

Preface

The increasing demand on enhanced security has led to an unprecedented interest in automated personal recognition based on biometric system. The biometric system makes use of physiological or behavioral characteristics to recognize individuals. Among all the biometric recognition systems, iris recognition system has been deployed in various critical application areas (homeland security, border control, web-based services, national ID cards, etc.) because of its unique, stable, and noninvasive characteristics. It is observed that iris image consists of nonuniform spectral information due to its irregular and random characteristics (tiny crypts, freckles, radial furrows, radial streaks, collarette, pigment spots, etc.).

Multi-resolution analysis (MRA)-based technique can be well suited to represent these iris image structures. It is well known that discrete wavelet transform (DWT) is a powerful tool in MRA. The power of DWT is to offer high temporal localization for high frequencies and good frequency resolution for low frequencies. Most of the iris image representation schemes in the literature used off-the-shelf wavelet basis to extract the features. *Although there is a defined standard for raw iris data, there is none regarding iris feature representation.* Thus, many issues are still open in the field of iris image feature extraction related to the choice of filter bank (FB). The design of FBs and investigations of their properties (near-orthogonality, regularity, time-frequency localization, linear phase, perfect reconstruction, etc.) for image-coding, denoising, compression, etc., have been carried out by many researchers. However, effectiveness of the properties in iris pattern recognition has not been addressed in the literature. Several nonideal factors (eyelids occlusion, multiple/separable eyelashes occlusion, reflection (specular, lighting), poor focus, partially opened eyes, motion blur, noncircular shaped of the iris/pupil, etc.) contained in iris images can increase the false rejection rate (FRR).

This book focused on the design of critically sampled separable and nonseparable wavelet filter banks (FBs) for effective iris image representation. These systems are important for feature extraction algorithms due to their nonredundancy (critical sampling). In addition, k -out-of- n :A post-classifier is explored to reduce the FRR. Due to the desired properties of these designed FBs like flexible frequency response, near-orthogonality, and regularity, the filter banks designed in this book can be more effectively used than the existing FBs in many signal processing applications like pattern classification, data-compression,

watermarking, denoising, etc. In this book, we have evaluated the performance of the designed FBs for extraction of features of the iris. However, these FBs can be used effectively to extract features from face, fingerprint, palm-print, ear, etc., for automatic person verification (identification).

A brief introduction to biometrics in general and iris in particular is presented in [Chap. 1](#). The motivation along with a brief review of the previously published related work (Iris recognition algorithms, one-dimensional filter-banks, and two-dimensional filter-banks) is also presented in this chapter.

[Chapter 2](#) explains the design of a new class of triplet half-band filter bank (THFB). The properties of the proposed class of THFB are investigated to extract the discriminating iris features. The details of THFB-based feature extraction process including post-classifier are explained in this chapter. We also provide the experimental results to show the effectiveness of the proposed technique.

In [Chap. 3](#), a nonseparable, nonredundant, multiscale combined directional wavelet filter bank (CDWFB) is constructed by the combination of directional wavelet filter bank (DWFB) and rotated directional wavelet filter bank (RDWFB). This chapter also discusses the iris feature extraction algorithm based on a combination of CDWFB and post-classifier. Experimentation is carried out to evaluate the performance of the schemes.

[Chapter 4](#) explains the iris feature extraction scheme based on 2-D nonseparable, nonredundant, multiscale hybrid finer directional wavelet filter bank and classification using fused post-classifier under nonideal environmental conditions. This chapter addresses the issue in the design of DWFB and extends the proposed class of THFB for the 2-D nonseparable filter bank. Simulation results for the proposed algorithm are also presented in this chapter.

[Chapter 5](#) addresses the issue in the design of proposed nonseparable FBs and presents the design of the new class of triplet half-band checkerboard shaped filter bank (THCSFB). This chapter also describes the directional ordinal measures (DOMs) for iris image representation using the designed class of THCSFB. The experimental results are provided to demonstrate the performance of this method.

This book provides the new results in wavelet filter banks-based feature extraction, and the classifier in the field of iris image recognition. It provides the broad treatment on the design of separable, nonseparable wavelet filter banks. It brings together the three strands of research (wavelets, iris image analysis, and classifier). This book contains the compilation of basic material on the design of wavelets that avoids reading many different books. The material on separable and nonseparable wavelet design has been reorganized significantly so to provide an easier path for newcomers and researchers to master the contents.

Iris Image Recognition

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Schemes

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