Received: 2 August 2021 | Revised: 23 August 2021 | Accepted: 25 August 2021
DOI: 10.37917/ijeee.17.2.12 Vol. 17| Issue 2| December 2021

Open Access

Iraqi Journal for Electrical and Electronic Engineering
Original Article

Iraqi License Plate Detection and Segmentation based on Deep Learning

Ghida Yousif Abbass *[1], Ali Fadhil Marhoon[2]
[1]IT Center, University of Basrah, Basrah, Iraq
[2]Electrical Engineering Department, University of Basrah, Basrah, Iraq

Correspondence
* Ghida Yousif Abbass
IT Center, University of Basrah,
Basrah, Iraq
Email: pgs2188@uobasrah.edu.iq

Abstract
Nowadays, the trend has become to utilize Artificial Intelligence techniques to replace the human's mind in problem solving. Vehicle License Plate Recognition (VLPR) is one of these problems in which the computer outperforms the human being in terms of processing speed and accuracy of results. The emergence of deep learning techniques enhances and simplifies this task. This work emphasis on detecting the Iraqi License Plates based on SSD Deep Learning Algorithm. Then Segmenting the plate using horizontal and vertical shredding. Finally, the K-Nearest Neighbors (KNN) algorithm utilized to specify the type of car. The proposed system evaluated by using a group of 500 different Iraqi Vehicles. The successful results show that 98% regarding the plate detection, and 96% for segmenting operation.

KEYWORDS: License Plate (LP), Vehicle License Plate Recognition (VLPR), Single Shot Detector (SSD), K-Nearest Neighbors (KNN).

I. Introduction

In recent years, the large number of car thefts, in addition to security breaches and attacks on public and private state institutions, using stolen cars and that without a license plate. Therefore, the trend has become to secure state institutions by using electronic displays linked to precise surveillance cameras to control the car entry manually.

Plate recognition technologies with deep learning techniques are used to speed up plate recognition processes with the help of image processing technologies.

Vehicle license plate recognition (VLPR) is one of the applications of artificial intelligence [1], license plate (LP) recognized without direct human intervention [2, 3] and this technology has been used for security purposes such as being used in electronic car parks and to secure a specific area [4]. Management of VLPR systems depends on the resolution of the image and the camera used to capture the image and depends on the parking of the car [5] and the surrounding conditions (light intensity, time of capturing the image (day, night), tilt angle, climate (fog, rain), etc.).

The License Plate (LP) detection may pass through number of stages. Before starting at any stage, a photo of the car to be identified must be taken. A camera with a resolution of (720 * 1640) pixel was used for this purpose.

The most important stage is how to locate the LP within the overall car image, because all the following stages depends on this stage. For this purpose, the Single Shot Detector (SSD) Algorithm [6] is used.

After that, image-processing technique used to crop the detected plate from the captured image, to be segment into different regions [7].

II. Literature Review

In 2014, Amir H. et al [8] used a better template-matching algorithm to detect the VLPR of Iranian cars. This algorithm scans the entire image surface to get the desired object through matching, the technique uses color pixel analysis to locate the plate, and search is used Adjusted bar to obtain the color tone of each pixel. When it obtains a number of target pixels, it analyzes them and matches the aspect ratio with the ratio of the standard license plate.

In 2017, Hussni Mubarak et al [9] proposed a system to identify Sudanese car plate using image processing techniques and matching templates. This identification process achieved by capturing the car image with the dimension of 1050*2048 pixels. Then using some morphological processes to determine the location of the LP within the image. The successful LP identification process in this study reaches 96%.

Naaman O. et al. [10], created a database of 1500 license plates pictures of the cars in the northern region of Iraq (Kurdistan Province) to be identified automatically.

The created database are utilized later on by Naaman O. et al [11] to specify the location of licence plate within the car image. The processing are accomplished through two stages named; training and testing. The Adaboost technology used for traning, while the K-fold cross-validation method used for testing. The validation process shows that the accuracy of correct detection reach 89% from the overall images.

In (2018) Chowdhury et al. [12] used a method to combine sliding concentric window (SCW) technology and morphological image processing to obtain the best results for vehicle license plate detection and extraction from the acquired image.

In (2019) Alperen Elihos et al. [13] presented a study for vehicle license plate identification using public road monitoring cameras based on Single Shot Multi Box Detector (SSD) technology in vehicle license plate detection and using the same technology to detect and recognize license plate characters.

In this paper, used deep learning Single Shot Detector (SSD) technology to identify the license plate of Iraqi cars. Also used image-processing techniques for license plate segmentation and K-Nearest Neighbors (KNN) algorithm to recognition license plate color.

