## ORIGINAL ARTICLE

# Automated new license plate recognition in Egypt

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**Abstract**   License plate recognition (LPR) was an effective form of Automatic Vehicle Identification (AVI) systems. In this paper, a new and simple technique was presented for Egyptian vehicle's LPR system. The proposed technique consists of three major parts: Extraction of plate region, recognition of plate characters, and database communication. A video stream was one of the most important advantages of this system. The real-time was capability, and that it did not require any additional sensor input such as infrared sensors. This approach provided a good direction and performance for Automated New License Plate Recognition in Egypt.

## 1. Introduction

Vehicles play very big role in transportation. In Egypt, vehicles have been increased because of population growth, cheaper, and installment of domestic car, more families have one or more cars. Therefore, control of vehicles is becoming a big problem and difficult to solve.

AVI systems are used for the purpose of effective control. LPR is a form of AVI. It is an image processing technology used to identify vehicles by only their license plates. Real time LPR plays a major role in automatic monitoring of traffic rules and maintaining law enforcement on public roads.

Since every vehicle carries a unique license plate, no external cards, tags, or transmitters need to be recognizable, only license plate.

There are many systems of LPR, those systems can be classified as: template matching method [1,2] and learning based method [3–11]. Some of the previous algorithms have limiting conditions [12], such as fixed illumination [13], fixed type of license plate, stationary backgrounds [14], prescribed driveways [11,15], limited vehicle speeds [16,17]. This study improves many of these limitations.

## 2. Methodology

The proposed technique was designed for LPR system. Fig. 1 shows the algorithm of the proposed technique.

### 2.1. Extraction

#### 2.1.1. Pre-image

There are three types of car detection in LPR system. The first method is sensor detection by using infrared sensors,

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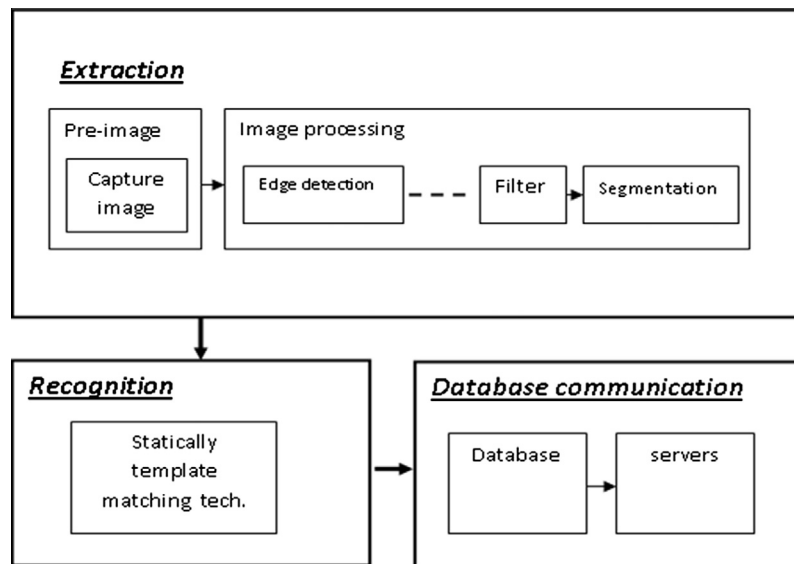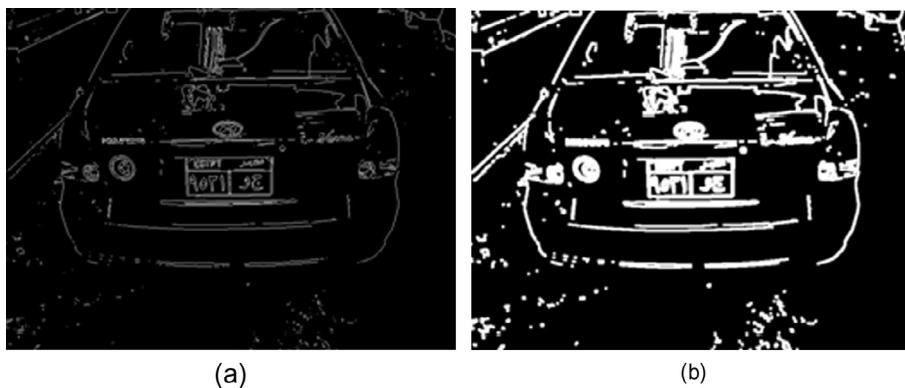
**Figure 1** The proposed technique algorithm.



