Iraqi Car License Plate Recognition Using OCR

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Abstract— **License plate recognition (LPR) system is an important system in our life. LPR is an image processing and a character recognition system that used to recognize any car from the others. An automatic license plate recognition system for Iraqi car license plates is proposed in this paper. An optical character recognition (OCR) is used with correlation approach and templates matching for plate recognition in this system. The software used is MATLAB R2014a. The algorithm is successfully constructed with sample of images correctly identified.**

Keywords— license plate recognition, optical character recognition, image processing, correlation, Otsu's thresholding, tophat filtering.

I. INTRODUCTION

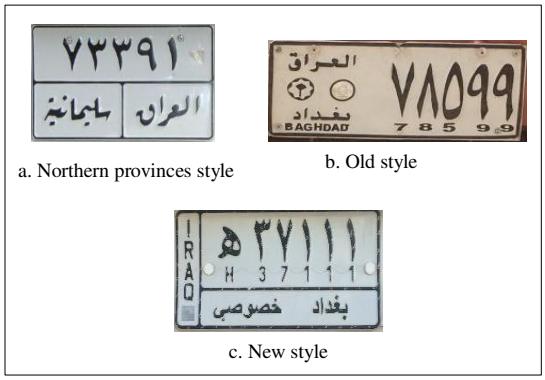
A License Plate (LP) is a rectangular metal plate contains numbers, characters and words, fixed on the car body and is used to identify the vehicles. In recent years, the importance of recognizing LP characters and numerals in an automatic manner has largely increased [1]. This research aims to recognize the numerals and characters, extracted from Iraqi LPs, into a text.

The recognition of license plates is very important in many applications such as Parking, Borders control, Detect and monitor traffic, Travel and Airport parking [2].

In many countries the license plates that written in English language as samples shown in Fig.1, the English letters is separated and the LP have a similar design for all cities in the country, so that will facilitate the recognition process of the characters. Because the LP is different and specific for each country, so the algorithms used for LPR system is different and specific too.

Fig. 1. Samples of some English license plates

In Iraq, there are 3 styles for Iraqi car license plates written in Arabic language [1] [3], The first style is for the three Northern provinces (Erbil, Sulymania and Duhok) as shown in Fig.2a the second style is the old style (before 2003) as shown in Fig.2b, and the third style is the new style which is shown in Fig.2c. The second and third styles are used for the other fifteen provinces and each has a different size and design.



a. Northern provinces style
b. Old style
c. New style

Fig. 2. Iraqi car license plate types

This research mainly consists of the following parts:

1) Location plate part or license plate detection (LPD): Is the first part of the system where locating the license plate from the car image.
2) Distinguishing between the three styles of Iraqi LP: in this part the differentiation between the three styles of Iraqi license plates is take place.
3) Pre-processing part: Thresholding using Otsu's method and morphological operations to enhance LP image.
4) License plate character segmentation (LPCS): Segment each number, character and word into sub images.
5) OCR part: Optical character recognition method for numbers, characters and words recognition.

Ng Simin [4] proposed Automatic car plate detection and recognition system for Malaysian car number plates, the algorithm constructed is to target field programmable gate

array FPGA as its end product. M.Gunasekaran [5] proposed OCR recognition system using feed forward and back propagation neural network. Guangmin Sun [6] proposed a new recognition method of vehicle license plate based on genetic neural network. Osslan Osiris Vergara Villegas [7] proposed License plate recognition using a novel fuzzy multilayer neural network. Pritesh Kanani [8] proposed Vehicle license plate localization using wavelets. Rachana Chahar [9] proposed an Automatic license plate reorganization system based on image processing using Lab VIEW. Eyad [10] proposed an Iraqi cars license plate detection and recognition using edge detection and templates matching correlation for the third style of LP (new style), the proposed system in this paper is designed to distinguish between the three styles of the Iraqi LP.

