

Chapter 4: Human Face Recognition

4.1 INTRODUCTION

In this chapter, we propose a system to identify the unknown person in a face image for which the position, scale and image-plane rotation of the face are unknown [44].

As shown in chapter 1, the previously reported face recognition systems are divided into the holistic approach and the analytic approach. The holistic approach [1-6] treats a face as 2D pattern of intensity variation. The analytic approach [1,7-9] recognizes a face using the geometrical measurements taken among facial features, such as eye and mouth.

If we can correctly detect facial features, the second approach is more robust to variations in lighting conditions than the first one. But, the correct detection of facial features is difficult when the lighting conditions are unknown. In addition, [1] compared the face recognition rates of the first and the second approaches by the experiments and reported that if facial expressions and lighting conditions were fixed, the first approach gave a higher face recognition rate than the second approach.

The holistic approach is divided into the template matching [1-3], the neural network-based approach [4] and the eigenspace method [5,6] as shown in chapter 1. But, the neural network-based approach can be applied only when the number of registered persons is small.

[5] stated that, the eigenspace method is robust to variations in facial expressions because it can use sample faces of different face expressions to construct the eigenspace. But, only when facial expressions slightly vary, the eigenspace method is robust to variations in facial expressions. In addition, if variations in facial expressions are not so large, the template matching can also cope with variations in facial expressions by using a face template which is not so influenced by facial expressions. For example, eye patterns are not so influenced by facial expressions. Thus, in this chapter, we propose a face recognition system based on the template matching. By using the iris detection algorithm shown in chapter 3, the system first detects the irises of the both eyes

and then normalizes the position, scale and image-plane rotation of the face in the image using the positions of the irises of both eyes.

After that, the algorithm measures the degree of match between the image and the face template of each person using the normalized cross-correlation value and determines a person with the highest degree of match to be the unknown person in the image.

Conventional face recognition systems use template matching [1] and eigenspace method [22] for the iris detection. But, the iris detection algorithm proposed in chapter 3 can detect the positions of the irises more exactly than these algorithms. Therefore, we can expect that the proposed face recognition system can make more correct face recognition than conventional systems.

We assume the followings about the input image:

- (1) The image is an intensity image.
- (2) The image is a head-shoulder image with plain background and the face in the image is a frontal face.
- (3) The size and the image-plane rotation of the face in the image are unknown although their lower bounds and upper bounds are given in advance.
- (4) The irises of both eyes appear in the image.

Below, we show the face recognition system proposed in this chapter.

4.2 IRIS LOCALIZATION-BASED HUMAN FACE RECOGNITION

4.2.1 Modeling stage

For each person, we prepare an intensity image of his frontal face and cut off two rectangular regions T and T_E such that the centers of T and T_E are the same and the height and width of T_E are larger by p than those of T . T and T_E are called the face template and the extended template of the person (see Fig.37). In the experiments, p was set to 10 pixels. We use the face template T as a model face for each person. The reason why we use the extended template for each person will be shown later.