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AUTOMATIC HANDWRITTEN BANK CHEQUE PROCESSING USING MACHINE VISION (LEARNING) IMPLEMENTATION

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ABSTRACT

Paper cheque is a traditional non cash payment tool so that any electronic payment and paper currency tool has not such advantageous and they are not appropriate for capital business transactions. In this research we use the database provided by author in order to recognize the date and courtesy amount. Exploiting the image processing as well as neural network, and combination of the support vector machines and neural network, we obtained the interesting results to recognize both character and text.

KEYWORDS: Paper cheque, image processing method, neural network, Support Vector Machine

INTRODUCTION

Paper cheques, transferred directly from sender to receiver so that the time and the target of payment is clear. The advantageous of the paper cheques is that any of the sender or receiver can include persons, financial institutes, interfaces, companies, countries, or any other organization. Paper cheques have the individual and significant role in business but as a result of non character recognition, their payment mechanism challenges are going to increase. So, there is a requirement to the new electronic payment includes the advantages and legitimate of paper cheques while the problems of manual payment does not exist.

Pattern recognition is one of the artificial intelligence branchs which deals with the segmentation and identification of observations. A perfect pattern recognition system is composed of a sensor that gathers the required observations in order to classification and identification. Also, it can extract the specifications that account the numerical or symbolic data from observations (these numerical data is shown with specification vector), and a classification rule or identification that responsible for classification or pattern identification based on the extracted features. The block diagram of the pattern recognition system is shown in Fig. 1.

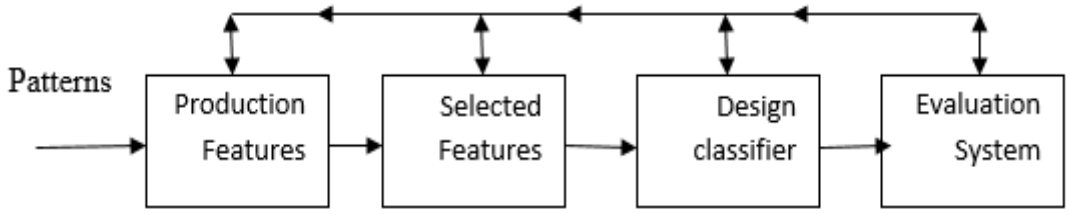

Fig. 1 The block diagram of the pattern recognition system

Pattern recognition has a practical role in most of area such as character recognition, author and signature authorization, finger print segmentation, and speech recognition. The industrial application of pattern recognition includes image investigation and machine printed objet recognition.

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other applications include tissue analysis, detection in reflected signals of radar or sonar, classification of earthquake waves, and identification of chemical particles. An OCR reads the scanned image, then configures its contents (including text, lines, images, tables, etc), finally converts it as an editable form.
Nowadays, most of scanner devices equipped with OCR software that enables them to recognize the text in the scanned document and saved it as a text file with the same format and font matched with original paper.
The third important part of the document is image. Rather than location recognition in the page, doing more analysis is the task of image processing and machine vision techniques. Image processing of the document can be classified in two types:

1- Text processing that deals with image components
2- Graphic processing that deals with symbols and non-character lines

After exploiting these graphic and character processing techniques, there is several megabytes of information to give a brief comprehension (Fig. 2).