III. Problem Definition

In Iraq, there are three types of license plates; the first type is that prevailed before 2003 as shown in Fig (1.A). The second type issued after 2012 shown in Fig (1.B), while the third type is that used in Kurdistan province shown in Fig (1.C) [14].

The main problems to be solved in this work are:

1. To create new database for different types of Iraqi license plates (LP).
2. Utilizing deep learning based algorithm to extract the car license plate from the image captured to the car.
3. Segmenting the LP into upper, lower and left side parts using image-processing technique.
4. Finally, the type of car is determined based on the left side segment of the LP.

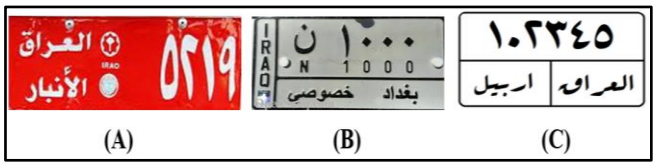


Fig. 1: Types of Iraqi License Plate

IV. The Proposed Methodology

Figure (2) shows the flow structure of the proposed system, which consists of the four stages that mentioned in the previous section.

A. *License Plate Localization*

In this paper, we will deal with one of the models for Iraqi car plates, which is the model that appeared after 2012 (the model named with the German number) found in Fig. (1.c) Due to the complexity of the design of this model compared with the models found in some other countries of the world, which are a rectangle that includes a sequence of numbers and letters according to a specific format and a specific arrangement specific to the country of the car plate, as shown in Fig. (3).

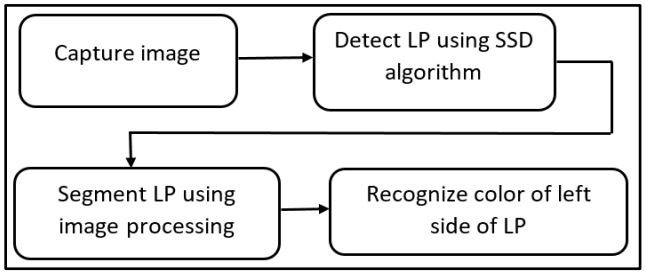


Fig. 2: Structure of the Proposed System

Through the foregoing, the need emerged to use the weights of previously trained deep learning algorithms network and benefit from them to identify and discover the Iraqi license plate. In this field, we used the Single Shot Detect (SSD) deep learning algorithm trained on car plates that shown in Fig. (3).

The (SSD) network identifies and discovers the car plate and returns the dimensions of the detected plate. To make the network fit with the Iraqi plates, we modified the dimensions of the detected plate from the image entered into the (SSD) network, and thus we were able to take advantage of the (SSD) algorithm in discovering and identifying the Iraqi car plate.

First, the image of the car is taken and applied to the modified (SSD) algorithm to discover the car plate and return the dimensions of the plate within the image. The dimensions are utilize to draw a rectangle surrounding the plate area in the original car image with its accuracy as shown in Fig. (4). In addition to another image representing the car plate after cutting it from the input image in order to be processes in the following stages.

Fig. 3: License Plate for other Countries

Detection Algorithm

1. Capture image.
2. Resize image to (300, 300) pixel.
3. Detect LP using SSD Algorithm.
4. Extract Top, Left, right, bottom of LP in the original image.
5. Draw rectangle around LP in the original image.
6. Write score of detection on the original image.
7. Cropped LP from the original image.

