AUTOMATIC NUMBER PLATE RECOGNITION

PROJECT REPORT

Submitted in fulfilment for the JComponent of

Digital Image Processing (SWE1010)

CAL Course

in

M.Tech. – Software Engineering

by

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ABSTRACT:

Automatic Number Plate Recognition (ANPR) is an image processing technology which uses number plate to identify the vehicle.

The main objective is to design an efficient automatic authorized vehicle identification system by using the vehicle number plate. The system is implemented on the entrance for security control of a highly restricted area like military zones or area around top government sectors like Parliament, Toll text collection, Supreme Court etc.,

The developed system first detects the vehicle and then captures the vehicle image. Vehicle number plate region is extracted using the image segmentation in an image. Optical character recognition(OCR) technique is used for the character recognition. The resulting data is then used to compare with the records on a database so as to come up with the specific information like the vehicle's owner, place of registration, further information, etc.,

The system is implemented and simulated in Matlab, and it performance is tested on real image. It is observed from the experiment that the developed system successfully detects and recognize the vehicle number plate on real images.

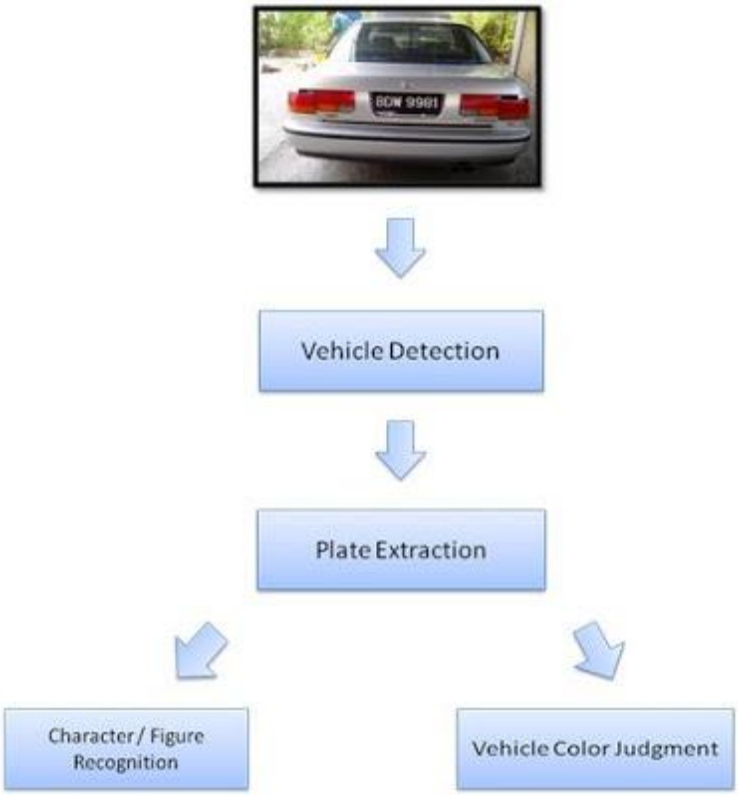
In last few years, ANPR has been one of the useful approaches for vehicle surveillance. It is can be applied at number of public places for fulfilling some of the purposes like traffic safety enforcement, automatic toll text collection, car park system

PROBLEM STATEMENT:

In this project, the main problem is to design and develop an Automatic Number Plate Recognition system for the application in a toll payment. In meantime, the system is not yet implemented into toll booth and usually need human supervision. With this project, the vehicles number plate will be automatically captured and the system will do all the images pre-processing method and the output will display using GUI.

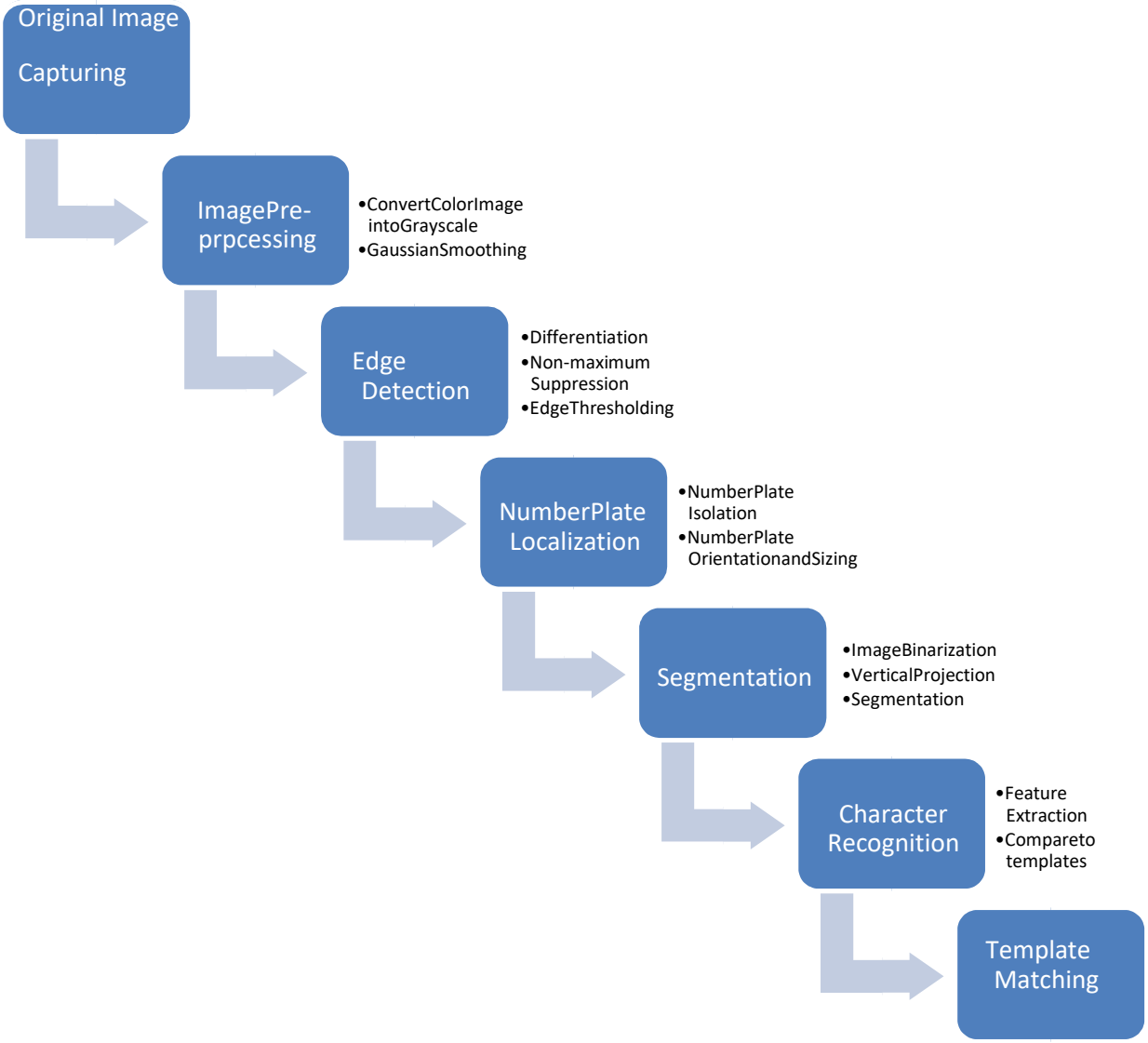
Another side problem is to upgrade, improve and rewrite the algorithms to make sure it is convenient with present technology. On the other hand, there are plenty of variety number plates like "AP032025", " TN32223" etc., on road, it is challenge to the system to extract the images because the normal standard license plate number already has its own standard size and pattern.

SYSTEM DESIGN:



MODULES

1. Original Image Capturing
2. Image pre-processing
3. Edge Detection
4. Number plate localization
5. Segmentation
6. Character recognition
7. Template matching



- The captured image is pre-processed by passing it over gray scale filter and edge detection is applied to isolate the region of interest, which is the number plate itself.
- A gray scale digital image in which each pixel is quantized exclusively the shades of neutral gray, varying from black at the weakest intensity to white at the strongest intensity.
- The obtained gray image is then binarized, that is, it is converted to logical matrix by giving the pixel values of 1 for white shade and 0 for black shade.

- The gray level plate images are enhanced by applying contrast extension and median filtering techniques. So,the contrast differences between images and the noises such as dirty regions in white background of the plate can be eliminated.

Image Pre-processing:

There are two options in Pre-processing menu:

Convert color image to grayscale:

Change the imported color image into grayscale image and displays the grayscaled image in the Original Image Panel. This option is only available when an image is imported.

Gaussian Smoothing:

This option is used to smooth the imported image by removes the noises in it. This can increase the successful rate of character recognition step.

Edge Detection:

Edge detection is a fundamental tool for image segmentation. Edge detection methods transform original images into edge images benefits from the changes of grey tones in the image. In image processing especially in computer vision, the edge detection treats the localization of important variations of a gray level image and the detection of the physical and geometrical properties of objects of the scene. It is a fundamental process detects and outlines of an object and boundaries among objects and the background in the image.

Edge detection is the most familiar approach for detecting significant discontinuities in intensity values. perform the edge detection algorithm to the imported image to remove all the other information except the edges. After perform this algorithm the edge information in the original image that displayed in the Original Image Panel will be changed into white color and all the other area will be changed into black.

Number Plate Localization:

Separate the number plate area from the image by moving a pre-defined slid window around in the image to find the area that contains the maximum number of white pixel, the isolated sub-image will be displayed in the Localization Panel. Because the pre-defined slid

window is usually bigger than the number plate, so the isolated area is bigger than the number plate. This option is only available when the edge detection algorithm is performed to the image.

Number Plate Orientation and Sizing:

Resize the isolated number plate by remove the border around the plate. This option is only available when number plate is isolated from the image.

Segmentation

There are three options in the Segmentation menu:

Image Binarization:

Get the sub-image from the original image as the same size and position of the resized number plate area, convert the sub-image into binary image and display it in the Localization Panel. This option is only available after the number plate is isolated and resized.

Vertical Projection:

Apply vertical projection on the binary sub-image to count the number of white pixels column by column, display the information as a curve in the Segmentation Panel.

