Face Detection Using Template Face Mask

Serdar Yilmaz[1], Metin Salhmuhsn[2]
[1]Fatih University Electrical and Electronics Engineering
Buyukcekmece, Istanbul, Turkey
[2]Kahraman Maras Sutcu Imam University Electrical and Electronics Engineering
Kahramanmaras, Turkey
syilmaz@fatih.edu.tr, msalihmuhsin@ksu.edu.tr

ABSTRACT: *In today's world, the importance of biometric studies is increasing day by day. Biometric face recognition study is the most widely used method in the legal environment. Commonly, face images are used in all identification systems(IDs, driver's license, passport, etc.). In particular, to improve the social security of city life, automatic face detection and face recognition systems are needed. Many studies are published in this domain now. So we developed a template matching method and performed to obtain face image from entrance picture. Average face mask was obtained using hundreds of people' normalized face images. Face mask has been applied to entrance picture and the shortest distance part of the entrance picture has matched the face mask. When applying of the face mask to entrance picture, corner detection and difference matrix methods are performed together improving the achievement. In addition, entrance picture background, luminance conditions have the negative effect that has been tried to choose simple background entrance picture.*

We realized in our study that it could be base for further studies on face detection-face identification. In addition, the system could be developed further using the artificial intelligence (AI) methods.

Keywords: Biometric Identification, Face Recognition, Face Detection, Temple Face Mask

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1. Introduction

In today's world, due to the increasing importance of biometric identification security, face recognition has increased the importance of its place. Biometrics is a field in which humans are being recognized by their biological features [1]. Finger print, hand geometry, iris recognition, face recognition and DNA can count on the biometric features for human feature analysis.

Face recognition does not need any sophisticated system and on the other hand face image is used for all social identification and documents which are like driver's license, passport and ID [2]. The studies on face detection and face recognition (identification) show varieties such as face detection and identification from color image or face detection and identification from the motion pictures. Different kinds of method detection and identification of the face are carried out. Basically, face detection needs to an algorithm to find the face image from the entrance picture and after that algorithm can identify the face

image. Algorithms of the face detection and identification are based on the feature extraction. Feature extraction can be performed by template matching or geometric based method [3]. In our study we performed template matching method.

Because of the high dimensional shape and the noise effects such as hair, glasses, beard, skin color and lighting influence, face detection and recognition are known as a complicated process. In this study, face recognition and identification has been performed on the color images. Process becomes two subsystems. First system is that theface image detects from the entrance color image and second is face identification by using database. Based on the identification of the face image, Principal Component Analysis (template matching) technique was used [4].

Face detection is the most difficult problem among the image processing studies. Because of the orientation of the face and illumination effect can mention about these difficulties. Simple background entrance picture makes easier to detect and identify of the face image. First, entrance picture means of histogram equalized and second edge detection applied using multi-level filter. The resulting edge images, energy function were calculated. After all face image separated from the entrance picture [5].

In a study, color entrance picture is used for face detection from the FERET database. Luminance conditional distribution model is based on to detect skin pixel in color images. After the detection of skin pixel, morphological operation functions were applied to get face image. End of the getting face image, template matching algorithm applied to skin region rectangles. Decision for detected image; including face or not, eye pair candidate's method was applied to the image by using linear transformation [6].

Preferred in some fuzzy and neural network applications, template matching method is also applicable for various other studies. In one study, a template matching method approach was used to form objects recognition [7]. In another study, to detect eye images, template matching method was used in accordance with fuzzy methods and so that an image processing system based on template matching has been developed [8].

Template matching method required very long signal processing time because of the limitations of hardware capability of the computer in the past decades. With the increasing of the hardware capacity of the computers, template matching method became more popular for image processing method. Artificial intelligence has started to adapt template matching methods in recently. This is the noticeable that we studied template matching method for face detection with template face mask. In this study, we will discuss to obtain template face mask and to get the face image from the entrance picture in details. We acquired successful results using template mask in the template matching method.

2. Materials and Methods

In this study, Matlab program was used for all simulations. First; how face mask was obtained and implemented. Second; how achieved face image from the entrance picture with face mask. Third; how multiple face images detected from the entrance picture. During the all face detections, details of the process will be discussed.

2.1 Face Mask

Face mask was used to detect face image from the entrance picture. If we calculate shortest distance part of the entrance picture using the face mask, we can define this part as a face image.