This paper is organized as follows: The algorithm used to implement the LPR system is described in section II and Experimental results are described in section III. Finally, Conclusion is summarized in Section IV.

II. LPR SYSTEM ALGORITHM

The main stages of the proposed system shown in Fig.3, these stages are:

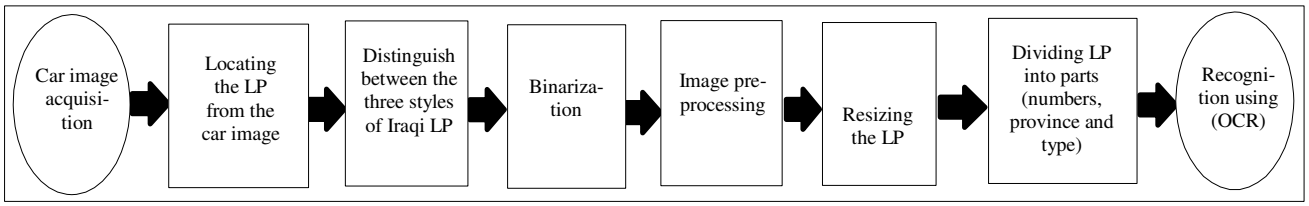


Fig. 3. The main stages of the LPR system

A. *Car image acquisition*

This is the first and the primary stage in LPR, the aim of it is to capture the front or the back side of the car where the license plate usually placed then applies the captured image to the next stage of the system. In this system the front side of the car is chosen and the database images are collected from many places like my college, parks and streets as shown in Fig.4.

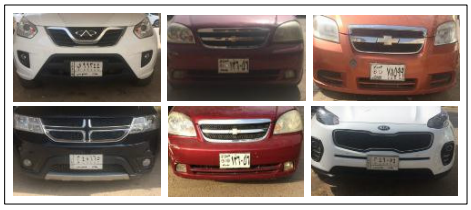


Fig.4 Captured images

B. *Locating the LP from the car image*

After the picture is captured the system works to locate the LP from the car image. In this stage the first step is cutting and resizing the original image as shown in Fig.5b, Then Image processing performed to focus the area of number plate [11], Smooth edges and contours to delete characters as shown in Fig.5c, Subtracting the original image to obtain the information previously deleted using tophat filtering and thus stays with the characters as shown in Fig.5d. Then removing the related elements with less than 70 pixels, Remove objects that are not candidates for plate and select the largest connected component after preprocessing as shown in Fig.5e, then cutting the plate from the original image as shown in Fig.5f.

C. *Distinguish between the three styles of Iraqi LP*

After the plate position was located, in this step the distinguishing between the three styles of the LP is taken place. The basic step used in discrimination between the three styles of the Iraqi LP is from the size of the plate. The flowchart in Fig. 6 describes how to detect the size of the plate to discriminate between the three styles.

