License Plate Recognition for Security Places

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Received **17 / 03 / 2009**
Accepted **09 / 09 / 2009**

المستخلص

يعد نظام تمييز لوحة تسجيل المركبات أحد أهم الواجهات التطبيقية لتقنيات الحاسوب في مجال الأنظمة الذكية. وكان الغرض من هذا البحث هو إيجاد طريقة ملائمة وسهلة لتمييز لوحة تسجيل السيارات. تم اقتراح خوارزمية، في هذا البحث، لأداء هذه الوظيفة وهذه الخوارزمية تركز على الخطوات التالية وكما يلي:

معالجة صور المركبات العراقية كخطوة أولية في هذا المجال، تقطيع صورة لوحة التسجيل من صورة المركبة الأصلية، الكشف عن الموقع الدقيق للوحة التسجيل من الصورة الناتجة (والتي تعد خطوة مهمة ودقيقة في نظام التمييز اللآلي)، قطع وفصل الكلمات الموجودة في لوحة التسجيل عن الأرقام، وأخيراً تمييز الأرقام الموجودة في الجهة اليمنى من اللوحة وذلك بعمل مقاطع برمجية تميز كل رقم حسب الخصائص التي يتميز بها وتمييز أسم المحافظة وبنفس الطريقة.

ان تطبيق البرنامج على مجموعة من صور (٢٥ صورة) المركبات الملتقطة بالكاميرا الرقمية على بعد ثابت وكانت نتيجة التمييز ناجحة بنسبة ٨٠% حتى مع الصور التي تحتوي على بعض التشوهات مثل وجود الأتربة على اللوحة. كانت نسبة الفشل تقريباً ٢٠%.

Abstract

The vehicle license plate recognition system is consider as the best aspects of applying computer techniques in the intelligent systems field.The goal of this research is suggest a new suitable and simply algorithm to do this work. This algorithm concentrate on the following steps:

Pre-processing the Iraqi vehicle image, cutting the registration plate image from the origin one, detection about the exact region of plate from the produced image (which is considered as the important step in the automatic recognition system), separation and cutting the words that existent in the registration plate, at last recognition the whole number by separating to its digits (which allocated in the right side of plate) by suggestion subroutine for every digit according to its attributes and Recognition the state name by the same way.

The application of this program to many of vehicles captured images (25 images) with digital camera on the fixed distance, the result are succeed with the rate 80% even with the images having some abnormalities such as dust on the plate. The fail rate is approximately 20% .

Keywords: License plate recognition, Image processing, Segmentation and Recognition, Input – output transport information systems.

1. Introduction

A quick technological development in the area of computer image processing and constantly increasing need for efficient and cheap security and steering systems resulted in the development of different kinds of solutions based of computer picture analysis. One type of these solution is automatic car identification systems basing on localization and recognition of the license plates shown in photos or camera picture.

License plate recognition systems can be applied in different situations. They can form the bases for automatic systems steering the access to protected areas i.e. parking, Access-Control, Tolling road, Border Control, Stolen cars, Traffic control, Marketing Tool, Travel, Airport Parking. According to practical use of these systems must fulfill specific demands [4].

The aim of this research is detection and recognition the Iraqi vehicle plate for the vehicles entered to the felicitation places (as known, in every country, the vehicles have certain plate shape with certain features).

2. Related work

There has been a number of software products that can be used for LPR mainly from USA and Europe [2]. There is explanation of their algorithms as follows:

Pavol F., J. R. Parker used median filter for smoothing the gray-level image. They applied Shen-Castan edge detector and genetic algorithm to find the bounding box of license plate. They applied thresholding to obtain a binary image then binary erosion and dilation to separate the foreground regions from each other that is for recognition the character localization [9]. Kwasnicka H., Bartosz W. thresholded the binary image then a special filter applied to it. The results of them are white and black areas because of the contrast between the characters and the license plate background. They performed grouping and eliminating of objects in connected component analysis method. Then horizontal and vertical projection character localization and segmentation was performed. To perform character recognition and syntax analysis three-layer neural network was designed [8]. Dimov D., V. S., Gluhchev G., S. B. undersampled the image to about 120 columns using pixel decimation. They applied Roberts edge operator to detect the vertical edge. They used rank – filter to create a bright spot. To segmentation the plate candidate they applied vertical projection to decrease the random noise [1]. El-

Adawi M., H. K., Haragi M. used otsu's method to determine the threshold value. They applied thin edge detector (convolution kernel). Then Dilation the image in both direction. Then character segmentation by used vertical and horizontal projection. Then character identification by used training neural network [2]. Tran D. D., Tran L. H. D., Tran V. P., Nguyen V. H. used Hough Transform and Contour algorithm for detect VLP and used horizontal and vertical projection to separate plate number then recognize the number by OCR of Markov Model [11]. Tran D. D., Duong A. D., Tran L. H. D. used combination of Hough Transform and Contour algorithm for detect VLP images from **various distances and have** angles between $\pm 30^{o}$ from the camera [10]. I-Chen T., Jui-Chen W., Jun-Wei H. used the morphological operation and Support Vector Machine (SVM) algorithm for detect VLP and used shape contexts for recognition [6]. Humayun K. S., Ye Z., Danish I. used histogram equalization and Hat transformation for image enhancement, used mathematical morphology for dilation and erosion and used neural networks for recognition [4][5].