Segmentation:

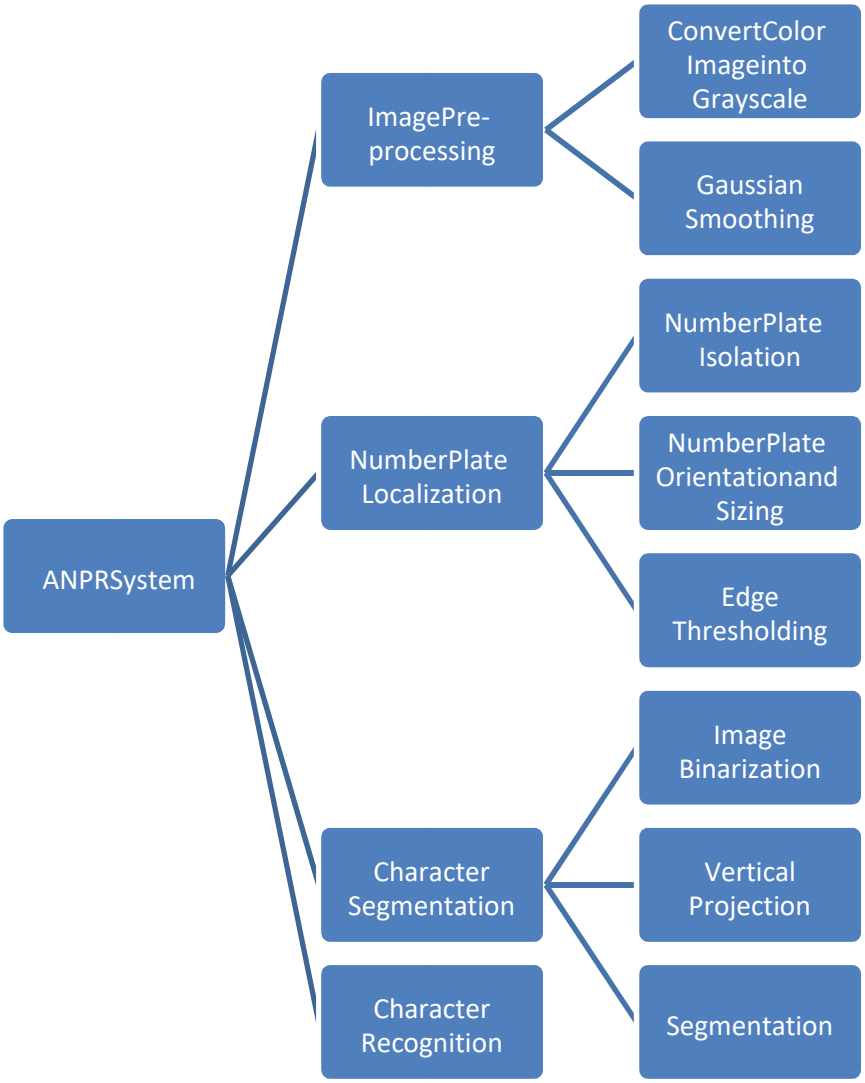
Separate binary sub-image into several parts by using the information from vertical projection, each separated part is supposed to contains one character and all of these parts are displayed in the Segmentation Panel.

Character Recognition:

Perform the character recognition algorithm onto the separated parts of the sub-image to recognize the character contains in them, change the character into ASCII form and display them into the Recognition Panel.

Function Overview

The whole system can be divided into four main parts: Image Pre-processing, Number Plate Localization, Character Segmentation and Character Recognition. Each main part contains some important functions



Software Requirement Specifications:

- The Roads Administration and the Customs Authority have joined forces to procure new ANPR equipment because the two authorities share this common objective, despite the differences in their needs and fields of activity.

- The system shall contain camera equipment/system for capturing number plates on passing vehicles that are moving or standing still and from unstable facilities and sound an alert adapted to the individual installation sites.

- It must be possible to take pictures of the number plate mounted on the front and the back of the vehicle being checked. The system must report only one of the occurrences of the same number plate.

- The tender must include image processing technology and presentation monitors for operation and for reporting findings to the operator.

- The system must communicate with the operator in Norwegian, alternatively in English until Norwegian is in place.

- The proposed solution must be capable of reading correctly 95% or more of the number plates that are scanned.

- The method for reading off precision must be specified, described and documented in the tender.

- The ANPR system must be capable of reading and interpreting the fonts used for European number plates in the same way as for Norwegian number plates

- Number plate recognition must function equally well, irrespective of light conditions, for example daylight, dusk, darkness at night.

- Any accompanying light equipment for the camera system must not be a distraction for motorists on the road. Any light facilities must be specified, explained and documented.

- The quality of number plate recognition must not be affected in varying weather conditions, such as snow, rain or mist (it is assumed here that the number plate is not dirty).
- All camera equipment, cables, leads and power supply units must be damp- and dust-proof. This must be IP 67 at a minimum.

- Cables must be flexible and it must be possible to use camera equipment at temperatures down to 20 degrees Celsius and up to +30 degrees Celsius
- The number plate recognition quality must have high tolerance for the use of different camera angles, before the quality of number plate recognition deteriorates.
- The system must be specified and documented in the tender.

- In alerts to operator, the image of the scanned number plate must be presented together with a color overview picture of the vehicle for visual verification of recognition. The alert must also contain all data registered in the list of "Vehicles of interest" for the vehicle in question.

- The camera system must count observations and maintain anonymized statistics of the number of vehicles scanned. This consists of the total number of observations, number of alerts triggered by these, description of why an alert was triggered and where and when the observations took place (GPS coordinates or equivalent).
- The solution must be specified and documented in the tender.
- The camera system must have a function that makes it possible to choose whether the data on the scanned objects should be stored or not, i.e. on and off. It must be possible to choose how long data should be stored and the quantity of information from the system. It must be possible to adjust this for the individual camera unit. The system must log when and by whom it is turned on and off.
- The solution must be specified and documented in the tender.
- The focal length of the camera must be between 5 – 20 meters, i.e. the distance between number plate and camera lens.

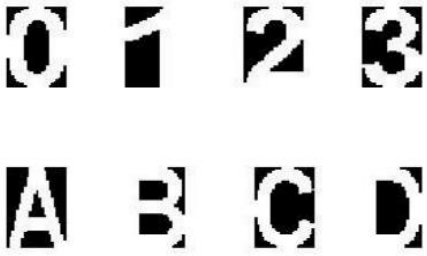
- The solution must be specified and documented in the tender.

IMPLEMENTATION:

Our project is implemented by using matlab

This process involves the use of a database of characters or templates. There exists a template for all possible input characters. Templates are created for each of the alphanumeric characters (from A-Z and 0-9)

For example:



- The characters of the identified number plate region are segmented using Regionprops function of MATLAB to obtain bounding boxes for each of the characters.
- Regionprops function returns the smallest bounding box that contains a character. (This method is used to obtain the bounding boxes of all characters in the number plate)

Automatic Number Plate Recognition(ANPR) Technology:

It is technical method of artificial vision (OCR) that allows the recognition of number plates in images of vehicles.

Generally, the ANPR technology can be bought in two modalities:

- The ANPR engine: can recognize the number plate directly from the images stored in a hard disk.
- The ANPR equipment (Hardware Recognition engine): all the hardware necessary to capture the images of the vehicles and to recognize the number plate and offer the maximum reliability.

Working of ANPR system:

The ANPR process is divided into three steps.

- Detection of the vehicle: The first step is to take an image of the vehicle at the right time.
- Capture of the images: Once the vehicle is detected, the following step is the capture of the vehicle.
- Number plate recognition process: Each ANPR manufacturer has developed its own recognition algorithms.

SOURCE CODE:

```
close all;
clear all;

im = imread('car3.jpg');
im = imresize(im, [480 NaN]);
imgray = rgb2gray(im);
imbin = imbinarize(imgray);
im = edge(imgray, 'sobel');
```

```
im = imdilate(im, strel('diamond', 2));
im = imfill(im, 'holes');
im = imerode(im, strel('diamond', 10));


Iprops=regionprops(im,'BoundingBox','Area', 'Image');
area = Iprops.Area;
count = numel(Iprops);
maxa= area;
boundingBox = Iprops.BoundingBox;
for i=1:count
   if maxa<Iprops(i).Area
       maxa=Iprops(i).Area;
       boundingBox=Iprops(i).BoundingBox;
   end
end

%all above step are to find location of number plate

im = imcrop(imbin, boundingBox);

%resize number plate to 240 NaN
im = imresize(im, [240 NaN]);

%clear dust
im = imopen(im, strel('rectangle', [4 4]));

%remove some object if it width is too long or too small than 500
im = bwareaopen(~im, 500);
%%%get width
 [h, w] = size(im);
% Iprops=regionprops(im,'BoundingBox','Area', 'Image');
% image = Iprops.Image;
% count = numel(Iprops);
% for i=1:count
%    ow = length(Iprops(i).Image(1,:));
%    if ow<(h/2)
%         im = im .* ~Iprops(i).Image;
%    end
% end


imshow(im);


%read letter
Iprops=regionprops(im,'BoundingBox','Area', 'Image');
count = numel(Iprops);

noPlate=[]; % Initializing the variable of number plate string.
```

```
for i=1:count
   ow = length(Iprops(i).Image(1,:));
   oh = length(Iprops(i).Image(:,1));
   if ow<(h/2) & oh>(h/3)
       letter=readLetter(Iprops(i).Image); % Reading the letter corresponding
the binary image 'N'.
       figure; imshow(Iprops(i).Image);
       noPlate=[noPlate letter]; % Appending every subsequent character in
noPlate variable.
   end
end
```

