Modelling an Automatic Recognition System for Iraq Vehicle License Plates by MATLAB

Faraj Humaidan Faraj
Electrical and Electronics Engineering
University of Karabuk
Karabuk, Turkey
2038171005@ogrenci.karabuk.edu.tr

***Abstract*— Due to the increase in the number of people and vehicles nowadays, the need for systems that allow automatic recognition of vehicle license plates has increased. Intended use can be briefly explained as traffic monitoring, control, and surveillance. The automatic vehicle license plate recognition system in different countries may have similar features, however the character recognition system differs from country to country. In this paper, an automatic license plate recognition system has been developed for Iraq. For this purpose, an Arabic character database was created, and automatic recognition was made for different types of license plates of different cities of Iraq. 870 images were selected for the Iraq license plate and applied with the help of OCR MATLAB; wherein the plate location is determined in the vehicle drawing by 846 plate localization from 870 plates.**

Keywords*— *license plate (LP), optical character recognition (OCR), automatic number plate recognition (ANPR), plate detection, Iraqi license

I. INTRODUCTION

With the rapid development of digital image processing and computer technology, the intelligent traffic management system has become indispensable for the transportation management system in the 21st century. Detection of plate position as the basis of character segmentation and character recognition in the automatic plate recognition system is an important part of the whole system. A vehicle license plate (LP) is a unique identification of a vehicle. The plate has a rectangular shape, contains letters and numbers; The vehicle license plate must be fixed to the body (at least on the back side) and means a legal license for public traffic [1]. In Iraq, the license plate is written in Arabic; and Iraqi car license plates can be classified into three types. The first type is used for the three northern cities (Erbil, Suleymaniye and Duhok). The second type is the old style (prior to 2003), and finally the third type is new in shape, as shown in Fig. 1. [2].

At present, all types of vehicle plates have begun to change with the new type. The dimensions of the vehicle (private, Taxi, Truck, Specialty, Agriculture, Construction, governmental). If there is a white stripe on the left side of the license plate, this means that the vehicle is a personal car. The yellow strip indicates it is a carrier vehicle. The red strip is for a taxi and the blue strip is used for governmental purposes [3].

In this paper, only four types (Personal, Taxi, Carry Car, Governmental Car) of new type plates used in Iraq are introduced accordingly. Applications were made with programs written in MATLAB.

The image extraction algorithm in the plate recognition system is proposed by Salah Al-Shami et al. [4]. Here, the optical character recognition is applied by assigning weights to the characters. This process depends on the selection of each character string and each character individually. This is very important because the manual selection of characters produces excellent conditions for accurate character recognition. Characterization depends on the exact characteristics of the character previously stored to compare. In Saudi Arabia, this technique has been used in several data sheets descriptions on license plates [4].

The proposed algorithm for the recognition of Malaysian special plates consists of four steps: Image Preprocessing, Scale-Invariant Feature Transform (SIFT), Feature Extraction, Key Point Matching and Object Location Determination. The recognition is performed by comparing the identified plate with a set of attribute points based on the Euclidean distance as a common measure of each template's vectors. In this technique, plates with italic and highly connected samples, in which the letters are normally written in lower case, are processed. Because these prefixes are difficult to separate into independent characters such as other standard plates, they must be considered separately for recognition [5].

BolotovaYu.A. [6] proposed a hierarchical model of temporary memory to enhance the recognition performance of the plates. Effective identification of a vehicle license plate from pictures is not an easy task. The guidelines for recognizing the plate can be identified by locating the plate on the image, then character segmentation on each character and then applying the optical character recognition process. Collected images are not always in perfect conditions. Considering images taken from narrow angles, the effectiveness of character segmentation is reduced. Recommended algorithms can also be used for corrupted text partitioning and recognition. This method used to identify the characters from the plate gives better results than the application of the technique without the pre-filtration component.

