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THE PROPOSED IRAQI VEHICLE LICENSE PLATE RECOGNITION SYSTEM BY USING PREWITT EDGE DETECTION ALGORITHM

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ABSTRACT

Since the number of vehicles is increasing hugely every year, the process of controlling and tracking those cars forms a significant human challenge. The automatic recognition of those cars can help in solving this problem and save much effort and time. The license plate could involve a lot of content, which make the recognition process is difficult to many researchers around the world. In addition to that, license plate may not have fixed in uniform place on the car, hence the recognition of this plate should recognize it. This research aims to recognize the characters, numbers, and words, that extracted from Iraqi LPS, into a text. This system consists of four main stages: The first phase is License Plate Detection by using the vertical Sobel edge detection and extracts these LP by using morphological operation. The second phase is License Plate Alignment. The third phase is License Plate Segmentation and isolates each character, numbers, and words of the license plate by using scanning techniques. The last phase is License Plate Recognition to display the alphanumeric character and words as the text file by using Prewitt edge detection algorithm. The overall performance of the system reached to 100%.

Keywords: *Image Acquisition, License Plate Detection, License Plate Rotation, License Plate Segmentation, License Plate Recognition, Morphological Operation, Edge Detection.*

1. INTRODUCTION

The advance computer applications provide many solutions for a lot of issues in our life. Where, many application using in several field such as in medial, security, monitoring, controlling and many others. Image processing is the most important field used currently in computer application, due to the most meaningful content are exist in image file format. Therefore, the technique of image processing has adopting in critical task such as vehicle controlling system. The application of vehicle controlling system can be found in such areas like: Parking system, Traffic monitoring systems, radar based control, and many other applications [1]. The License Plate Recognition system is a form of automatic vehicle identification. The vehicle license plate recognition system has some different useful applications such as traffic control, border control, access control, detection of stolen vehicles, parking control, speed control, and enforcing the entry for authorized people to specific areas [2]. Vehicles in each country have a unique license number, which is write on its license plate. This number distinguishes one car from the other. An automated system can be implemented to identify the license plate of a car and extract the characters, numbers, and words from the region containing a license plate [3]. The accuracy of license plate recognition system is affected by the type of image process technique used and the content of plate itself, where many plates involves a special characters or symbols. The accuracy also depends on the captured image, and the direction (pose) when the image has been captured. Thus, there are many international researchers around the world, they adopt their proposed methodologies to recognize and distinguish vehicles in their countries [4]. The major aim of this paper, is to proposed a license plate recognition system that able to recognize the Iraqi vehicle license plates. The proposed Iraqi license plate recognition system consists from four major stages which are: Image acquisition, detection and extracting features, recognition the extracted features, and finally print the result in text file.

2. RELATED WORK

Ibrahim et al, adopt neural network to train the proposed algorithm to recognize the characters and

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numbers in plates, they used Hidden Markov algorithm, which required train and observe the result status before fixing the weights [1]. Eyad I., and Thaaer A., they introduced a concept to recognize the license plate by take a snapshot when the car passes, then template matching is performed to recognize the registered cars [3]. Majida et al, propose the new architecture in License Plate Character Recognition (LPCR) based on Support Vector Machines (SVMs) with Bee Colony Optimization Algorithm (BCOA). This Algorithm is used to dynamically select the best training data set for SVMs throughout training [5]. M. M Aziz introduces gate control system that controls the gate of the campus based on the license plate. The system will use the image processing technique with pattern recognition to recognize the license plate. Image processing filters are used to make the plate clearer by reducing the noise of image which made the image easier to discriminate [6]. Thaler et al. convert the text on digital images of vehicle license plates to a text file that can be edit and used as such by any other program or application that needs it [7]. Ali et al, they used clustering algorithm (K-means) to cluster the result of Gabor features. The main goal behind clustering algorithm is to reduce the dimensionality that produced by the features. After that, classification algorithms are used to classify every plant into its desired class, where three classification algorithms are selected and trained to compared the results between them [8]. In this paper, a novel approach is introduced by used set of sequence methods, the proposed technique shows that the recognition rate is very accuracy and its able to recognize the license plates in spite of the collected images are variant in pose directions. The proposed methods focused in the beginning by converting the image into gray, then Sobel filter adopt to discover the edges of object, after that Otsu algorithm is used to select the optimal threshold which useful to discard the sample edges details. The result of previous step is continuing with edge histogram equalization, finally the detection and recognition phase is used to recognize the plates number and write the result into test file. This work, is differs from previous related works, by focused on edge detection and segmentation steps, and do not used methods that required training or spent a lot of time in recognition phase, the proposed system archive high accuracy for recognizing the IRAQI license plates as shown in experimental result section.