**Figure 2** The capture of original image.



**Figure 3** The gray scale image.



(a)

(b)

**Figure 4** (a) Sobel edge detector, (b) dilation.

**Figure 5**  (a) Filled image, (b) erosion image.



**Figure 6**  (a) Smoothing image, (b) filtering image.

the second is image processing methods, and the third is loops techniques (magnetic loopsinductive loops).

The image processing method was used in this technique. The captured image of a car taken from 3 m by a camera. Fig. 2 shows the capture of original image.

### 2.1.2. Image processing

This stage was divided into two sub-stages.

● **Detection stage:**

The identification of objects within an image can be a very difficult task. In this stage, the capture image of the car converted to gray scale image. Fig. 3 shows the gray scale image of capture image.

The aim of this stage is to find rectangles of plate vehicles. The edge detection was applied by using Sobel edge detector. Morphological algorithm, dilation, and erosion [18–22] were used.

In dilation, every background pixel that is touching an object pixel is changed into an object pixel. Dilation makes the objects larger, and erosion is adversely of dilation. Dilation was used in vertical and horizontal lines to detect the structure of rectangle. Sobel edge detector and dilation are shown in Fig. 4.

The filling holes algorithm used to fill rectangles that result from dilation process. Smoothing the filled image result from filling holes algorithm by eroding it using erosion operation with square structure element to specify the candidate plate re-

gions. However, there may be more than one candidate region for plate location. The filled image and erosion image are shown in Fig. 5.

Filtering and smoothing eroded image by using 2-D median filter with mask $5 \times 5$ then followed by removing unwanted objects which its counts may not form a candidate region for the plate. Fig. 6 illustrates the smoothing and filtering image.

To obtain the plate region in this phase, the other regions must be eliminated. Some criteria tests were applied to the final image, and these tests include:

1. Rectangle check
   Checking that the candidate regions for plate had rectangle shape by compare white pixels count of these regions to their areas with $\pm 5\%$ tolerance
   If count of white pixels = $\pm 5\%$ area of these region
   This region may be a plate
   Else
       This region not a plate
2. Plate dimension check
   The Egyptian plate had a fixed dimension with height equal to 17 cm and width equal to 32 cm, so the ratio between heights to width approximately 1:2.

After rectangle check, the dimension check applied of the succeed regions of rectangle shapes, If 1.5 < width/height of the succeed region < 2.5

This region may be a plate
- Else
  This region not a plate

By applying the previous steps, the candidate plate regions and locations would be defined, cutting, and saving them from the gray scale image and original image to use later. Fig. 7 shows the Egyptian plate region.

- **Segmentation:**

Segmentation is one of the most important elements in automated analysis. At this step, the objects or other entities of interest are extracted from an image for recognition processing [23]. In the segmentation of plate characters, license plate is segmented into its constituent parts obtaining the characters individually.

A new Egyptian license plate has a fixed size 17 cm × 32 cm as shown in Fig. 7. The plate region is divided into three parts, the first part is high part of plate region with 62 mm [24] that contains word of Egypt by Arabic and English, a background color of this region refers to type of car (private, taxi, etc.). The reminder region of the plate is divided vertically into two regions; right half contains plate characters, and left half contains numbers.

Each of Egyptian plate regions of gray scale image and original image was segmented into two parts with a ratio 1:2 from the height. Analyzing the first part of original image using color filter to obtain the type of car.

Then used the second part of the gray scale image. Filtering for enhancing the image and removing the noises and unwanted spots. At first outer boarder was removed then inner separator between letters and numbers. Then, median filter was applied to enhance the image, and the next step removed unwanted objects, which less than 200 pixels because there