CREATE TEMPLATES:

```
%CREATE TEMPLATES
%Letter
A=imread('char/A.bmp');
B=imread('char/B.bmp');
C=imread('char/C.bmp');D=imread('char/D.bmp');
E=imread('char/E.bmp');F=imread('char/F.bmp');
G=imread('char/G.bmp');H=imread('char/H.bmp');
I=imread('char/I.bmp');J=imread('char/J.bmp');
K=imread('char/K.bmp');L=imread('char/L.bmp');
M=imread('char/M.bmp');N=imread('char/N.bmp');
O=imread('char/O.bmp');P=imread('char/P.bmp');
Q=imread('char/Q.bmp');R=imread('char/R.bmp');
S=imread('char/S.bmp');T=imread('char/T.bmp');
U=imread('char/U.bmp');V=imread('char/V.bmp');
W=imread('char/W.bmp');X=imread('char/X.bmp');
Y=imread('char/Y.bmp');Z=imread('char/Z.bmp');
Afill=imread('char/fillA.bmp');
Bfill=imread('char/fillB.bmp');
Dfill=imread('char/fillD.bmp');
Ofill=imread('char/fillO.bmp');
Pfill=imread('char/fillP.bmp');
Qfill=imread('char/fillQ.bmp');
Rfill=imread('char/fillR.bmp');
```

```
%Number
one=imread('char/1.bmp');  two=imread('char/2.bmp');
```

```
three=imread('char/3.bmp');four=imread('char/4.bmp');
five=imread('char/5.bmp'); six=imread('char/6.bmp');
seven=imread('char/7.bmp');eight=imread('char/8.bmp');
nine=imread('char/9.bmp'); zero=imread('char/0.bmp');
zerofill=imread('char/fill0.bmp');
fourfill=imread('char/fill4.bmp');
sixfill=imread('char/fill6.bmp');
sixfill2=imread('char/fill6_2.bmp');
eightfill=imread('char/fill8.bmp');
ninefill=imread('char/fill9.bmp');
ninefill2=imread('char/fill9_2.bmp');
```

```
%*-*-*-*-*-*-*-*-*-*-*-*-
letter=[A Afill B Bfill C D Dfill E F G H I J K L M N O Ofill P Pfill Q Qfill R Rfill S T U V W
X Y Z];

number=[one two three four fourfill five six sixfill sixfill2 seven eight eightfill nine ninefill
ninefill2 zero zerofill];

character=[letter number];

NewTemplates=mat2cell(character,42,[24 24 24 24 24 24 24 24 ...
   24 24 24 24 24 24 24 ...
   24 24 24 24 24 24 24 ...
   24 24 24 24 24 24 24 ...
   24 24 24 24 24 24 24 ...
   24 24 24 24 24 24 24 ...
   24 24 24 24 24 24 24]);
```

```
save ('NewTemplates','NewTemplates')
clear all
```

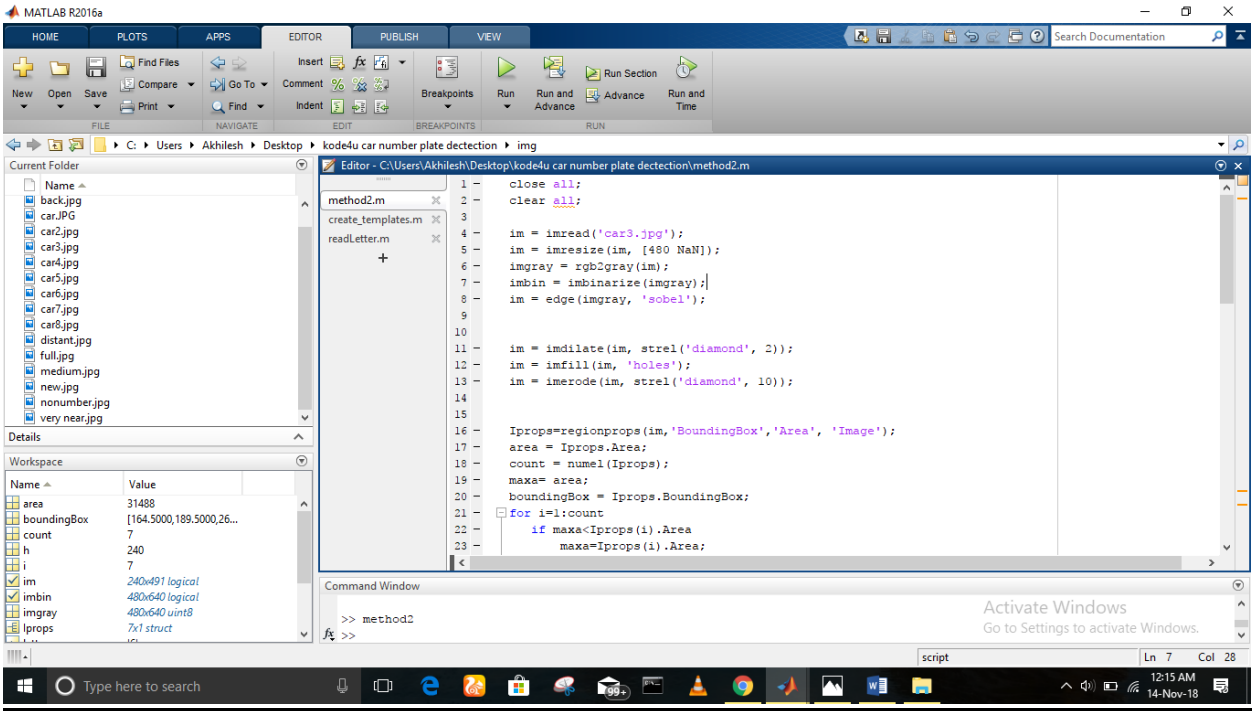
READ LETTER:

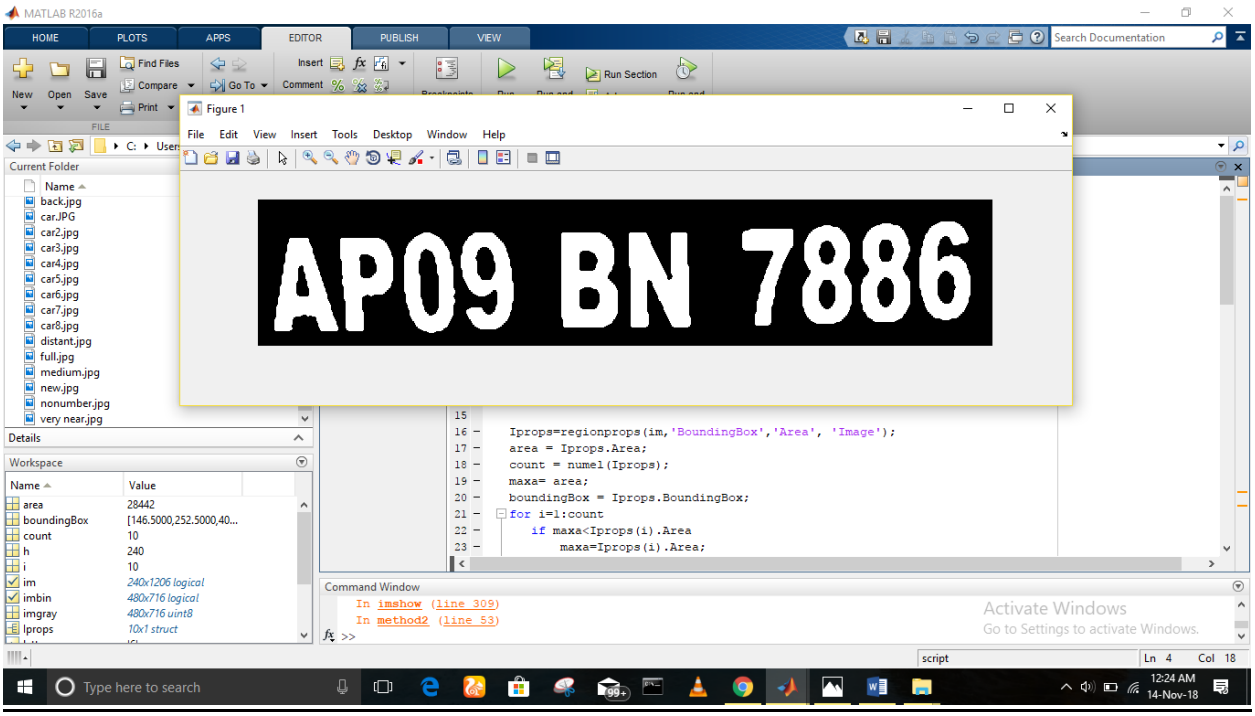
```
function letter=readLetter(snap)
%READLETTER reads the character fromthe character's binary image.
```

