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A passport recognition and face verification using enhanced fuzzy ART based RBF network and PCA algorithm

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ABSTRACT

In this paper, passport recognition and face verification methods which can automatically recognize passport codes and discriminate forgery passports to improve efficiency and systematic control of immigration management are proposed. Adjusting the slant is very important for recognition of characters and face verification since slanted passport images can bring various unwanted effects to the recognition of individual codes and faces. Therefore, after smearing the passport image, the longest extracted string of characters is selected. The angle adjustment can be conducted by using the slant of the straight and horizontal line that connects the center of thickness between left and right parts of the string. Extracting passport codes is done by Sobel operator, horizontal smearing, and 8-neighborhood contour tracking algorithm. The string of codes can be transformed into binary format by applying repeating binary method to the area of the extracted passport code strings. The proposed radial basis function (RBF) network is applied to the middle layer of RBF network by using the fuzzy logic connection operator and proposing the enhanced fuzzy adaptive resonance theory (ART) algorithm that dynamically controls the vigilance parameter. After several tests using a forged passport and the passport with slanted images, the proposed method was proven to be effective in recognizing passport codes and verifying facial images.

1. Introduction

Because of globalization and the improvement of transportation, the number of people that arrive from and depart to different countries from airports has increased. The clerk of immigration control currently uses his/her bare eye to verify the passport. The purpose of immigration control is to find forgery, criminal, illegal immigrants, or someone prohibited from departing the country. A passport has information about the owner's identification photograph, nationality, name, social security number, gender, passport number, and so on.

It is difficult to use only bare eyes to distinguish and control the immigration process [4]. Time will be delayed, and due to obscure and unsure methods, accurate search of people who should not be allowed in the country will not be possible. Therefore, this paper shows how to extract a string area of codes by applying Sobel operator, horizontal smearing, and 8-neighborhood contour tracking algorithm. The extracted string area becomes binary by applying a repeating binary method, which is applied with a conditional dilation morphology (CDM) mask in order to recover the characters of an individual code. A CDM mask is a conditionally expanding mask that disregards variables that are not qualified for the condition, and expands variables [2,6].

In order to extract individual codes from the string area to which CDM mask is applied, the individual code is extracted by 8-neighborhood contour tracking algorithm [9] and recognized by the enhanced fuzzy adaptive resonance theory (ART) based radial basis function (RBF) network. The picture area is extracted based on the center of the coordinate values of the string area of the code. By calculating the distance value between the feature vector of the facial image from the passport and the feature vector of the facial image from the database, it is possible to find out whether the passport is forged.

2. Passport code extraction and slant compensation

The image is placed on the left and the user information is placed on the right. The user information is represented in one code that is placed in the bottom of the passport. Therefore, this code must be extracted in order to recognize the user information. In this paper, real passports that are currently in use are used to extract code areas as shown in Fig. 1. The background area of the user's code information is colored white and the 44 characters stands in two rows.

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Fig. 1. Passport image.

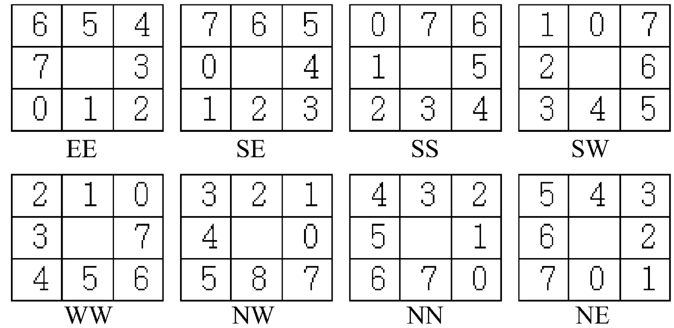

Fig. 2. The 8-neighborhood contour tracking process mask.

2.1. Extraction of code areas

The edge is detected by applying the Sobel mask to an original image of the passport, and horizontal smearing is applied to the image in which the Sobel mask has been applied. The method for extracting the string area of codes by applying the 8-neighborhood contour tracking algorithm to the horizontally smeared images is as follows.

P_i^r and P_i^c are the vertical and horizontal pixels of the string areas of the extracted code, P_i^{r+1} and P_i^{c+1} are the next progressing vertical and horizontal pixels, respectively. P_s^r and P_s^c are vertical and horizontal pixels of the first contour tracking mask, respectively.