3. Features of Vehicle License Plate

Vehicle License Plate (VLP) in this paper is Iraqi VLP has the following fixed features:-

1. The plate has a rectangular shape with two columns of data on it: characters and number.
2. The plate has dark character on a bright white background.
3. The width and height of the license plate is practically known.
4. Te orientation of the plate is approximately aligned with vertical and horizontal.
5. The distance between the camera and vehicle is approximately five meters.

All these features can be shown in figure (1).

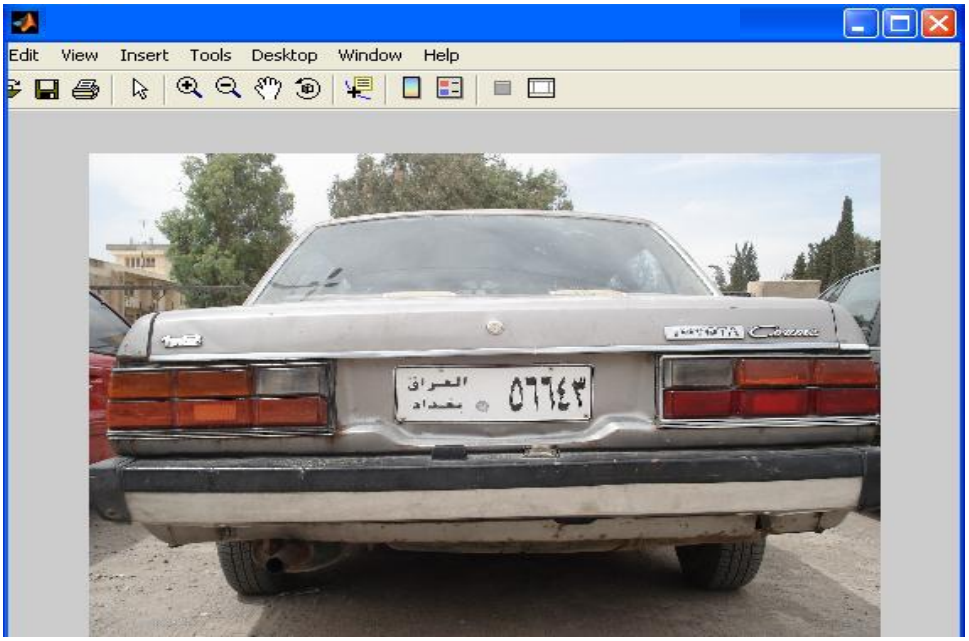
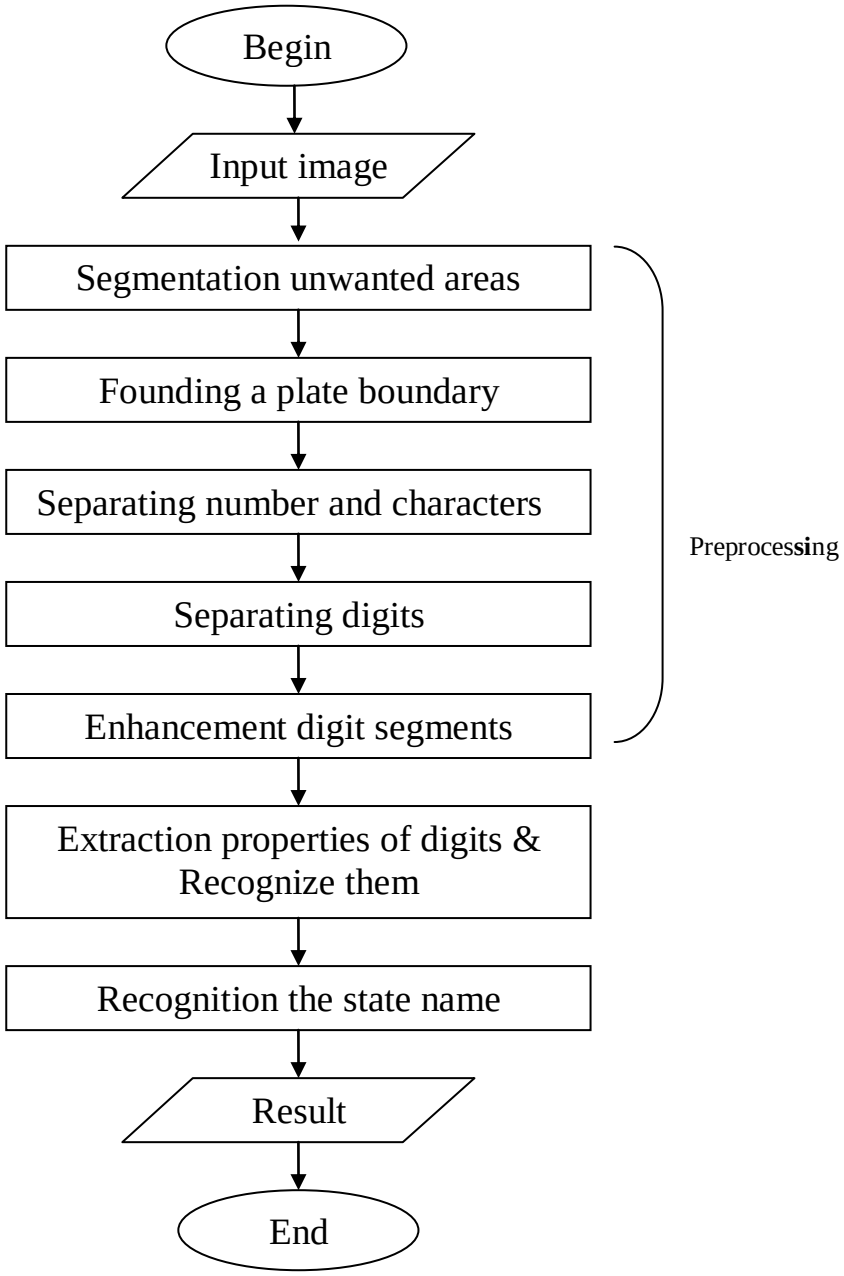