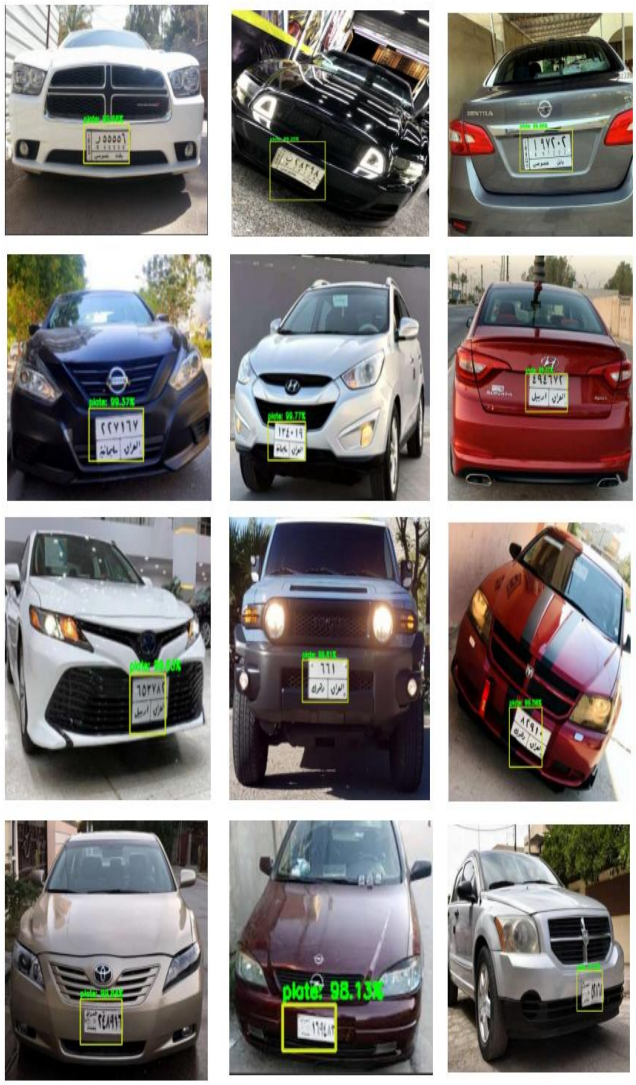


Fig. 4: Detection of Iraqi Cars License Plates

B. *License Plate Segmentation*

Due to the multiplicity models of Iraqi car plates, we choose the most complex and most common model in most governorates of Iraq. It is the model known in Iraq as the German model (the model that appeared after 2012) to complete the segmentation and differentiation processes.

In this work, we segment the car dashboard into four areas (the left side part, the upper part, the lower part and the lower right part) This segmentation is utilized to identify the contents of each part and identify and distinguish them accurately and thus know the identity of the car correctly.

In the segmentation of the license plate of the car, we cut it vertically to get the left side part of the license plate, which is the entrance to the next stage of our work, which is the phase of color recognition in the side part of the plate. Then the rest of the plate was taken to perform a horizontal cutting of the plate to get the upper part of the plate that contains the plate number and the lower part of the plate that contains the governorate to which the car belongs and the type of car. Then we go back to perform the vertical cutting process again for the lower part of the plate until we get a right part that includes the name of the governorate and a left part that includes the type of car as shown in Fig. (5) and Segmentation Algorithm [15, 16].

Region side	Region top	
	Region left	Region right

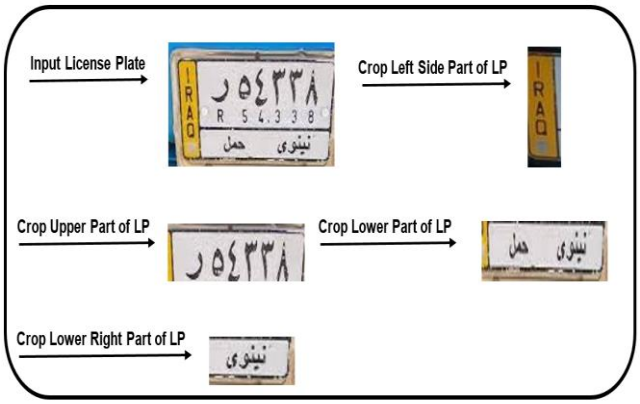


Fig. 5: License Plate Segmentation

Segmentation Algorithm

1. Input the crop LP.
2. Finding LP dimensions (width, height).
3. Make start row = 0 and make start_col = 0.
4. Crop left side of LP from (start_row, start_col) to (height, width/10).
5. Crop upper side of LP from (start_row, start_col) to (height/2, width).
6. Crop lower side of LP from ((height/2) + 3, start_col) to (height, width).
7. Finding lower side dimensions (width1, height1).
8. Crop lower side of LP from (0, (width1/2)) to (height1, width1).

C. *License Plate Color Recognition*

Iraqi car plates have different colors, and each color indicates a specific type of car. In this paper, we will discuss four colors of them as shown in Table (I).

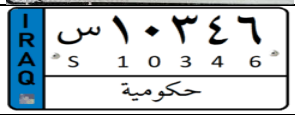
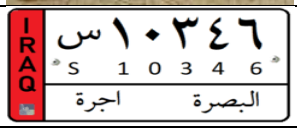
After cutting the left side part of the plate, it processed at this stage to distinguish its color. Through this distinction, the type of car (private, government, carry, taxi) are determined. We used K-Nearest Neighbors (KNN) classifier technology [15], which trained based on R, G, and B Color Histogram to distinguish colors (red, white, blue, yellow).

At first the features extracted to obtain the R, G, B Color Histogram values for the training data, then the KNN classifier trained using the Color Histogram, and then the classification done using the trained KNN.