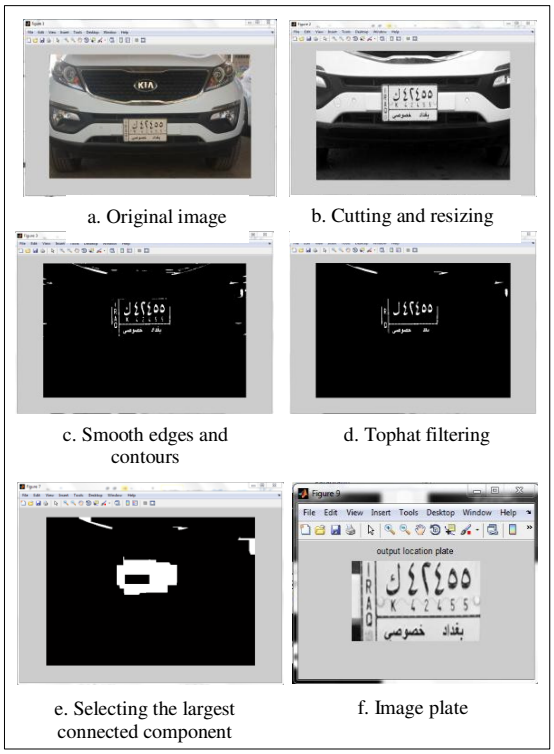


Fig. 5. Locating the LP

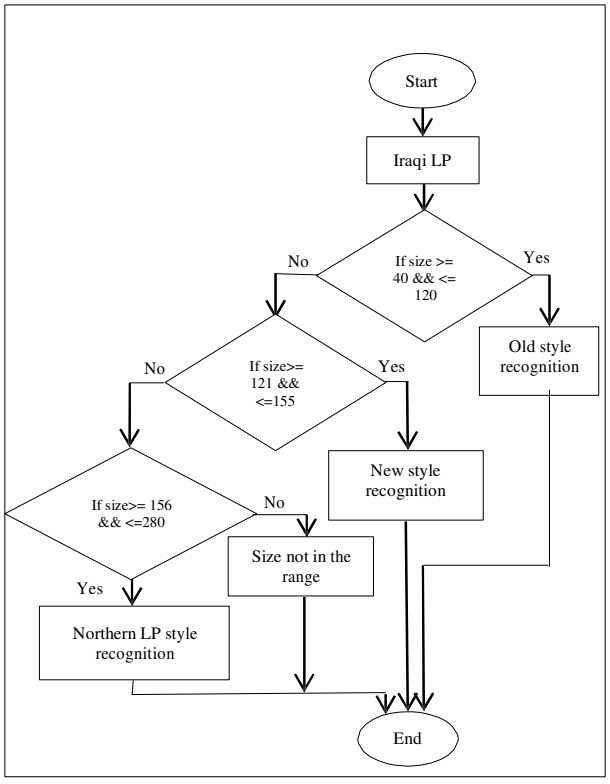


Fig. 6. Flowchart for distinguish between the three styles of Iraqi LP

If any of the three styles of LP was found, the process of the recognition will follow the process shown in Fig.7 with some differences explained later in each stage.

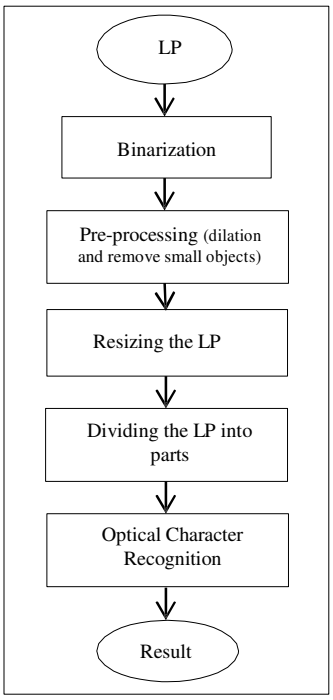


Fig. 7. Preparing and Recognition the LP

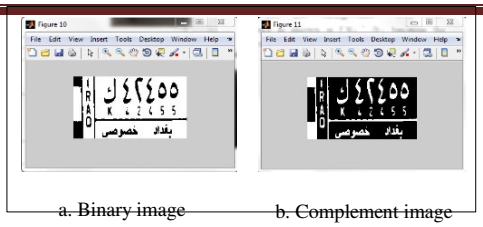
D. *Binarization*

After distinguishing between the three styles of the license plates now is the time of converting the gray image (gray LP image from the locating LP stage) to a binary image as shown in Fig.8a and this is done by using Otsu's thresholding [12], it is used to automatically perform clustering based image thresholding, or the reduction of a gray level image to a binary image. The algorithm of this method calculates the optimum threshold separating the two classes (foreground and background).

The pseudo-code can be translated in MATLAB such as using the two following instructions:

```
level = graythresh(I)  %find the optimum threshold for the image.
BW= im2bw (I , level); %convert image to binary based on level.
```

Afterwards, complement of binary image takes place as shown in Fig.8b, because the background of the image is white and the foreground is black and the required is opposite to perform the recognition correctly.

