Crosscheck of Passport Information for Personal Identification

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Abstract. This paper proposes a character region extraction method and picture separation used for passports by adopting a preprocessing phase for passport recognition system. Character regions required in recognition make black pixel and remainder of the passport regions make white pixel in the detected character spaces. This method uses MRZ sub-region in order to automatically decide the threshold value of the binary image and this value is applied to the other character regions. Tthis method also executes horizontal and vertical histogram projection in order to remove picture region of the binary image. After the region detection of the picture area, the image part of the passport is stored in the database for face images. The remainder of the passport is composed of characters. The extraction of the picture area shows 100% of extraction ratio and the extraction of the characters for the recognition shows 96% of extraction ratio on ten different passports. From the obtained information, crosscheck process of MRZ information and field information of passport is implemented.

1 Introduction

A person's identification number, used at airports is on an increase through globalization and development of transportation. With the increase in the number of user, the time consumed for the immigration control judgment has also increased. Immigration control judgment is used to manage immigration and immigration person searching forgery passport possessor, emigration and immigration forbidder, wanted criminal, and emigration and immigration ineligibility persons such as alien. A passport recognition system is required to make these immigration control judgment more efficient and precise. Most existing passport cognition system extracts and recognizes the MRZ (Machine Readable Zone) code and the picture of the passport [1, 2]. MRZ code refers to the recognition code that expresses the substance of the passport substance by 44 characters per each line for passport recognition. However,

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it is limited to distinguishing forged passport that recognize MRZ code. To recognize the MRZ code as well as the data, this paper proposes a method which extracts all characters to make binary image and correct picture region in passport image. If we can compare the data in passport with the MRZ code, we can improve the effectiveness of distinguishing forged passports.

Extent recognition system does not require special binarization method because it only recognizes MRZ code. However, binarization method that separates background and character in passport of color image is needed to recognize all data in passport. This paper proposes a binarization method which uses character RGB property and histogram of MRZ region. Extraction of picture region is proposed by a method which executes horizontal and vertical histogram projection and analyzes the result value to decide the top and left boundary as well as the height and width. Scanned image uses resolution of 200 dpi. After extraction of each character, a crosscheck of the traced characters is performed in order to compare corresponding information.

2 Information Extraction Process in Passport

The first process of extracting the information in passport makes the binary image of the interest region and must remove picture image among portion that is extracted in passport. After removing the picture image, we can extract the characters and the necessary information. The whole system for passport recognition is shown in Fig. 1. This paper deals with the character extraction and crosscheck routine without recognition process.

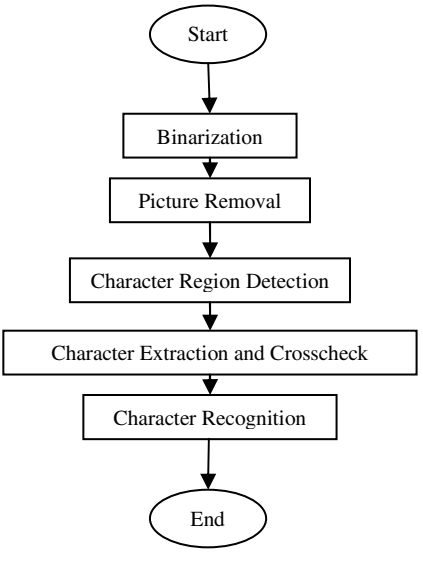

Fig. 1. Overall Process of Passport Recognition

3 Binarization of Passport Image

3.1 Binarization Phase

First of all, the RGB value of the character is analyzed for the whole image in order to make binary image. Making binary image is performed through two phases as shown in Figure 2 to establish a threshold value automatically.

Fig. 2. Two Phase of Binarization

3.2 Background Elimination Using Special Specificity of RGB

The R, G, and B value of character region has fewer than 200 in passport image and three values are considered of similar value similarity with black and white image. Also, the background of MRZ that is applied at the next phase has a value that is close to white. Each pixel is checked for value R, G and B and every pixel with a single value of more than 200 is judged as the background. The background of MRZ code region and extracted pixel is revised with white color of RGB (255, 255, 255) value.