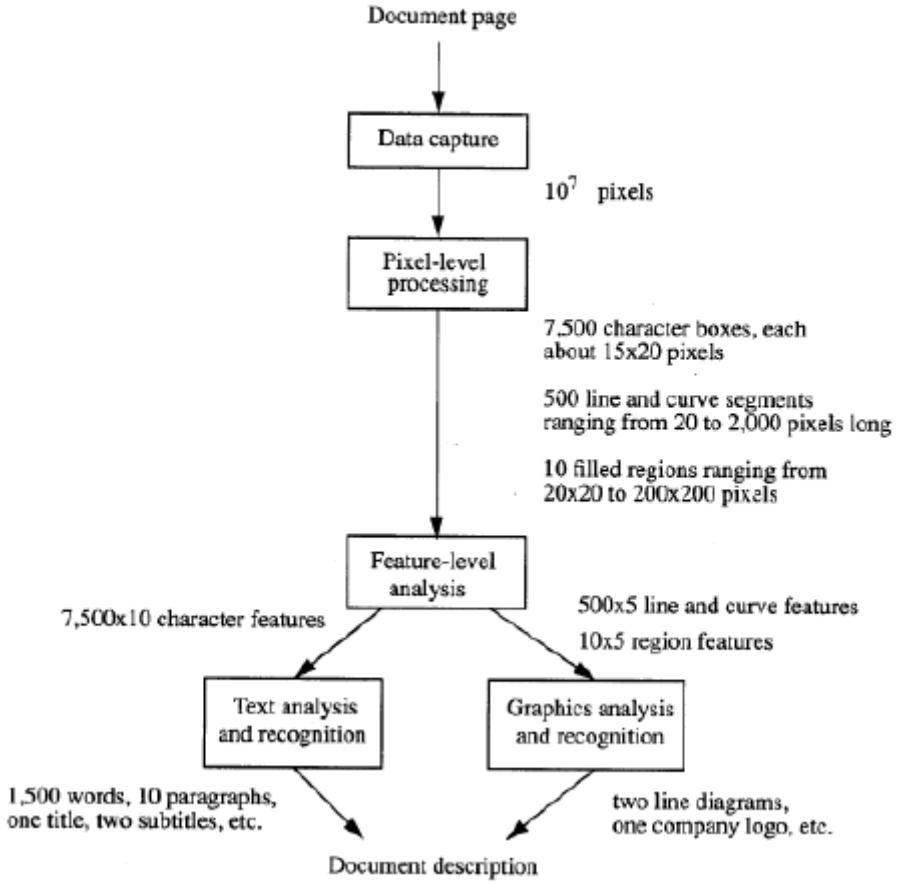


Fig. 2 Block diagram of recognition system

The Persian character recognition has a long term history. The first official reports of these efforts are came back to the first years A.D. in this paper, it is aimed to search the position of the cheques and recognize their contents using optical character and image recognition.

Designing the system to recognize the handwritten Persian cheques

Authors in (Sadri, et al., 2006), proposed the system to segmentation and recognition of handwritten Persian bank cheques. They have focused on the date and courtesy amount of the cheque in their system. In this study, we use a

database provided by author to configure the numbers and dates. This database includes 500 images that are prepared and verified by 200 men and 200 women.

In this step, image processing techniques are exploited to remove the colored background and to prepare the desired field of cheque to extract them. In the first step, the colored image of cheque can transfer to binary grayscale using Otsu method in (Otsu, 1975). The example of this transformation is illustrated in Fig. 3.

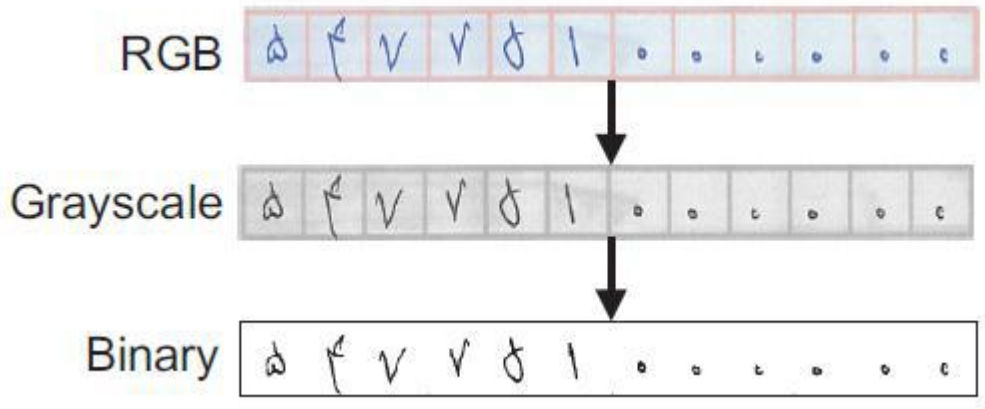


Fig. 3 the transformation of colored image to gray and black, white level

After binarization of cheque image, it is required to segment the digits individually. It has been feasible by the cheque structure and the space between the digits. It is shown in Fig. 4.