Face mask was obtained from the CNNL database. CNNL face database consists of over 1200 individuals between ages of 15 to 60 years old person. Subjects come from different ethnic backgrounds. 733 are men and 467 are women from the total person of the database [9, 10]. CNNL database's face picture has 115 pixel row and 82 pixel column therefore face mask will be the same size.

Face mask generation is shown in Figure 1. Only five face images were used for mask creation.

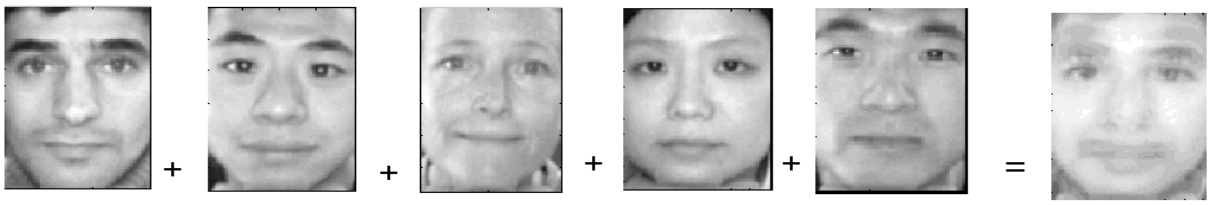

Figure 1. Example obtaining the face mask from five normalized image

The formula used to create the face mask is given in equation (1). *n* is the number of the face images used to obtain face mask. Collected facial image were normalized by dividing number of *n*.

$$\sum_{i=1}^{82}\sum_{j=1}^{115}\frac{[I_1]_{ij}+[I_2]_{ij}+\ldots+[I_n]_{ij}}{n}=[FM]_{ij} \quad (1)$$

I: Normalized face image

i: Column number

j: Row number

n: Normalized face image number (100 face image)

FM_{ij}: face mask ($i \times j$ matrix)

Face mask was applied to entrance picture and the shortest distance part of the entrance picture matched the face mask. Sizes of the face mask were decreased if face image is smaller than the face mask inside of the entrance picture. On the other hand sizes of the entrance picture were decreased if the face mask is smaller than the face image inside of the entrance picture. Because face mask and face image sizes should be close to each other as much as possible. As can be understood from Figure 1, there is no noise data because face mask existing from normalized face image and this it is increasing the performance to detect to face image.

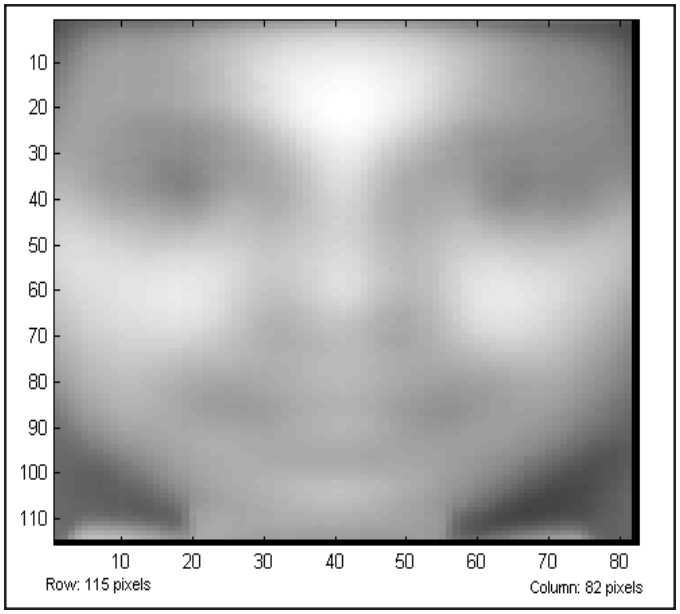

Figure 2. Face mask image calculated from hundred normalized face image

In Figure 2, face mask has been seen. Template face mask used 115x82 sizes. Face mask is created from the CNNL database using hundred normalized face image.

2.2 Face Image Detection

First, color entrance pictures were converted to gray level images. To achieve better performance a median filter was applied to gray level entrance picture. Thus, much softer gray level images were obtained.