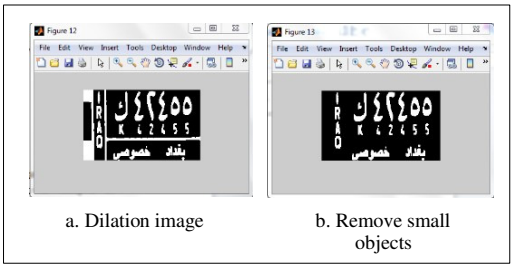


a. Binary image b. Complement image

Fig. 8. Binarization

E. *Image Preprocessing*

Image preprocessing stage is necessary to prepare the image for recognition; first using mathematical morphological (image dilation), the algorithm expands or thickens foreground objects in an image as shown in Fig.9a. Then the lines and the small objects less than 50 pixels where removed to make the LP clearer for dividing stage for correctly recognition which is shown in Fig.9b.



a. Dilation image b. Remove small objects

Fig. 9. Image pre-processing

F. *Resizing The LP*

In this stage the resizing of the license plate image into a constant size for every input image to the system to make a correct dividing in the next stage.

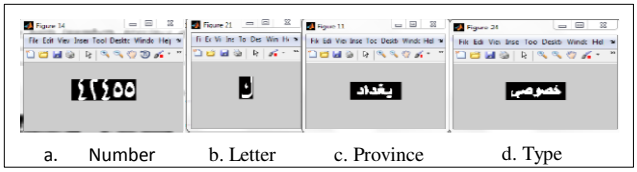
The pseudo-code can be translated in MATLAB such as the following instruction:

```
B = imresize (A, scale) % resize an image.
```

G. *Dividing LP into Parts (Numbers, Province and Type)*

Now the time of partitioning the LP image into parts, there is a difference in this stage for the three styles:

- Number and province parts for the two styles (Northern Province style and old style).
- Number, province, type and letter parts for new style as shown in Fig. 10.



a. Number b. Letter c. Province d. Type

Fig. 10. Dividing the LP

H. *Recognition Using OCR*

OCR is the process of converting an image into a computer editable text. The text and numbers in an image is not editable, the letters, characters and numbers are made of tiny dots (pixels) that together form a picture of text and numbers. OCR is classified into two types, offline recognition and online recognition. In offline recognition the source is either an image or a scanned form of the document whereas in online recognition the successive points are represented as a function of time and the order of strokes are also available. Here in this paper only offline recognition is used [4][13].

In this stage, first the numbers are segmented (each number into sub-image) by using labeling connected components [9] as shown in Fig.11. Each number, letter, province and type should be resized to the size of the preloaded templates.

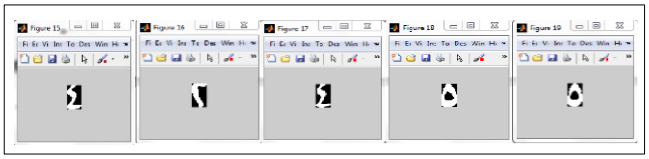


Fig. 11. labeling the numbers

Images of numbers from 0 to 9, Iraq provinces, letters and types of cars in Iraqi LP all these variables are stored in the form of cell in which each matrix represents a character, all the model inputs are saved under the name 'TEMPLATES' . The separated images of numbers, letters, provinces and type are correlated with templates (each part with its saved templates) which are reloaded into the system. Once the correlation is completed, the template with the maximum correlated value is declared as the character present in the image and prints it into a text file.

In the new style of the LP there is a difference in the type and province recognition. Before the dividing process of the type and province, first cutting the type and province together to decide if the car type is government or not. This is done by counting the number of labeling connected components objects. If the number of objects is less than or equal to five then the car type is government, else the dividing process and recognition for type and province is taking place as shown in Fig.12. This procedure were required because the government LP has only one word (حكومة) while the other LPs have two words as shown in table II.

