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# Design and simulation system to detect the location and extraction of the license plate numbers of vehicles using template matching and averaging

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**Abstract**: Today, the identification and extraction of the license plate numbers of vehicles entering the car parking and entrance systems has become an essential part of the system. In this paper, we introduce an efficient system with high precision and high speed for rapid detection of plaque location and extract license plate numbers for a Vehicle. The system was tested on 150 shots in three plate recognition, character separation and extraction of performance numbers were equivalent to 95.6 percent that shows the accuracy is acceptable.

**Keyword***:* Identification plate, segmentation characters, license plate Recognition (LPR), template matching

## I INTRODUCTION

Long Vehicle parking systems has long been based on objective observation of the human user and or the camera. Later, with the advent of image processing systems, the image plate was also extracted, and was considered as the most important centers of military, security, office plants, stores and ..... Today, with the development of image processing and the ability to extract characters from color images led to a recent discussion of simulation systems as to extract the license plate numbers in most conferences, and to find ways to identify the location extract license plate numbers. But in any case, the issue of creating a comprehensive and efficient system that can operate with a minimum of complexity and cost of making the vehicle license plate number of the input extract seems to be a applicant. This paper introduces a system which generally consists of three parts.

1- Car detection of input
2- Identification and segmentation of the image of plate from the taken image of the vehicle
3- Extraction plate numbers

The process described below and in Figure (1) is shown.

The downloaded images are converted to grayscale. Then, toward the surrounding objects (edges) from the output of the previous case, we can derive. And make The edges of the image to be removed by Sobel. Sobel derived type is selected because, unlike Canny derive it has less complexity and is fast. Now for the integration of these lines (joined by edge), we dilate image pervious state of our "diamond".now lines are more close to each other we can fill the close spaces[1]. It creates white solid objects, but also gained a rectangular white plate image is identified.

The solid objects are numbered. Among these numbered objects, we are seeking for special conditions to get the following items [10]. The special conditions for the license plate of a car in Iran for whatever color is the same. However, with the coordinates and dimensions of the object to separate it from the rest of the image. Equal to that segmented image from the original color image are separated. The picture angle relative to the horizon, and it earned during the angle will be placed in a horizontal orientation. However, we de-noise image of the license plate and the license plate frame and other components of the waste to remove plaque, only characters in the image plate remain. Then we began to segmenting characters in

the image plate. After this step we have eight pieces of images, each containing a character.

