

# Chapter 1: Introduction

## 1.1 HUMAN FACE RECOGNITION

The human face recognition has many applications such as personal identification, criminal investigation, security work and login authentication. Automatic recognition of human faces by computer has been approached in two ways: holistic and analytic. The holistic approach [1-6] treats a face as 2D pattern of intensity variation. The analytic approach [1,7-9] recognizes a face using geometrical measurements taken from facial features, such as eye and mouth.

We first illustrate face recognition systems using the first approach. Chellappa *et al.* [10] and Samal *et al.* [11] gave excellent surveys of face recognition research prior to 1995. But, the face recognition area has become very active since 1995.

Brunelli *et al.* [1] used template matching for face recognition. The algorithm prepares a set of four masks representing the eyes, nose, mouth and face for each registered person (see Fig.1). To identify the unknown person in the image, the algorithm first detects the eyes via template matching and then normalizes position, scale and rotation of the face in the image plane using the detected eye position. Next, for each person in the database, the algorithm places four masks on their positions relative to the eye position and computes the cross-correlation values between the four masks and the image. The unknown person in the image is classified as the person giving the greatest sum of the cross-correlation values to the four masks.

Beymer [2] proposed a template based system for recognizing faces for varying poses. The algorithm produces several 2D views for each registered person by varying the face rotation out of the image plane. In the face recognition phase, the algorithm finds a 2D view that has the best match to the image and classifies the unknown person in image as the person corresponding to this view.



**Fig.1** Four masks used in the template matching.

Doi *et al.* [3] proposed a face identification system for automatic lock control. The basic idea of this system is the same as that of [1]. However, Doi *et al.* proposed a new template matching method which was robust to lighting fluctuations.

Sato *et al.* [4] used a neural network approach instead of template matching. In this approach, output units correspond to registered persons and input units correspond to pixels of the input image. Sato *et al.* trained the neural network using three face templates for each person. In the face recognition phase, the neural network computes an output vector from each test image. The unknown person in the image is classified as the person corresponding to the output unit that has the maximum value of the output vector if the maximum value is greater than a threshold value.

Turk *et al.* [5] used the eigenspace method instead of template matching. This method constructs an eigenspace for each registered person using sample face images. In the face recognition phase, the test image is projected onto the eigenspace of all registered persons to compute the matching errors. The unknown person in the image is classified as the person corresponding to the eigenspace giving the smallest matching error. Kirby *et al.* [6] proposed a similar method. Turk *et al.* [5] reported that, the eigenspace method was relatively robust to variations in position, scale and pose of the face if the eigenspace of each person was constructed by using face images with different positions, scales and poses. But, if variations in position, scale and pose of the face are not so small, the method requires the normalization of the face. That is, the face has to be normalized to standard position, scale and pose.