# INTERNATIONAL JOURNAL OF RESEARCH – GRANTHAALAYAH

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Science

# USING AN EIGEN VALUES AND SPATIAL FEATURES FOR BUILDING AN IRAQI LICENSE PLATE DETECTOR AND RECOGNIZER

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## Abstract

This paper produced a system for license plate recognition problem for Iraqi cars. The system depending on edges and position to locate license plate and character detection within it, for characters' recognition an Eigen value for prepared templates was used to identify each character with template matching for recognizing government. Euclidian distance is invested for taking a decision; Experiments show that the recognition success was high and precise.

***CITE THIS ARTICLE:*** Enas Wahab Abood (2017). "USING AN EIGEN VALUES AND SPATIAL FEATURES FOR BUILDING AN IRAQI LICENSE PLATE DETECTOR AND RECOGNIZER." *International Journal of Research - Granthaalayah*, 5(2), 13-22. https://doi.org/10.5281/zenodo.345436.

## 1. Introduction

For each vehicle, A License Plate Number (LPN) considered as an identification data used to trace the vehicle on roads and in records, controlling access and parking, stolen and marketing [1]. There are more than half a billion vehicles on the worldwide and they are differing in types of its LPN from country to country as well as is the same country [2], so we need an effective method to ease the detection and recognition butter than manual methods. The first studies of automatic Vehicle License Plate (VLP) recognition were being started since 1990s. The first module was based on boundary lines characteristics. The car image was preprocessed to enhance boundary lines(edges) with some filters like gradient filter to produce an edging image then being binarized to detect lines by suggested algorithms like Hough transform, after that a plate-candidate is represented by 2-parallel [3][4]. The completed systems of Vehicle License-Plate Recognition System (VLPRS) contains three main tasks: VLP detection, plate number segmentation, and plate number recognition, in real time applications the speed in any of these task is important as the accuracy is required and that speed in processing comes from putting some constrains in capturing the car images like camera distance and angle [5].

Many automatic methods were presented to license plate recognition by many researchers using mathematical and artificial intelligent techniques like fuzzy space[6] , neural network, template matching and image frequency analysis approach (such as DFT) .Some researchers combine two or more methods as  a classifier like including a decision tree and a hold up vector machine with a harmonized fifth-degree polynomial kernel [7],or using a neural network classifier as in Optical Character Recognition System(OCRS) that contain two layers of Probabilistic Neural Network (PNN)  which was trained to classify alphanumeric characters from car license plates based on data extracted from algorithmic image processing(OCR) ,also using a three-layer feed-forward neural network to test images in real parking lots based on Spatial/Frequency Domain Filtering for extract features[8] while others used ELMAN Neural network as a classification mechanism with edge as a basic in segmentation[1]. A hidden Marcov model take a place as a recognizer within OCR model that produced by Tran Duc Duan and et.al. for Vietnamese plates recognizer in real time application that was evaluated in two experiential image sets [5].

The proposed system recognizes Iraqi car number that take three different shapes but all composed of Arabic alphabets and Indian digits. The main steps of the system are feature extraction and recognition, the feature extraction contains the image acquisition, segmentation of the region of interest (ROI). Then the extracted ROIs are fed to a classifier using a Euclidian function with an Eigen values for saved database of digits and letters.  the results of experiments proved that the proposed system works efficiently, and simultaneously to improve the accuracy for the recognition.

## 2.  Contents of LPR System

To build a successful LPR system you need elements like images for cars that may captured directly or saved previously with a suitable cameras from front or back of the car and in our system we used a frontal images of  parked cars in different weather conditions and fixed distance and resolution, A second element is a database for comparison that contains all characters used in LP ,with Iraqi LP and for this system    an Indian digits ( ٩ ٨ ٧ ٦ ٥ ٤ ٣ ٢ ١ ٠ ) and the Arabic alphabet "أ ب ج د ر س ط ف ك م ن و ي " stored as an Eigen values table and template for government syllable . Finally, a computer with a suitable software and hardware especially a camera and programming language like MATLAB that make ease to deal with digital signals like images and videos.

## 3.  Preparing a Database

### 3.1.LPN Images

In Iraq there are many types of license plates that differentiate by foreground and background colors, font types and overall style of its information ,as in fig(1).