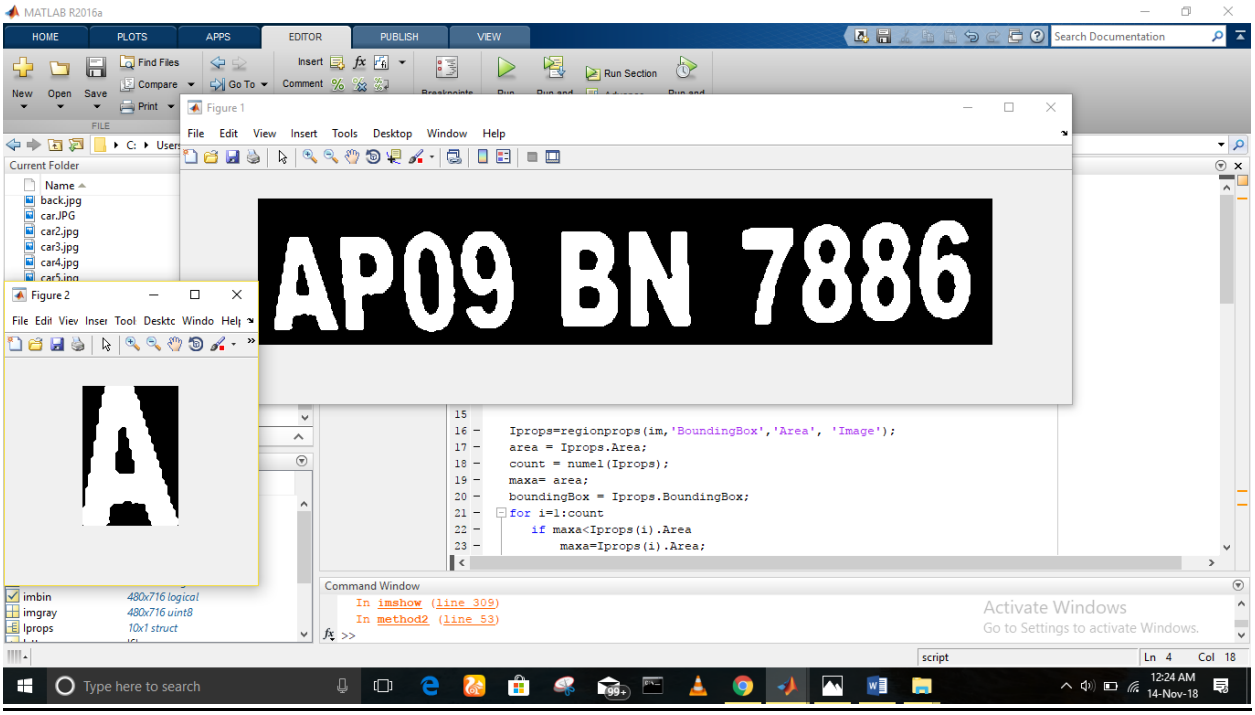
```
%   LETTER=READLETTER(SNAP) outputs the character in class 'char' from the
%   input binary image SNAP.

load NewTemplates % Loads the templates of characters in the memory.
snap=imresize(snap,[42 24]); % Resize the input image so it can be compared
with the template's images.
comp=[ ];
for n=1:length(NewTemplates)
    sem=corr2(NewTemplates{1,n},snap); % Correlation the input image with
every image in the template for best matching.
    comp=[comp sem]; % Record the value of correlation for each template's
character.
    %display(sem);

end
vd=find(comp==max(comp)); % Find the index which correspond to the highest
matched character.
%display(max(comp));
%*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-
% Accodrding to the index assign to 'letter'.
% Alphabets listings.
if vd==1 || vd==2
    letter='A';
elseif vd==3 || vd==4
    letter='B';
elseif vd==5
    letter='C';
elseif vd==6 || vd==7
    letter='D';
elseif vd==8
    letter='E';
elseif vd==9
    letter='F';
elseif vd==10
    letter='G';
elseif vd==11
    letter='H';
elseif vd==12
    letter='I';
elseif vd==13
    letter='J';
elseif vd==14
    letter='K';
elseif vd==15
    letter='L';
elseif vd==16
    letter='M';
elseif vd==17
    letter='N';
elseif vd==18 || vd==19
    letter='O';
elseif vd==20 || vd==21
    letter='P';
elseif vd==22 || vd==23
    letter='Q';
```

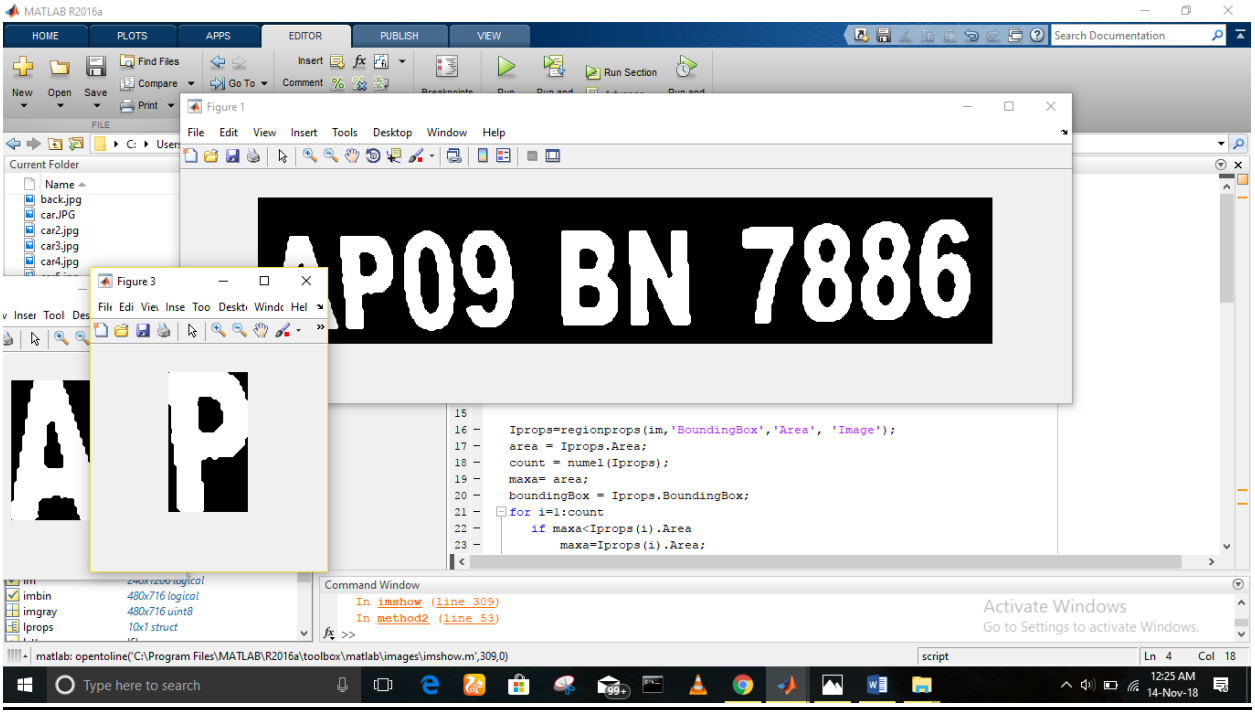
```
elseif vd==24 || vd==25
    letter='R';
elseif vd==26
    letter='S';
elseif vd==27
    letter='T';
elseif vd==28
    letter='U';
elseif vd==29
    letter='V';
elseif vd==30
    letter='W';
elseif vd==31
    letter='X';
elseif vd==32
    letter='Y';
elseif vd==33
    letter='Z';
    %*-*-*-*-*
% Numerals listings.
elseif vd==34
    letter='1';
elseif vd==35
    letter='2';
elseif vd==36
    letter='3';
elseif vd==37 || vd==38
    letter='4';
elseif vd==39
    letter='5';
elseif vd==40 || vd==41 || vd==42
    letter='6';
elseif vd==43
    letter='7';
elseif vd==44 || vd==45
    letter='8';
elseif vd==46 || vd==47 || vd==48
    letter='9';
else
    letter='0';
end
end
```

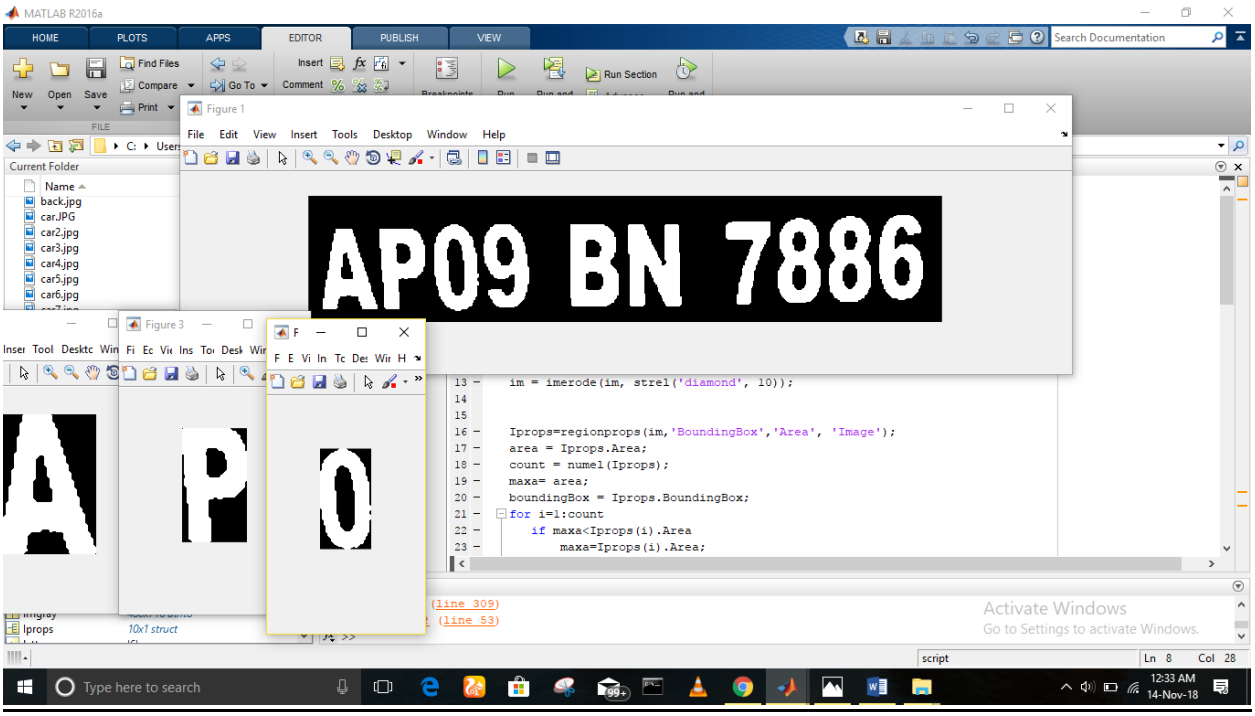
SCREENSHOTS:

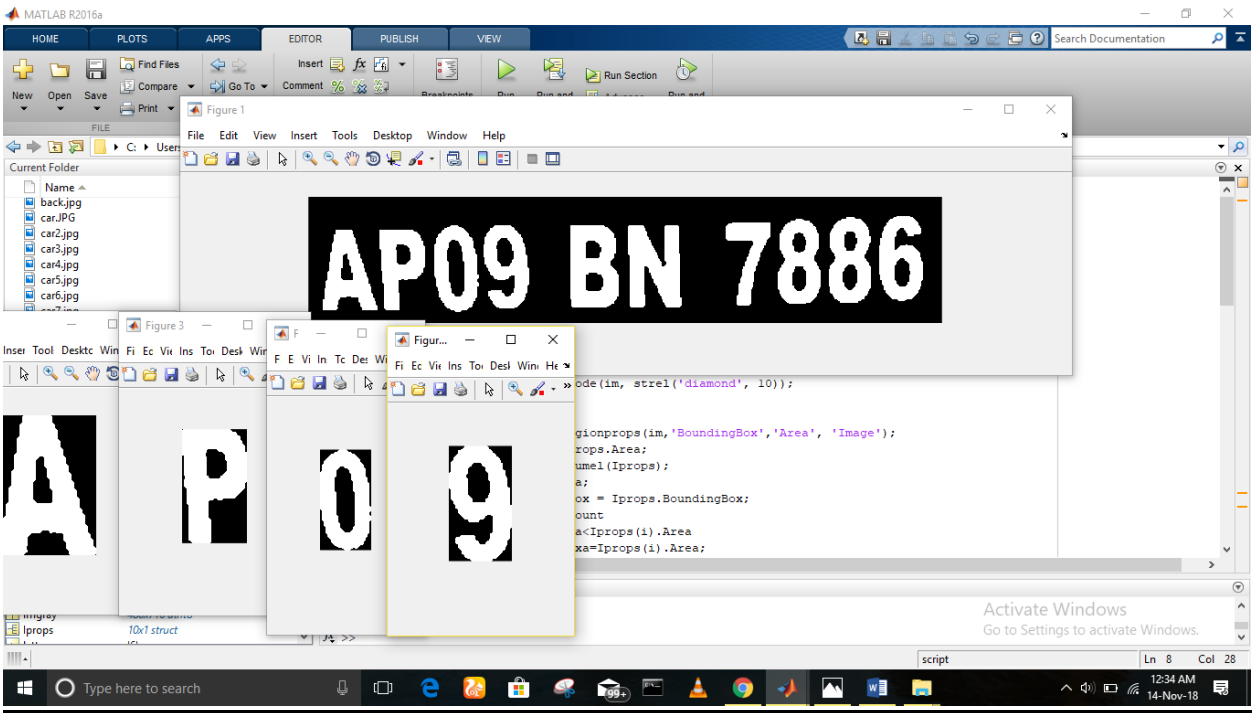

MATLAB R2016a
HOME
PLOTS
APPS
EDITOR
PUBLISH
VIEW
Search Documentation
Editor - C:\Users\Akhilesh\Desktop\kode4u car number plate dectection\method2.m
method2.m
create_templates.m
readLetter.m
close all;
clear all;
im = imread('car3.jpg');
im = imresize(im, [480 NaN]);
imgray = rgb2gray(im);
imbin = imbinarize(imgray);
im = edge(imgray, 'sobel');
im = imdilate(im, strel('diamond', 2));
im = imfill(im, 'holes');
im = imerode(im, strel('diamond', 10));
Iprops=regionprops(im,'BoundingBox','Area', 'Image');
area = Iprops.Area;
count = numel(Iprops);
maxa= area;
boundingBox = Iprops.BoundingBox;
for i=1:count
if maxa<Iprops(i).Area
maxa=Iprops(i).Area;
Command Window
>> method2
Workspace
Name
Value
area
31488
boundingBox
[164.5000,189.5000,26...
count
7
h
240
i
7
im
240x491 logical
imbin
480x640 logical
imgray
480x640 uint8
Iprops
7x1 struct
Activate Windows
Go to Settings to activate Windows.
script
Ln 7
Col 28
Type here to search
12:15 AM
14-Nov-18

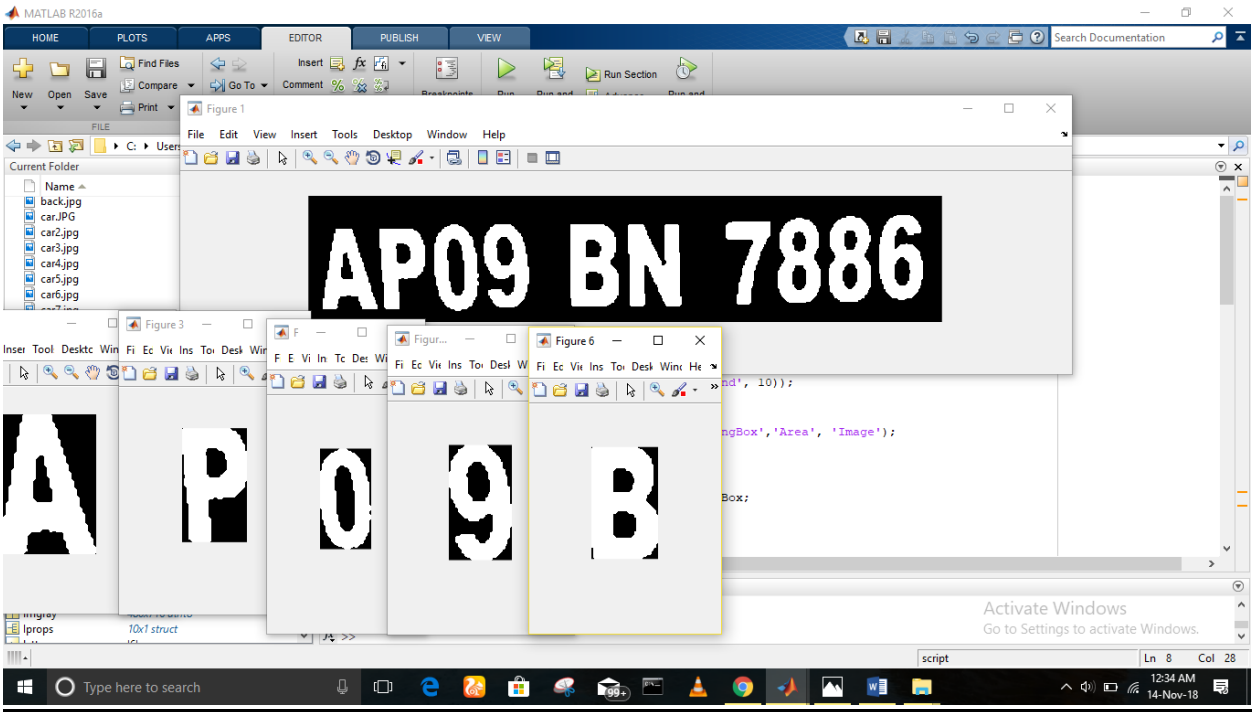

MATLAB R2016a
Figure 1
File Edit View Insert Tools Desktop Window Help
AP09 BN 7886
Iprops=regionprops(im,'BoundingBox','Area', 'Image');
area = Iprops.Area;
count = numel(Iprops);
maxa= area;
boundingBox = Iprops.BoundingBox;
for i=1:count
if maxa<Iprops(i).Area
maxa=Iprops(i).Area;
In imshow (line 309)
In method2 (line 53)
Activate Windows
Go to Settings to activate Windows.
script
Ln 4
Col 18
12:24 AM
14-Nov-18

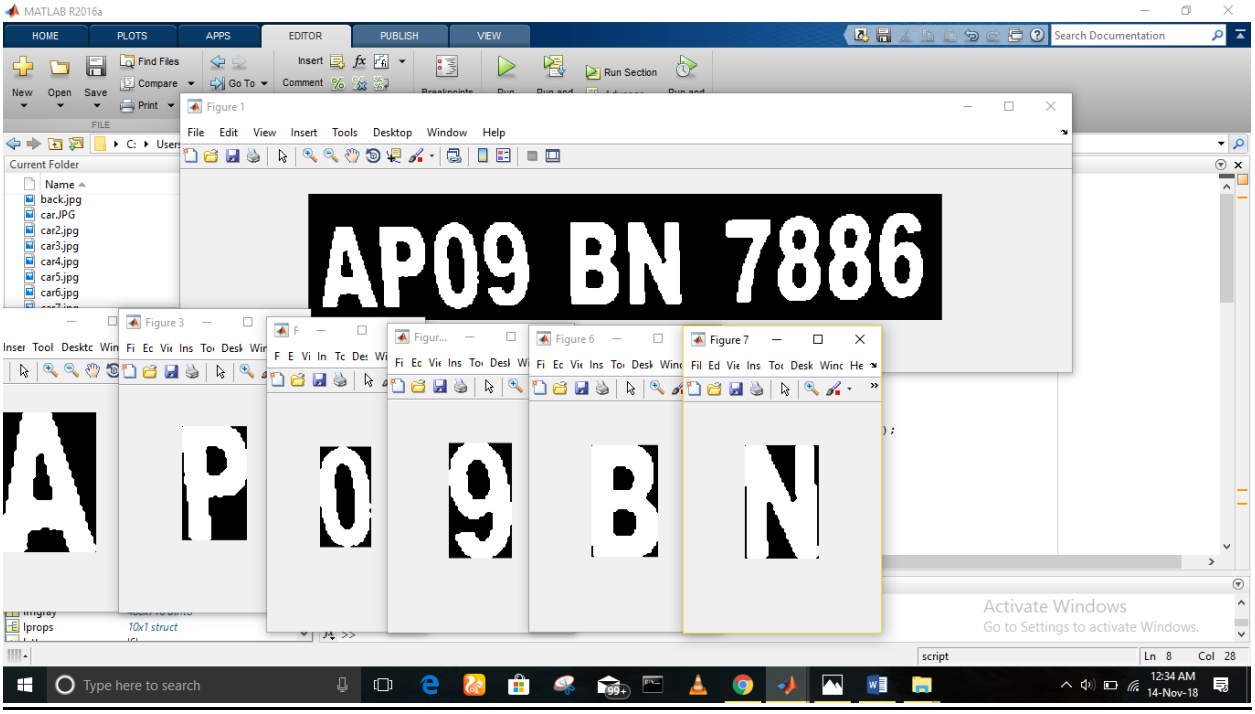

MATLAB R2016a
Figure 1
AP09 BN 7886
Figure 2
Command Window
In imshow (line 309)
In method2 (line 53)