Figure (1): Car image with recognizable License Plate

4. Proposed VLP recognition algorithm

The flowchart of the proposed algorithm for the vehicle license plate recognition is shown below



Flowchart of the recognition algorithm

4-1. Pre-processing stage

This work done with color images captured by a digital camera with specific distance from vehicle and transferred to computer memory.

At the beginning convertion the image to the binary form by two steps as follows:

1. convert the input color image to a grayscale.
2. compute a global threshold level that can be used to convert a gray image to a binary image using the commands (im2bw).

```
(Program section of convert image to binary code )
x=imread('dd.bmp');
figure(11),imshow(x);
x1=imresize(x,[600 800]);
m=x1(300,320);
l1=x1;
load trees
l1 = im2bw(x1,map,0.4);
y=l1(200:end-250,250:end-250);
figure(1),imshow(l1);
figure(2),imshow(y);
y=imresize(y,[600 800]);
[ r c]=size(y);
h=0;
```

In a grayscale image, the thresholding transform sets each gray level that is less than or equal to chosen value T (the threshold value) to **0** and each gray level greater than T to 1. The result is a black and white image with **0** representing black and 1 representing white image. In this algorithm the threshold value is 0.4 approximately, it depends on the average brightness of the image. As shown in figure (2).

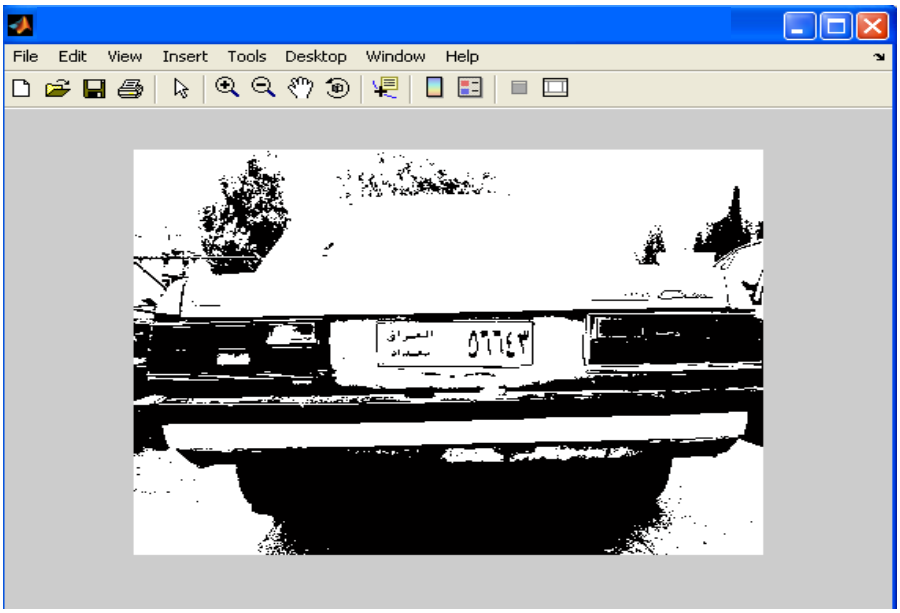


Figure (2): Thresholding image

4-2. Segmentation stage

This stage includes four substages :

4-2-1. Segmentation unwanted areas

The purpose of this stage is to locate the plate that enclose the license number. The whole idea depends on the boundary of the license plate only. This algorithm tries to decrease the amount of data in the image and avoid unwanted areas to extract only the area which have the same properties of the license plate already. This is done by limitation the central rectangular area, then resizing it to full page size by used the command (imresize). This process is illustrated in figure (3).