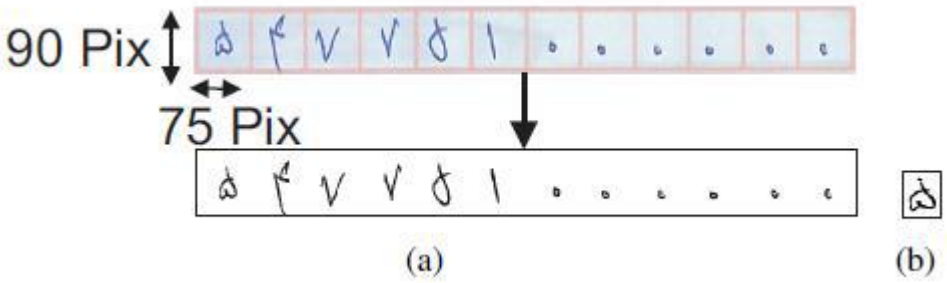


Fig. 4. Segmentation of digits

After segmentation, the noise has been removed by an algorithm and smoothing has been done. Then, using the slant correction algorithm in (Sadri et al., 2010) the slants of digits are modified.

At the following, the existing gaps in digits are filled through ARAN algorithm in (Cheriet, 2007; Ehsani and Babaee, 2006). and a normal image of digits is achieved. The results of these process are depicted in figures 5 and 6.

Fig. 5 Filling of segmented digits

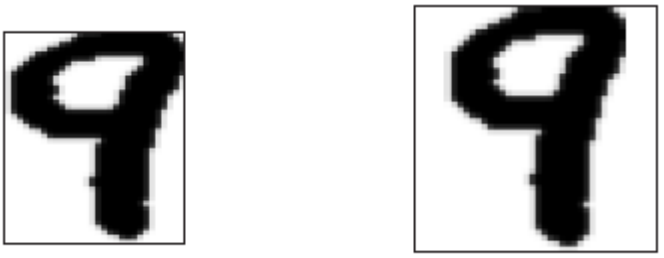


Fig. 6. normalization of isolated digits

Various type of feature extraction methods are used to extract the Persian handwritten digits which are investigated and compared in this research.

Feature extraction algorithms used in this paper are: Zoning, Chain codes, Outer profiles, and Crossing counts.

Then we use the nearest neighbor, Neural Networks, and Support Vector Machine methods to do the specifications and classifications of digits. The results are shown in tables 1,2,3 respectively.

Table. 1 The results of nearest neighbor on different feature

Classifier	K-Nearest Neighbour (K=3)	
Features	Chain code	Zoning
Isolated digits	%92.20	**%95.00**
Dates	%60.29	%71.46
Courtesy amounts	%48.96	%69.42
Check level	%34.71	%55.13

Table. 2 The results of neural network on different feature

Classifier	Neural Networks	
Features	Combination of (Chain code, Crossing counts)	Chain code
Isolated digits	**%96.50**	%94.70
Dates	%75.50	%62.33
Courtesy amounts	%73.40	%70.42
Check level	%60.20	%46.01

Table. 3 The results of Vector Machine methods on different feature

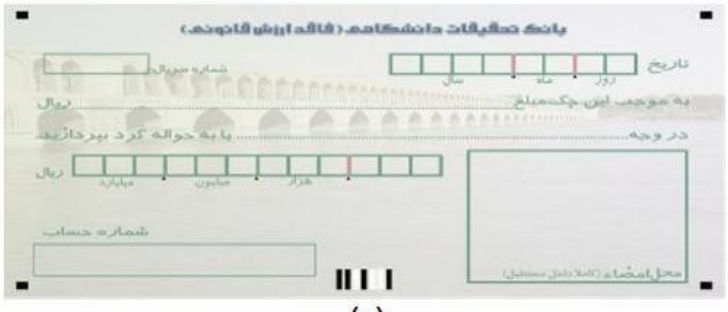
Classifier	Neural Networks	
Features	Combination of (Chain code, Crossing counts)	Chain code
Isolated digits	**%96.50**	%94.70
Dates	%75.50	%62.33
Courtesy amounts	%73.40	%70.42
Check level	%60.20	%46.01