Training Color Recognition Algorithm

1. Using train dataset contain four class every class contain 100 color (red, white, blue, yellow).
2. For image in training dataset do:
   a. Read image from training dataset.
   b. Split image to color RGB.
   c. Used histogram to extract feature of color.
   d. Save result in the training data file.

TABLE I
Types of Iraqi Car License Plate

Color	Car type	Picture
White	Private car	
Blue	Government car	
Yellow	Car carry	
Red	Taxi	

Classifying Algorithm

1. Input left side to training algorithm to extract feature of image.
2. Used KNN algorithm for classification.
3. Reload the training data file.
4. Used threshold k = 3.
5. Calculate Euclidean Distance.
6. Save result of Euclidean Distance.
7. Test response of neighbors and choose the top value.
8. predict = KNN classifier

V. The Results

Figure (6) shows some of the results that we obtained from applying this method proposed in this paper. Through the figure, it can be note that the car, even if it tilted at an angle, we get good results in detection, segmentation and recognition. In addition, even if the license plate is not clear, our method gives a good result.

To ensure the effectiveness of the method proposed in this paper to discover the car plate, it was test on a group of Iraqi cars of all three types (model before 2003, model after 2012 and Iraqi Kurdistan Model) and it gave the results presented in Table (II).

The result of LP segmentation of the car dashboard into four parts (the left side part, the upper part, the lower part and the lower right part) for 490 Iraqi car pictures of the model that appeared after 2012 are shown in Table (III).

As for the proposed method for distinguishing the color in the left side part of the car plate, it tested on the same images on which the cutting was tested, and it gave the results shown in Table (IV).

Through Table (II), it can be conclude that the accuracy of determining the license plate for Iraqi cars is 98%, while the accuracy of segmenting Iraqi car plates is 96%, depending on the results of Table (III), while color discrimination was 95%, which that shown in Table (IV).

Fig. 6: The Results of the Proposed Work

TABLE II
Result of Detection

Car Model	No of Car	Correct Detection	Incorrect Detection	Detection Rate
Model After 2012	500	490	10	98%
Iraqi Kurdistan Model	120	110	10	92%
Model Before 2003	20	18	2	90%

TABLE III
Result of Segmentation

Car Model	No of Car	Correct Segmentation	Incorrect Segmentation	Segmentation Rate
Model After 2012	490	470	20	96%

TABLE IV
Result of Color Recognition

Car Model	No of Car	Correct Color Recognition	Incorrect Color Recognition	Recognition Rate
Model After 2012	490	465	25	95%

VI. Discussion

Developing Number Plate detection methodologies is a topic widely studied among the community of computer vision [16].

Yasir Elhadi et al. [17] presented a method for detecting the license plate of Sudanese cars using one of the deep learning techniques, Faster Region-Based Convolutional Neural Network (Faster RCNN), which is able to recognize regions containing objects based on the proposed regions network. Also able to classify detected objects. This method correctly detects the LP in images, obtaining an overall accuracy of 93% with 100 images.

H. Hakim, and A. F. Marhoon [18], Designed a system to assist the visually impaired using deep learning techniques Tiny YOLO v2 technology to identify obstacles in front of the disabled to avoid them.

In this paper, used another deep learning technique is Single Shot Detector (SSD) to identify Iraqi license plates. In terms of speed and accuracy, the SSD model outperforms the alternatives (Faster R-CNN and YOLO). To test this model, we used 500 images of Iraqi cars bearing the German number, and the accuracy of discovering the plates was 98%.

VII. Conclusions

Since each country has its own design for license plates, so we proposed in this paper a special model for detecting Iraqi license plates through the use of the Deep Learning Algorithm (SSD). It is characterized by its speed in processing and has given good results in terms of detection accuracy of 98% and the speed of Detection, identification and cutting of the license plate from the captured image of the car, approximately 2 seconds or less. We also used image-processing techniques to segment the car license plate into parts (the left side part, the upper part, the lower part and the lower right part). The segmentation accuracy was up to 94%, which is a good accuracy because the results of this process forwarded to the next stage. The last stage of distinguishing the color located on the left side of the car plate using the histogram and with the help of (KNN) techniques, and the accuracy of color discrimination was up to 94% and in a short time of approximately one second.

It helped us a lot in determining the type of car (private, government, pregnancy, taxi) in a short time, approximately one second. As shown in Table (V).

TABLE V
Result of Timer

Processing	Time of Processing
Detection	2 seconds
Segmentation	1 seconds
Recognition	1 seconds

Conflict of Interest

The authors have no conflict of relevant interest to this article.

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