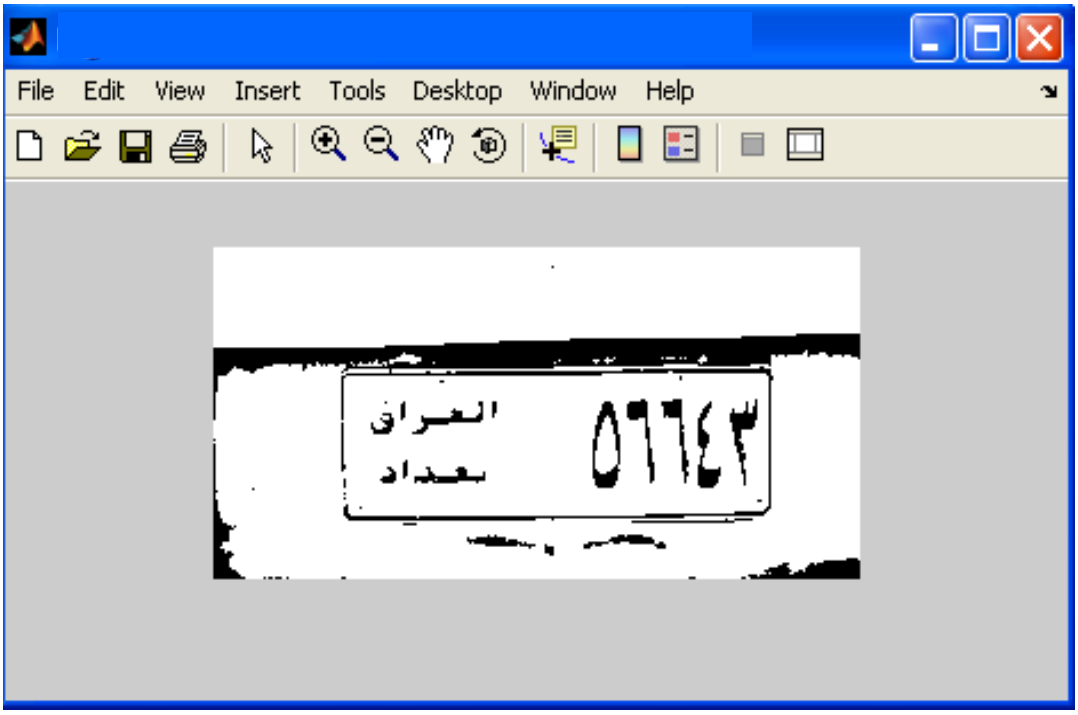


Figure (3): The Plate area segmented

4-2-2. Founding plate boundary

The extraction of license plate from the processed cutting image done by:

1. Searching about any column having approximately the same length of the license plate (number of pixels) with the condition of that all pixels are white and the first pixel of the examined column is the same pixel of the row by scanning from the first pixel of the top-left corner to down of the image,the same work done for the bottom-right corner.
2. There is also a condition of finding a row that have the value 1 (white color) and have approximately the same length in the top and bottom of plate by scanning from left to right .

The next step is,cutting the additional rows and columns (the white ones) around the wanted data (digits and words), then resizing the image to full page, this is shown in figure (4).

```
(Program section of founding plate boundary)
      for j=1:c
         for i=1:r-200
       if((y(i:i+200,j)==1)&(h==0))
       if(y(i,j:j+400)==1)
       if(y(i+200,j:j+400)==1)
                 n=i;
                 n2=n+200;
                 n1=j;
                 n3=n1+530;
                 h=1;
             end
       end
       end
             end
       end
      y1=y(n+23:n2+10,n1+20:n3);
      y2=y1;
      figure(3),imshow(y1);
      y=imresize(y1,[600 800]);
```