Design of new structure to improve the automatic processing in bank cheques

In this section we first explain some challenges and issues on the current cheques in Iranian banks. There are as follows:

1- There are various colors in the background in current cheques that can not be isolated in the pre-processing mode. In binarization process this problem may create noise and lead to some errors in digit processing.
2- The cheque scanning and transferring them to digital image may involve a little slant. This is because there are not special directors to identify the angles. Modification of these slants is a critical step.
3- There are different financial institutes and as a results of them, various fields exist in the current cheques. So, automatic extraction of information and positioning the fields is impossible.
4- As a result of overlapping fields, the cheque owner fills it disorderly and this causes serious problem.
5- The date and courtesy amount are separated by " /" but it may write as "|" incorrectly. This leads to an error when reading the date or courtesy amount.

To overcome the mentioned problems, we propose a new structure in Fig. 7 that facilitates the image processing and increases the accuracy.



(a)

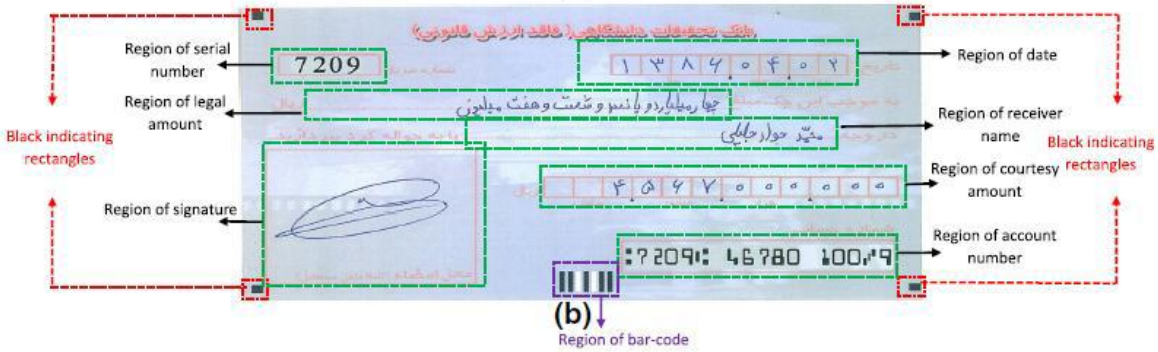


Fig. 7 the proposed structure

At the following we discuss about the specification of the proposed model.

1- Using the slight and smooth color in background in order to overcome the isolation problems in current cheques.
2- Using four filled rectangles to modify the slant of scanned image
3- Using barcode in order to add image information of cheque and processing
4- Using predefined areas to fill the cheque information that prevents the overlapping problem.

Recognizing the Persian handwritten digits using neural network

The authors in (Ehsani and Babaee, 2006). exploited the sub character classification using neural network to identify the handwritten digits.

The Persian handwritten is defined so that the authors write the characters connectively and right to left style. This style is on contrast of other languages which are written left to right separately. Fig. 8 shows some examples of Persian characters and their connectivity. Also, deformation of the character to its position is illustrated.

Isolating the characters in Persian alphabet is realized using sub character isolation algorithm. To this end, it is required to obtain the total handwritten area in order to isolate each character. Based on this algorithm, the pixels are scanned in four directions; left, right, top, and down. Then, black pixels are marked. After that, flood fill algorithm is used for connected pixels. It is possible to isolate the dots and other signs after isolating the sub characters.

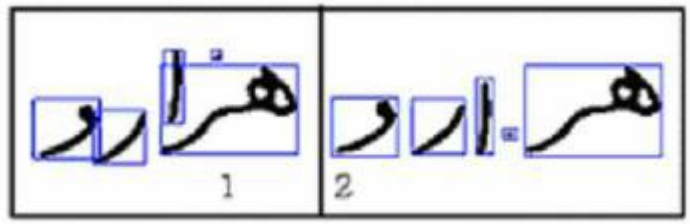


Fig. 9 sub character isolation by flood fill algorithm

Recognizing each sub character based on the extracted features is a critical step. In order to classification and identification of each sub character, we use the Perceptron neural network that is shown in Fig. 10.