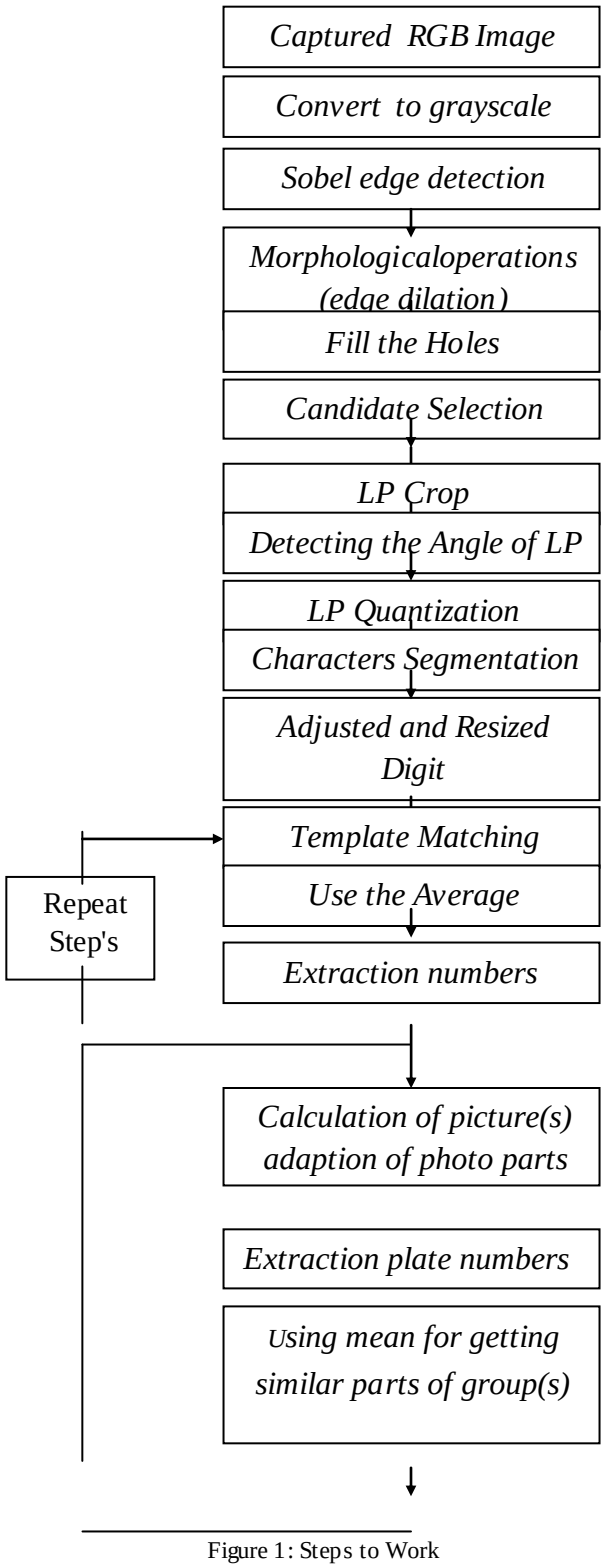



Figure 1: Steps to Work

Then using a template matching mechanism[2,5], it identifies the number or letter of that piece of image. The detection is based on a database of characters, being presented to template matching algorithm is presented. This database contains 9 sets of numbers in which each number is a collection of 10 images of different scenarios. Using the method of the *cross- correlation* to find the closest resemblance to each segment averaged image with a series of segmented acts.and finally the number corresponding to a number of seceded from the corresponding image In this way the individual characters we identify and extract plate image. The following sections discuss these steps in more detail and briefly explain the reason for using it will. We can briefly consider the work as follows:

## II THE PROPOSED METHOD

In this paper we identify and isolate the incoming plate in the picture below steps to do so

### 2.1 Pre-processing and edge detection

We get the picture the color (RGB) using equation (1) can be converted to grayscale.

$$A_{GL} = \frac{3A_R + 6A_G + A_B}{10} \qquad (1)$$

AGL where the image is converted to grayscale and AR, AG and AB spectra of red, green and blue of the original image.[7] To detect extreme variations (edges), there are two methods:

Use the first derivative:

$$I'(x) = -1.I(x-1) + 0.I + 1.I(x+1) (2)$$

Use the second derivative:

$$I''(x) = 1.I(x-1) - 2.I(x) + 1.I(x+1) (3)$$

In the next two images are considered to be the gradient term (the largest directional derivative) face. And different thresholds depending on the neighborhood, there are several methods for calculating these values.

One of the most powerful methods for computing the edge, is a canny method. In this way, there are two thresholds to detect strong and weak edges and only the edges of the edges are acceptable to have a strong connection. Thus less likely diagnosis is wrong about the noise., But Sobel operator due to low processing speed and size when compared to other methods, including canny, workability desired. Sobel edge detection method, in fact, is using Sobel masks. In Figure 2, two edge detection, horizontal and vertical Sobel masks are shown.

| | | |
|---|---|---|
| -1 | 0 | 1 |
| -2 | 0 | 2 |
| -1 | 0 | 1 |

(a)

| | | |
|---|---|---|
| 1 | 2 | 1 |
| 0 | 0 | 0 |
| -1 | -2 | -1 |

(b)

Figure 2: vertical mask (a) , Horizontal masks (b)

Next, a vertical and horizontal Sobel operator is applied on the image to amplify the corresponding edges. Then an appropriate threshold T is used to generate the binary images where the edges are highlighted in a black background. (See Equation 2).

$$G(x,y) = \begin{cases} 1 & if\ A(x,y) \geq T \\ 0 & Other\_Wise \end{cases} \qquad (4)$$

The experiments suggest that the threshold T must be from nearly 0.25 for clear, noise free, bright environments to almost 0.12 for noisy, darker environments.[1]

### 2.2 Morphological Operations

Edge of our continuous, we used Morphologicaloperations of the dilation.[6,8] To perform a structural component of the dilation must first be defined, then it can be compared with the structural component and the expansion did. In order to dilation the operations of the operation that increases the size of the internal components of one or more pixels in the image as is. This may result from a binary image where the effect of such noise or undesirable actions threshold is established, must be corrected. For example, the image of the two components may be connected to each other. The algorithm is applied so that all the black spots on the filter dilation, whereas at least one study has examined the choice of white neighbors, the point of the white will will continue to be If the black. Spread the mathematical definition is as follows:

The resulting expansion of the input image A and B is the structural component of the image reflected in the B if it moves, it is still a subset of A. In other words:

$$A \oplus B = \{z | (\hat{B}_Z) \cap A \neq \emptyset\} (5)$$

As well as a structural component geometry is selected. [1,]

### 2.3 Calculation of area characteristics of the image

To find the license plate image is obtained from the previous step, we are looking for an area with unique features. It features all the same and the color is not affiliated plaques can be considered as follows.