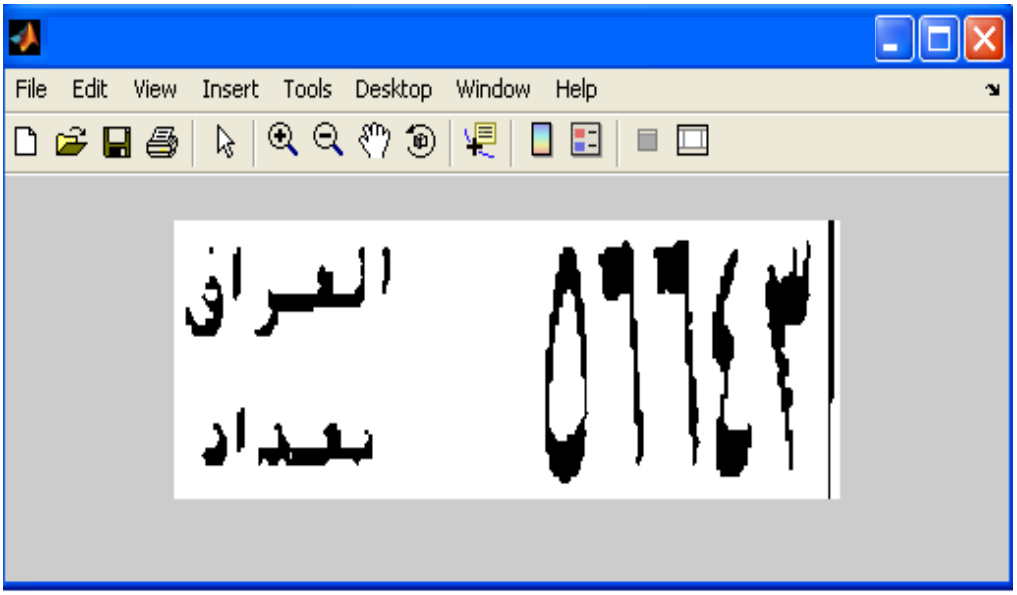


Figure (4): The extracted Plate

4-2-3. Separating number and characters

The extracted plate is divided into two parts, the left one records the name of the country and below of it is the name of state. The right one records the number of vehicle. This is done by searching (in the middle region of the plate) about any column have the same length (no. of pixels) of license plate with the value 1 (white) by scanning the image from top to bottom. So the region of the plate number could specified from character region and resized it to full page.

4-2-4. Separate digits

1. For the right part of plate, searching about the column that have a pixel of the value 0 (black) which is point to the beginning of the first digit by using the proposed function (get1). The value of this column is holded, then searching about the end of the digit by using the proposed function (get2) by searching about the column which all of its pixels are valued 1(white). This column is pointed to end of digit.
2. After finding the begin and end of every digit. Sectioning this region from the number image can done and named it as(p), then resizing it to the dimensions (400,100) pixels for distinced shown and combination the same area of every digit.
3. Repeating the previous steps until finding the last digit of the number image (on the plate).The obtained images of the digits are illustrated in Figure (5).
4. Sending the data of every digit region (p) to the proposed function (u) for recognize the digit image .

(Program section of separate digits)

```
while(k2<c)
  for i=1:c-1
    f=y(:,i);
    l=get1(f);
    if(l==1&h==0)
        n=i;
        h=1;
    end
end
y=y(:,n:end);
p1=y;
h=0;
[r c]=size(y);
 h=0;
 k1=3;
 for i=k1:c-1
    f=y(:,i);
    l=get2(f);
    if((l==1)&&(h==0))
  h=1;
   n=i;
    end
 end
 k2=k2+1;
p=y(1:r,k1:n);
[f]=find(p==0);
if(f~=0)
  p=imresize(p,[400 100]);
```

(Program section of detect the begin of digit)

```
function l=get1(x);
l=0;
[r c]=size(x);
for i=1:r
    for j=1:c
        if(x(i,j)==0)
            l=1;
        end
    end
end
```

(Program section of detect the end of digit)

```
function l=get2(x);
l=0;
h=0;
m=1;
[r c]=size(x);
for i=1:r
    for j=1:c
    if(x(i,j)==1)
    m=m+1;
        end
    end
     if(m==r)
    l=1;
        end
end
```

