Pattern recognition systems in the problems of automatic person identification using the passport data

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Abstract

The work describes the implementation of modern technology for remote sensing and data processing in the area of human activities concerned to the security provision, based on usage of pattern recognition algorithms and neural networks. The Republic of Kazakhstan State Identities and Passports were used as the basis; The ICAO 9303 MRZ Standard was used. Obtained stable recognition model for identification of known passport types, and MRZ section decoding.

Keywords: neural networks, pattern recognition, raster data, image processing

1 Introduction

Security systems, based on usage of modern hardware and software solutions have had a huge spread abroad as well as in our country. It is necessary to note the state program "Secured City" [1], which realized by establishing video cameras in large cities of RoK. Passengers registration systems in airports [2], based on face recognition algorithms. Multiple penetration of such systems in different areas of human activity shows the huge potential of researches and development in this knowledge area. And growing problems in the area of security systems, that the governments and corporate sectors face, necessitated further development of more effective method of problem solutions. Proposed model in this paper allowsto automate process of person registration by automatically recognizing it's passport data and extracting the meta information from passport using OCR methods based on neural networks.

Application of similar models was proposed by Young-Bin Kwon and Jeong-Hoon Kim [3]

2 Overview of the study area

The problem of automated passport recognition is solved under different tasks and business processes, where it is necessary to improve the work throughput of person identification process, like – migration processes in the border control area, the logging of visitors for the secured area and so on. Currently almost all countries have accepted ICAO 9303 standard of passport template, that should have the Machine Readable Zone(MRZ), to allow for automated recognition processes to be implemented. And this standards simplifies the algorithms creation of extracting the meta information from documents acquired by scanners on other optical sensors.

Under scope of this work the problems of automated national identities and passports of Republic of Kazakhstan recognition and extraction are surveyed. Currently there are 4 types of national ID presented in RoK, that have MRZ:

1 National ID Type A

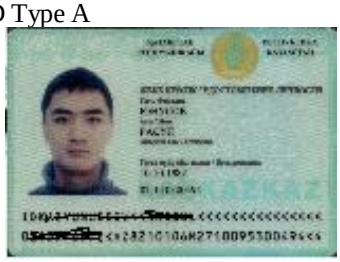

FIGURE 1 A type document

2 National ID Type B

FIGURE 2 B type document

3 National ID Type C

FIGURE 3 C type document

4 National Passport of the RoK citizen

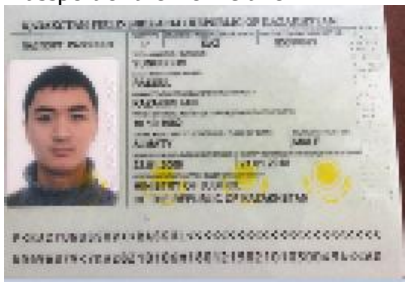

FIGURE 4 Passport

Depending of the document type the image can contain person face picture and MRZ, and also the type of the MRZ (3 lines or 2 lines, described by ICAO 9303).

Thus this work surveys next problems:

1. Identification of document type by analysis of image;
2. Determining the possible rotation angle of document against horizontal scanning plane and implementing the de-skew process;
3. Information extraction from the document – identification of human face and MRZ for further processing.

Under scope of problem the scanner Fujitsu 65fi (format A6) was used. The scanner area is bigger than the possible different passport sizes, and it imposes additional conditions of variable environment of scanned area, where the passport borders should be found.

Number of algorithms were used to solve the problem:

1. The borders extraction algorithm based on the gradient direction analysis [4];
2. Strict lines detection algorithm [5];
3. Template matching algorithm on the basis of matrices correlation [6];
4. Geometry topology comparison;
5. Face detection algorithm on the image [7];
6. MRZ recognition on the basis of neural network OCR system.

3 Adopting relevant technology

This paper surveys the problems of information extraction from images and the ways of improving the quality by the implementation of artificial neural networks.

Among the existing approaches for the OCR there are two base methods – the template matching and the invariant topology of character extraction. Current work uses the first approach due to the simplicity of implementation of ANN classifier for the one type of font used under the ICAO 9303 standard.

The image analysis for solving the problems surveyed under this paper consists of 5 stages, depicted on Figure 5.

