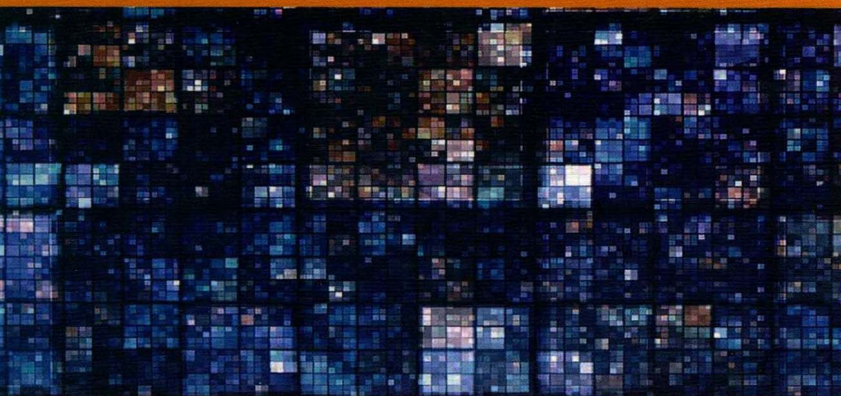


# Facial Multi-Characteristics and Applications

人脸多样化特征及其应用

(英文版)

Bob Zhang  
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David Zhang



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**FACIAL MULTI-CHARACTERISTICS  
AND APPLICATIONS**

# PREFACE

The human face plays an important role in our social life, from which we can extract many forms of information, such as identity, gender, race, age, emotions, health, personality, attractiveness, etc. Faces with multi-characteristics have long been a source of interest to psychologists and other scientists in a wide range of disciplines. In recent years, as the performance of computers and digital cameras have been significantly improved, computer-based facial image analysis has attracted extensive attention.

What features can we extract from a face and given these features what applications can we develop? These questions will be answered in this book. In fact, we can extract multi-characteristics from a face, which forms two types of features, e.g., permanent (or physiological) features and changed features. Furthermore, the permanent features can also be separated into two classes: special (or unique) features for individuals and common features for some particular crowds, while changed features can be obtained by means of some disease and by impulses. As a result of these features, there will be four different applications, including facial identification using permanent special features, beauty analysis with permanent common features, facial diagnosis by disease changed features, and expression recognition through impulse changed features.

This book is based on our research, which describes the four types of typical features extracted from a face. Each type of feature and its corresponding application are given in detail, where every application begins with an overview to introduce its current development. Afterwards, some related features extracted from a face, including facial unique features for individual identity, statistical common features for beauty analysis, changed color features for facial diagnosis and changed geometry features for expression recognition are provided. Experimental results under different applications have shown the superiority of these facial multi-characteristics. The contents of this book will benefit researchers, professionals, graduate and post-graduate students working in the related facial research field, pattern recognition, biometrics, etc. This book will also be very useful for interdisciplinary research.

Our team has been working on facial multi-characteristics and its ap-

plications more than 10 years. We appreciate the related grant supports from the Science and Technology Development Fund (FDCT) of Macao SAR (124/2014/A3), the National Natural Science Foundation of China (NSFC) (61602540), the National Key Research and Development Program of China (61332011 and 2017YFB0802300), and the Hong Kong Polytechnic University. The authors would like to thank Dr. Zhaotian Zhang, Dr. Xiaoyun Xiong, and Dr. Ke Liu from NSFC for their consistent support to our research work.

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# Chapter 1 Introduction

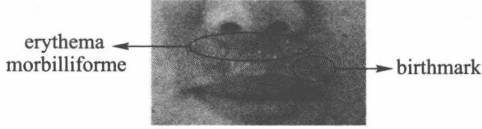
Faces with multi-characteristics have long been a source of interest to psychologists and other scientists in a wide range of disciplines. Many different types of important information are visible in faces. In this Chapter, two main features (e.g., permanent features and changed features) are defined, where permanent features can be separated into special (or unique) features for individuals and common features for some particular crowds. On the other hand, changed features are obtained by some disease or by some stimulus. In addition, each type of feature can be found from its corresponding application, including facial identification in permanent special features, beauty analysis in permanent common features, facial diagnosis by disease changed features, and expression recognition by stimulus changed features.

## 1.1 Why Faces with Multi-Characteristics

Human faces play an important role in our social life, from which we can extract many kinds of information, such as identity, gender, race, age, emotion, health, personality, and attractiveness. In recent years, thanks to the significantly improved performance of computers and digital cameras, computer-based facial image analysis has attracted extensive attention. The most investigated research topic is face recognition, which has been successfully applied in entrance control, homeland security, and computer security (Li and Jain, 2011; Kawulok et al., 2016). In addition, some other applications, like facial expression recognition (Simon, 2008; Faigin, 2008; Bhatia, 2012), facial beauty analysis and facial diagnosis (Kiviluoma, 2013; Zhang et al., 2016; Meneghini, 2005), have also attracted the attention of researchers from many different fields.

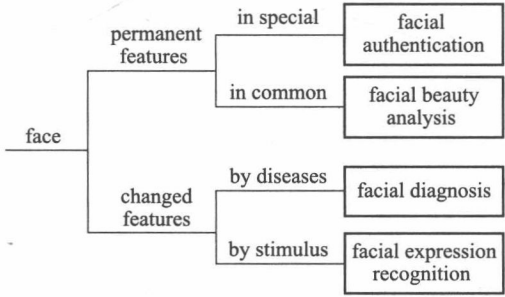
A human face is a complex object with varying features. What features can we extract from the face and what applications can these features provide? This chapter will answer these questions. In fact, we can find multi-characteristics from a face, which may be classified into two main types of features, e.g., permanent (or physiological) features and changed features

obtained by some outside influences during one’s lifetime. For example, a birthmark on the face can be taken as a permanent feature, while erythema morbilliforme on the face can be categorized as a changed feature (see Fig. 1.1).



**Fig. 1.1** (See Color) A typical example where a birthmark is a permanent feature and erythema morbilliforme is a changed feature.

Furthermore, the permanent features can also be separated as two types: special (or unique, such as a birthmark) for individuals and common for some particular crowds (like men/women group); and the changed features can be obtained by disease (such as erythema morbilliforme) or by some stimuli (e.g., a belly laugh if someone heard a funny joke). As a result, these different kinds of features can be applied for different applications, including facial identification for permanent special features, facial beauty analysis for permanent common features, facial diagnosis by disease changed features, and facial expression recognition by stimulus changed features. Based on these definitions, the guideline of this book is summarized in Fig. 1.2.



**Fig. 1.2** Book guideline of facial multi-characteristics and applications.

## 1.2 Facial Authentication Using Permanent Special Features

As one of the most successful applications of facial multi-characteristics, facial authentication has received significant attention. There are at least two reasons for this trend: the first is the wide range of commercial and law enforce-