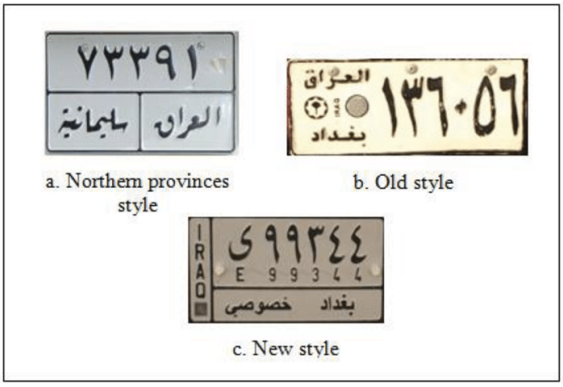

Fig. 1. Iraqi Vehicle Licence Types.

II. PRE-PROCESSING

The automatic plate recognition system faces many challenges. Hence, this step is necessary to improve the input image and make it more suitable for the next processing steps. The first step in preprocessing is the application of image improvement by increasing the brightness levels of the dark valuable areas in the image. This is mostly done to thicken the characters and plate edges and to eliminate the effect of the diagonal strips appearing on the Iraqi plate characters and edges. This is followed by increasing the saturation of the image to increase the distinction between colors. The image is then converted to grayscale. The preprocessing thus increases the image contrast to separate the background [9].

A. Density Image(Grayscale Image)

Gray levels represent the range of quantities in grayscale image processing. Currently, the most widely used storage method is 8-bit storage. The 8-bit grayscale image has 256 levels of gray and the density of each pixel can range from 0 to 255, 0 is black and 255 is white. Another commonly used storage method is 1-bit storage [10].

B. Binary Image

Binary Image is a digital image in which one-pixel value can be assigned to one of two-pixel values. The two colors commonly used for binary image are black and white. Binary images used as masks in digital image processing or due to some commonly used operations such as segmentation, thresholding [11].

C. Filtering

It can be clearly understood that the brightness level value between neighboring pixels varies greatly. Thus, to avoid further loss of information, changes in values are averaged by conversion of histograms through a low pass digital filter. This step is done by considering the right and left side values. Histograms before and after filtering are shown, after passing the histograms through the low pass filter, unwanted regions are removed from the image using another filter. Rows and columns with low histogram values are considered unwanted regions. Since the lower histogram values show much less variation between neighboring pixels, since they include a plate and a flat background with alphanumeric characters in the region, the difference in neighboring pixels, especially the edges of the characters and plates, will be very high, and the horizontal and vertical histograms of the lower values will no longer be necessary. Thus, the plates are filtered using the dynamic threshold applied to both the horizontal and vertical histograms. The filtered histogram consists of the region's most likely to contain the number plate [12].

D. Edge Detection Techniques

Robert, Sobel and Prewitt are classified as classic edge detection operators that are simple and easy to use but highly sensitive to noise. The classical operators and the canny operator are in the first-order derivative-based edge detection (Gradient Method) category. The Marr-Hildreth edge detector is a gradient-based operator that uses Laplacian method to derive the second derivative of the image.

E. Techniques of Optical Character Recognition Systems

A typical OCR system consists of several components. The first step is to digitize the analog document using an optical scanner. When regions containing text are found, each symbol is removed by segmentation. Noise reduction is provided by filtering the noise as preprocessing to facilitate character recognition. The recognition of each symbol is performed using symbol classes obtained from the previous learning stage. Finally, contextual information is used to reconstruct words and numbers of the original text. The steps for automatic recognition are shown in Fig. 2. [13].

F. Segmentation

The subdivision of the character. Segmentation is important because the ratio achieved when separating various lines in the character directly affects recognition performance. Internal segmentation is used here to separate lines and curves in composite characters. Character segmentation strategies are divided into three categories: (a) open segmentation (b) implicit segmentation and (c) mixed strategies.

III. EXPERIMENTS AND RESULTS

Recognized the mechanism of determining the number of new Iraqi plates and show the vehicle type is private, taxi, truck or official, whether the type of Iraqi cars is correctly identified and then read the image through OCR. In addition, the OCR system is used by programming the graphical user interface (GUI) via MATLAB and through the GUI interface, where the boxes are designed as desired by the programmer.