Step 1. Initialize with Eq. (1) in order to apply 8-neighborhood contour tracking algorithm to the string code area, and find the pixel by applying progressing mask as shown in Fig. 2.

$$P_i^{r-1} = P_i^r, \quad P_i^{c-1} = P_i^c \tag{1}$$

Step 2. When a black pixel is found after applying the progressing mask in the current pixel, calculate the value of P_i^r and P_i^c as shown in Eq. (2):

$$P_i^r = \sum_{i=0}^{7} P_i^{r+1}, \quad P_i^c = \sum_{i=0}^{7} P_i^{c+1} \tag{2}$$

Step 3. For the eight progressing masks, apply Eq. (3) to decide the next progressing mask.

$$\text{If } P_i^r = P_i^{r+1} \text{ and } P_i^c = P_i^{c+1} \text{ then rotates counter-clockwise} \tag{3}$$

Step 4. Stop if P_i^r and P_i^c return back to P_s^r and P_s^c or go back to Step 1 and repeat. If $|P_i^r - P_s^r| \leqslant 1$ and $|P_i^c - P_s^c| \leqslant 1$ then break, else go back to Step 1.

2.2. Slant compensation of passport images

Since passport images can be tilted during the scan, "image slant compensation" is very important for face verification. If there is no slant during the extracting of strings of passport codes, extracting strings by selecting two areas that form maximum section by horizontal projection is possible. However, if slanting exists, this method is not useful. Skew compensation is applied by selecting the longer of two extracted strings, and then using the straight line that connects the center of the string's thickness of the left and right sides and the slant of the horizontal line of that string. The extraction of code area and the image tilt compensation of the proposed method are shown in Fig. 3.

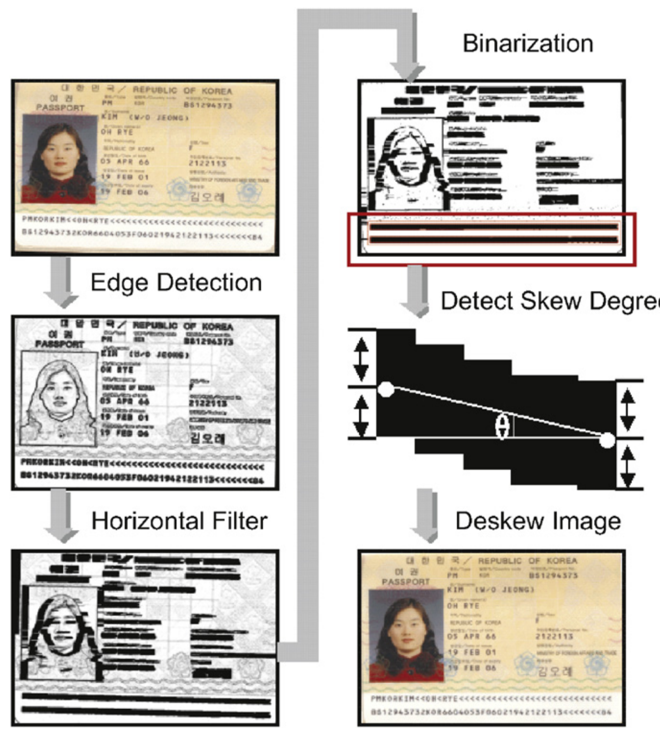

Fig. 3. Code character detection and skew compensation.

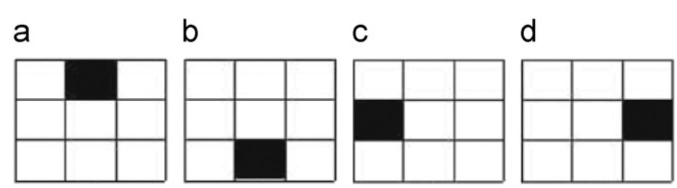

Fig. 4. CDM mask.

2.3. Image enhancement and extraction of individual codes

The CDM mask shown in Fig. 4 is used in order to transform the extracted string area to binary information, and to restore the characters of the individual code of the binarized string area.

The first step, Fig. 4(a), reconstructs bounding box's top horizontal outermost portion if the mask reach to character information into interior for horizontal direction by top-down method. The second step reconstructs left vertical elements by using a left-right method. The third step reconstructs horizontal elements of character from the bottom by using a bottom-up