3.3 Threshold Value Decision Using MRZ Region

Threshold value used for judging the character region must be decided to extract the character region in passing above the first phase. Threshold value decision that can judge character region used MRZ that exist in all passport of world. This paper decides threshold value searching for lower part line among MRZ code for two lines without using whole MRZ region and using that region. A method to set region is as following. The original image is shown in Fig. 3 and the result image in Fig. 4.

1. Run horizontal histogram projection according to Equation 1 from lower part of image
2. Decide i value that V[i] is greater than zero for the first time by start line and search again form i and decide j value that V[j] is equal to zero by end line.

$$V[i] = \sum_{j=0}^{width} f(j) \qquad \begin{cases} f(x) = 0 & if \quad color(x) = RGB(255,255,255) \\ f(x) = 1 & Otherwise \end{cases} \quad \text{(Eq.1)}$$

As ditto result, threshold value is established by R, G, B histogram calculation of each pixel except for the background region. If the threshold value is established to the maximum value, color pixel may still remain. Therefore, dwindle when accumulated value includes about 80% of whole pixel and is decided by threshold value. A threshold value, Rt, Gt and Bt, can be settle as 173. By last step, pixel that is RGB(Rt, Gt, Bt) in whole image is zero that express black pixel and remainder pixel is 1 that express white pixel. Fig. 5 shows the result of binary image of passport.

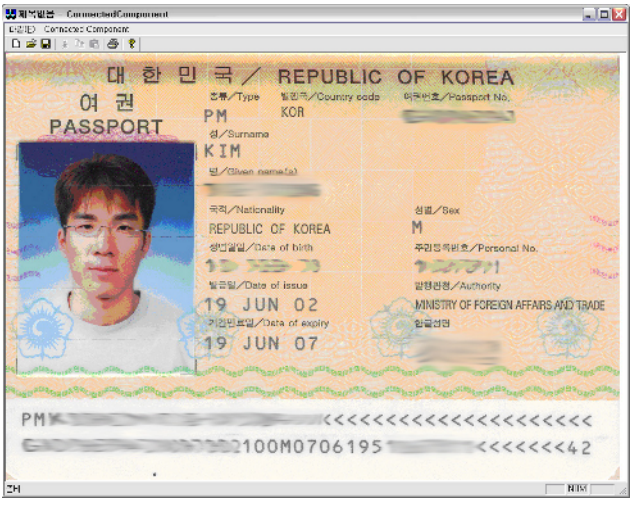

Fig. 3. Example of Passport Image

Fig. 4. Detected MRZ for Threshold Decision

4 Picture Removal of Binary Image

In Fig. 5, the result of binary image contains picture region and characters. Non-characters, such as picture region must be removed to extract the character region correctly. Several research results that separate character and non-character region are published [3-7]. In this paper, we use a method that uses the height and width of line after making word region using extension and reduction process of each connected components. The removal of the picture region is accomplished using the character

and non-character extraction algorithm [4]. A process that removes picture region is as follows:

1. Run horizontal histogram projection using Equation 1.
2. Decide upper boundary and height of picture using result value.
3. Run vertical histogram projection using Equation 1.
4. Decide left boundary and width of picture using result value.

4.1 Upper Boundary Detection of Picture Region

We trace a line that does not include black pixel using horizontal histogram projection result. Although fixed word space does not exist in passport, space exists in upper of

