaining databases contain less number of noisy images and its images have more homogeneous characteristics.

3.4 Pre-processing

In the setup of the optic devices used in the capturing of UBIRIS images, we maximized the amount of collectable information, saving images in the TIFF format with average size of 15 MBytes. Therefore, due to constraints in the information diffusion over internet, pre-processing became a requirement. We made three different versions of the database: 800 × 600 pixels (width × height) with 24 bit color images and 200 × 150 pixels (width × height) with 24 bit color and greyscales images.

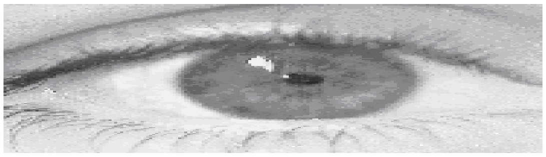

Figure 3.7 Iris with Lighting Reflections

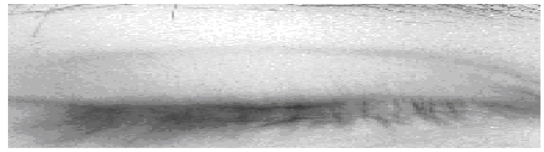

Figure 3.9 Out-of-iris Images

Figure 3.8 Iris with Specular Reflections

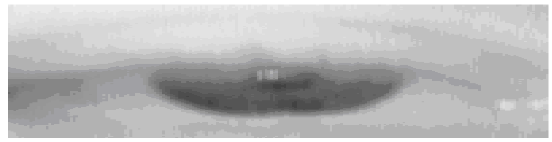

Figure 3.10 Motion Blurred Iris

Table 3.1 Overview of the Noise Factors in Public and Free Iris Image databases.

Iris Database	Eyelids obstruction	Eyelash obstruction	Lighting reflections	Motion blurred	Off-angle	Out-of-iris	Poor focused	Partial iris	specular reflections
	---Iris Noisy Factors--								
BATH	X	X	-	-	X	-	-	-	-
CASIA	X	X	-	-	-	-	-	-	-
ICE	X	X	-	-	-	-	X	X	-
MMU	X	X	-	-	-	-	-	-	-
UPOL	-	-	-	-	-	-	-	-	-
UBIRIS	X	X	X	X	-	X	X	X	X
WVU	X	X	-	X	X	-	X	X	-

3.4 Conclusion and future work

We randomly selected 100 images from each of the above described iris databases, hoping that they were representative of the respective database images. As expected, through the analysis of different databases, we obtained a more objective idea about the degree and type of noise characteristics of each image database. After the identification of the types of noise that each available database contains, it is concluded that the UBIRIS Database can become the sample database to test the iris recognition methods for the non-cooperative environment .Further it is described that the majority of these databases were build having the image's quality as main concern, inducing its use in the cooperative setting. Apart from UBIRIS, WVU iris image database is the one that contains a relatively larger number of noise within the captured iris regions. However, the image corrupted by reflections (specular and lighting) is a weak point, and made UBIRIS the main database for our experiments.

References

[1]*http://www.smartsensors.co.uk/information/bath-iris-image-database*

[2] Dobes and Libor Machala.*Upol iris image database. 2004.* http://phoenix.inf.upol.cz/iris

[3] Chinese Academy of Sciences Institute of Automation. *Casia iris image database*. 2004. http://www.sinobiometrics.com

[4]*http://www.di.ubi.pt/~hugomcp/doc/ProencaAlexandreAliasing* NormalizationCIS2006.pdf.

[5] Jiali Cui, Yunhong Wang, Tieniu Tan, Li Ma, and Zhenan Sun. *A fast and robust iris localization method based on texture segmentation*. 2004. *http://nlpr-web.ia.ac.cn/english/irds/papers/cuijl/SPIE.pdf*

[6] R. Wildes. *Iris recognition: an emerging biometric technology. Proceedings of the IEEE*, Vol. 85, No. 9, pp. 1348-1363, 1997.

[7] Lye Liam, Ali Chekima, Liau Fan, and Jamal dargham. *Iris recognition using self-organizing neural network. In IEEE, 2002 Student Conference on Research and Developing Systems*, pages 169–172, Malasya, 2002.

[8]J. G. Daugman, *"High confidence visual recognition of persons by a test of statistical independence," IEEE Trans. Pattern Anal.Mach. Intell*., vol. 15, Nov. 1993.

[9]J. G. Daugman, "*How iris recognition works," IEEE Trans. Circuits Syst. Video Technology*., vol. 14, no. 1, pp. 21–30, Jan. 2004.

[10]*http://www.di.ubi.pt/~hugomcp/doc/ubiris_techReport.pdf*

[11] Li Ma, Yunhong Wang, and Dexin Zhang. *Efficient iris recognition by characterizing key local variations. In IEEE Transactions on Image Processing, vol. 13, no. 6*, pages 739–750,U.S.A., 2004.