Figure 1: Types of Iraqi license plates

A digital camera was used to capture a frontal image of each car with a fixed resolution about (1200x800) pixels and 2meter distance then stored for being processed to get a database of LPNs.

The images of License Plates (LPs) were extracted automatically from frontal images by resizing images all in same size, enhancing image edges by using RETINEX algorithm that used mainly to improve contrast and intensity variance for an image by compression mechanism with dynamic rang [9], converting the image to binary and labeling the connected components of the image. After that searching for LP in the image with spatial conditions that are the size and position of it.

A 90 frontal car images were used to extract the LPN of different types to use for preparing the digits and alphabets database, fig (2).
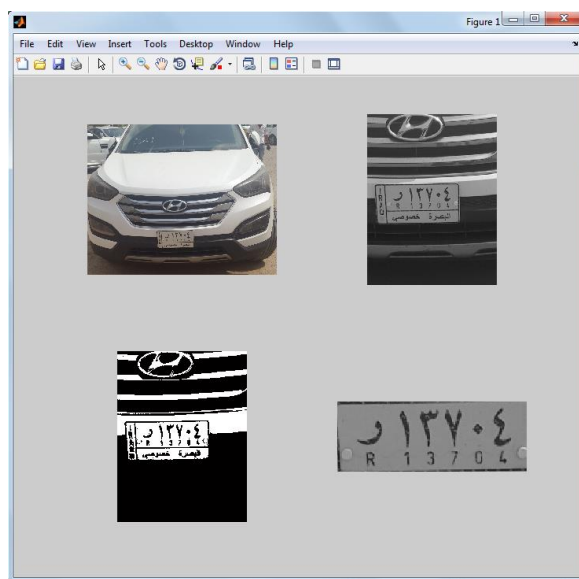


Figure 2: Extracting LP segment from frontal colored images for database

### 3.2.Eigen Core Patterns

The most effective component in our system is the Eigen Core that used for recognition. Images for all digits and alphabets were automatically cut from LP, isolated and preprocessed by binarization and resizing with 50x50 pixels, fig (3).
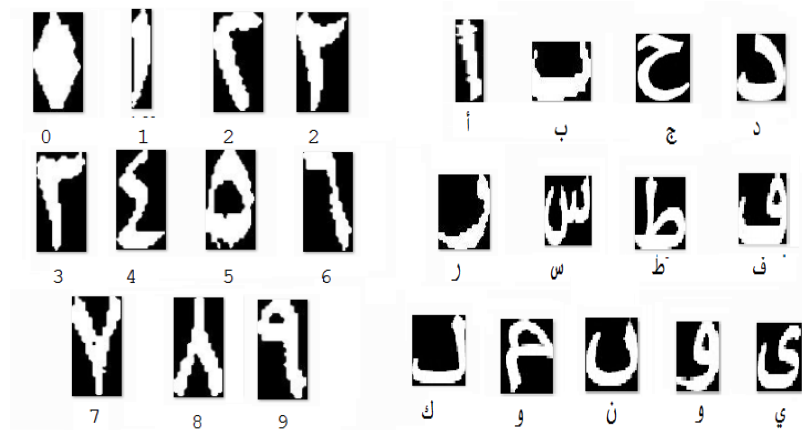


Figure 3: Indian digits and Arabic alphabet that used for recognition

Then an Eigen values was estimated for each digit and alphabet then stored for recognition, as in table (1).

Table 1: Eigen values for alphabet and digits

| number | Eigen value | letter | Eigen value |
| --- | --- | --- | --- |
| 0 | 1.643854377 | أ | 2.18E+06 |
| 1 | 1.656857267 | ب | 4.16E+06 |
| 2 | 1.654095654 | ح | 1.50E+06 |
| 3 | 1.655746666 | د | 2.81E+06 |
| 4 | 1.657524531 | ر | 3.02E+06 |
| 5 | 1.644788966 | س | 2.72E+06 |
| 6 | 1.662421303 | ط | 2.24E+06 |
| 7 | 1.655834446 | ف | 4.03E+06 |
| 8 | 1.660293086 | ك | 3.83E+06 |
| 9 | 1.65697125 | م | 1.88E+06 |
| 2 | 3.12183840 | ن | 3.69E+06 |
|  |  | و | 2.04E+06 |
|  |  | ي | 3.49E+06 |

### 3.3.Spatial Features

The place of the LP within the car usually steady in the central of it in front as well as in the back.The system cut a central segment from image of the car ,in this segment  the most possible

position is between 150 and 200 pixels from the left and with height between 180 and 220 pixels and width lies between 80 to 120 pixel.