Face mask and face image inside of the entrance picture sizes should be close to each other and this equalization is done by manually. Face mask was shifted inside of the entrance picture to find face image. Each movement of the face mask and its projection difference were recorded in a difference matrix (DM). This process was started from the left upper corner of the entrance picture and shifted to the right. Each time mask was moved to one pixel right, when mask came to the rightmost, face mask shift to the one pixel down with starting leftmost. All this movement, face mask and its difference projection was recorded in difference matrix (DM). The smallest projection parts of the entrance picture and face mask matched. Because shortest

distance image projections show the face image.

$$DM = \sum_{m-i}^{m} \sum_{n-j}^{n} | EP_{mn} - FM_{ij} | \quad (2)$$

DM: Difference matrix

EP_{mn}: Entrance picture ($m \times n$ matrix)

FM_{ij}: Face mask ($i \times j$ matrix)

In the formula (2), shows how we used to face mask detection to face image from the entrance picture.

3. Experimental Results

In Figure 3, face mask size was decreased 42% and its size was adjusted as 68×50 pixels. Matching of the face mask and entrance image shortest part (face mask and its projection) is shown in this figure.

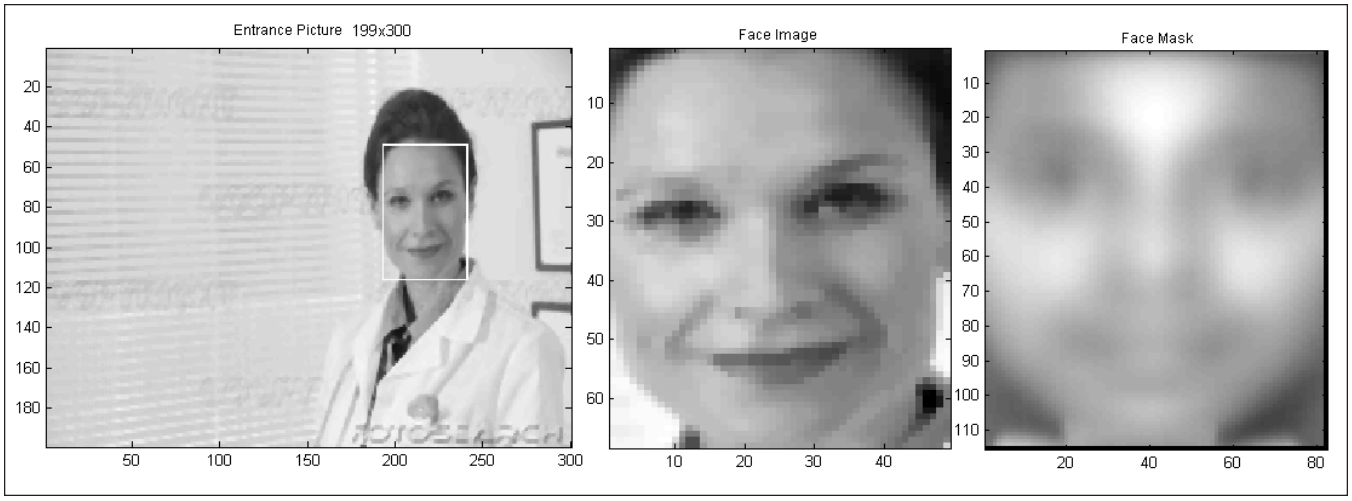

Figure 3. Entrance picture, face image and 42% reduced face mask

In Figure 4, face mask size was reduced to 42% like as the previous example. Similarly, a successful matching to the minimum distance projection parts to face image was obtained.