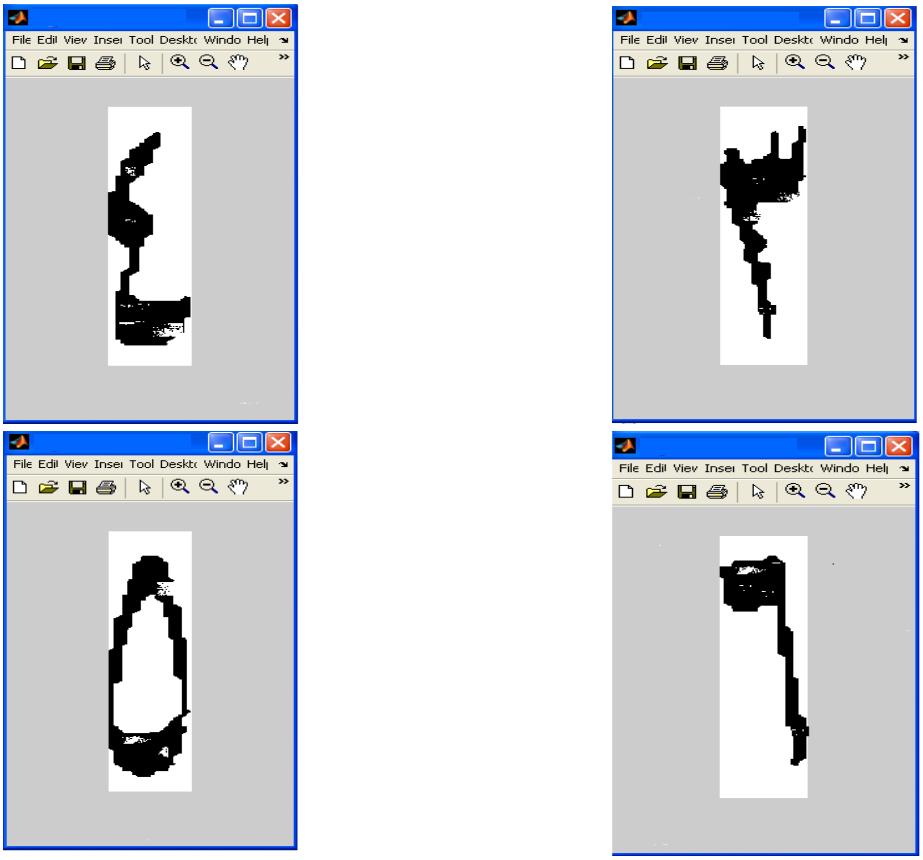


Figure (5): Plate-number segments

4-3. Enhancement digit segments

After separating the digits from number, taking the data of every digit as inputs of the proposed function p, enhancing the image of every digit to obtain the clear one by using dilation algorithm. This is done in two steps:

1. Searching about any white pixel that before and after it are black pixels.
2. coloring this white pixel (distorted one) with black ones.

The results of this process are shown in figure (6).

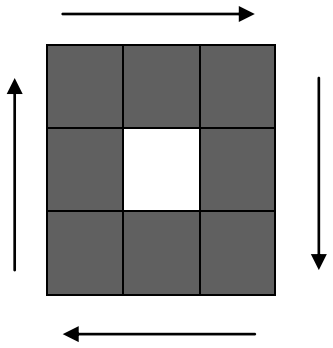
The scanning for distorted pixels is beginning for every digit segment by using many of conditional statements as following scanning loops:

1. from up to down
2. from down to up
3. from right to left
4. from left to right

This work like the pepper and salt method (filter name) .

(Program section of enhancement)

```
function p=Repairpixel(x);
p=x;
[r c]=size(p);
for i1=1:100
for i=1:r
for j=1:c-6
if(p(i,j)==0)
if(p(i,j+1)==1)
 if(p(i,j+6)==0)
     p(i,j+1)=0;
 end
 end
 end
 end
end
 for i=1:r
for j=c-6:1
if(p(i,j)==0)
if(p(i,j+1)==1)
 if(p(i,j+6)==0)
     p(i,j+1)=0;
 end
 end
 end
 end
  end
```



The directions of searching for the distorted pixel

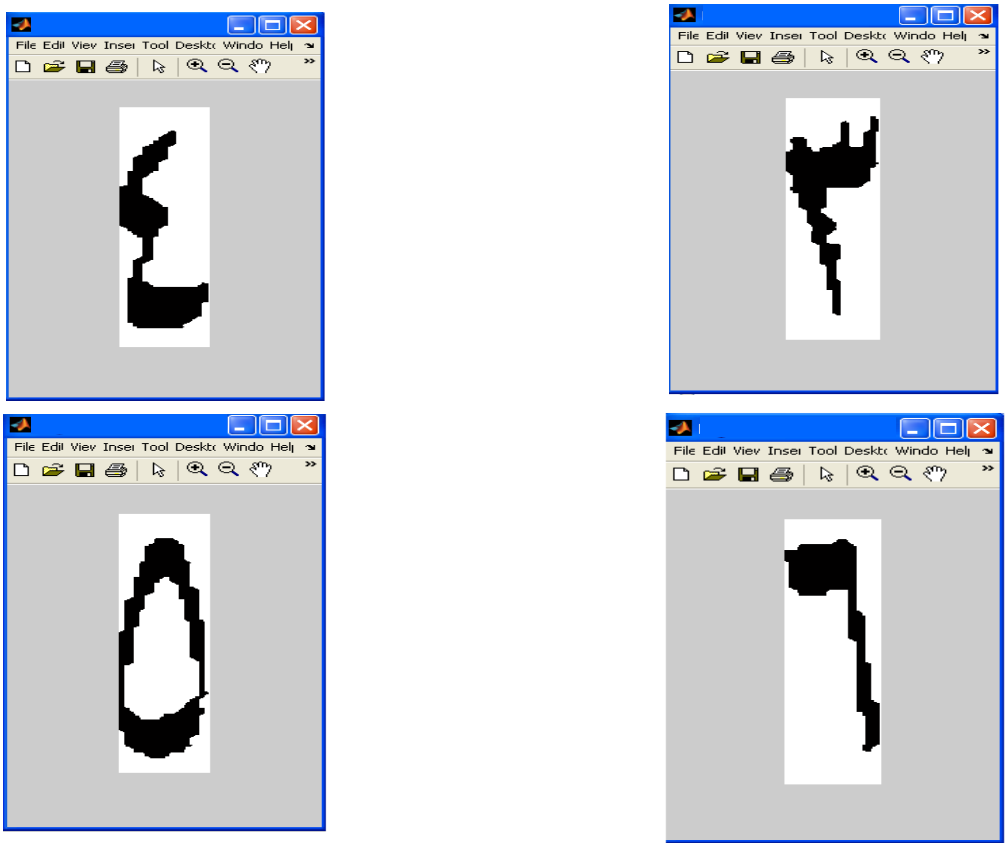


Figure (6): The enhanced Segments

4-4. Extraction properties of digits

To recognize the value of every extracted digit done by using the following algorithm

1. Specifying the properties for every digit and put it in a data base table, as shown in table (A).
2. Specifying the special regions for sectioned digit in the plate as shown in figure (7).
3. Comparing the special regions obtained from step (2) with the data base.
4. If there is matching with any digit in the data base then putting the value of digit as variable in storage, if not go to step (7).
5. Repeating step (2-4) until final sectioned digits.
6. Collecting these digits to recognize the whole number of plate and display it.
7. End.