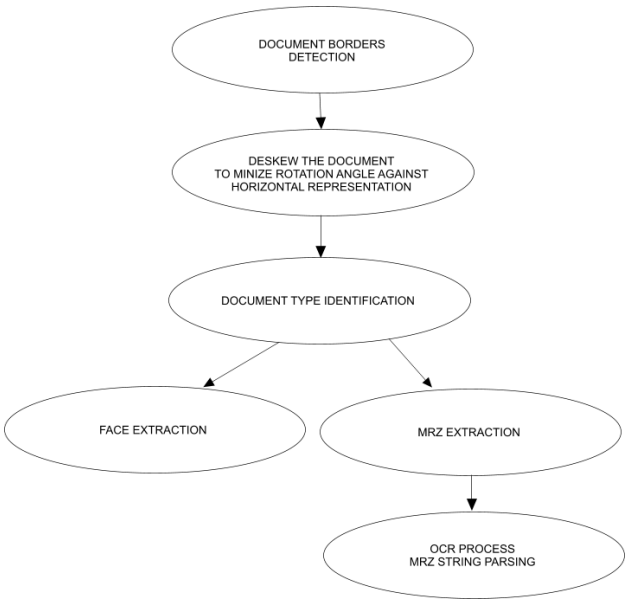

FIGURE 5 Passport recognition process

3.1 DOCUMENT BORDERS IDENTIFICATION

The document borders on the scanned image search problem is common, because there is a variance in sizes of different document types and also it is inevitable that human puts the document in the scanner with possible shifts and rotations. Also the task becomes more difficult when the scanning process can take with closed or opened flat, that leads to different environment on the image where it is necessary to detect the document.

For borders identification there were used algorithms of gradient change detection on the basis of Canny Edge detector [4].

The application of such algorithm and its different coefficients gives results, that are dependent on optical resolution of scanner that produces the image (300DPI is used under scope of work) and also the type of document template.

To reduce the number of not meaningful elements, that are obtained as a result of applying this algorithm, the image was resized and blurred in advance.

Obtained edges (also borders of documents) allow to step into the next stage of processing – searching of angle degree against the horizontal scanning plane and de skew the image to compensate the rotation till getting the zero degree offset.

3.2 DE SKEW THE DOCUMENT

The result obtained under previous stage can be processed for the line detection analysis of connected pixels. For this process we have used the Hough Line Transform algorithm [5]. And the lines, that we are looking at should be not shorter than the smallest document size divided by 2.

It is possible that we will get the lines, that do not represent the real borders of document. But such lines can be easily filtered by the statistics analysis because of their casual appearance.

In the scope of work, we have used the algorithm that takes into account the statistics of the lines, that should not exceed the deviation from the horizontal plane of 10 degrees.

After obtaining straight lines, that represents boundaries of the document it is possible to determine the slope relative to the horizontal plane, and compensate the tilt by rotating the entire scanned image by the inverse value. This procedure allows to solve several problems:

Preparation of the horizontal position of the text information;

1. Determine type of document template;
2. Extraction (if present) of a human face.

3.3 TEMPLATE MATCHING ALGORITHM FOR DOCUMENT TYPE DETERMINATION.

For all document types and for each side of the document we have selected the unique areas that are not repeated in position, size and textural features on other types of documents.

For each document has been selected for at least 5 characteristic features. Characteristic features have been saved as templates for future use of the search algorithm on the image [6].

The Threshold of correlation value for patterns was chosen sufficiently low valued by 60%, which allows the algorithm to work in different environments noise. But making the low threshold gives us the possibility of false positive occurrences. The To reduce the possibility of incorrect identification of the type of documents have been applied topological matching algorithms mutual arrangement patterns. Ie all distances and offset relative to each other templates. When no matching geometric topology found fragment is taken as a false positive and is excluded from the sample.

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3.4 FACE DETECTION ON THE DOCUMENT

If the document that is scanned under the Republic of Kazakhstan standard and we have determined it by template matching algorithm it becomes very easy to mark the area with the presence of photos of the human face. However, in this work we assume the use of passports, the form of which is not known (templates, which were not collected, such as a US passport). Then such a passport is treated as a standard ICAO 9303 template with two lines of rows in the MRZ. However, the position of the human face can vary depending on the issuer country of passport. To solve this problem we have used search algorithms of human faces [7]. This algorithm is invariant to the size of a human face depicted on image, because it uses a pyramidal descent for matching purposes.

3.5 MRZ EXTRACTION

To extract MRZ we solve the problem of selecting the proper threshold value for image binarization. The machine readable zone has the following characteristics - the symbols have significant pixel intensity values range from 0 to 100, and a background - a monotonic textured surface, white noise or some light pattern generally in the range of pixel intensity 120 and 255. As seen in the boundary between significant and insignificant pixels is not great. In this case, there are noises of different nature - worn, creased, partial lack of character, the presence of stains. Particularly in the case of document types A document radiographic phenomenon appears when the flat is opened, which increases the complexity of determining the threshold value for binarization. Thus, the combination of adaptive threshold and a linear threshold binarization algorithms have been applied [8].