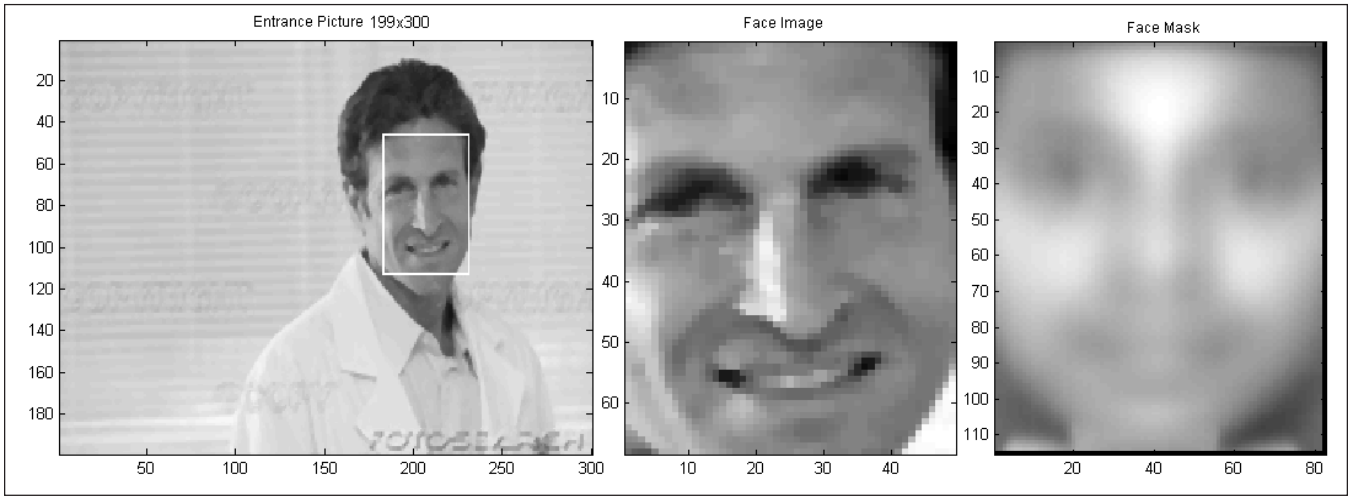

Figure 4. Entrance picture, face image and 42% reduced face mask

Figure 3 and Figure 4 entrance picture sizes were defined as same but different face detection studies were performed because of the difference face shape size between two pictures.

In Figure 5, the method was implemented to an entrance picture which includes black man face. Face mask size was reduced 40%. We have concluded that there is no performance loose for template matching method.

