Chapter 9
Efficient Iris Identification with Improved Segmentation Techniques

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ABSTRACT

In this chapter, the authors propose and implement an improved iris recognition method based on image enhancement and heuristics. They make major improvements in the iris segmentation phase. In particular, the authors implement the raised to power operation for more accurate detection of the pupil region. Additionally, with their technique they are able to considerably reduce the candidate limbic boundary search space; this leads to a significant increase in the accuracy and speed of the segmentation. Furthermore, the authors selectively detect the limbic circle having center within close range of the pupil center. The effectiveness of the proposed method is evaluated on a grand challenge, large scale database: the Iris Challenge Evaluation (ICE) dataset.

1. INTRODUCTION

Over the past decade biometric authentication has become a very active area of research due to the increasing demands in automated personal identification. More recently several new notable techniques and methods with applications to face recognition (Liu & Yang, 2009), (Liu, 2007), (Yang, Liu, & Zhang, 2010), eye detection (Shuo

& Liu, 2010) and iris (Verma, Liu, & Jia, 2011) biometrics have been proposed. Among many biometric techniques, iris recognition is one of the most promising approaches due to its high reliability for person identification (Ma, Tan, Wang, & Zhang, 2004).

The iris is a thin circular diaphragm, which lies between the lens and cornea of the human eye. Figure 1 shows the iris region between the sclera and the pupil. The formation of the unique patterns of the iris is random and not related to
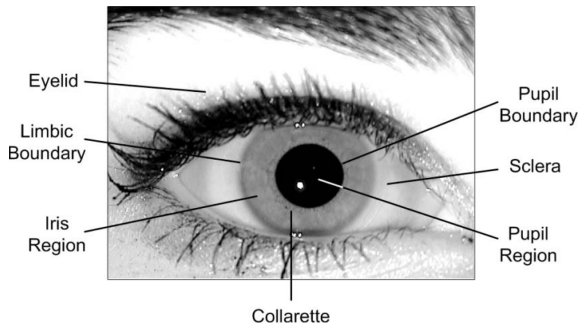
any genetic factors (Wildes, 1997), and the iris patterns remain stable throughout the adult life. Thus, the patterns within the iris are unique to each person and two eyes of an individual have independent iris patterns. Some research shows that when compared with other biometric features such as face and fingerprint, iris patterns are more stable and reliable (Du, Ives, & Etter, 2004).

A general approach to iris recognition consists of four stages: 1) image acquisition, 2) iris segmentation, 3) feature encoding, and 4) decision making. Recent work focuses on handling eye gaze and eyelash exclusion (Daugman, 2007). Bayesian approach to matching of warped iris patterns is discussed by Thornton, Savvides, and Vijayakumar (2007). Beacon guided search for faster iris matching is discussed by Hao, Daugman, and Zielinski (2008) and use of short-length iris codes from the most descriptive regions of the iris for fast iris matching is proposed by Gentile, Ratha, and Connell (2009).

In this paper, we propose and implement an improved iris recognition method based on image enhancement and heuristics. We make major improvements in the iris segmentation phase. In particular, we implement the raised to power operation for more accurate detection of the pupil region. Additionally, with our technique we are able to considerably reduce the candidate limbic boundary search space, this leads to a significant increase in the accuracy and speed of the segmen-

tation. The segmentation performance is further increased with the application of the thresholding. Furthermore, for higher accuracy and speed, we selectively detect the limbic circle having center within close range of the pupil center. The effectiveness of the proposed method is evaluated on a grand challenge, large scale database: the Iris Challenge Evaluation (ICE) (Phillips, 2006) dataset. The pupil is correctly segmented for 99.8% of the images in the dataset. Iris region detection is 98.5% for the right eye and 98.8% for the left eye. The rank-one recognition rate for our method is 3.5% and 2.7% higher than that of the ICE method for the right eye and the left eye respectively. Furthermore, we improve upon the ND_IRIS (Liu, Bowyer, & Flynn, 2005) by a significant 2% for the rank-one recognition rate of the left eye. The verification rate is about 10% higher than the ICE method for each eye at a much lower equal error rate; this emphasizes the higher accuracy of our system.

The rest of the paper is structured as follows: In Section 2, we briefly overview several representative works on image acquisition, segmentation, feature encoding and matching. Section 3 describes the dataset used in our experiments along with the implementation details of our improved recognition system. We evaluate the performance of our method and present a detailed analysis of the experimental results in Section 4. Future research directions are discussed in Section 5 and conclusions are drawn in Section 6.

2. RELATED WORK

Various algorithms have been proposed for iris recognition, one of the earlier systems proposed by Flom and Safir (1987) operates under highly controlled conditions: (i) a headrest is used; (ii) the subject is asked to look at an image in order to stabilize the gaze, and (iii) the process is supervised by an operator. The pupil region is detected by finding large connected regions of pixels with intensity values below a given threshold. In order

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