**Figure 9**    (a) Image numbers. (b) Image letters.
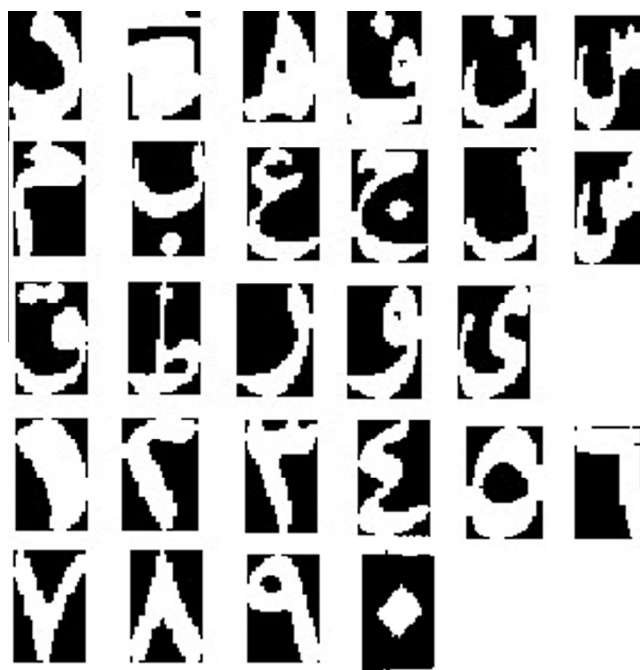


**Figure 10**    The individual characters and numbers.



**Figure 11**    Alphanumeric characters.



**Figure 7**    The Egyptian plate.



**Figure 8**    (a) Image with outer border. (b) Image without border.
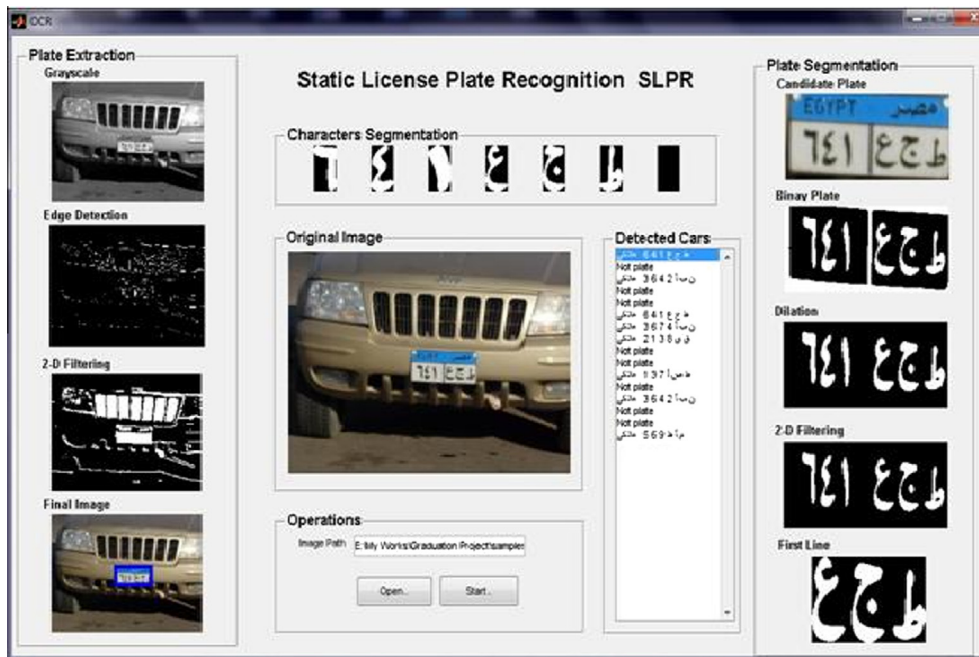
**Figure 12**    The characters recognition by GUI.

**Table 1**    Database of vehicles refer to their colors.

| Color | Refers to |
|---|---|
| Light blue | Private vehicles |
| Orange | Taxis |
| Red | Trucks |
| Gray | Buses |
| Beige | Limousines and tourists' buses |
| Green | Diplomatic vehicles |
| Yellow | Vehicles with unpaid customs |
| Dark blue | Police vehicles |

**Table 2**    A symbol of traffic administration table.

| الحرف الثاني | الحرف الأول | الارقام | الحرف | المحافظة |
|---|---|---|---|---|
| | | 3 | ﺝ | القاهرة |
| | | 4 | ﺝ | حلوان |
| | | 4 | ﺍ | الجيزة |
| | | 4 | ﺝ | 6اكتوبر |
| | عن | 4 | ﺝ | الاسكندريه |
| | ﻥ | 4 | ﺍ | البحيره |
| خ | ﻃ | 4 | ﺍ | بور سعيد |
| ﺱ | ﺩ | 4 | ﺝ | السويس |
| ﺕ | ﻅ | 4 | ﺝ | الاسماعيليه |

were some letters which had a dot. Fig. 8 shows Image with and without border.

Then dilation operation was applied to the image for separating the characters from each other if the characters were close to each other. After this operation, separating the image into two parts with the same size, one part contained numbers and the other contained letters, this separation increase the performance of recognition.