3. MATERIALS AND METHODS

In this research, we proposed to detect and recognition Iraqi Vehicle License Plate. The proposed implemented by many steps as shown in figure 1.

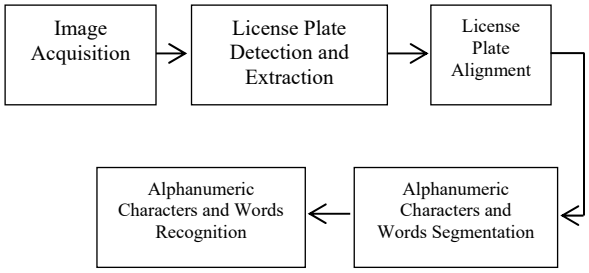

Figure 1: Block Diagram for proposed System

The details for proposed System are present as the following:

3.1: Image Acquisition: -

It is the primary stage in the proposed IVLPR system, the aim of this phase is to capture image from the front or back side of the vehicle, as shown in Figure 2. Location of camera depends on the purpose of using the camera, and it is outside of this study scope.

Front side **Back side**

Figure 2: Image Acquisition through Camera

3.2: License Plate Detection and Extraction: -

This phase includes all the necessary steps to find the accurate region of the license plate from the captured image, and all the needed adjustments on License Plate are make. All that is do throughout the following steps:

3.2.1: Converting RGB Image into Gray Image:

The first step is to convert the color image into gray image as shown in Figure 3.

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Figure 3: Converting RGB Image into Gray Image

3.2.2: Vertical Sobel Edge Detection: -

It is used to detect the edges of the image. Edge detection is the very important step in image analysis. Edges represent the boundary of objects which can be used to identify the shapes and area of the particular target. Sobel filter uses to detect an edge in the image. This step is very useful when many objects are existing in image. The main goal behind this step is the license plate actually exist with unique form and shape its totally differs from the car. Therefore, the intensive changes can be discovered through the object boundary, hence, the edges of objects are discovered and recognized from each other. Sobel is most popular method to discover the edges of tainted objects, the result of applying Sobel upon the selected images is shown in the following Figure 4.

Figure 4: Vertical Sobel Edge Detection

3.2.3: Binarization of Vertical Gradient Image: -

It involves the conversion of vertical gradient image into a binary image. Binarization the vertical gradient image based on finding the threshold value. Otsu algorithm is used to select the threshold value. These algorithms choose the optimal threshold depending on the intensity level of vertical gradient image. So, if the magnitude of the pixels in the vertical gradient image is less than the threshold value, it is expressed as "0", and if it is greater than the threshold value, it is expressed as "1", as shown in Figure 5.

Figure 5: Binary Vertical Gradient Image

3.2.4: Edge Horizontal Histogram: -

At this stage, we count the histogram of an image. The histogram represents the sum of pixels in each row of an image. In computer vision application, histogram is very useful technique for threshold selection. Ultimately an array containing the column-wise aggregate is created, as shown in Figure 6. The resulted array contains two columns, the first column involves the index of the rows and the other columns contain the sum of the pixels that belongs to the corresponding row. In this case we find the threshold for that array, every pixel value in the row with the number of pixels less than threshold should change to zero.

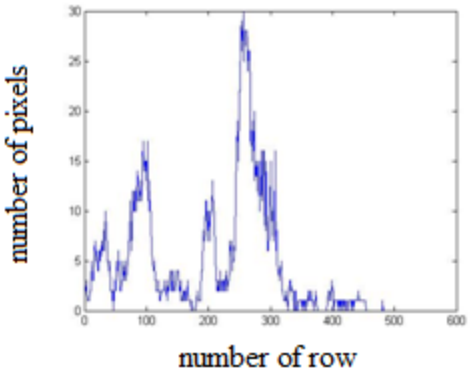

Figure 6: Edge Horizontal Histogram

The resulted image of applying Edge Horizontal Histogram is shown in the following Figure 7.

