

Preface

Literally, the word “biometrics” is composed of the prefix “bio”, meaning “life” in Greek, and the suffix “metrics”, meaning “measure”. Indeed, its main aim is to perform measurements on human beings. The term also refers to a discipline describing statistical and mathematical methods employed to process data related to life sciences. Even though several scientific communities “share” the word “biometrics” to deal with some specific fields such as medicine and ecology, this book is dedicated basically for security purposes. Actually, we believe that it is within this context that biometrics is best known, including the non-scientific community. This biometrics considers, in particular, the problem of identification and authentication of individuals using their characteristics. In fact, this issue goes back to the 19th Century, especially through the practice of anthropometry, but it has probably existed, under other forms, long before that time. The history of biometrics is exciting but its evolution is even more exciting. Over generations, human attitudes have changed and continued to mutate to the point where the degree of acceptability and subtlety is constantly evolving depending on the needs, constraints, and events that the world is aware of. Biometrics has changed a lot, and this term is becoming more and more common in our everyday language: the biometric passport, the biometric ID card, the biometric lock, etc. In the coming years, we expect that huge applications dealing with biometric-based systems will be developed. For example, according to the analysis of the biometrics market, published by the “International Biometric Group (IBG)”, we can find an increasing trend for both businesses and public sectors. As an example, we may mention one of the major programs of biometric identification that no country has ever known before. It consists of enrolling all Indian citizens to build a single national database.

Potentially, biometrics can be considered as an effective measure to allow an ease-of-use of technical systems or to provide some solutions to socioeconomic, management, and security issues. However, it is important to emphasize the fact that biometrics should be taught and controlled so that human identity, privacy, and

freedom can be respected and that ethics is a priority or even a fundamental condition for the balance of the contemporary society.

Technically speaking, biometrics, as considered so far, would certainly not have existed without the progress reached in other disciplines, such as electronics, computer science, and signal and image processing. Within this context, many excellent books on biometrics have been published in recent years, highlighting both the software and the hardware aspects and considering more specifically acquisition systems and data processing techniques. But, this book is somehow different in the sense that the purpose is basically to provide a survey on biometrics as represented by French and some French-speaking research teams. The aim is to help postgraduate students, researchers, and engineers who need an introduction to biometrics and those who want to major in this field. In addition, we have tried to strike a balance between the chapters dedicated to research and those proposed for educational purpose by including *Matlab* code.

As the book title suggests, signal and image processing methods are presented by considering applications related to the identification and authentication of individuals. Obviously, two-dimensional/three-dimensional (2D/3D) face recognition, iris, and hand biometrics are considered, but the contents of this book are also extended to multibiometrics as well as to the performance evaluation of biometric systems. In addition, some signal processing tools such as classification, cryptography, and data protection are also presented.

The book consists of 15 chapters and is structured as follows:

Chapter 1: entitled “Introduction to Biometrics”. The history of biometrics is briefly reviewed; then the most common biometric modalities and their evaluation are presented. The multimodality and the privacy aspects are also discussed.

Chapter 2: in this chapter, “Introduction to 2D Face Recognition”, is proposed for educational purposes. It is especially intended for beginners. Its aim is to introduce some classical techniques and algorithms of facial biometrics by considering some local, global, and hybrid approaches.

Chapter 3: in this chapter, entitled “Facial Soft Biometrics for Person Recognition”, the aim is to deal with a specific type of biometrics that deals with some traits, such as the color of the eyes and hair, to identify persons or a group of persons.

Chapter 4: entitled “Modeling, Reconstruction and Tracking for Face Recognition”, the chapter addresses issues related to the acquisition of faces “on the fly”, in particular, by the use of multiview acquisition systems. Within an authentication context, the issues related to the 3D shape and to the texture of the face are addressed.

Chapter 5: in this chapter, entitled “3D Face Recognition”, 3D acquisition for biometrics, the preprocessing, as well as the symmetric and asymmetric face recognition are discussed.

Chapter 6: biometrics cannot be presented without addressing the iris modality. This is indeed the purpose of this chapter entitled “Introduction to Iris Biometrics”. The overall architecture of an iris biometric system is presented, which is essentially helpful for beginners. Afterwards, a step-by-step reference processing technique is detailed.

Chapter 7: in this chapter, entitled “Voice Biometrics: Speaker Verification and Identification”, some signal processing tools, in particular those used for analysis, modeling, and filtering, are elaborated within the context of speech recognition.

Chapter 8: this is another chapter for beginners, entitled “Introduction to Hand Biometrics”, in which the reader can perform basic processing (e.g. minutia extraction), using *Matlab* code. Links to several helpful databases are also provided.

Chapter 9: entitled “Multibiometrics”, this chapter presents various structures of multibiometric systems and the different biometric data fusion methods. Illustrations derived from industrial systems are also presented.

Chapter 10: in this chapter, biometrics is seen from a different viewpoint, in comparison with common techniques. Specifically, it consists of extracting signatures from biosignals and medical images for the purpose of identification or authentication. This biometrics, which is particularly robust to “spoofing”, is called “hidden biometrics”. In particular, we focus on biometrics using electrocardiogram (ECG), electromyogram (EMG), and some medical imaging techniques (e.g. brain MRI images, hand X-ray images, and anatomic images).

Chapter 11: after a brief review of some common definitions related to biometric systems, this chapter, entitled “Performance Evaluation of Biometric Systems”, is dedicated to the presentation of some tools used to assess the performance of biometric systems. Furthermore, interesting illustrations on keystroke dynamics systems are also presented.

Chapter 12: in biometric applications, it is often necessary to use classification techniques to associate a given feature with a predefined class. For this purpose, we present in this chapter, entitled “Classification Techniques for Biometrics”, numerous parametric (e.g. naive Bayesian and linear discriminant analysis (LDA)) and non-parametric (e.g. k -nearest neighbor (KNN), neural networks, and support vector machine (SVM)) methods. *Matlab* codes are also included.

Chapter 13: the main purpose of this chapter entitled “Data Cryptography” is to understand the basics of cryptography, including modern cryptography. It is obvious that the reader can use such a tool to encrypt biometric data.

Chapter 14: this chapter, entitled “Visual Data Protection”, is complementary to the previous chapter. It is dedicated to the protection of visual data through some specific methods, including digital watermarking and fingerprinting.

Chapter 15: in this chapter, entitled “Biometrics in Forensics”, the issues of facial comparison and voice comparison are discussed within the forensic context. The inference of the identity in forensics is also considered.

Finally, it is important to point out that this book would not have been possible without the active contribution of researchers from the French and French-speaking biometric community as well as some non-French-speaking researchers. This book is also the result of the participation of some members representing major industries and institutions active in the fields of biometrics and security. It is to all these participants that we wish to express our gratitude.

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