Chapter 3
Gabor-DCT Features with Application to Face Recognition

Zhiming Liu and Chengjun Liu

Abstract. This chapter presents a Gabor-DCT Features (GDF) method on color facial parts for face recognition. The novelty of the GDF method is fourfold. First, four discriminative facial parts are used for dealing with image variations. Second, the Gabor filtered images of each facial part are grouped together based on adjacent scales and orientations to form a Multiple Scale and Multiple Orientation Gabor Image Representation (MSMO-GIR). Third, each MSMO-GIR first undergoes Discrete Cosine Transform (DCT) with frequency domain masking for dimensionality and redundancy reduction, and then is subject to discriminant analysis for extracting the Gabor-DCT features. Finally, at the decision level, the similarity scores derived from all the facial parts as well as from the Gabor filtered whole face image are fused together by means of the sum rule. Experiments on the Face Recognition Grand Challenge (FRGC) version 2 Experiment 4 and the CMU Multi-PIE database show the feasibility of the proposed GDF method.

3.1 Introduction

Face recognition is an active research area due to the complexity of the problem and the enormous applications in the commercial and government sectors [14], [30], [35], [24], [21], [20], [19], [28], [22]. The Face Recognition Grand Challenge (FRGC) program [28] reveals that faces in the uncontrolled environment with lower image resolution and larger illumination variations pose grand challenges to face recognition performance. Traditional holistic face recognition methods, such as the...
The Eigenfaces method [37] and the Fisherfaces method [11], have difficulties in tackling these grand challenge problems.

In this chapter, we propose a discriminative color facial parts based approach to address the grand challenge in face recognition. Due to their small size and local characteristics, these facial parts are more robust to image variations, such as in illumination, pose, and partial occlusions. In particular, our face recognition method applies four discriminative facial parts — the left eye component, the right eye component, the nose component, and the mouth component — together with the whole face image for deriving similarity scores for decision making by means of score fusion. To improve the discriminative capability, the $R$ component image in the $RGB$ color space is adopted for defining these facial parts. Note that the $R$ component image in the $RGB$ color space possesses more discriminating power than the component images in several other color spaces for face recognition [29].

We further propose a novel Gabor-DCT Features (GDF) method to process the discriminative color facial parts for improving face recognition performance. Fig. 3.1 shows the system architecture of the GDF method. Specifically, the $R$ component image of the whole face is first derived from the color face image, and is then filtered by a set of Gabor wavelet kernels. The Gabor filtered images corresponding to each facial part are then grouped together based on adjacent scales and orientations to form Multiple Scale and Multiple Orientation Gabor Image Representation (MSMO-GIR). Each MSMO-GIR further undergoes Discrete Cosine Transform (DCT) with frequency domain masking for dimensionality and redundancy reduction, and then is subject to discriminant analysis for extracting the Gabor-DCT features. Finally, at the decision level, the similarity scores derived from all the facial parts as well as from the Gabor filtered whole face image (the $R$ component image) are fused together by means of the sum rule for decision making.