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Figure 7: Binary Vertical Gradient Image

3.2.5: Find Candidate Regions of License Plate: -

The morphological operation is use to find candidate regions of the license plate in the binary vertical gradient image. The morphological closing that defined as follows:

$$\text{Closing operation} \quad A \bullet B = (A \oplus B) \ominus B \tag{1}$$

Where $\oplus$,and Θ denote dilation and erosion operations respectively. Closing operation implemented on the binary images, so the output of this step as shown in Figure 8.

Figure 8: Binary Vertical Gradient Image

3.2.6: Accurate Cropping Regions of License Plate: -

After implementing the closing operation, still many regions with different size exist in addition to candidate license plate region. So the prior knowledge of the ratio of width to height for license plate used to remove non-plate candidate regions, the result shown in Figure 9.

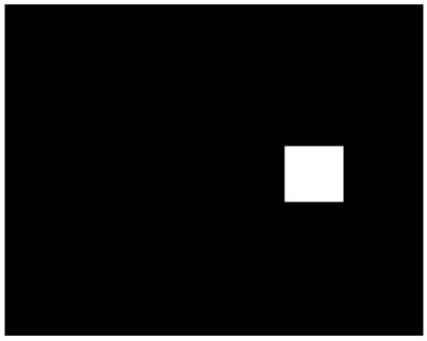

Figure 9: Accurate Region of License Plate

The license plate region will be viewed by reconstructing the region from the gray image, and the result is shown in Figure 10.

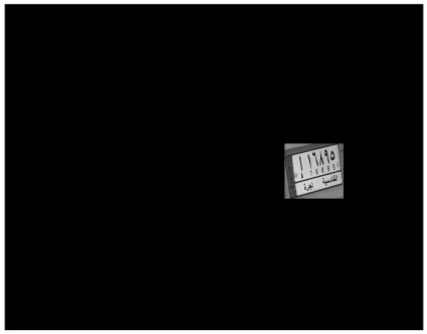

Figure 10: Accurate Region of License Plate

The license plate region is cropped from the image by using scanning techniques; the image is scan horizontally and vertically. The horizontal scanning technique of image represented as the last set of rows from the top side with all pixels having a value of "0" is removed and the last set of rows from the bottom side with all pixels having a value of "0" is removed. While the vertical scanning technique of image represent as the last set columns from the left side with all pixels having a value of "0" is removed and the last set of columns from the right side with all pixels having a value of "0" is removed. After execution this technique would have cropped the top, bottom, left, and right parts of the image, as shown in the following figure 11.

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Figure 11: Cropped The License Plate Region

3.3: License Plate Alignment: -

Since vehicle images might have taken with different angles, so we need to estimate the skew angle of the license plate image and rotate it to have a right license plate, as shown in Figure 12.

Figure 12: License Plate Rotation

3.4: Alphanumeric Characters and Words Segmentation: -

This stage involves segmentation of characters, numbers, and words from the license plate image. All that is achieve throughout the following steps:

3.4.1: Remove Unwanted Regions of License Plate: -

In this stage all the unwanted regions of the license plate will be removed, it is the area bounding the license plate. Then, the license plate will be segmented to two connected areas one for the upper side of the license plate and the other for the bottom side of the license plate, as shown in Figure 13 (a-b).

(a)The Vehicle ID Region (b) The Vehicle Class Region and Province Name

Figure 13: The wanted Regions of License Plate

3.4.2: Resize the License Plate Image: -

The wanted regions of license plate have different size and resolution depending on the system hardware that used for image acquisition. In this case, the image of the Vehicle ID Region will be resized to 200*400 pixels, while the vehicle class region and province name resize to 150*400 pixels, as shown in Figure 14.

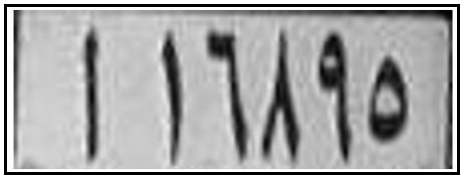

Figure 14: The Vehicle ID Region of License Plate

3.4.3: Binarization of The License Plate Regions:

This step involves converting the license plate regions to the binary level by using Otsu algorithm and taking the complement for it, as shown in Figure 15(a-b).