(Program section of recognition number ٣)

```
Function u=Recognize(p);
  u=10;
 p=Repairpixel(p);

 if(p(90,3)==0||p
 (90,5)==0)

 if(p(80,30)==1||
 p(80,33)==1)

 if(p(80,60)==0||
 p(80,63)==0)

 if(p(50,85)==0||
 p(290,99)==1)

 disp('three');
  u=3;
  u
      end
      end
      end
  end
```

(Program section of recognition number ١)

```
      if(p(40,90)==1)


      if(p(320,80)==0)


      if(p(110,40)==0)


      if(p(200,60)==0)

      if(p(150,10)==1)
          disp('one');
       u=1;
       u
           end
            end
        end
            end
end
```

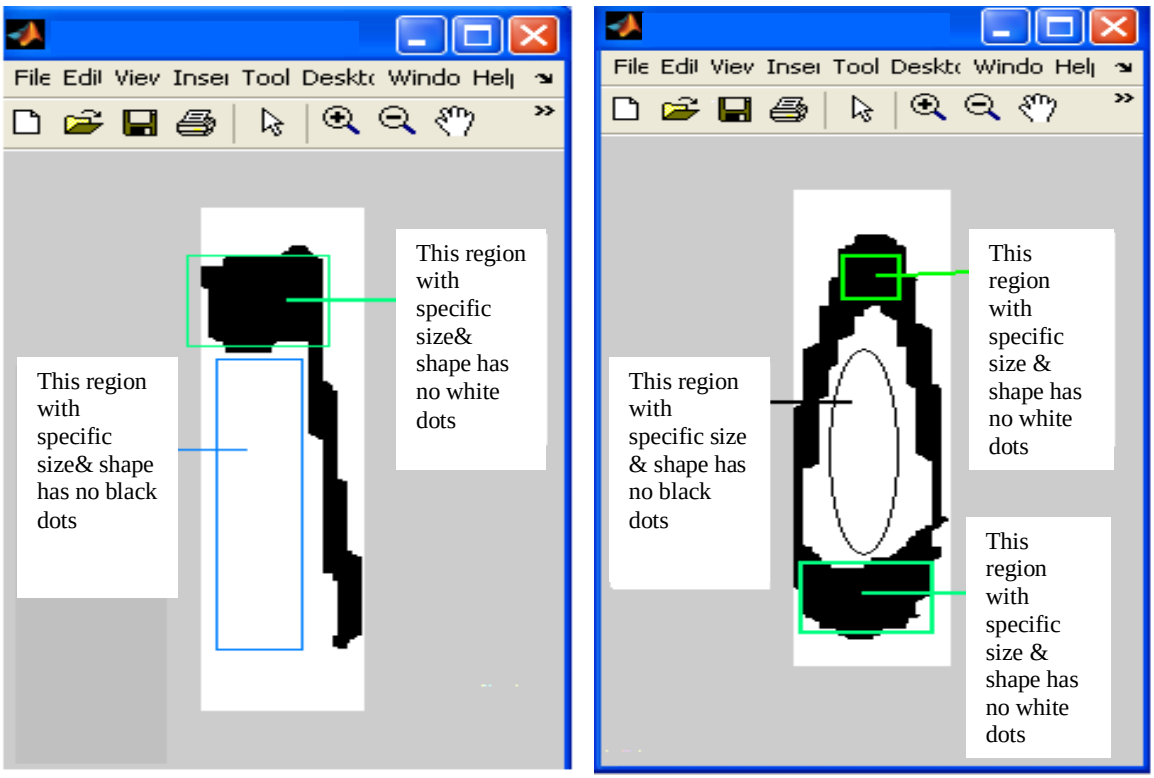


Figure (7): Some properties of digits

4-5. Recognition the state name

The recognition of the states done after cutting the left-down region of the plate image and resizing it to full page.

Recognizing the name of state on the plate by using the same functions for separate digits (get1 and get2). The function (get1) searching for the beginning point of the section while the function (get2) searching about the end of this section. This is done in two steps:

1. Taking the state-word section.
2. Sectioning the word to many sections with specific length, as shown in figure (8).

As example, the state بغداد has three specific sections and the state نینوى has two specific sections, etc.