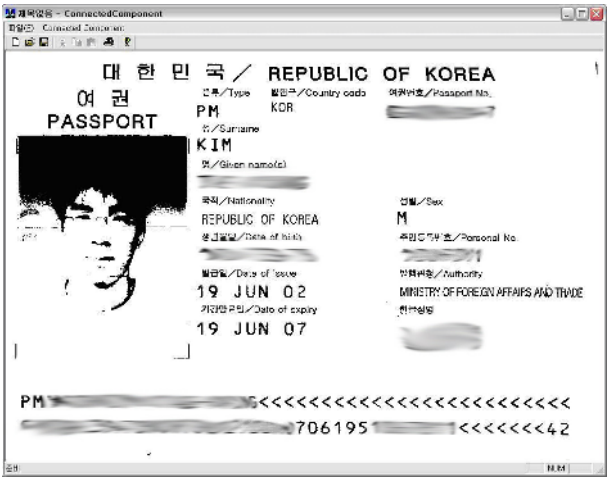

Fig. 5. Binary Image of Passport

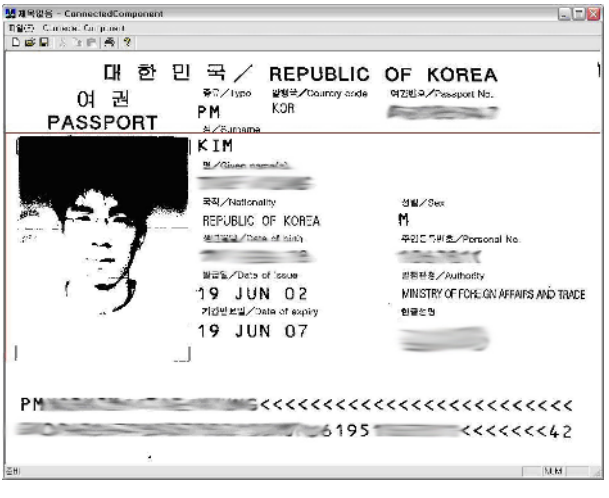

Fig. 6. Boundary of Picture Region

picture. Therefore, we have searched result V[i] value of projection result and find i that V[i] has zero. As can see in Fig. 5, part that V[i] has zero is three parts in upper direction of picture region. Part that can be decided by the upper boundary of picture region among these parts uses property that picture region is fixed in passport. It can be in position change according to scanned state, but picture region is keeping fixed height. Therefore, we can search for i that V[i] is zero in more than fixed height value h that is established by threshold value and decide that the i value is upper boundary. Fig. 6 shows the decided upper boundary.

4.2 Height Detection of Picture Region

If the upper boundary of picture region is decided, height of picture region can be decided from the upper boundary. First, we can deicide MRZ's upper boundary by the projection method. A picture region is located between two upper boundaries. Thus, picture region can be decided searching V[i] value for upside direction from MRZ and finding that V[i] value is non zero for the first time. Value that subtract i value from the upper boundary gets into height of picture region. Fig. 6 shows the decided height of picture region.

4.3 Left Boundary Detection of Picture Region

We can decide the left boundary using the result value of a vertical histogram projection. The left boundary can be decided searching V[i] value from left of passport image and finding that V[i] value is nonzero for the first time.

4.4 Width Detection of Picture Region

Decision of a width of picture region uses method to decide non-character region [4]. Since the upper/left boundary and height of picture region were decided before, we run vertical histogram projection within the region. Then, we examine result value