The new Iraqi license plate is a plate with a black line and a colored rectangle on the sides, with a white base (text background). It is one of the world's most difficult automatically recognized license plates. Includes Arabic and English letters and numbers. The license plate consists of three rectangles. The right rectangle of the license plate is white if the car is personal or taxi; and if colored red it is a governmental usage car if blue and carry car if yellow. In the license plate recognition system designed in this thesis, after reading the image obtained from a digital camera, it is converted to an image and text, reading the right strip and identification of the type of vehicle, and compared with the character defined by OCR.

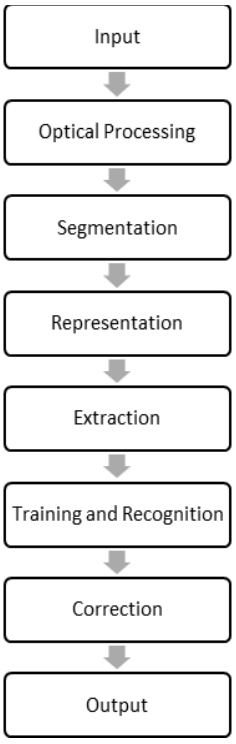

Fig. 2. The steps of Automatically Recognition.

A. Algrithms Used in Automatic Licence Plate Recognition (ALPR) System

ALPR is a system that can determine the license plate number from its image and convert it to text. However, there are different stages that must be subjected to the picture to identify the characters on the plate. To cope with the differences in the Iraqi license plate with English and Arabic characters, separate letters are required for the type or different lines after a few preliminary operations, including normalization and correction of the deviation. We have some pre-process steps that have proven to be of great benefit in reducing analytical and computational results before achieving results. The resulted object is compared to the color bar result to see if they do match or not.

B. Work Steps

1) Creating Dataset

All the Arabic numerals and letters we have created will be processed, and this dataset is the Arabic numerals and letters on the Iraqi plate. In this paper, only Arabic numerals and letters were identified and recognized. Since the pictures were captured by different angles, indicating that the character was slightly different, we created Arabic numerals and letters in various ways to match them precisely as seen in Fig. 3.

2) Preprocessing System

The main purpose of preprocessing is to improve the contrast of the input image, reduce the noise in the image, thus increase the processing speed, improve the visibility and quality of the input image. In the proposed approach for ANPR, in the preprocessing step, first the RGB image is converted to gray level image, and then the noise from the grayscale image is removed using Edge detection and filtering [14].

$$Gray = 0.30*R + 0.59*G + 0.11*B \quad (1)$$

Convert a gray-level image to a binary image: Converts this grayscale image to binary by threshold. The output binary image may be lower than the level value for all pixels in the input image and have values of 1 (White) or 0 (Black) for all other pixels. The implementation of this method is easy and simple to be understood. The result is easy to analyze the binary image. The dual level image obtained from the gray level image is shown in Fig. 4. Threshold is a nonlinear process that converts a grayscale image into a binary image in which two levels are assigned to pixels below or above the specified threshold value as shown in Fig. 5.

3) Edge Detection

The edge detection process includes different edge detection filters and methods such as Roberts, Sobel, Prewitter and Canny. We used Sobel operator which is a discrete differentiation operator used to calculate the change of image density function for edge detection. At each pixel of an image, the Sobel operator either gives the corresponding gradient vector or is normal to the vector as seen in Fig.6.

4) Labelling

In this step, the edges in the image are identified and labeled with unique numbers. This step is used to identify important edges, including the license plate. Fig. 7. shows the labeled image.

TABLE I. TYPES OF LICENCE PLATES

No	Type of car	Strip color	Type of car (in Arabic)
1	Personal	White	خصوصي
2	Taxi	Red	تكسي
3	Carry car	Yellow	حمل
4	Governmental	Blue	حكومي

5) Vertical and Horizontal Histogram Operations

The vertical and horizontal histogram is used to locate the license plate in the vehicle image. The horizontal histogram is obtained by summing the Dx matrix line by line, and the histogram is a length-length sequence of columns as shown in Fig. 8. Likewise, the vertical histogram is obtained by summing the Dy matrix (column-by-column) and the histogram is a length-numbered sequence. After obtaining the horizontal and vertical histograms, the histograms are passed through a low pass filter and then thresholder to keep the values whose histogram values are above a certain value.