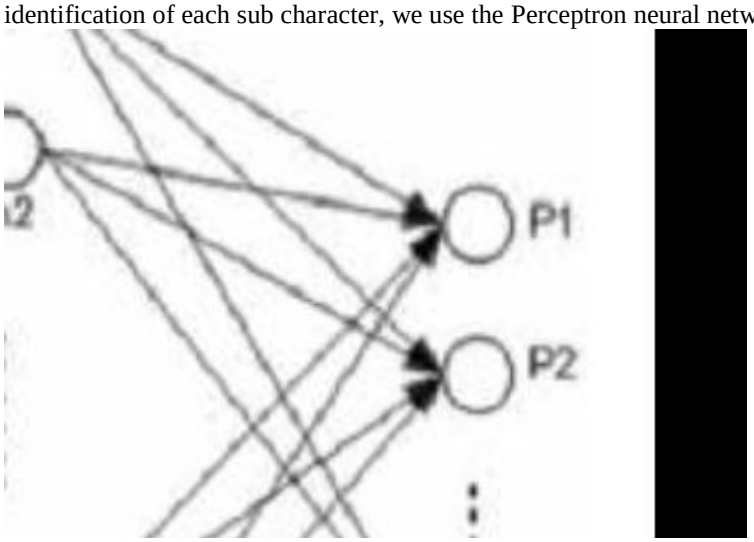


Fig. 10 structure of desired neural network

Research method

First of all, we provide the required data, that is Persian handwritten cheques. These cheques are belonged to various banks and the informative fields of them are filled by different persons. Then, they are converted to digital image by scanner. The colored images that are prepared in pre-processing step, transferred to the grayscale images and their

backgrounds are removed. In this way, the black and white image is achieved that contains only the main field of the cheque.

Since the information of every chaque is written in different positions, it is required to prepare a pattern for various bank cheques before data extraction. This is realized by multilayer pattern that are black and white background images and the fields are identified by gray rectangle.

Before that, the black and white image of bank cheques is obtained that is used as a pattern and the type of cheque. Then, using the likelihood index, the bank cheque is prepared. After preprocessing, the comparison has been done and the most similar one is selected as a bank cheque. Also the related fields are obtained using extracted pattern. Finally, the information of fields is extracted using neural network.

Elimination of colored background form the text

In the proposed method, the luminance of image in the colored space of YIQ is calculated as:

ILum= 0.299 R + 0.587 G + 0.114 B

In addition, we supposed that the background is more transparent than the text. Nevertheless, it is needed to calculate the negative image as :

ILum = 1 - ILum

To automatic check of above situation, the expected value of grayscale(μ) in luminance is used as follow:

$$\mu = \frac{1}{rc}\sum_{i=1}^{r}\sum_{j=1}^{c} I_{Lum}(i,j)$$

In this way, if μ<0.5 it is concluded that the background is darker than text and the negative image is calculated as equation (2). After pre-processing, the brightness of an image is corrected in such a way that its expected value be always greater than 0.5.

Five fuzzy system is used to correct the image brightness and CW coefficient is calculated. As a general rule, if the mean to be closer to 0.5, the CW coefficient would be closer to one. The mean of luminance is considered as an input of this expert system and based on Fig. 11 involves five Gaussian functions that are Almost Near, almost very near, far, median, and far. Also, the output of this system is CW coefficient (the weight of brightness correction). CW is a scalar between 1 and 2 and includes five Gaussian functions as Almost High, low, almost none, high. ‹Median

In the extraction step, the five conditional Fuzzy system is defined as follow:

If (μ is VeryNear) then (CW is High)
If (μ is AlmostNear) then (CW is AlmostHigh)
If (μ is Median) then (CW is Median)
If (μ is AlmostFar) then (CW is Low)
If (μ is Far) then (CW is AlmostNone)