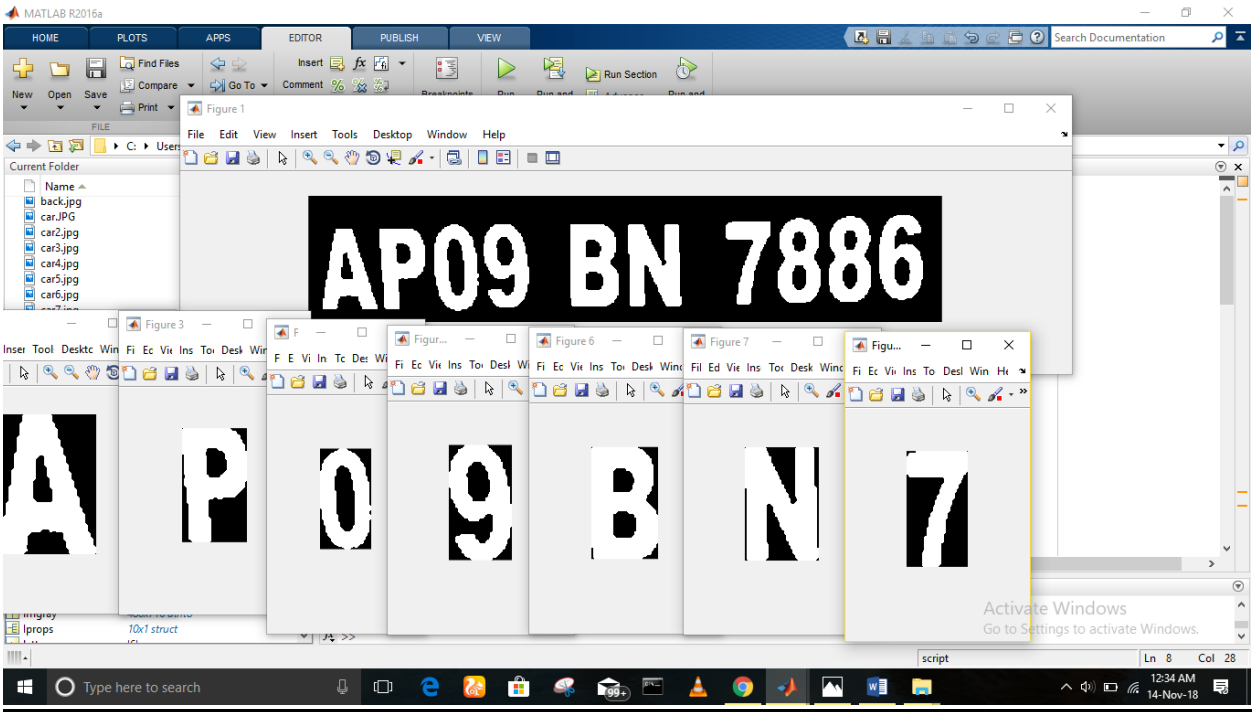

MATLAB R2016a
Figure 1
AP09 BN 7886
Figure 3
Command Window
In imshow (line 309)
In method2 (line 53)

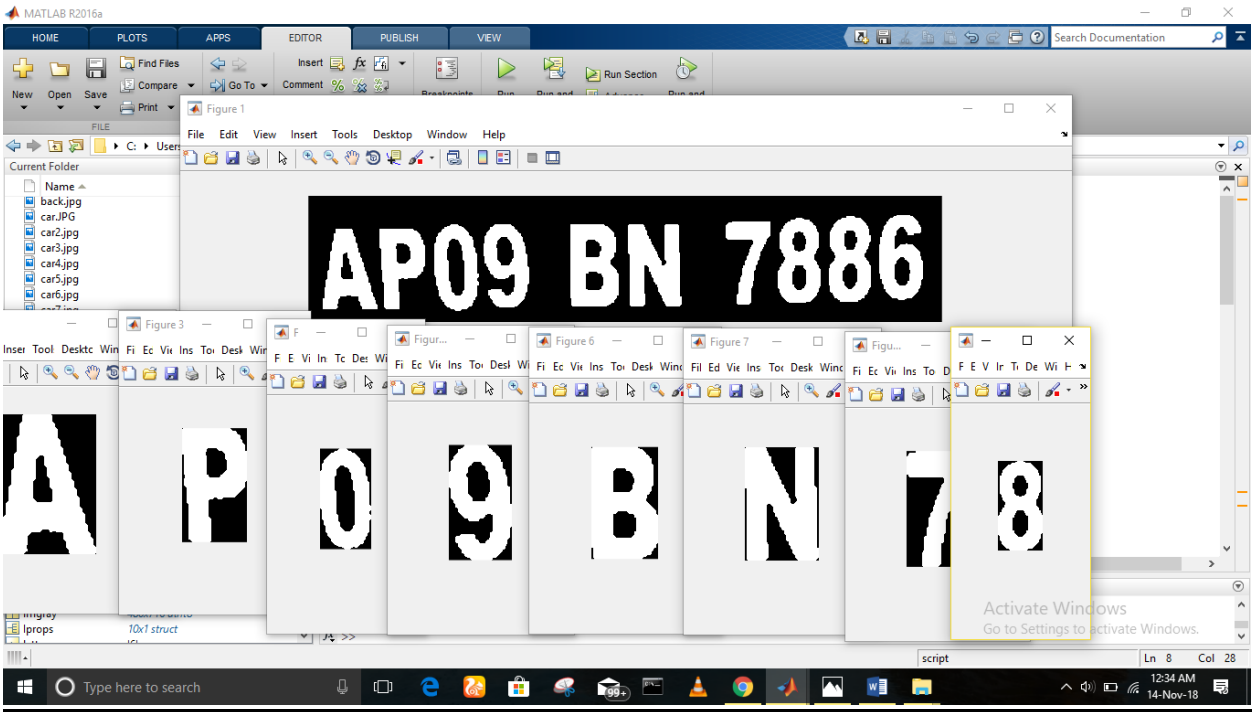

MATLAB R2016a
HOME
PLOTS
APPS
EDITOR
PUBLISH
VIEW
Figure 1
File Edit View Insert Tools Desktop Window Help
AP09 BN 7886
Figure 3
im = imerode(im, strel('diamond', 10));
Iprops=regionprops(im,'BoundingBox','Area', 'Image');
area = Iprops.Area;
count = numel(Iprops);
maxa= area;
boundingBox = Iprops.BoundingBox;
for i=1:count
if maxa<Iprops(i).Area
maxa=Iprops(i).Area;
Activate Windows
Go to Settings to activate Windows.
12:33 AM
14-Nov-18


MATLAB R2016a
HOME
PLOTS
APPS
EDITOR
PUBLISH
VIEW
Figure 1
File Edit View Insert Tools Desktop Window Help
AP09 BN 7886
Figure 3
Activate Windows
Go to Settings to activate Windows.
12:34 AM
14-Nov-18


MATLAB R2016a
HOME
PLOTS
APPS
EDITOR
PUBLISH
VIEW
Search Documentation
Figure 1
File Edit View Insert Tools Desktop Window Help
AP09 BN 7886
Figure 3
Figure 6
Current Folder
Name
back.jpg
car.JPG
car2.jpg
car3.jpg
car4.jpg
car5.jpg
car6.jpg
Activate Windows
Go to Settings to activate Windows.
Type here to search
12:34 AM
14-Nov-18


MATLAB R2016a
HOME
PLOTS
APPS
EDITOR
PUBLISH
VIEW
Search Documentation
Figure 1
File Edit View Insert Tools Desktop Window Help
AP09 BN 7886
Figure 3
Figure 6
Figure 7
Current Folder
Name
back.jpg
car.JPG
car2.jpg
car3.jpg
car4.jpg
car5.jpg
car6.jpg
Activate Windows
Go to Settings to activate Windows.
Type here to search
12:34 AM
14-Nov-18