1- having a minimum area of more than 6500 pixels
2- minimum ratio of black to white houses more than 82%
3- of rectangular area

These three features are identified with an area with a high likelihood of plaque is included. First, we obtained images of the cavity filling down the formula No. (2) to convert binary

Then the image is converted to binary matrix. The dimension of this matrix is the number of image pixels in length and width. However we have a matrix containing a zero or one (1 points and 0 points of white, black).

In this matrix is a rectangular area with the following features to be removed:

- $\cup_{i=1}^{n} A_i \geq 6500 \quad , A_i = 0\ or\ 1 \qquad (6)$
- $\frac{\sum_{i=0}^{m} 1}{\cup_{i=1}^{n} A_i} \geq 0.82 \quad , m \leq n$

Where n is the number of pixels and pixel count is 1 m. Values are calculated empirically. Finally, because it is possible in some circumstances, such a feature may have more than two objects, the object with the greater area we choose. Or if no object with the desired condition is found, we select the largest object in the image.

### 2.4 Plate detection angle relative to the horizon:

Plaque detection angle relative to the horizon line (axis x), we act as follows.

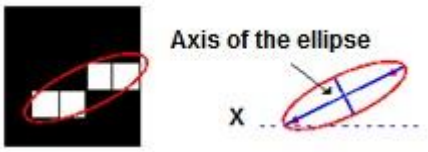
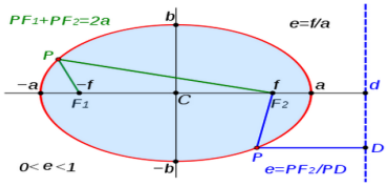



Figure 3: Image angle computing

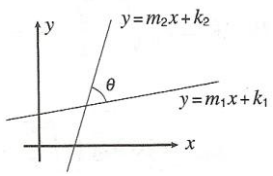
The left side of Figure 4 shows the image and the corresponding ellipsoid and Right axis for the ellipse, but the ellipse is shown. The red dots are the ellipse center and axis of the ellipse is marked with blue.

To obtain the angle of the focal points of the ellipse is calculated.




*Focal length:* $f = e.a \quad , \quad 0<e<1 \qquad (7)$

The second focal point of the mirror at this point. However, the slope of the line that passes through these two points, we calculate and We use the following formula to calculate the angle.




$$\tan\theta = \frac{m_2 - m_1}{1 + m_1.m_2} \quad , \quad (m_1.m_2 \neq 1) \quad (8)$$

**2.5 character Segmentation:**

Plaque image obtained in the previous step, this step can be segmented. The separation to be done first, we have a default value (initial value) for each bandwidth, we consider. This value is empirical. The pieces are starting image for the bandwidth we calculate. If the default value is the higher of the initial amount to start up operations, and we'll repeat the operation. But if less than or equal to, the end points are also used to extract the images.

If after completion of the work, the number of pieces of eight images below. Then reducing bandwidth we again start to separate.

**2.6Template Matching**

The technical implementation of the closeness is a technic measuring between the reference image and a set of the amount images that template is called. This Template is a set of numbers in moods and different angles, which can occur at any time LPR. For this purpose, adaptive normalized using the proximity measure obtains. For implementation in binary form, the number of pixels in each image region is formed. The actual classification should be done based on the method of k nearest neighbors[2].

Matching has a big problem. And that picture is susceptible to distortion. And factors such as font characters, its angle relative to the horizon, the brightness and resolution of each image are the factors that may template on the difference between the reference image obtained with our help. To resolve this problem, we put pre-image of each character to get them all the time and put in a horizontal orientation. Also, the brightness and the size (in terms of size and resolution) image to all the images and shapes available in a database (the source) will be equal to this problem is resolved. Also, if we get a large number of samples for each character in your database, we can increase the probability of correct choice by far.

To obtain a value close to matching the two images together using the cross-correlation between two objects we use [4]. The formula for:

$$d^2_{f,t}(u.v) = \sum_{x,y} [f(x,y) - t(x-u, y-v)]^2 \quad (9)$$

The sum of each x and y under the window consists of a selection of images of u and v. Extension d2 is as follows:

$$d^2_{f,t}(u.v) = \sum_{x,y} [f^2(x,y) - 2f(x,y)t(x-u, y-v) + t^2(x-u, y-v)] \quad (10)$$

Section $\sum t^2(x-u, y-v)$ constant., If we assume that the $\sum f^2(x,y)$ also be fixed. Mutual solidarity clause will be simplified as follows.

$$c(u,v) = \sum f(x,y)t(x-u, y-v) \quad (11)$$

The formula for measuring the proximity and similarity between the original (u) and the template (v). Which c is how close the two images is greater than [13].

In the last step we have to increase the accuracy and performance of the system at this stage, we used a new method, and it is averaging method. Simply choose the correct image while increasing accuracy and thereby detect integer.