Fig. 11 the fuzzy system of contrast correction

Fig. 12 the related functions of fuzzy system contrast adjustment

Here, phase extraction is done from database in mamdani method. Finally, the expert system uses the non- fuzzy of center to calculate the CW coefficient as an output parameter. Now the brightness of luminance image can be corrected using the CW coefficient.

$$\hat{I}_{Lum}(x,y) = CW.I_{Lum}(x,y)$$

The mean of corrected image is :

$$\mu_c = \frac{1}{rc}\sum_{i=1}^{r}\sum_{j=1}^{c} \hat{I}_{Lum}(i,j)$$

Noise cancelation

The first step in most of the image processing and machine learning algorithms is noise cancelation of image. This is because without this method, the outputs of these algorithms would not be desirable. Gaussian and uniform noise can be analytically investigated and suppressed. But point noise does not obey of any specific algorithm. There are many linear and non -linear filters to remove these kinds of noise that are investigated in [8]. The linear filters causes the

image to be non-transparent. Generally, the non-linear filters outperform the linear ones. One of the earliest non linear filters is mean filter that has good performance[9]. In this filter, all of image pixels are shifted to a specific neighbor and the details of image are removed that causes the reduction in resolution.

Persian digit recognition

There are 860 images for each digit that exist in internet database. After binarization and noise cancellation, all of them are normalized to 40*40 and are saved in to four dimensional matrix.

First of all, the analysis method of the main elements are applied to some parts of database. In this case we use 200 training samples for each digit. After choosing the number of 200 various images for each digit, that cover all of probable states, they are saved into a specific matrix and the analysis method is applied on this matrix. The feature vector is resulted from the eigenvectors of selective matrix. Subtracting each of training image from mean matrix and considering the eigenvectors matrix, their relevant feature is extracted. This feature is used as a training of neural network in a saved matrix. The desired neural network in this work is a 3 layer MLP neural network with backward error propagation and mean square error training method.

Persian character recognition

In most studies the hidden markov chain is used to Persian and Arabic character recognition. because there is not any requirement of segmentation, noise robustness, variations, and availability. Therefore, we used this method for Persian character recognition in cheques. The hidden markov chain is used for speech recognition problems. The variable window is set on the signal and is moved to extract the signal specifications. These features are used to train. In a similar way, we can use the variable window of hidden markov chain to recognize the text.