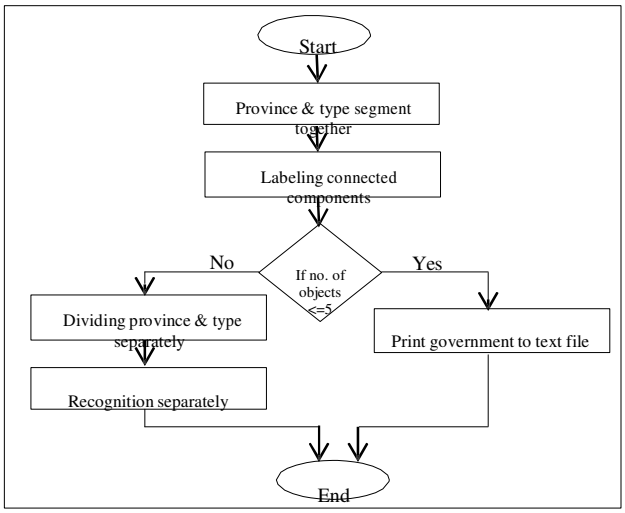


Fig. 12. Flowchart for government, type and province recognition

III. EXPERIMENTAL RESULTS

Experiments have been performed to test the proposed system, the recognition of sample images and to measure the accuracy of the system. The system is designed in MATLAB R2014a for recognition of Iraqi license plates. The images for the input to the system are colored images with variable sizes. The test images were taken under various illumination conditions. The measurements of accuracy are given by Table I.

TABLE I. EXPERIMENTAL RESULTS OF ACCURACY

Unit of LPR system	Number of accuracy	Percentage of accuracy
Extraction of plate region	35/40	87.5 %
Recognition	30/35	85.7 %

The database that used to test the system is 40 images, only 35 LP are extracted correctly. The main reasons that the 5 images are not extracted are: either image is unclear or the process of clean up the unwanted objects in some images will wiped out some important information and that cause the crop of the LP is incorrect as shown in Fig.13.

Fig. 13. Incorrect crop of LP

There are 30 from total 35 images that the LP extracted the recognition is correct, the 5 images are correctly extracted the LP but the recognition failed, that because the LP is not divided correctly in the dividing stage to preparing the LP for recognition stage. For example, in the number part there are more objects not the numbers only that makes the recognition process failed as shown in Fig.14.

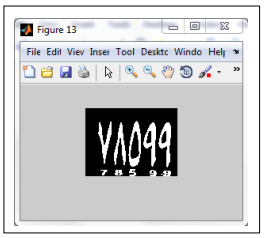
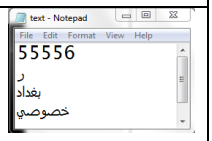
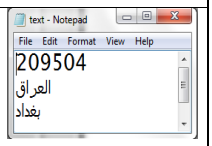
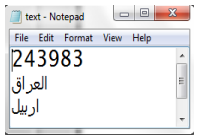
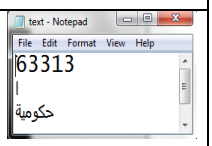


Fig. 14. Incorrect dividing

The results of the recognition for some samples of cars are given by Table II.

TABLE II. EXPERIMENTAL RESULTS OF RECOGNITION

Car image	Image plate	Results (text file)
		
		
		
		

IV. CONCLUSION

In this paper, the application software for the recognition of car license plate is designed. Firstly we extracted the plate location, and then separate the plate characters individually by segmentation and finally applying template matching with the use of correlation for recognition of plate characters. This system is designed for the identification for Iraqi license plates and the system is tested over a 40 images. Finally it is proved to be 87.5% for extraction of plate region and 85.7% for the recognition unit accurate, giving the overall system performance of 86.6% recognition rate.

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