

Preface

The development of machines able to autonomously and covertly perform reliable recognition of human beings is a long-term goal in the biometrics field. Some of the biological traits used to perform biometric recognition support contactless data acquisition and can be acquired covertly. Thus, at least theoretically, the subsequent biometric recognition procedure can be performed without the subjects being aware or have knowledge of it, and can take place in uncontrolled scenarios (e.g., banks, airports, public areas, etc.). This real-world scenario brings many challenges to the pattern recognition process, essentially because the quality of the acquired data may vary depending on the acquisition conditions. The feasibility of this type of recognition has received increasing attention and is of particular interest in visual surveillance, computer forensics, threat assessment, and other security areas. There is a growing interest in the development of biometric recognition systems that operate in unconstrained conditions, and important advances have been recently been achieved in this field, in the various aspects covered in this book, ranging from the recognition of ears, eyes, faces, gait, fingerprint, handwritten signatures, altered appearances, and pattern detection and recognition issues arising in biometrics applications.

The goal of this volume is to summarize the state-of-the-art in signal and image processing techniques to newcomers to the field of biometrics and for more experienced practitioners, and to provide future directions for this exciting area. It offers a guide to the state-of-the-art, and the mainstream research work in this field is presented in an organized manner, so the reader can easily follow the trends that best suits her/his interests in this growing field.

The volume opens with [Chap. 1](#) by Verdoolaeghe et al. The authors present concepts of manifold learning and information geometry, and discuss how manifold geometry can be exploited to obtain biometric data representations. The authors also compare some of the representative manifold-based methods applied to face recognition, and conclude that manifold learning is a promising research area in noncooperative facial recognition, specially because it can accommodate different head poses and facial expressions in a unified scheme.

In [Chap. 2](#), Patel et al. define the remote face recognition problem and discuss some of the key issues in this area. They investigate features that are robust to face variations, which are useful for developing statistical models that account for these

variations in remote face recognition, and conclude by pointing out some open problems in remote face recognition.

In [Chap. 3](#), Proença et al. introduce facial sketch recognition as link between a drew representation of a human face and an identity, based on information given by a eyewitness, and compare computer-aided facial sketch recognition and humans performing the same task. Their analysis allows to conclude which sets of facial features are more appropriate considering the facial sketch reliability.

In [Chap. 4](#), Singh describes a mutual information-based age transformation algorithm that does a multiscale registration of a gallery and probe face images, by minimizing the variations in facial features caused by aging. The performance of the proposed algorithm is compared with other known algorithms for recognizing altered facial appearances, and the experiments show that the proposed algorithm outperforms the existing algorithms.

In [Chap. 5](#), Zheng reviews three face recognition algorithms (matchers), and present and compare the fusion performance of seven fusion methods: linear discriminant analysis (LDA), k-nearest neighbor (KNN), artificial neural network (ANN), support vector machine (SVM), binomial logistic regression (BLR), Gaussian mixture model (GMM), and hidden Markov model (HMM). The author obtains promising results on a set of 105 subjects, and concludes that the performance of an integrated system equipped with multispectral imaging devices is much higher than that of any single matcher or any single modality, which shall enable night vision capability (i.e., recognizing a face at dark or at nighttime).

The volume continues with six chapters on the recognition of ears, eyes, gait, fingerprint, handwritten signatures, and pattern detection and recognition issues arising in biometrics applications. In [Chap. 6](#), Barra et al. describe the state-of-the-art in unconstrained ear processing, which due to its strong three-dimensional characterization, its correct detection and recognition can be significantly affected by illumination, noise introduced by hair, pose, and occlusion. They discuss and compare the representative 2D and 3D approaches for ear processing, and point out open problems for future research of ear processing in uncontrolled settings.

In [Chap. 7](#), Zhou et al. argue that the blood vessel structure of the sclera is unique to each person, and is able to be acquired nonintrusively in the visible wavelengths. Also, sclera recognition has been shown to achieve reasonable recognition accuracy under visible wavelengths, whereas iris recognition has only proved accuracy in near infrared images. Hence, by combining iris and sclera recognition, they achieve better recognition accuracy than when using each of traits in an isolated way. Authors introduce a feature quality-based unconstrained eye recognition system that combines the respective strengths of iris recognition and sclera recognition for human identification, and can work with frontal and off-angle eye images.

In [Chap. 8](#), Makihara et al. handle the problem of varying gait speed, in terms of recognition effectiveness. They describe a method of gait silhouette transformation that handles varying walking speed changes in gait identification. When a person changes his walking speed, the dynamic features (e.g., stride and joint angle) also

vary, while static features (e.g., thigh and shin lengths) remain relatively constant. Based on this observation, authors propose to separate static and dynamic features from gait silhouettes by fitting a human model. Then, a supervised factorization-based speed transformation model for the dynamic features is described. Finally, silhouettes are restored by combining the unchanged static features and the transformed dynamic features. The evaluation carried out shows the effectiveness of the algorithm described, turning it particularly suitable to be used in unconstrained acquisition scenarios.

In Chap. 9, Vatsa proposes a quality assessment algorithm based on the Redundant Discrete Wavelet Transform to extract edge, noise, and smoothness information in local regions and encodes into a quality vector. The feature extraction algorithm first registers the gallery and probe fingerprint images using a two-stage registration process. Then, a fast Mumford–Shah curve evolution algorithm extracts level-3 features: pores, ridge contours, dots, and incipient ridges. Gallery and probe features are matched using Mahalanobis distance measure and quality-based likelihood ratio approach. Further, the quality induced sum rule fusion algorithm is used to combine the match scores obtained from level-2 and level-3 features. In Chap. 10, Housmani and Salicetti address the problem of quality of online signature samples. Authors note that while signature complexity and signature stability have been pointed in the literature as main quality criteria for this biometric modality, the main drawback is the measurement of such criteria separately. In this chapter, they analyze such criteria with a unifying view, in terms of entropy-based measures. Based on experiments carried out on several well-known datasets, the authors conclude that the degradation of signatures due to mobile acquisition conditions can be accounted for using the entropy-based measures.

In Chap. 11, Grabowski and Sankowski discuss the main problems of human tracking in noncooperative scenarios. Authors pay special attention to the tracking capabilities of the acquisition hardware and to image segmentation techniques. As a general conclusion, the authors argue that off-the-shelf Pan–Tilt–Zoom cameras can be a viable solution for biometric systems requiring human tracking in noncooperative scenarios, even for demanding traits, as in the case of such a small structures like the human iris.

As editors, we hope that this volume focused on signal and image processing, as well as in pattern recognition techniques applied to biometrics, will demonstrate the significant progress that has occurred in this field in recent years. We also hope that the developments reported in this volume will motivate further research in this exciting field.

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