(a)The Vehicle ID Region (b) The Vehicle Class Region and Province Name

Figure 15: Binarization of The License Plate Regions

3.4.4 Segmentation of The License Plate Regions: -

The goal of this step is to segment each character, number and word from the license plate regions Fig 15. So, alphanumeric characters of the vehicle ID region are segment by using the horizontal scanning technique. The horizontally scanning technique is implement by searching the image from left to right and top to down, at any step of searching the first value of "1" is referring to the beginning of the first character, at this case searching continue until finding the end of characters (find zero value). This process continues for of the characters until the end of the image at the right side. The result of this step shown in Figure 16 (a-b).

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(a)The Vehicle ID Region (b) The Vehicle Class Region and Province Name

Figure 16: Segmentation of The License Plate Regions

3.5 Alphanumeric Characters and Words Recognition

The final stage of the proposed system is recognizing each segmented character, numbers, and words that extracted from license plate regions. In this the stage Prewitt edge detection algorithm used. The percent value will be determining for each character, number, and word according to the equation (2). The resulted value compare with the values stored in the prior determined database.

$$\text{percentage value} = \frac{\text{Comparing the white edge pixels between for the input detected image and database images}}{\text{The total white edge pixels for the input detected image}} * 100\% \quad (2)$$

the matched values identify the character, numbers, and words, as shown in Figure17.

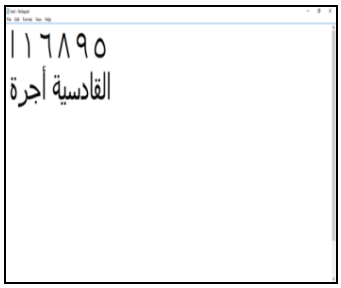

Figure 17: Alphanumeric Characters and Words Recognition as Text File

4. RESULTS AND DISCUSSIONS

1.The proposed system has evaluated on 50 license images selected from our database. Selected database involves different cars where the license plate also involves subtle changes from others. Tested Database involve images for variant Iraqi vehicle license plates, where these plates include general information that unique to each other's, but typically the plates are existing in unique forms, in such a way the IRAQI plates are recognized from other plates that belong to other countries. The following table 1, shows the results of proposed system, where the images are captured by using Optical Camera called (Kodak Z750 Cam.), and also the photos were taken from different angles, to includes different pose in order to evaluate the recognition rate of the proposed system. The implementation details of proposed system are shown in appendix of this paper and the summary results for only 8 cars are shown in the following Table 1. The implementation details of Table1 is illustrates in the appendix A of this paper.

2. Recognition rate is the basic measure used in evaluating search strategies and was computed as follow (2):

$$\text{Recognition rate} = \frac{\text{Number of image corretly recognized}}{\text{Total number of the tested image}} * 100\% \quad (2)$$

After applying the proposed method upon our selected database, the Recognition rate for our vehicle image database is 100% .

3. Proposed system also is compared with other related systems and the proposed technique shows better efficient result than others as explained in Table 2.

5 .MOTIVATION OF PROPOSED SYSTEM:

The new motivation in this paper is introduced by using Sobel Edge Detection technique which provides a better result to discover the objects in the given scene in image. Objects could be any part of a given image, hence, detect the interest objects is an important step in recognition system [9]. After the edges detected, threshold selection step is start, which is very useful to discard the small objects which also called fractal objects. Binarization process help to reduce the noise in an image and, horizontal histogram used to select the optimal threshold value to discard the pixels that fall out the license plate area. Closing operation is performed upon binary image, where the license plate contains the property that the edges densities are continuous with each other's, hence, the plate object can be recognized from those that exist in image, in efficient mode. Therefore, the proposed system couldn't require training or texting phases and its able to recognize license plates in an efficient way and do not consuming time.