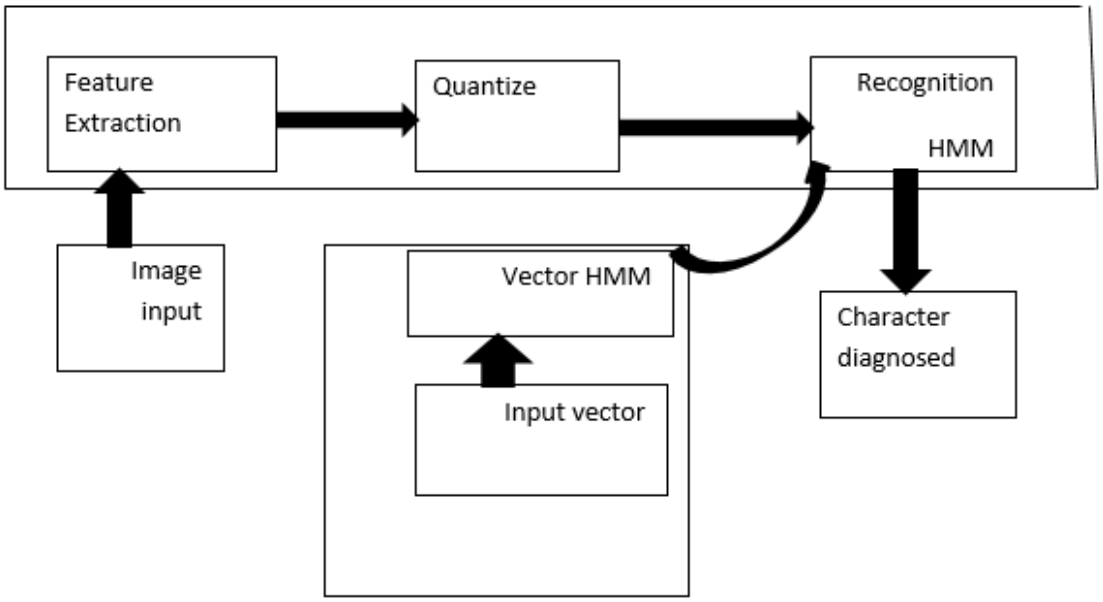


Fig. 11 the method based on HMM

some extra directions are used in this paper to write the character. First, the angle between any character point is calculated(Θ), then these angles are divided into 16 levels. Each character is shown by observation of directions.

Fig. 12 a set of directions of ح and ب character

in hidden markov model, the structure of model with N states and K observation symbol is shown. Then, the training set X is injected, and the optimized parameter is obtained.

$$P\left(X\middle|\hat{\Theta}\right) = \max_{\Theta} P(X|\Theta) = \max_{\Theta} \sum_{Q \in Q^N} P\left(X,Q\middle|\hat{\Theta}\right)$$

$$\Theta = \{\pi, A, B\}$$

The model can be trained using the following Matlab commands:
[ESTTR, ESTEMIT] = hmmtrain(seq,TRGUESS,EMITGUESS)

In fact we have an achieved parameters and a set $\Theta = \{\pi, A, B\}$ X. then, we are going to extract the probability of:

$$P(X|\Theta) = \sum_{all\ Q} P(X, Q|\Theta)$$

The following commands can recognize the model:
[PSTATES, logpseq] = hmmdecode(seq,TRANS,EMIS)
In order to measure the detection rate, a set of 32 characters for each sample is assumed.

The results of background cancellation

Fig. 12 results of background cancellation

Table. 4 results for matching values of cheque images and base images

Neural network		**classification**
combination of Chain Code and Crossing Counts	Chain Code	features
93.98 %	94.24 %	Separated digits
68.25 %	71.25 %	dates
54.21 %	67.14 %	Courtesy amount

neural network of MLP		**Recognition rate of each digit**
test	training	
95.21	99.66	0
96.14	98.41	1
97.01	99.21	2
95.20	97.54	3
96.52	98.05	4
97.01	97.41	5
97.16	97.65	6
97.63	98.58	7
98.60	98.54	8
98.42	99.25	9

Selecting the maximum likelihood, we can identify the cheque and it is possible to isolate the main informative parts of the cheque from the whole image of the cheque. This is implemented by a multilayer mask generated by grayscale.

Persian digit recognition of date and courtesy amount fields

Results of Persian character recognition using markov model

we use two methods to extract the features. The first one is freeman direction and the second is variable window that their results are explained individually. **Conclusion**

In this paper we proposed the new system to identify the type and informative field of the cheques. The colored image is converted to black and white cheque without background. Then, using likelihood test, we can determine the type of cheque and exploiting the multilevel masks prepared before, the images of informative fields are extracted. After this step, the cheque digits are recognized. These processes, have been done with high accuracy.

We investigated this method on the Persian handwritten cheque. The results were accurate and fast. Analyzing the content of the classified text and using the recovery algorithms, we can segment the classified images. In this way, the effective method for the fast and accurate search of various fields of handwritten cheque ,based on recovered and processed images, would be resulted. Also it is possible to search the characters and digits in Persian handwritten cheques. This method is based on the Persian cheque recognition that can be extended to other handwritten such as English. The advantages of the proposed method is that there is no need to predetermine the type of cheque. Because, the type of

a cheque is recognized automatically and the fields are extracted using the mask. for any new chaequ it is only required to obtain the cheque pattern. The system can recognize the position of fields and extract the cheque information. However, the final results are highly depended on the cheque type recognition and the position of informative fields. So, it may be a metric error while evaluating the similarity of a cheque image and a base image. These results to disturb the whole process. Therefore, it is recommended that to use the appropriate method. this can be realized using the background patterns , neural network classification, image clustering, and image recovery. Using the methods that can accurately extract higher data are preferable. Generally, it is beneficial to use multiple methods to extract the features and apply the best classification method.

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