## 4. Segmentation

Two stages in this system involved segmentation, first cleared previously to extract the LPN from car image and the other is segmenting each character from LPN to be recognized.

This process is a very important step in this system and the most difficult due to many reasons like noisy, variance of illumination, distortion and erosion. The system firstly determines the type of LP depending on number of segments in plate (LPN1, LPN2 and LPN3), fig (4).
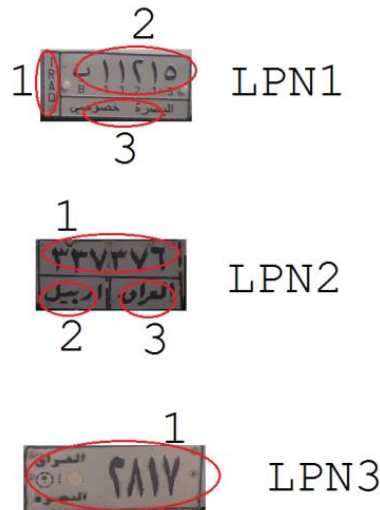


Figure 4: LPNs segments

After determining the type of LPN a process of segmenting characters is begin, for any kind the LPN image is resized by (200X100) pixels then complemented (white to black and vice versa) and labeling all objects after removing small ones:

- If the LPN of type (LPN1, LPN2), the first segment is processed firstly that have numbers. The position of the segment and its size determine if its LPN1 or LPN2: -
1) LPN1: In it the segment 2 is containing the characters of numbers that begins with alphabet then five digits with different shape of digit number 2, fig (5) .and the other two segments the first is ignored and the third is important due to the name of government that mentioned there.
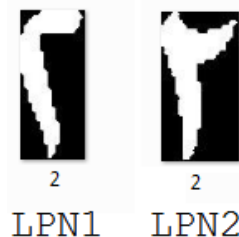


Figure 5: Two shapes of digit 2 used in Iraqi LP

2) LPN2: This type has only six digits within segment 1 and the segment 2 is used to determine the government.

• if LPN of type LPN3 then only one segment contains all information and the number of the digit is not fixed and differs from one to other.

After segmenting the LP and detect its type a process of extract characters is begin by complementing the segment to turn the characters to objects, removing small objects (>100 pixels) and extracting each one as a special file to be recognized, fig(6).
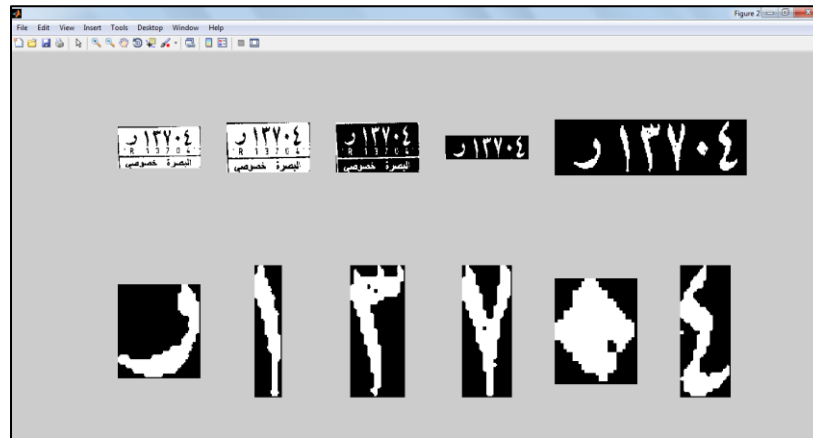


Figure 6: Steps for detecting characters and extraction

## 5. Recognition

The recognition stage depending on Eigen values was stored as patterns for each character and it happens as showed in fig (7):
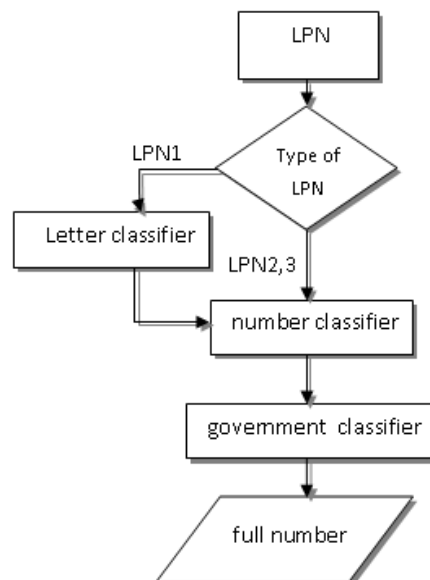