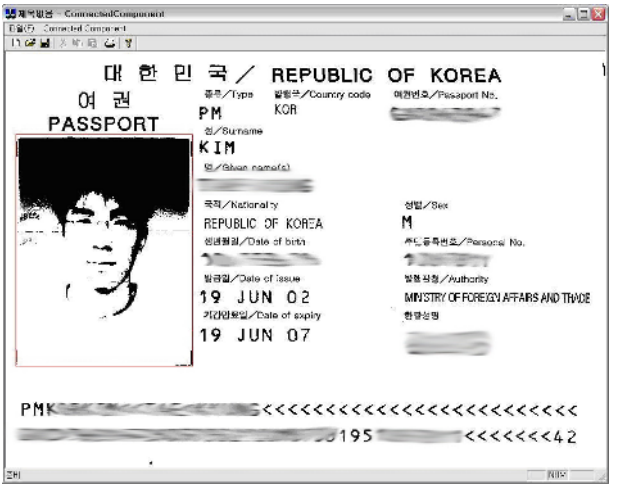

Fig. 7. Picture Region Detection

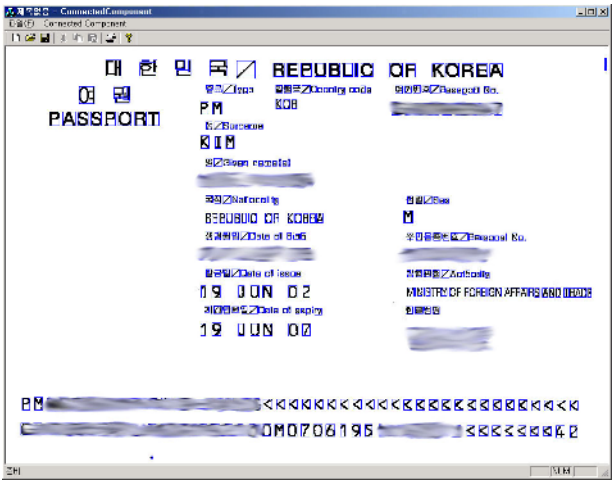

Fig. 8. Character Extraction of Passport Image

V[i] and calculate number that V[i] is non zero consecutively. And if V[i] is zero, we is fixed as in the case decide the upper boundary of picture. If i cost is smaller than w, we repeat same work from portion that next time V[i] is nonzero. The w is established 2/3 of general picture image width.

Fig. 7 shows the detected picture region and Fig. 8 shows picture removal of passport image and the connected component search result for character part extraction.

5 Passport Data Extraction

5.1 MRZ Data Extraction

The MRZ data can be obtained by the lower 2 lines of the passport images as shown in Fig. 8. The ICAO provides the rules of the generation of MRZ data [1]. If we generate the automata for MRZ analysis, we can obtain the MRZ data without any recognition because the field separator is defined by the alphabet <. The process of automata analysis is as follows:

1. Starting character of fist line is P (fixed size).
2. Second character is passport type (fixed size).
3. Next three characters define the issuing country (fixed size).
4. Variable name fields composed of first name and name divided by the separator. If the name field can not fulfill the whole field of first line, the other field is filled by separators.
5. The second line starts with the passport number field with variable size. This field 6. is finished by a check digit field.
6. Next is a nationality field with three characters (fixed size).
7. Six digit of date of birth field (YYMMDD). This field is finished by a check digit field.

8. One character for gender (M or F, fixed size).
9. Six characters of date of expiry (YYMMDD). This field is finished by a check digit field.
10. Variable personal information fields. If this field can not fulfill the whole field of second line, the other field is filled by separators except last two fields of check digits.

Passport automata for MRZ are shown in Fig. 9 and Fig. 10 illustrates the screen of extracted MRZ data.

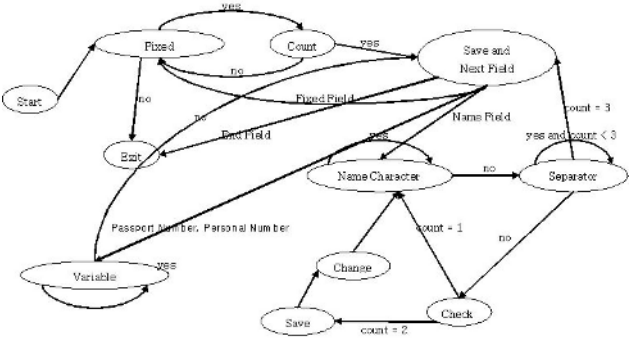

Fig. 9. Passport Automata

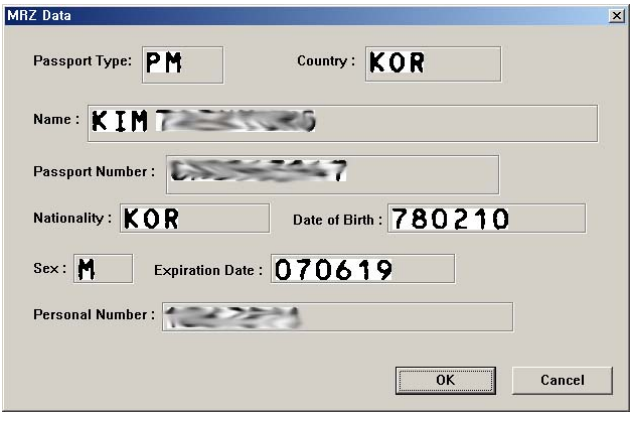

Fig. 10. Extracted MRZ Data

5.2 Information Extraction of Upper Part of Passport

The connected components of Fig. 8 contain the character information. If the character part is successfully detected, we can extract the information from the MRZ and detected character part. This character part has essentially same information of MRZ. Most of information is identical and some part is different form but contains same information such as month information. In reality, upper character part contains more information than MRZ. For example, month information in MRZ is two digit