6) Plate Recognition Section

The main purpose of this step is to ensure that the images are classified and fully recognized for selection and to convert the image to text consisting of letters and numbers obtained from number plates. First, a database containing all Arabic numerals, letters and words was created. When regions containing text are found, each symbol is removed by segmentation. The extracted symbols are preprocessed, eliminating noise to facilitate pretreatment. The identity of each symbol is determined by comparing the descriptions of the symbol classes obtained with the previous learning stage and the extracted features. It compares the discrete characters in the license plate with the characters in the database [13]. The process steps described previously apply to the portion of the plate.

7) Comparison of Objects

After selecting the edges and angles on the car plate, each letter, number, and word will be taken one by one and compared with the data entered and saved in the device programmed by Octave. The matching method used to read the license plate is between 1 and -1. When we retrieve the characters on the license plate from the car panel, we match all the data we have, and because of this match, the template character closest to 1 is assigned to the character being read. The more data that is available for a code, the easier it is to recognize it, but it is also possible to misrecognize the shapes between them, especially those that are close to the one written in Arabic.

Fig. 3. Created Dataset Design

Fig. 4. The Image of the Display

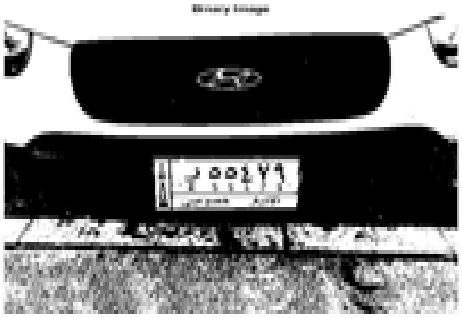

Fig. 5. The Picture of Binary (two levels)

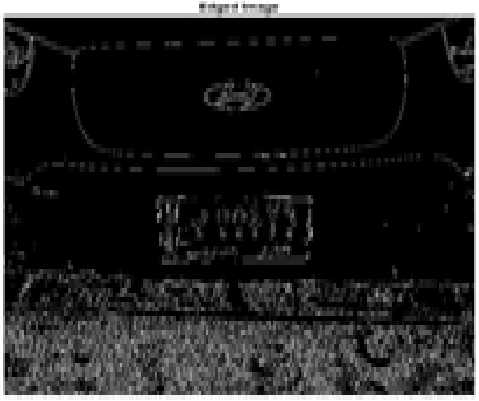

Fig. 6. The Sobel Operator Result Edge Detection.

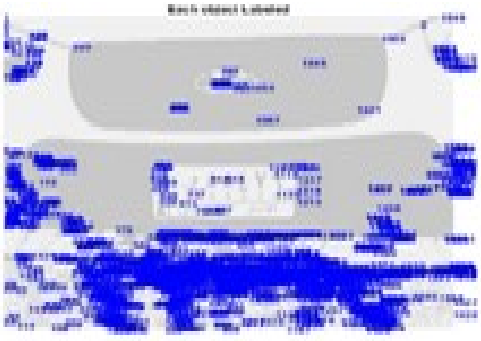

Fig. 7. The Image of the Discrete Object.

8) Compare Vehicle Type

This step is the new step in license plate recognition, as the license plate recognition system has not yet been performed for Iraqi license plates, indicating whether the vehicle type indicated on the color strip on the license plates matches the existing information. If the result of the color strip is the same as the type of vehicle registered on the number plate, the window with the text APRROVED will appear on the screen, if it is the same, the window containing the text REJECTED will appear on the screen.

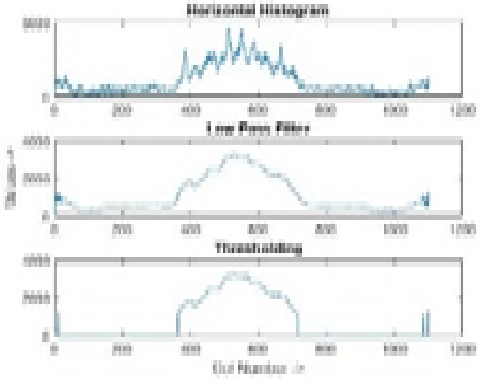

Fig. 8. The Horizontal Histogram of Low Pass Filter and the Threshold Result.