MATLAB R2016a
HOME
PLOTS
APPS
EDITOR
PUBLISH
VIEW
Search Documentation
Figure 1
File Edit View Insert Tools Desktop Window Help
AP09 BN 7886
Current Folder
Name
back.jpg
car.JPG
car2.jpg
car3.jpg
car4.jpg
car5.jpg
car6.jpg
Figure 3
Figure 6
Figure 7
Activate Windows
Go to Settings to activate Windows.
script
Ln 8 Col 28
Type here to search
12:34 AM
14-Nov-18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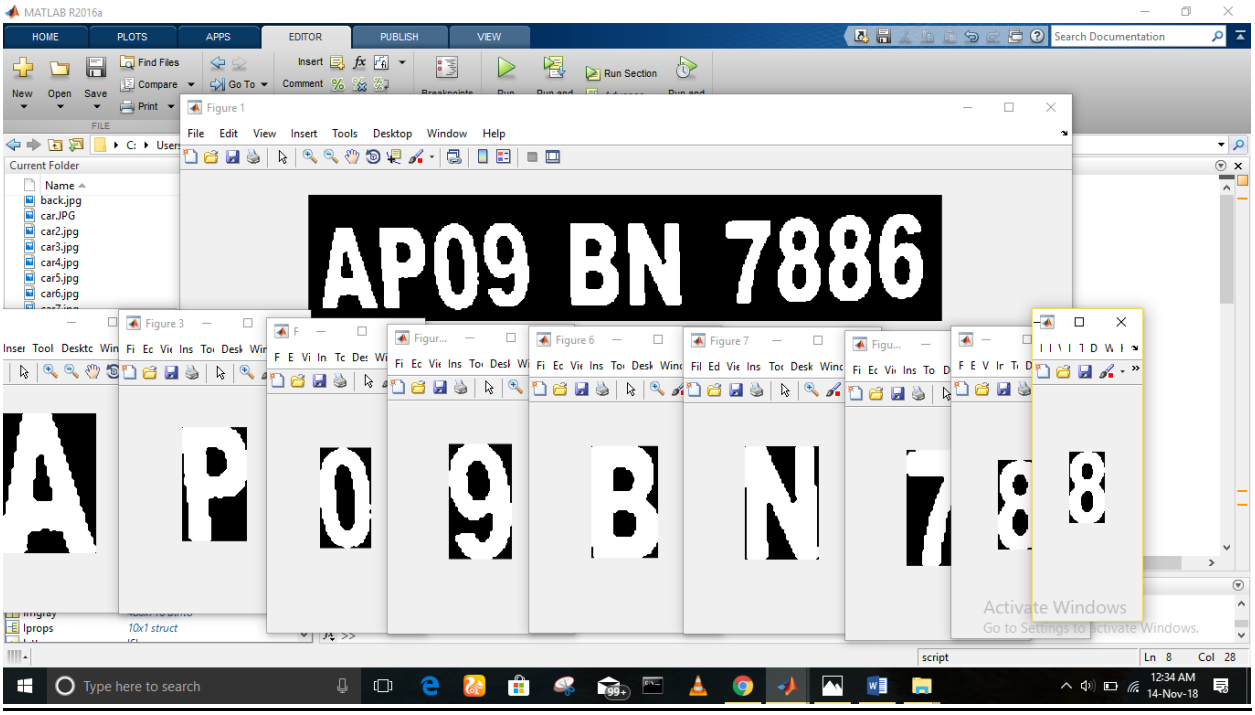
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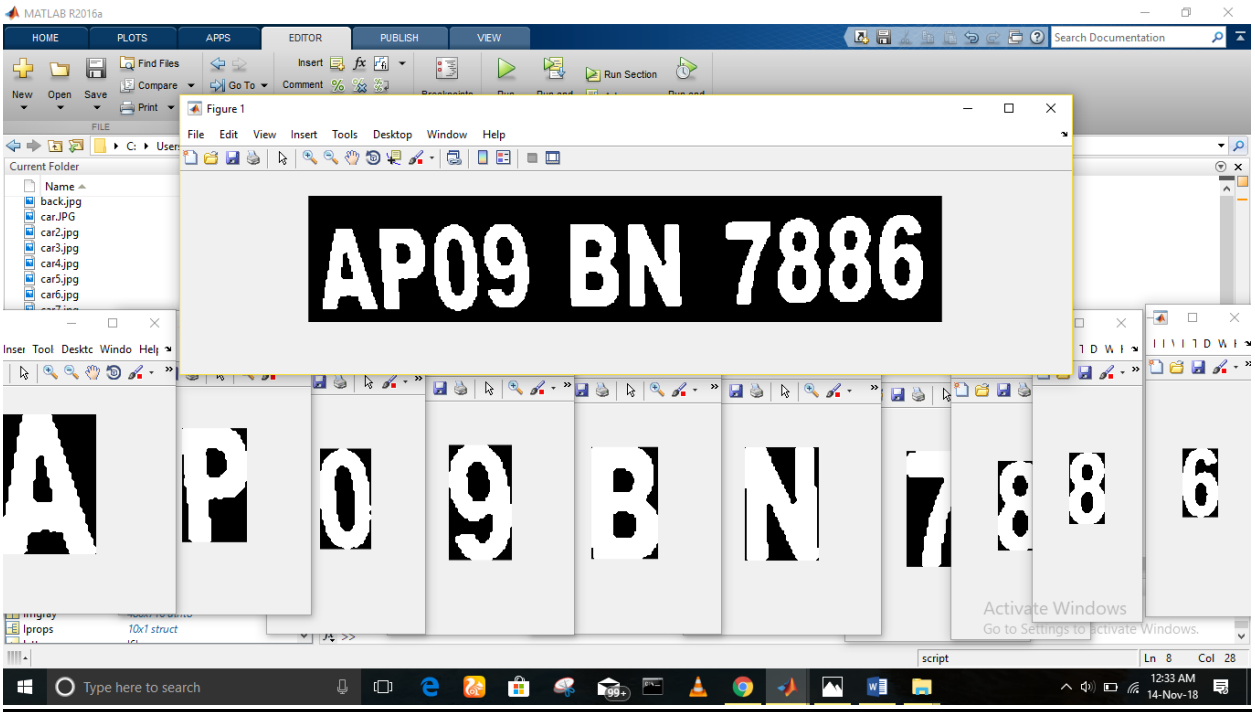
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The Benefit and Contribution of ANPR System

This project has many benefits that can be apply into our community. These are the several benefits that has related with the project.

- Traffic Enforcement.

- Automatic number plate recognition is an advantage in several areas of traffic enforcement and
can be place in an areas where speeding is common problem.

- Law Enforcement.

- The system can be mounted on a patrol car to record plates at passing car. This information can be compared with the law enforcement data base for vehicles associated with the crime.

- Vehicles Access.

- Automatic number plate recognition is also useful for vehicles access. On toll roads, these systems can be used to allow cars to pass through toll gates without stopping, where the system will record the number plate. In fact, the system can be upgrade example like the user can pay the toll fees with online payment after system send the bill by email

Advantage of MATLAB

1. Data can be represented in terms of matrices or vectors.
2. MATLAB coding is shorter and simpler
3. Algorithm used in MATLAB can be converted to use in hardware.
4. The system will perform faster when using "Matrix Approach".
5. MATLAB possesses power graphic visualization tools.

Recommendation

The following things can be enhanced to improve the performance of the ANPR system which are the plate region extraction system can be improved by including additional features which are unique to the plat region. These features may be for instance horizontal and vertical histogram of the internal region, which shows the presence of characters, can be used to identify similar regions that may affect the extraction process. Also improved additional features such as color based techniques can also be used. For the ANPR, improvement in noise reduction techniques can be suggested in order to improve the segmentation and classification accuracy.

With the popularity in Digital Image Processing technology, 3-dimensional image processing analysis is considerable for the future development.

Conclusion

- For the whole project, the "Simulation of Automatic Number Plate Recognition using Matlab for Toll Payment" worked well and achieved the objectives of project.
- ANPR system can recognized the character of number plate for both vehicles which is local number plate and also an international number plate.
- Result from this system has made table so that everyone can refer and understand clearly.

Reference Links:

https://www.researchgate.net/publication/224565257

http://likeblackfyp.blogspot.com/search?updated-max=2013-04-11T22:00:00-07:00&max-results=7

REFERENCE PAPER:

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AUTOMATIC NUMBER PLATE RECOGNITION SYSTEM FOR VEHICLE IDENTIFICATION USING OPTICAL CHARACTER RECOGNITION

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***Abstract*—Automatic Number Plate Recognition (ANPR) is an image processing technology which uses number (license) plate to identify the vehicle. The objective is to design an efficient automatic authorized vehicle identification system by using the vehicle number plate. The system is implemented on the entrance for security control of a highly restricted area like military zones or area around top government offices e.g. Parliament, Supreme Court etc. The developed system first detects the vehicle and then captures the vehicle image. Vehicle number plate region is extracted using the image segmentation in an image. Optical character recognition technique is used for the character recognition. The resulting data is then used to compare with the records on a database so as to come up with the specific information like the vehicle's owner, place of registration, address, etc. The system is implemented and simulated in Matlab, and it performance is tested on real image. It is observed from the experiment that the developed system successfully detects and recognize the vehicle number plate on real images.**

Keywords- Number Plate Recognition; vehicle identification; optical character recognition; Character Recognition

I. INTRODUCTION

The Automatic Number Plate Recognition (ANPR) was invented in 1976 at the Police Scientific Development Branch in the UK. However, it gained much interest during the last decade along with the improvement of digital camera and the increase in computational capacity. It is simply the ability to automatically extract and recognition a vehicle number plate's characters from an image. In essence it consists of a camera or frame grabber that has the capability to grab an image, find the location of the number in the image and then extract the characters for character recognition tool to translate the pixels into numerically readable character. ANPR can be used in many areas from speed enforcement and tool collection to management of parking lots, etc [1]. It can also be used to detect and prevent a wide range of criminal activities and for security control of a highly restricted areas like military zones or area around top government offices. The system is computationally inexpensive compare to the other ANPR systems [2][5]. Besides the robustness, the earlier methods use either feature based approached using edge detection or Hough transform which are computationally expensive or use artificial neural network which requires large training data [2][3][4]. The presented ANPR system is aimed to be light weighted so that it can be run real time and recognizes Sindh standard number plate under normal conditions. The ANPR system works in three steps, the first step is the detection and capturing a vehicle image, the second steps is the detection and extraction of number plate in an image. The third section use image segmentation technique to get individual character and optical character recognition (OCR) to recognize the individual character with the help of database stored for each and every alphanumeric character.

The rest of the paper is organized as follows: section 2 will present the software and hardware models of the developed ANPR system. Section 3 will present the simulation results obtained

using the developed ANPR system. Section 4 discusses the results briefly and finally section 5 will end the paper with conclusion and future works.

1.2. II. SYSTEM MODEL

The overall ANPR system can be subdivided into the software model and hardware model. The section will discuss the both models in detail.

1.2.1. A. Software Model

The main and the most important portion of this system is the software model. The software model use series of image processing techniques which are implemented in MATLAB 7.0.1. The ANPR algorithm is broadly divided into three parts:

- Capture image
- Extract the plate from the image
- Recognize the numbers from the extracted plate

The first step is the capturing of an image using the USB camera connected to the PC. The images are captured in RGB format so it can be further process for the number plate extraction.

The second step of the ANPR algorithm is the extraction of the number plate in an image. A yellow search algorithm is used to extract the likelihood ROI in an image. As the official number plate of Sindh has yellow background with alphanumeric character written in black, it is easy to detect the plate area by searching for yellow pixels. The image is search for the yellow color pixels or some which are closer to yellow in value. If pixel value is of yellow color the pixel obtained after the search algorithm is in black and white format. After identify the ROI, image is then filtered using two different filtering techniques. The first technique involves removing of all white patches that are connected to any border and set their pixel value to 0. The second filtering technique use pixel count method to remove the small regions in an image other than the plate region. The number of consecutive white pixels is inspected and regions that contain number of white pixels less than the predefined threshold are set to 0. At this stage the image contains only the vehicle number plate. Smearing algorithm [x] is used next to extract the number plate in an image. The smearing algorithm is search for the first and last white pixels starting from top left corner of an image. The image is then cropped that only contain the vehicle number plate.

The third step of the developed ANRP algorithm uses Optical Character Recognition (OCR) algorithm to recognize the vehicle number. The resultant cropped image obtained after the second step is inverted i.e. all white pixels are converted to black and black pixels to white. Now the text is in white and the plate background is black. Before applying the OCR the individual lines in the text are separated using line separation process. The line separation adds the each pixels value in a row. If the resultant sum of row is zero that means no text pixel is

present in a row and if the resultant sum of row is greater than zero that means the text is present in row. The first resultant sum greater than zero represents the start of the line and after this the first resultant sum equal to zero represents the end of the line. The start and end values of the line is used to crop the first line in the text. The same process continues to separate the second line in the text.