3.5 MRZ PARSING

The figure 6 demonstrates the sample MRZ image obtained from the scanner. We can easily determine the little slope of the text direction. Such slope can persist even after second stage of de-skew process during the passport processing algorithm. The text direction slope is defined as the relative position of the leftmost character and the rightmost character in each line. The de skew method applied using affine transformation by rotating around the central axis of the entire document and repeating the whole algorithm from the first step.

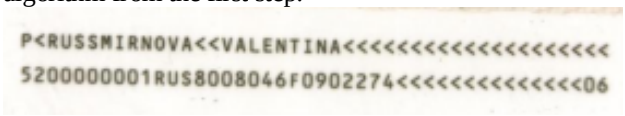

FIGURE 6 Machine readable zone

After rotation of the text and obtaining the desired effect we repeat the binarization process for characters selection. We take into consideration the noise and the false characters that can appear along the lines and out of the lines.

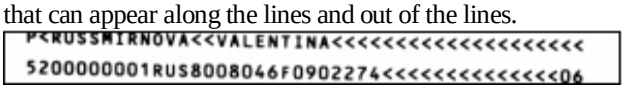

FIGURE 7 Binarized machine readable zone

We calculate the confidence number of recognition of each letter separately and then summarize total confidence of MRZ string recognition process.

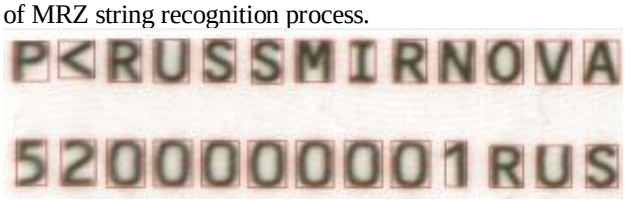

FIGURE 8 Bounding box of each symbol calculation

And on the final stage we calculate the control sums provided by ICAO 9303 of meaningful MRZ string elements, that can give us the information – if the recognition passed right or if the document has compliance to the ICAO 9303 standard.

4 Suggestions

Commercial application of OCR have been used since 1955. Among the solutions for automated recognition of text information we can note these main directions:

1. Adaptive OCR, that covers problems of recognition different languages ant text styles, recognition of mono text styles, document segmentation and mathematic models of text recognition [9].
2. Hand write text recognition system, which is still in active research and covers many problems of text direction, text position and style, recognition of hand write text, free writes text recognition systems and specialized devices for hand writing [10].
3. Image preprocessing [11], which covers problems of filters application for getting the clear input for classifiers.

4. Post processing intellectual systems [12], which covers problems of intensive input noises.
5. Text recognition systems in multimedia [13], which cover problems of text recognition on simple photo and have deal with edge and contour selecting, projective and non linear distortion.

It is important to note, that absolute validation in text recognition systems is still cannot be made without human correction. That is why the active researches still continue in this area.

5 Conclusions

In the scope of the work, there were solved such tasks as:

1. Redundant algorithms of face detection on images;
2. Redundant OCR algorithms using neural network;
3. Pattern matching algorithm using correlation computation;
4. Application of geometry topology check algorithm.

High quality rate of passport recognition and information extraction have been obtained under conditions of 300 DPI scan resolution and little values of passport rotation degree (less than 10 slope). The neural network (for OCR) was trained to recognize characters on only one image of each character without pan and tilt. This affects the quality of recognition and solving ambiguities in recognizing dissimilar characters in high noise environments. It is therefore critical to minimize the slope of the passport to the horizontal scan axis. The text recognition can be improved after first iteration and determination of text slope by analyzing the first letter and last letter in each line and their vertical offset. If the offset is greater than 0.1 degree we rotate whole image again to compensate this offset and repeat OCR process again which in all cases gives better confidence result than previous.

There are still opened questions of characters identification ambiguity using algorithms based on neural networks. The most striking example is the symbols "0" - "Zero" and "O" - «The letter of the alphabet". In most cases, the distance between the two presentations is extremely low and the percentage of occurrence of false-positive identification symbol becomes high enough. Therefore, more research is needed in the area of how to properly recognize the pattern of character depending on the context position, and researches in the construction of context dependent neural network.

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