**Figure 13**    Database of city car.

Separating image into number and letter parts is illustrated in Fig. 9.

After separation, horizontal projection was applied to find starting and end points of characters. Then, the individual characters and numbers cut from the plates are shown in Fig. 10.

### 2.2. Character recognition

After segmentation steps, the characters and numbers were cut into blocks with fixed size as shown in Fig. 10. These blocks were matching with previous database blocks of characters (27 alphanumeric characters – 17 alphabets and 10 numerical) with the size of $50 \times 25$ as shown in Fig. 11.

The statistical correlation method was used in matching technique. Since there were two signals as unknowns (input image and known database image) in this system, cross correlation was used.

Let $F_1(j,k)$ and $F_2(j,k)$ for $1 \leqslant j \leqslant J$ and $1 \leqslant k \leqslant K$

Represent two discrete images denoting the image to be searched and the template, respectively. The normalized cross correlation between the image pair is defined as:

$$R(m,n) = \frac{\sum_j\sum_k F_1(j,k)F_2(j-m+(M+1)/2, k-n+(N+1)/2)}{\left[\sum_j\sum_k |F_1(j,k)|^2\right]^{1/2}\left[\sum_j\sum_k |F_2(j-m+(M+1)/2, k-n+(N+1)/2)|^2\right]^{1/2}}$$

The graphical user interface (GUI) in MATLAB was used to build this technique. Fig. 12 shows the characters recognition by GUI.

### 2.3. Database communication

#### 2.3.1. Database

Database was built by using Microsoft access database. It depended on the majority information of a car such that: type of a car, detect a car city, and faults cost.

*2.3.1.1. Type of a car.* Plate color which recognizes types of the cars. There are many color plates in Table 1.

*2.3.1.2. Detect a car city.* Traffic administration in Egypt designed rules to identify each car in Egypt. These rules depended on the number of digits of characters and numerical numbers to detect a car city. A symbol of a traffic administration table which used to detect the city (government) of the car in Table 2 and database table in Fig. 13.

| The faults | the cost |
|---|---|
| كسر الاشاره | 150p |
| السرعه الكبيره د اثناء السير. | 150p |
| نقل عدد ركاب اكثر من المخصص | 150p |

**(a)**

**Fault_Table**

| ID_Fault | Cost | Type_Fault | Add New Field |
|---|---|---|---|
| 1 | 150 | كسر اشاره | |
| 2 | 150 | عدد ركاب اكثر | |
| 3 | | | |
| * (New) | | | |

**(b)**

**Fault_Car**

| ID_Car | ID_Fault | Date_Fault | ID_City |
|---|---|---|---|
| 1 | 1 | 12/1/2010 | 4 |
| 2 | 1 | 5/7/2009 | 1 |
| 3 | 2 | 3/2/2010 | 3 |
| 1 | 2 | 12/5/2010 | 2 |
| 4 | 1 | 12/1/2010 | 1 |
| 3 | 1 | 12/6/2010 | 5 |

**Figure 14** Faults toll and two database tables.

**Table 3**   Zero normal form table.

| Car_num | City | Color | Type | Fault | Date fault | IP city | Cost fault |
|---|---|---|---|---|---|---|---|
| ٢٤٥ ج ـ و | Cairo | Blue | Private | Beak sign | 12/1/2010 | | 150p |