IV. Recognition Performance Analysis

870 images were selected for the Iraq license plate and applied with the help of OCR Octave [15]; wherein the plate location is determined in the vehicle drawing by 846 plate localization from 870 plates.

Plate recognition could not be completed because only two plate localizations were not successful. Table 2 provides information about the plate image data set used in the experiments. Of the 870 vehicle license plate images, 846 were recognized correctly. In the determination of the vehicle type, 822 of the 846 vehicle license plate images were used in the experiments and of them were correctly identified and the vehicle type mapping of the license plate was made.

Plate recognition performance (PRP) can be calculated with the Eq. (2):

$$PRP = \frac{\text{number of correctly read plate images}}{\text{number of all images}} * 100 \qquad (2)$$

V. Conclusions

This technique, which is used to automatically detect license plates, has not yet been formally applied in Iraq. To benefit from this technology in parking, shopping centers and government services, there are areas of use in Iraq General Traffic Directorate.

Failure to take vehicle license plate images from the correct angle, dirty plates are the most important factors that decreases the performance of the recognition process. The lack of appropriate lighting conditions due to the reflection of the light falling on the plate adversely affects the recognition performance. On some plates, a certain number of characters can be recognized correctly instead of all characters.

In this paper, there are new recognition methods which are based by adding an English character database to the created database, it can be provided to recognize the Latin letters and numbers on the plate. Different filtering methods can be added to show scanned numbers that prevent reading characters.

TABLE II. THE DATASET USED IN EXPERIMENTS

No.	Calculation Type	Number of plate images
1	Total number of pictures	870
2	Number of plate images localized	846
3	Number of plates recognized with OCR	854
4	Number of plates with color strips for vehicle type	851
5	Number of matching plates compatible with vehicle type color strip	854

REFERENCES

[1] K. B. H. Y. a. J. K. Y. Yoon, " "Blob Extraction based Character Segmentation Method for Automatic License Plate Recognition System,"," in International Conference on Systems, Man, and Cybernetics, IEEE, 2011.

[2] D. o. I. P. Traffic. [Online]. Available: "http://www.itp.gov.iq/,".

[3] O. S. Siddik, in Vehicle Number Plate Detection (IRAQI PLATES), 2014.

[4] S. Al-Shami, "Feature Extraction Method for Licence Plate Recognition," in International Conference on Digital Information and Communication Technology (DICTAP) , 2015.

[5] Y. H. T. K. H. M. H. W. H. H. Sin Ng, "Detection and Recognition of Malaysian Special License Plate Based on SIFT Features," researchgate, 2015.

[6] A. A. D. V. G. S. Yu. A. Bolotova, "License plate recognition with hierarchical temporal memory model," in in 9th International Forum on Strategic Technology, IFOST 2014 - Cox's Bazar, Bangladesh, 2014.

[7] M. M. A. A. M. T. a. A. M. A. A. Badr, "Automatic Number Plate Recognition System," Annals of the University of Craiova, 2011.

[8] K. V. T. Kumar, "A Theory Based on Conversion of RGB image to Gray image," International Journal of Computer Applications (0975 – 8887), 2010.

[9] P. A. P. K. A. Mishra, "The Quality Identification Of Fruits In Image Processing Using Matlab," IJRET: International Journal of Research in Engineering and Technology , 2014.

[10] S. B. D. Mitra, "Automatic Number Plate Recognition System: A Histogram Based Approach," IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE), 2016.

[11] K. M. P. B. S. K. G. A. Chaudhuri, "Optical Character Recognition Systems for Different Languages with Soft Computing," 2017.

[12] S. K. S. Kaur, "An Efficient Approach for Automatic Number Plate Recognition System under Image Processing," International Journal of Advanced Research in Computer Science, 2014.

[13] G. Ocrad, "Optical Character Recognition program," [Online]. Available: www.gnu.org/software/ocrad/.