Figure 7: Main Graph of character recognition

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- Detecting the type of LPN to recognize the first character as letter, then recognizing the others as numbers with type LPN1 while all characters are digits(numbers) with types LPN2 and LPN3.
- Each type of LPN is differing from another in position of the word that represent the government as fig (4) , To classify the government the largest object of the name is taken and matched   with stored syllables for each government name using matching template and Euclidian distance equation.
- The Euclidian distance equation was estimated for each value of the character with the stored value then taking the less value to determines the opposite character, these values were a number represent either an Eigen values or stored matching templates.

## 6. Results

Three classifiers were invested in this system one for Arabic letter that take a place for LPN1 to recognize a 13 letters.

The Eigen value for the image of letter is calculated with other letters that stored for recognition then a Euclidian distance vector applied between the new value and others that computed and stored for recognition, Taking the less value to detect correspond letter. This method gave a good result with some letters that are differentiating in shape among them while some other are looks similar in some LPNs due to its similarity and they all shows in table(2) .

The letters (أ – ح – س – ط – م -و ) are recognized much better than the others while ( د -ر) are recognized mostly like each other ر as  د and vice versa and also the letters (ي-ن – ك -ف -ب) they seem to be similar as in fig(8).



Figure 8: A letters that seem to be similar in recognition

The second classifier is for number recognition; the same process of letter image is applied to number image with the values of table (1).

The result of recognition was quite good and very acceptable, they are showed in table (2) with facing some overlapping between some numbers caused by their likelihood such as:
﴿ ٢–٣ ﴾ and ﴿ ٦–٩ ﴾, fig (9).

Table 2: Experimental results of the system

| letter | Rate of success | number | Rate of success |
| --- | --- | --- | --- |
| أ | 85% | 0 | 90% |
| ب | 70% | 1 | 92% |
| ح | 73% | 2 | 78% |

| | | | |
|---|---|---|---|
| د | 52% | 2 | 95% |
| ر | 55% | 3 | 85% |
| س | 88% | 4 | 89% |
| ط | 73% | 5 | 95% |
| ف | 65% | 6 | 71% |
| ك | 68% | 7 | 87% |
| م | 95% | 8 | 93% |
| ن | 71% | 9 | 74% |
| و | 95% | | |
| ي | 60% | | |

A third classifier was used to define which government the car is belong. A good result was presented in recognizing government names for over than 100 images of cars as in fig(10).



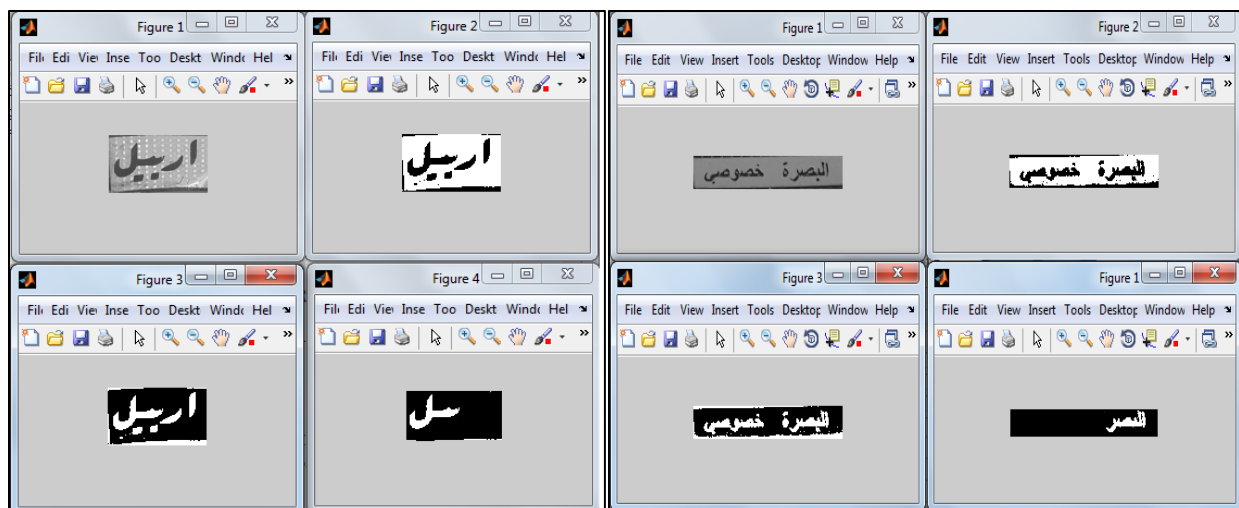Figure 9: The digits that look similar in recognition