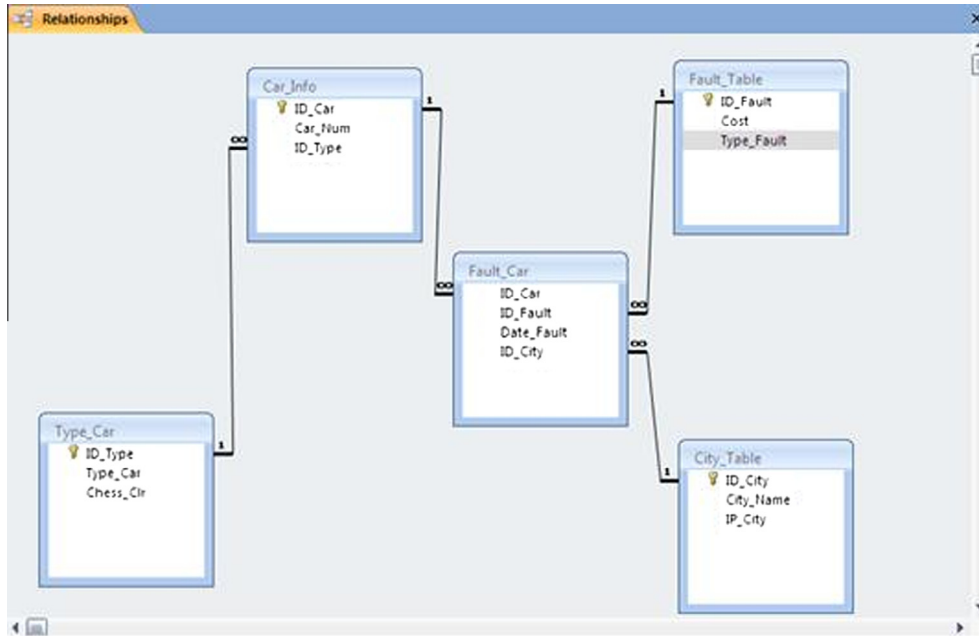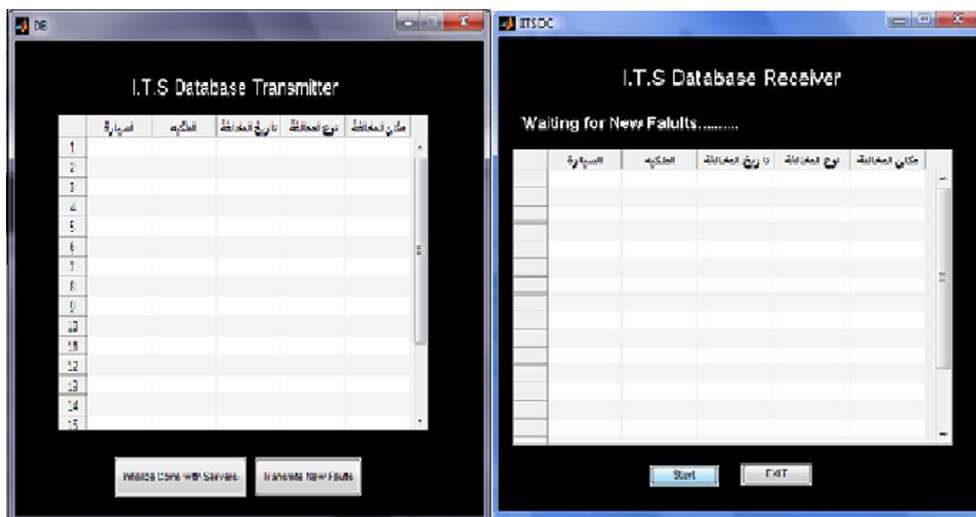| City | Color | Type | Fault | Date fault | IP city | Cost fault |
|---|---|---|---|---|---|---|
| Cairo | Blue | Private | Beak sign | 12/1/2010 | | 150p |



**Figure 15**   The relation among tables.



**Figure 16**   Database transmit and receive.

*2.3.1.3. Collect information about the faults.* There are a lot of faults for careless drivers which cause big problems. So, traffic administration put a toll to restrict of careless driver. Fig. 14 shows the faults toll and two database tables.

*2.3.1.4. Assemble database.* All the previous information collected in the zero normal form table which shown in Table 3.

The construction and relationships among database facilities tables are illustrated in Fig. 15.

### 2.3.2. Network and servers

The User Datagram Protocol (UDP) was used to send and receive data through wireless network among the servers of the

cities. By using UDP, computer applications and datagram can send messages to other hosts on an Internet Protocol (IP). Fig. 16 shown the database transmitted and received by using UDP and GUI.

## 3. Experimental results

The proposed technique had been experimented to measure the performance and accuracy of the system. The system was tested by 100 patterns under several conditions. The characters and numbers were obvious and clear in new plate that played a good condition for identification. The identification was 91%. The failed identification came from mostly motion blurred or overlapped by other Vehicle's body or slant and dirty in the plates.

## 4. Conclusions

This system was designed by GUI and UDP under Matlab software for recognizing a new license plate in Egypt. A video stream at a real time was advantage of this technique. The performance and accuracy were excellent (91%). Database was built by traffic administration rules, so that the system could be applied as practical application.

