A

Group Project – III (EC445) Report

On

"Number plate detection using MATLAB"

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Certificate

This is to certify that the report entitled "**Group Project – III (EC 445)**" is a bonafide work carried out by **Ishan Patel, Amartya Singh and Rahul Thakkar** under the guidance and supervision of **Hardik Modi** for the subject Group Project – III (EC 445) of 7th Semester of Bachelor of Technology in Electronics & Communication at Faculty of Technology & Engineering (C.S.P.I.T.) – CHARUSAT, Gujarat.

To the best of my knowledge and belief, this work embodies the work of candidate himself, has duly been completed, and fulfills the requirements of the course.

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Abstract

Digital image processing is the use of a digital computer to process digital images through an algorithm. As a subcategory or field of digital signal processing, digital image processing has many advantages over analog image processing. It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and distortion during processing.

In this project we have learnt about the basics of image processing. We have also learned programming for image processing in MATLAB. We have also learnt about many new steps involved in image processing. We have learned about many new functions in MATLAB required during different steps of image processing.

Table of content

1-Introduction to Digital image processing

Signal processing is a discipline in electrical engineering and in mathematics that deals with analysis and processing of analog and digital signals, and deals with storing, filtering, and other operations on signals. These signals include transmission signals, sound or voice signals, image signals , and other signals e.t.c.

Out of all these signals, the field that deals with the type of signals for which the input is an image and the output is also an image is done in image processing. As it name suggests, it deals with the processing on images.

It can be further divided into analog image processing and digital image processing.

Analog image processing

Analog image processing is done on analog signals. It includes processing on two dimensional analog signals. In this type of processing, the images are manipulated by electrical means by varying the electrical signal. The common example include is the television image.

Digital image processing has dominated over analog image processing with the passage of time due its wider range of applications.

Digital image processing

The digital image processing deals with developing a digital system that performs operations on an digital image.

What is an Image?

An image is nothing more than a two dimensional signal. It is defined by the mathematical function f(x,y) where x and y are the two co-ordinates horizontally and vertically.

The value of f(x,y) at any point is gives the pixel value at that point of an image.

The above figure is an example of digital image that you are now viewing on your computer screen. But actually , this image is nothing but a two dimensional array of numbers ranging between 0 and 255.

128	30	123
232	123	321
123	77	89
80	255	255

Each number represents the value of the function f(x,y) at any point. In this case the value 128 , 230 ,123 each represents an individual pixel value. The dimensions of the picture is actually the dimensions of this two dimensional array.

Relationship between a digital image and a signal

If the image is a two dimensional array then what does it have to do with a signal? In order to understand that , We need to first understand what is a signal?

Signal

In physical world, any quantity measurable through time over space or any higher dimension can be taken as a signal. A signal is a mathematical function, and it conveys some information.

A signal can be one dimensional or two dimensional or higher dimensional signal. One dimensional signal is a signal that is measured over time. The common example is a voice signal.

The two dimensional signals are those that are measured over some other physical quantities. The example of two dimensional signal is a digital image. We will look in more detail in the next tutorial of how a one dimensional or two dimensional signals and higher signals are formed and interpreted.

Relationship

Since anything that conveys information or broadcast a message in physical world between two observers is a signal. That includes speech or (human voice) or an image as a signal. Since when we speak , our voice is converted to a sound wave/signal and transformed with respect to the time to person we are speaking to. Not only this , but the way a digital camera works, as while acquiring an image from a digital camera involves transfer of a signal from one part of the system to the other.

How a digital image is formed?

Since capturing an image from a camera is a physical process. The sunlight is used as a source of energy. A sensor array is used for the acquisition of the image. So when the sunlight falls upon the object, then the amount of light reflected by that object is sensed by the sensors, and a continuous voltage signal is generated by the amount of sensed data. In order to create a digital image , we need to convert this data into a digital form. This involves sampling and quantization. (They are discussed later on). The result of sampling and quantization results in an two dimensional array or matrix of numbers which are nothing but a digital image.

Some of the different Image processing software are:

- MATLAB
- Adobe camera raw
- KNIME
- IDL
- Photoshop
- MeVisLab
- Nvidia RTX

2-Need of Digital Image Processing

- It is needed to remove noises in an image.
- To restore a noisy or damaged image.
- Improvement of pictorial information for human perception.
- Image processing for autonomous machine application.
- Efficient storage and transmission.
- To enhance the image.
- To manipulate different contents of image such as brightness, sharpness, contrast, etc.