Once the lines in an extracted vehicle number plate are separated, the line separation process is now applied column wise so that individual character can be separated. The separated individual characters are then stored in separate variables. The OCR is now used to compare the each individual character against the complete alphanumeric database. The OCR actually uses correlation method to match individual character and finally the number is identified and stored in string format in a variable. The string is then compared with the stored database for the vehicle authorization. The resultant signals are given according to the result of comparison. The complete detail of the software model is shown in figure 1.

1.2.2. B. Hardware Model

The hardware model consists of sensors to sense the presence of a vehicle, camera to capture the image, a motor with motor driver circuit to control the barrier on the entrance, PC on which algorithm is executed, and microcontroller for controlling the complete hardware of the ANPR system.

As the vehicle enters and settles in the field of the sensor, the infrared sensor sense a vehicle and gives a signal to the PC through microcontroller 89C51 to capture the image of the vehicle. The camera connected to the PC through USB port captures the image of a vehicle. The ANPR algorithm on a PC receives the image and performs the processing, which yields the vehicle number. This number is then compared to the authorized number to confirm it validity and finally provides signal to microcontroller to control the system hardware. If the inputted plate contains the authorized number then the barrier on the entrance will be raised up using motor, green indication light will be switched on and ‘Access Granted’ will appears on the display, and if the inputted plate contains an unauthorized number then barrier will not be raised, red indication will be switched on and ‘Access Denied’ will appear on the display. The complete hardware model is shown in figure 2.

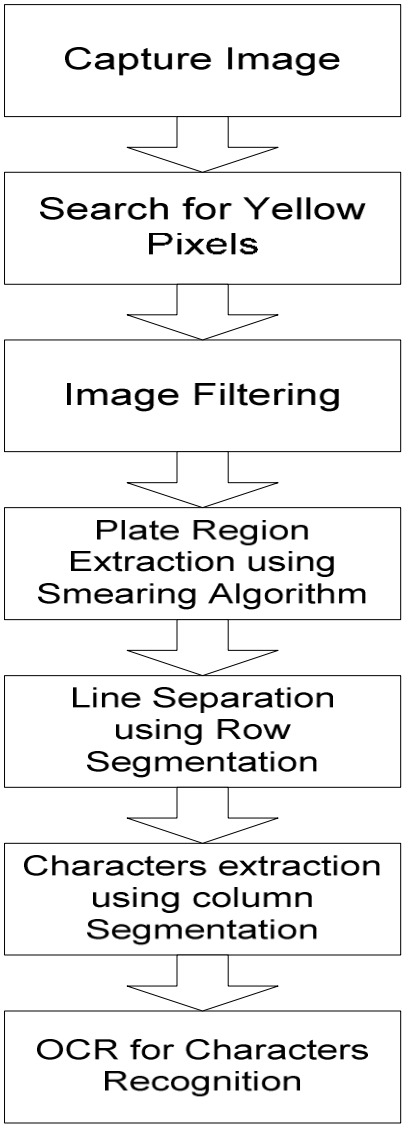

Figure 1 Steps of automatic number plate recognition software model

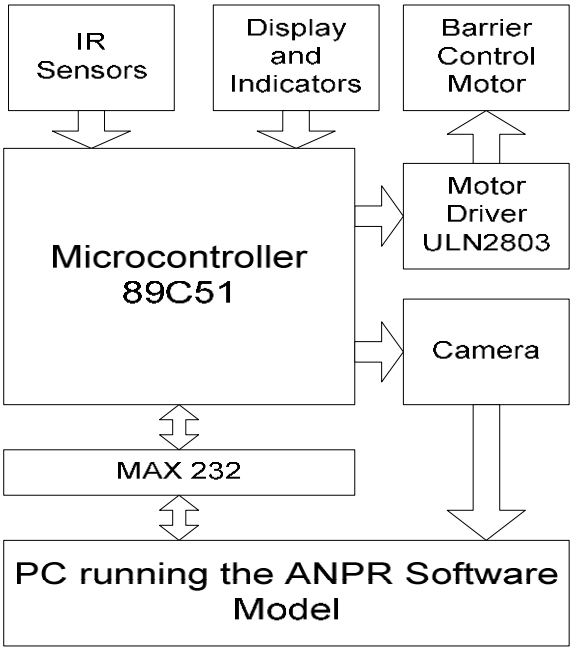

Figure 2 Hardware setup of ANPR system

1.3. III. SIMULATION RESULTS

This section presents the simulation results of the developed ANPR system.

Firstly, the camera is interfaced using Matlab with the PC. The camera is attached using USB port. Different images of cars having different colors and structure types are taken and stored in PC. The different effects of the day lights are also considered during the processing. The images are in RGB format and the resolution is 800 x 600 pixels as shown in figure 3.

After capturing the image the next step was the yellow search algorithm. Figure 4 shows the images after the executing the yellow search algorithm. The white region represents the yellow or color closer to the yellow. It can be observed that the yellow search algorithm successfully detect the ROI that only contain vehicle number plate. The smearing algorithm used next to extract the vehicle number plate as shown in figure 5. Once the vehicle number plate is extracted, it is converted into the binary format. Figure 6 and figure 7 show the binary and inverted binary format respectively.

The row and column segmentations methods are used next to extract the individual character in the vehicle number plate. The results of the row and column segmentation are shown in figure 8 and figure 9 respectively. Finally OCR is used for character recognition and each and every alphanumeric character is recognized as shown in figure 10.

1.4. IV. DISCUSSION

The system start works when the sensor detects the presence of car at the entrance. The micro-controller sends

Figure 3 Images taken using USB camera

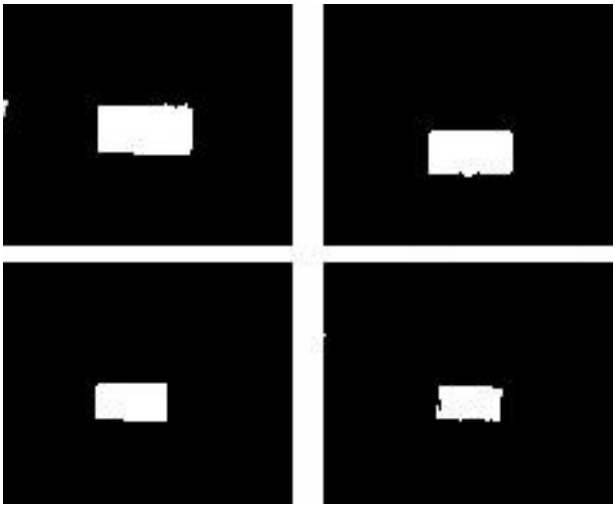

Figure 4 ROI detection using yellow search algorithm

Figure 5 Vehicle number plate extraction using smearing algorithm

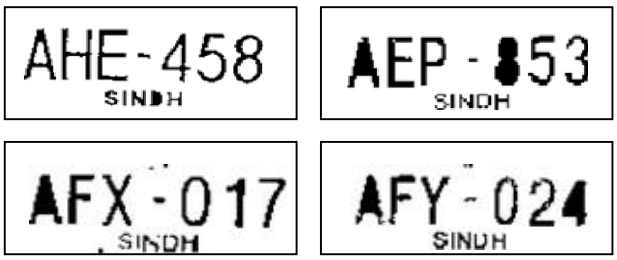

Figure 6 Binary image

Figure 7 Inverted binary image

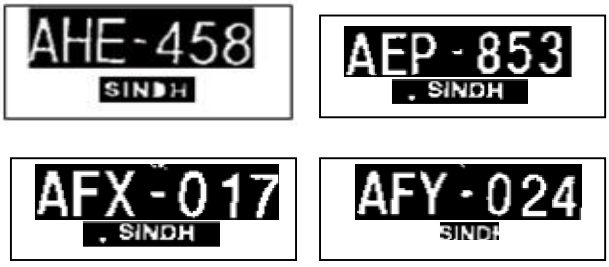

Figure 8 Line separation using row segmentation

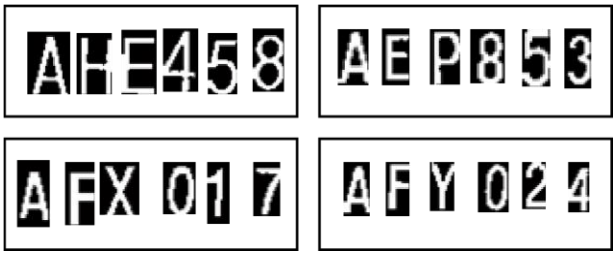

Figure 9 Character separation using column segmentation

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Figure 10 Recognize character using OCR

the signal to PC for capturing image using USB camera attached with the PC. The PC starts the ANPR algorithm and identifies the vehicle authorization. The ANPR View publication stats algorithm is tested on large number of images with the resolution of 800 x 600 pixels. The results shows that the developed ANPR algorithm successfully detects the Sindh standard vehicle number plates in various day conditions and shows the higher detection and recognition rate. It can detect and recognize vehicle plates from various distances. The distance affects the size of the number plate in an image. Once the vehicle number plate is detected, the individual characters are recognized using the OCR algorithm. The OCR use correlation method for the character recognition and the probability of the recognition can also be calculated. The system is computationally inexpensive and can also be implemented for real time vehicle identification system.

1.5. CONCLUSION AND FUTURE WORK

In this paper, the automatic vehicle identification system using vehicle license plate is presented. The system use series of image processing techniques for identifying the vehicle from the database stored in the PC. The system is implemented in Matlab and it performance is tested on real images. The simulation results shows that the system robustly detect and recognize the vehicle using license plate against different lightening conditions and can be implemented on the entrance of a highly restricted areas.

The implementation works quite well however, there is still room for improvement. The camera used in this project is sensitive to vibration and fast changing targets due to the long shutter time. The system robustness and speed can be increase if high resolution camera is used. The OCR methods used in this project for the recognition is sensitive to misalignment and to different

sizes, the affine transformation can be used to improve the OCR recognition from different size and angles. The statistical analysis can also be used to define the probability of detection and recognition of the vehicle number plate.

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***** THANK YOU *****