Table 1: Eight sample of the proposed system results

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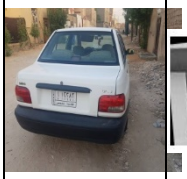
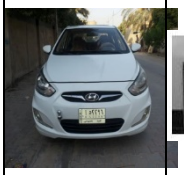
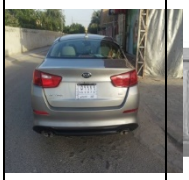
NO.	Input Image	Rotated License Plate	Recognized characters, numbers and words
1			٥٥١٠٥٨ بغداد خصوصي
2			١٣٥٤٥٢ النجف اجرة
3			ر٣٨٥٦١ الانبار خصوصي
4			١١٢٣٨٣ القادسية خصوصي
5			١٥٢٢٩٦ النجف خصوصي
6			١١٥١٣٤ النجف خصوصي
7			١٥٩٩٧٩ النجف خصوصي
8			١٥٧٠٤٨ النجف خصوصي

Table 2: Comparing the performance of proposed system with other systems

Papers	Recognition methods	Recognition rate (%)
A Vehicle License Plate Detection and Recognition System [10]	RBF neural network architecture	91
License Plate Recognition Algorithm for Passenger Cars in Chinese Residential Areas [11]	The fuzzy decision-making method	92
Iraqi Cars License Plate Detection and Recognition System using Edge Detection and Template Matching Correlation [12]	Template Matching Correlation	98.24
A Real-Time Mobile Vehicle License Plate Detection and Recognition [13]	Back-propagation neural network	88.71
An Automatic Recognizer for Iraqi License Plates Using ELMAN Neural Network [14]	ELMAN Neural Network	76
Automatic License Plate Recognition in Kurdistan Region of Iraq (KRI) [15]	(SVMs),(K-NN) and (RBF)Techniques	96.72
License Plate Numeric and Characters Recognition [16]	Local density distribution	98.99
Artificial Intelligence based Iraqi License Plate Recognition System [17]	Artificial Neural Network	97
Gate Control System for New Iraqi License Plate [18]	Comparing Technique	93.33
Real Time Recognition and Tracking of Iraqi Vehicle License Plate [19]	Back propagation neural network	92
The proposed system [20]	**Prewitt Edge Detection Algorithm**	**100**

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6. CONCLUSION

This paper proposed system for automatic Iraqi vehicle identification based on the license plate recognition. Where the system helps the security applications for vehicle tracking, or enforcing control on vehicles entering restricted areas (such as airports or governmental buildings). The proposed system has been tested with 50 images and give excellent results. The Recognition rate was 100% for Iraqi vehicles. Also, the system performance was compared with other works and gives better results than the another algorithms as shown in Table 2.

7. Limitations and Future Work

The recognition of license plate number task of any vehicle is totally depends on the acquired image. Hence, the noise or degraded images typically produced bad recognition results. Therefore, there some limitation may occur when we consider all circumstances in this work. First, this work is capable to detect and recognize the Iraqi vehicles and not designed to recognized other vehicle plates. Second, the acquired images should be existing in high resolution and not captured by other optical sensors. Third, the pose (direction) of acquired image should not effect on appeared number, otherwise recognition couldn't perform this task clearly. Fourth, the acquired images actually collected in day light time and not in day night, to be more efficient to recognize the number than other times. Finally, I planning to used combination of novel technique to reduce the recognition time in efficient mode.

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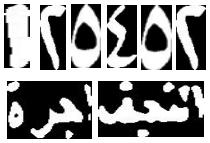
APPENDEX A: Eight sample of the proposed system results

N	Input Image	Detected and Extracted License Plate	Rotated License Plate	License Plate Segmented	Recognized characters, numbers and words
1					٥١٠٥٨د بغداد خصوصي
2					١٢٥٤٥٢ النجف اجرة
3					٢٨٥٦١ر الانبار خصوصي
4					١٢٣٨٣ القادسية خصوصي
5					١٥٢٢٩٦ النجف خصوصي

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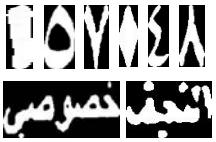
N	Input Image	Detected and Extracted License Plate	Rotated License Plate	License Plate Segmented	Recognized characters, numbers and words
6					١١٥١٣٤ النجف خصوصي
7					١٥٩٩٧٩ النجف خصوصي
8					١٥٧٠٤٨ النجف خصوصي