(Program section of state-name recognition)

```
function p1=namecity(y);
[ r c]=size(y);
h=0;
k2=0;
k3=1;
k4=0;
g=0;
while(k2<c)
  for i=1:c-1
    f=y(:,i);
    l=get1(f);
    if(l==1&h==0)
        n=i;
        h=1;
    end
end
y=y(:,n:end);
p1=y;
h=0;
[r c]=size(y);
 h=0;
 k1=3;
 for i=k1:c-1
    f=y(:,i);
    l=get2(f);
    if((l==1)&&(h==0))
  h=1;
   n=i;
 end
 End
```

Table(A):properties of digits

Digit	No. of rows	No.of columns	Value
٠	40…120	50	1
	300…350	50	1
	200	50	0
١	40&150	90&10	1
	110&320&200	40&80&60	0
٢	60&130&290	90&10&50	0
	130…200	40	1
	80…90	20…60	0
٣	40…60	30…40	1
	150	20	0
	300	85	1
٤	180&330&200	10&25&45	0
	40&200&300	80&95	1
	200…230	50	1
٥	350…360	50	0
	50…60	50	0
	60	10	1
٦	310&60	90	0
	120…325	50…60	1
٧	150	15&85	0
	1…160	50…55	1
٨	300	15&85	0
	190…400	50…55	1
	150	50	1
٩	320&100	80…60	0
	130…340	10…50	1

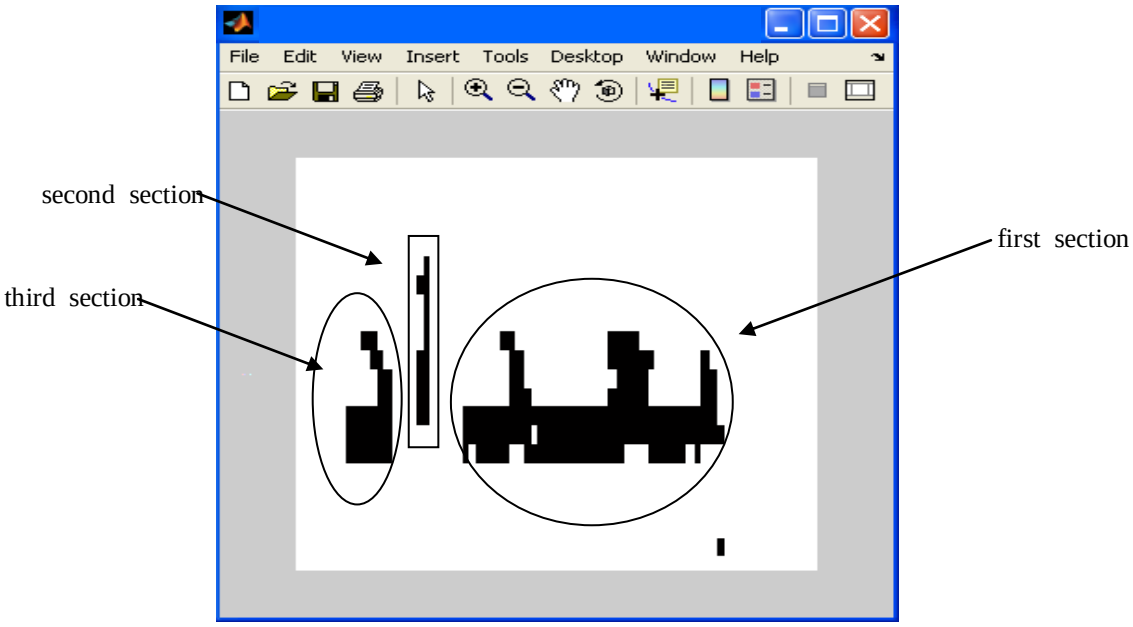


Figure (8): State- word sections

5. Conclusions

The goal of the research is to investigate the possibility to create a system for national vehicle identification based on the license plate recognition. In that no additional hardware such as transmitters mounted on the vehicle. The results obtained is real data and quite satisfactory. Finally the results could be obviously extended to other applications in Input-output transport system, ship, trains, etc. The algorithm will be extended to include different shape of plates with different registration.

The algorithm was tested for images captured by digital camera. The test done for 25 car images. The result is read for 20 images, that is mean 80% of them are good recognition. Fig. (9) and fig. (10) shows the application of the algorithm and the response of the program was to identify the plate number and its registration. The disadvantage identification came from the fixed screws on the plate that was recognized as zeros, and if the distance between the camera and car was more than certain limit or major slant on the plate. If the background of the plate was not white the contrast of characters has been poor. There is possible of many problems in shadowed regions but this could be solved by concentrate the illumination to the car region.

6. Future work

Applying modern mathematical methods for recognition the Iraqi vehicle license plate with the consideration of different colors for all types of Iraqi vehicles.

Applying the same algorithm of this research for recognize the state name for all states of Iraqi vehicles with the consideration of special features of every state.

Figure (9): Car image before and after processing

Figure (10): Car image before and after processing

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