Figure 10: Governments recognition

## 7. Conclusion

The system scores very good results in recognizing using Eigen values as a features and Euclidian distance as a matching scheme ,The collected images were taken under different condition of weather and illumination with  various degrees of distortion and erosion that caused mostly some difficulty in segmenting and matching, the experimental results showed in fig(11),table(2).
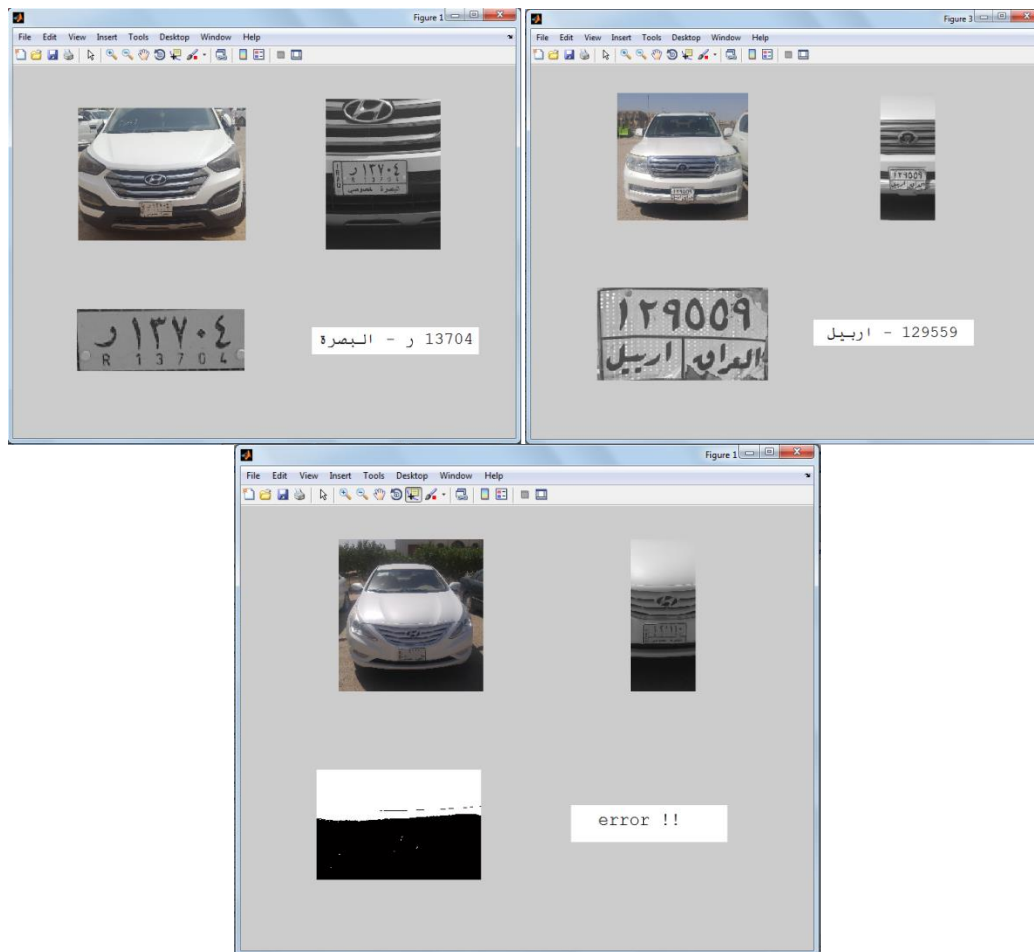
Figure 11: Results of the system

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