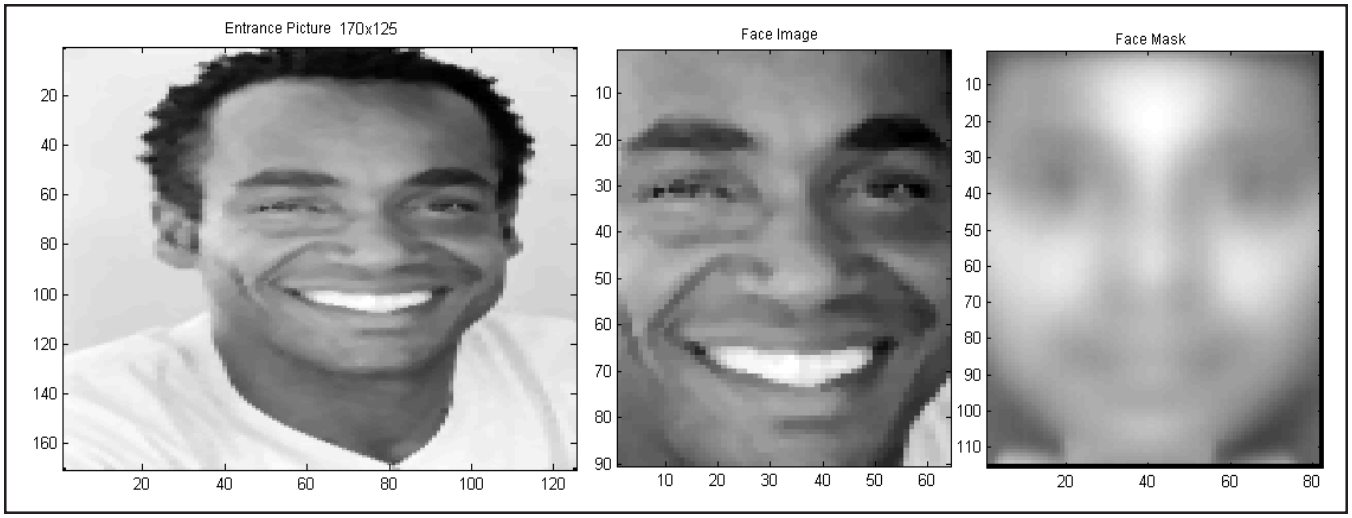

Figure 5. Entrance picture, face image and 40% reduced face mask

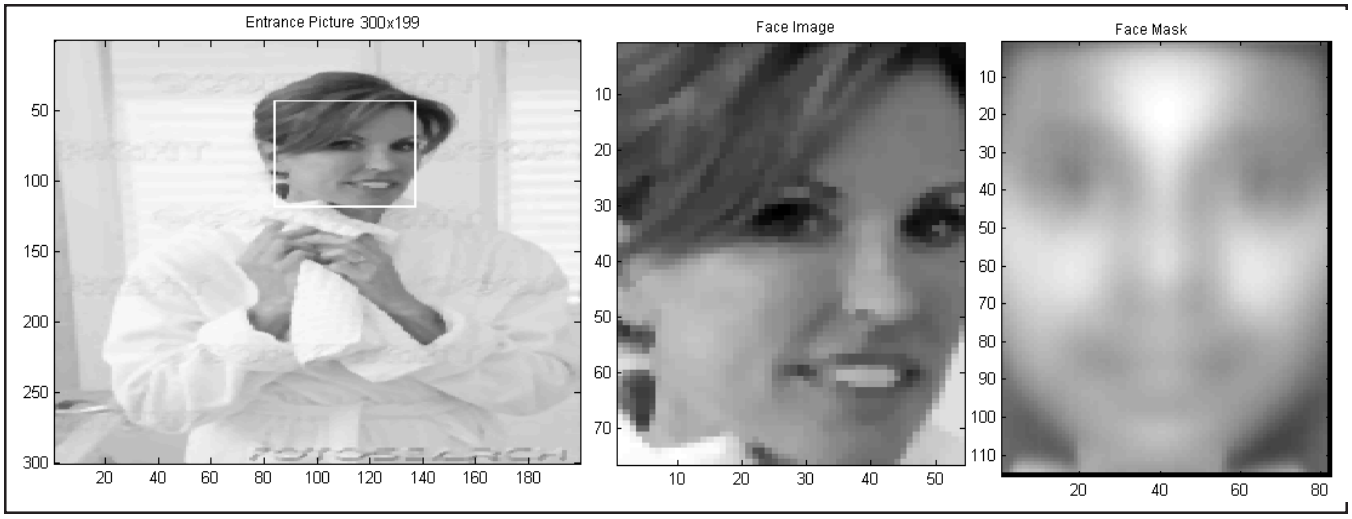

Figure 6. Entrance picture, face image and 35% reduced face mask

Figure 6 shows an entrance picture of a woman face. Template matching performance is successful even though woman face direction is different than the objective of the camera.

More than one face images inside of the entrance picture scenario also was considered in our study. For this purpose, Figure 7 was used as an entrance picture. To find more than one face image face mask was applied to the entrance picture again. After the first face image detection from the entrance image, first image projection was painted to the white thus second face image can be detectable. Detection of second image same process was repeated to detect third face image.

If face mask size and face image sizes are close to each other inside of the ±10% error, at that time matching performance is increasing.

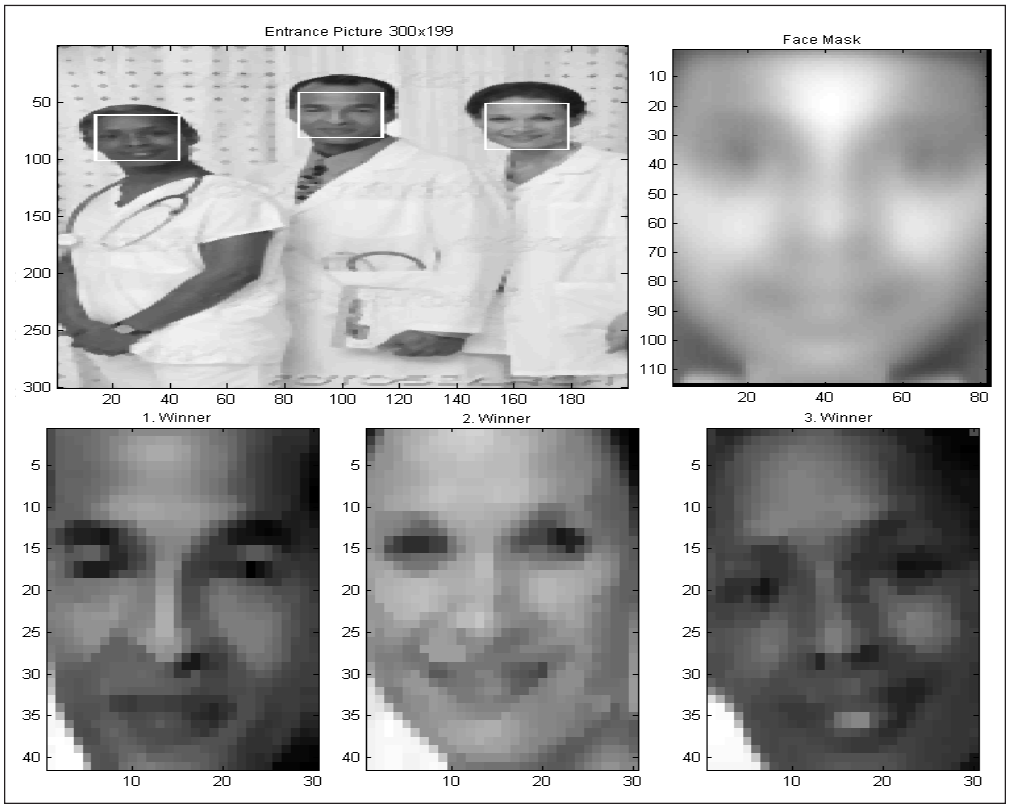

Figure 7. Entrance picture is including three human face, winner face image and 50% reduced face mask