## References

[1] J.R. Cowell, Syntactic pattern recognizer for vehicle identification numbers, Image and Vision Computing (1995).
[2] V. Shapiro, G. Gluhchev, D. Dimov, Towards a multinational car license plate recognition system, Machine Vision and Applications 17 (3) (2006) 173–183.
[3] L. Zheng, X. He, Q. Wu, T. Hintz, Character recognition of car number plates, in: International Conference On Computer Vision (VISION'05), vol. 1, 2005, pp. 33–39.
[4] M.S. Aksoy, G. Cagil, A.K. Turker, Numberplate recognition using inductive learning, Robotics and Autonomous Systems Elsevier 33 (2000) 149–153.
[5] K.K. Kim, K.I. Kim, J.B. Kim, H.J. Kim, Learningbased approach for license plate recognition, Neural Networks for SignalProcessing X, 2000. In: Proceedings of the 2000 IEEE Signal Processing Society Workshop, vol. 2, 2000, pp. 614–623.
[6] Y. Zheng, H. Li, D. Doermann, Machine printed text and handwriting identification in noisy document images, IEEE Transactions on Pattern Analysis and Machine Intelligence 26 (2004) 337–353.
[7] B. Zhao, Y. Liu, S.W. Xia, Support vector machine and its application in handwritten numeral recognition, in: Proceedings 15th International Conference on Pattern Recognition, vol. 2, 2000, pp. 720–723.
[8] L. Zheng, X. He, Number plate recognition based on support vector machines, in: Proceeding of IEEE AVSS 2006 Conference. ISBN-13: 978- 0-7695-2688-1, 2006.
[9] J.A.G. Nijhuis, M.H. Brugge, K.A. Helmholt, License plate recognition using DCTNNs, Security Technology, in: Proceedings 1998 Fifth IEEE International Workshop on Publish, 1998, 1997, pp. 212–217.
[10] S. Draghici, A neural network based artificial vision system for license plate recognition, International Journal of Neural Systems 8 (1997) 113–126.
[11] R. Parisi, E.D.D. Claudio, G. Lucarelli, G. Orlandi, Car plate recognition by neural networks and image processing, in Proc. IEEE Int. Symp. Circuits and Systems, vol. 3, 1998, pp. 195–198.
[12] D.M. Emiris, D.E. Koulouriotis, Automated optic recognition of alphanumeric content in car license plates in a semi-structured environment, in: Proc. Int. Conf. Image Processing, vol. 3, 2001, pp. 50–53.
[13] P. Davies, N. Emmott, N. Ayland, License plate recognition technology for toll violation enforcement, in: Inst. Elect. Eng. Colloquium Image Analysis for Transport Applications, vol. 1, 1990, p. 2.
[14] L. Salgado, J.M. Menendez, E. Rendon, N. Garcia, Automatic car plate detection and recognition through intelligent vision engineering, in: Proc. IEEE Int. Carnahan Conf. Security Technology, 1999, vol. 71–76.
[15] K. Miyamoto, K. Nagano, M. Tamagawa, I. Fujita, M. Yamamoto, Vehicle license plate recognition by image analysis, in: Proc. Int. Conf Industrial Electronics, Control and Instrumentation, 1991, pp. 1734–1738.
[16] G. Adorni, F. Bergenti, S. Cagnoni, Vehicle license plate recognition by means of cellular automata, in: Proc. IEEE Int. Conf. Intelligent Vehicles, 1998, pp. 689–693.
[17] A. Broumandnia, M. Fathi, Application of pattern recognition for Farsi license plate recognition, ICGSTGVIP Journal 5 (2) (2005).
[18] F. Martín, M. García, J.L. Alba, New Methods for Automatic Reading of VLP's (Vehicle License Plates), Presented at IASTED International Conference Signal Processing, Pattern Recognition, and Applications, SPPRA 2002.
[19] Hongliang Bai, Changping Liu, A hybrid license plate extraction method based on edge statistics and morphology, in: Proc. Conf. on Pattern Recognition (ICPR), 2004, pp. 831–834.
[20] Danian Zheng, Yannan Zhao, Jiaxin Wang, An efficient method of license plate location, Pattern Recognition Letters 26 (15) (2005) 2431–2438.
[21] SherrZheng Wang, HsMian Lee, Detection and recognition of license plate characters with different appearances, in: Proc. Conf. Intelligent Transportation Systems, vol. 2, 2003, pp. 979–984.
[22] Serkan Ozbay, Ergun Ercelebi, Automatic vehicle identification by plate recognition, World Academy of Science, Engineering and Technology 9 (2005) 1.
[23] Rafael C. Gonzales, Paul Wintz, Digital Image Processing Book, 2nd ed., Prentice-Hall, 1987.
[24] Emad F. Elkhaiat, Transportation System between Theoretical and Application book, Police Academy, 2009.