Chapter XVI
Book Summary

ABSTRACT

With the title "Advanced Pattern Recognition Technologies with Applications to Biometrics" this book mainly focuses on two kinds of advanced biometric recognition technologies, biometric discrimination techniques and multi-biometrics. Biometric discrimination techniques are presented in Parts I and II, while multi-biometrics is described in Part III. While the methods and algorithms described in Parts I and II are very suitable for biometrics as they take into account characteristics of biometric applications such as high dimensionality and small sample size, Part III mainly introduces three kinds of biometric fusion techniques that respectively fuse biometric information at the feature level, matching score level and decision level as well as their applications cases. This chapter summarizes the book from a holistic viewpoint. Section 16.1 summarizes the contents of the book and indicates the relationship between different chapters in each part. Section 16.2 reveals that how the methods and algorithms described in different parts can be applied to different data forms of biometric traits. Section 16.3 provides comments on the development of multi-biometrics.

16.1 CONTENT SUMMARY

In this section we summarize the contents of all the three parts and indicate the themes of different parts, respectively. While Part I explores several advanced biometric discrimination technologies such as orthogonal discriminant analysis, parameterized discriminant analysis, and maximum scatter difference discriminant

analysis, this part is indeed focused on biometrics with the small sample size (SSS) characteristic. In Chapter IV, by defining the three SSS strategies (SSS Strategy one, SSS Strategy two and SSS Strategy three) for solving the SSS problem using discriminant analysis, we provide clear and detailed description on how a discriminant analysis technique should be properly applied to biometrics with the SSS characteristic. On the other hand, in Chapter V and Chapter VI we develop novel discriminant analysis methods applicable to biometrics with the SSS characteristic. In Chapter V, we address biometric issues with the SSS characteristic by developing two weighted discriminant analysis methods respectively on the basis of the nullspace and the range space of the within-class scatter matrix. In Chapter VI, we address biometric issues with the SSS characteristic by proposing the maximum scatter difference discriminant analysis method. The most advantage of this method is that when applied to biometrics the nature of the method allows the SSS problem to be automatically avoided. This excellent property of the method also allows one to use discriminant analysis for biometrics with ease.

Part II mainly presents tensor-based biometric discrimination technologies, tensor independent component analysis, tensor non-negative factorization, tensor canonical correlation analysis and tensor partial least squares as well as their applications to biometrics. These techniques allow ideas of conventional methods and algorithms such as the idea of conventional linear discriminant analysis (LDA) methods to be applied to new data forms such as two-dimensional matrices. For example, whereas conventional LDA is just applicable to one-dimensional vector, tensor-based discriminant analysis method enables the discriminant analysis methodology to be directly applied to two-dimensional matrix data. Indeed, a number of tensor-based methods and algorithms described in Part II can be viewed as improvements to conventional methods and algorithms that are workable for only sample data in the form of vectors as shown in Part I. In addition, when we describe well-known two-dimensional PCA and LDA respectively from the points of view of tensor PCA and LDA, we provide readers with a more easy way to understand tensor methods.

Part III primarily presents multi-biometric technologies including feature level fusion, matching score level fusion and decision level fusion technologies and applications examples of these technologies. Fundamental concepts and definitions of multi-biometrics such as multi-biometric technology taxonomies are also presented in this part. One of the relationships between this part and the previous two parts is as follows: The methods presented in Parts I and II can serve as feature extraction methods of multi-biometrics and then the multi-biometric system can implement the verification or recognition task by integrating the multi-biometric technologies with the feature extraction result. On the other hand, Part III is also different from Parts I and II as follows: Part III primarily emphasizes technical aspects of multi-biometrics, whereas Parts I and II mainly focus on theoretical aspects of foundation