numbers. The upper character part is represented by three characters. The table of comparison of each field is presented in Table 1.

Table 1. Comparison of Passport Fields

	Identical Field	Non-Identical Field
Passport Type	√	
Country	√	
Name	√	
Passport Number	√	
Nationality		√
Date of Birth		√
Sex	√	
Expiration Date		√
Personal Number	√	

The field of nationality has different number of characters. Thus, these fields are treated carefully. Fig. 11 shows the extraction of candidates characters for crosscheck.

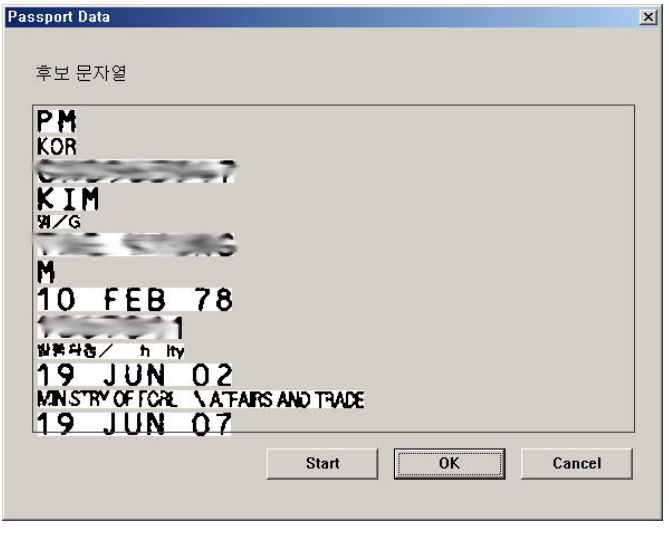

Fig. 11. Extraction of Character Part of Passport

6 Data Extraction Results

Character extraction experiment is performed with ten different passport images. Table 2 shows the extraction results of 10 different passport images of different countries. The database which we used seems small but the gathering of real passport

image is not easy way. Because of privacy problem, we must obtain the permission of use. The picture area detection and character part extraction results are shown in Table 2. The MRZ data extraction shows good results. But the extraction of character part shows moderate result. As shown in Fig. 11, the extracted characters are not either same size or same font. Thus, the character recognition for the extracted data is required for the precise comparison.

Table 2. Extraction Results of Passport Information

Picture Area Detection	Extraction of the characters	MRZ Data Extraction	Crosscheck/Field
10/10 (100%)	1370/1420 (96%)	852/880 (96%)	68/90 (75%)

7 Conclusions

This paper proposes a method to extract characters and picture in passport to implement passport recognition system. Most pre-process for passport recognition used way to extract MRZ code and picture region. However, this paper is using double extraction method for all character of passport as well as MRZ code. If passport recognition system is implemented by applying this method, precise recognition can be improved comparing MRZ code and data in passport. And extraction of picture region can be used to data for face recognition in hereafter. The research that extracts character in foreign passport as well as domestic passport is needed to implement automatic passport recognition system to after this subject. The extraction of the picture area shows 100% of correct separation ratio and the extraction of the characters for the recognition shows 96% of extraction ratio away ten different passports. Also, the method that can automatically compare passport data with MRZ code is also implemented for the crosscheck purpose. The crosscheck method shows moderate rate of comparison with MRZ and extracted character part. Thus, character recognition must be applied. After recognition, we may re-apply the comparison of crosscheck concept in order to verify the fraud of passport. For further study, a priori knowledge of the passport such as location information and the colour may use to improve the recognition.

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