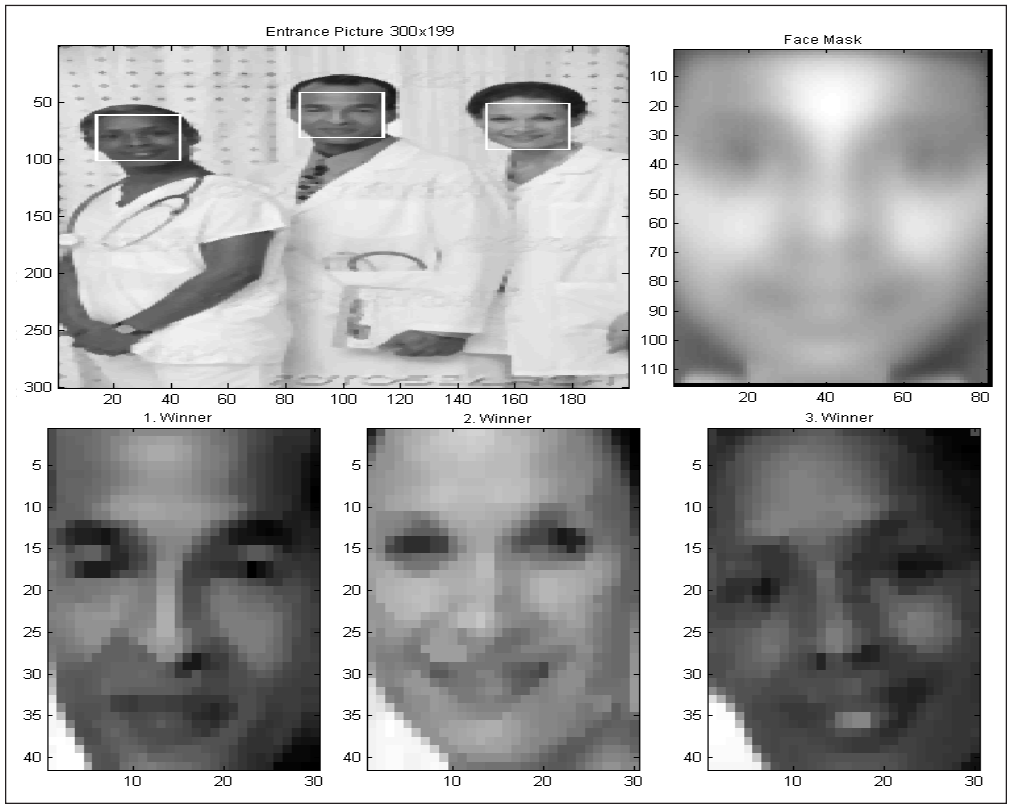

Figure 8. Entrance picture is including three human face, winner face image and 65% reduced face mask

50% reduced size face mask applied to the Figure 7 entrance picture. 65% reduced size face mask was applied to the entrance image in Figure 8. So detected faces away from the noise effect like ear, hair etc. When we compared detected face image Figure 7 and Figure 8, we found that they are not exactly same.

4. Discussions and Future Works

Using the template matching method, face shapes were detected from the entrance picture successfully. Image based face mask has been developed to obtain template face image. The template face mask can be evaluated as a simple and successful method to detect face from the entrance picture. Although light, contrast, complex background, skin color differences affects face mask method has worked successfully.

Template face mask and face image from the entrance image should be close to each other approximately 10% error. If face image size is greater than the face mask size or face mask size is greater than the face image size, out of 10% error, matching performance is decreasing.

As a result of this work, there could be improvement in pattern detection-recognition studies in future based on the template mask pattern. For future study, the size of the face mask should be set as automatically to find face from the entrance image. Additionally entrance image and face mask could be associated with artificial intelligence methods, so that the performance of the mask can be improved. Thus multiple face images searching to entrance picture could be processed using artificial intelligence methods.

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