In this way we have formed image template for any number of different angles and different scenarios of 10 (which ever amount is greater accuracy also increases) in a series called the number corresponding to the template form and a set of 90 images for numbers up be the same as the characters do. Next, segmented image of a pre-set template to compare the number and proximity of the calculated. These values together and then divided by the number of the template to (whose value is 10).

Value is near the mean image separation is set to its template. These for the 9 series (including the numbers 1 through 9) are repeated. At the end of each set had a greater average separation of the image is closer to that of the corresponding number to set it as the number of the image is extracted to identify.

$$c_{m1} = \frac{c(u, v_{1,1}) + c(u, v_{1,2}) + \cdots + c(u, v_{1,10})}{10}$$

$$c_{m2} = \frac{c(u, v_{2,1}) + c(u, v_{2,2}) + \cdots + c(u, v_{2,10})}{10}$$

$$\vdots$$

$$c_{m9} = \frac{c(u, v_{9,1}) + c(u, v_{9,2}) + \cdots + c(u, v_{9,10})}{10} \quad (11)$$

Where $u$ been image segmented and $v_{i,j}$of the template image of i-thand the image of j-th and C mi it is set close to the average value of image segmented the template is set i-th. In this case:

$$R_{max} = Max\{c_{m1}, c_{m2}, \ldots, c_{m10}\} \quad (12)$$

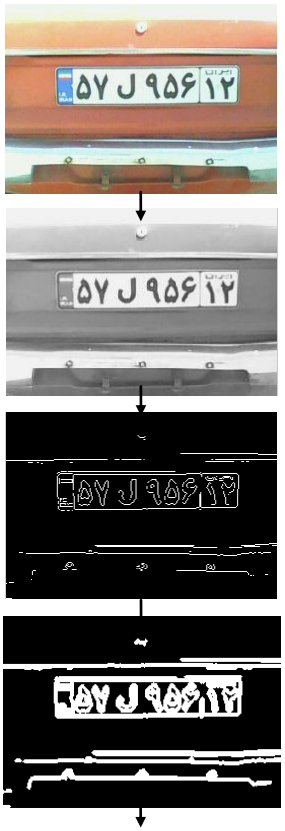
And finally:

$$if\, R_{max} = \forall c_{mi} \Rightarrow i = NamberRecog\, nazition \quad (13)$$

In which i is extracted from the image of u is segmented.

## III SIMULATION

Based on the above, we begin the process of detecting and extracting the desired number plate being, the following results are obtained.



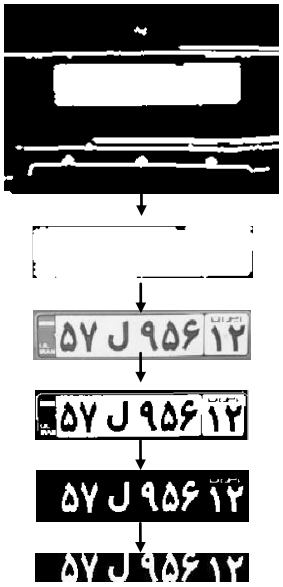


Figure 4: Identify the location of the plaque

Figure 5: Characters Segmentation and also Adjusted and Resized Digit

Our algorithm with images taken from different angles tested vehicles. In most cases, the system identifies and extracts the license plate image, the entire image is carefully extracting the license plate area contains. But in some areas of the rectangle (the fill hole) as another plaque was mined. The studies indicated that the continuous phase of the edges, the edges of the license plate image absolutely not connected to each other by a continuous increase of the problem was fixed.

segmentation of the algorithm due to the use of different terms in the number of pieces, including images of characters (for example, if the number is less than 8 had low initial bandwidth) performance of the system was good. The character extraction stage, the system has an acceptable accuracy and errors related to wrong numbers from the numbers 2 and 3 (which were often related to environmental conditions). However, with the rise and expansion of the database and to consider the types of environmental noise is less than the problems themselves.Table (1) of the proposed method and system performance [1] has been evaluated.

Table 1: Evaluation of the proposed system and the system presented in [1]

| The proposed system | | |
|---|---|---|
| SystemLPR | Correct Result | Accuracy percentage |
| Identify plaque | 147/150 | 98% |
| Segmentation Characters | 144/150 | 96% |
| Template matching | 145/150 | 96.6% |
| The proposed system in [1] | | |
| Identify plaque | 146/150 | 97.3% |
| Segmentation Characters | 141/150 | 94% |
| Template matching | 138/150 | 92% |

As we can see the accuracy of the proposed system in comparison with the proposed method [1] has been more carefully. And compared with neural networks [3] has less complexity and speed is acceptable in real-time systems can also be used.

## IV CONCLUSIONS

The analysis conducted in this paper, and procedures performed on various images, we reached the conclusion The method of averaging in the implementation stage will increase the accuracy and performance of the system.

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