3-Advantage and Disadvantage of Digital Image Processing

Advantages:

- Digital images can be processed by digital computers.
- Important features such as edges can be extracted from images which can be used in industry.
- Images can be given more sharpness and better visual appearance.
- Minor errors can be rectified.
- Image sizes can be increased or decreased.
- Images can be compressed and decompressed for faster image transfer over the network.
- Images can be automatically sorted depending on the contents they have.
- Unrecognizable features can be made prominent.
- Images can be smoothened.
- It allows robots to have vision.
- It allows industries to remove defective products from the production line.
- It allows weather forecasting.
- It is used to analyze cells and their composition.
- It is used to analyze medical images.

Disadvantages:

- Misuse of copyright is now easier than it earlier was. For instance, images can be copied from the Internet just by clicking the mouse a couple of times.
- The value of the image will get worse? This has not necessarily happened everywhere. Images held in image banks still have reasonably good prices, inspite of the fact that downloading images through the net is fast and easy. The profitableness of digital photography has increased the number of images and photography in general.
- Work has become more technical, which may not be a disadvantage for everyone.
- A digital file of a certain size cannot be enlargened with a good quality anymore. For instance, a good poster cannot be made of an image file of 500 kb. However, it is easy to make an image smaller.

4-Applications of Digital Image Processing

Some of the fields of application of digital image processing are as follows:

- Image sharpening and restoration
- Medical field
- Remote sensing
- Transmission and encoding
- Machine/Robot vision
- Color processing
- Pattern recognition
- Video processing
- Microscopic Imaging
- UV imaging
- Machine/Robot vision
- Automatic hurdle detection in vehicles
- Pattern Recognition

5-Number plate detection need

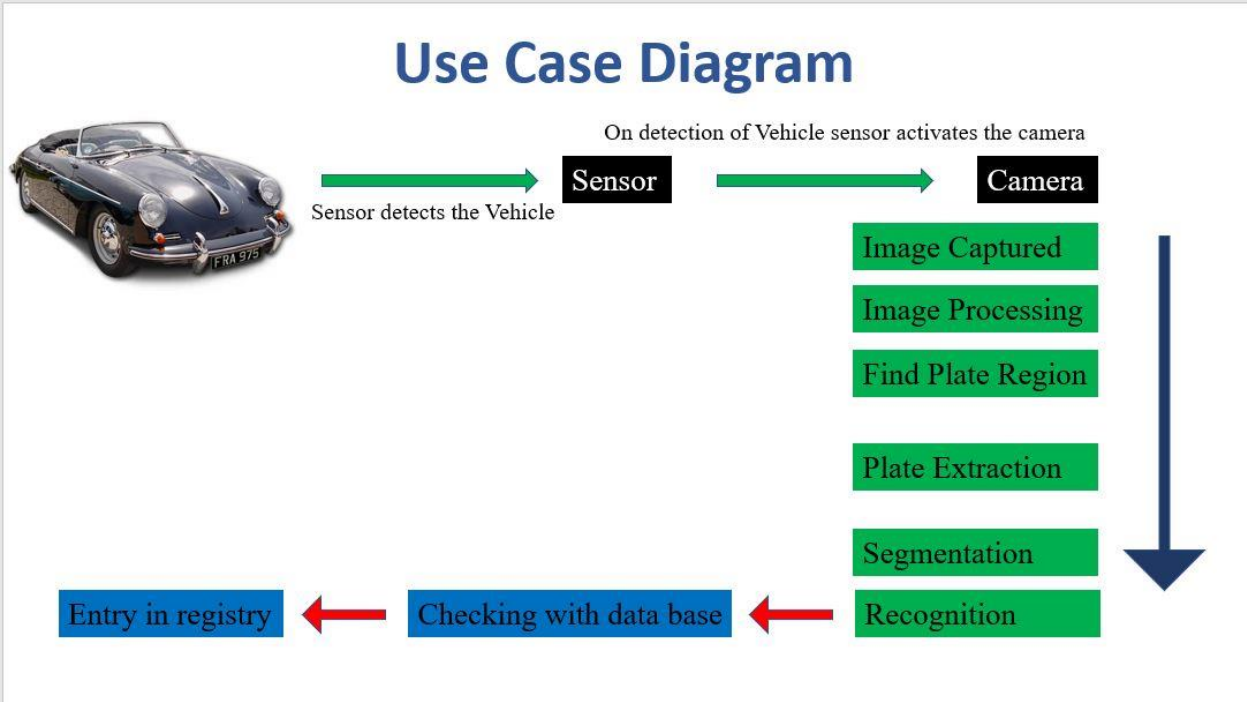
In everyday life many vehicle passes through traffic cameras. The number plate detection of per vehicle by human is very length and time consuming process.

So to overcome that problem the automatic number plate detection is very useful. It reduces human effort by very great extent and consumes less time as is more accurate.

If any car is over speeding or broke any traffic rules and it can be easily detected and the number plate can be recognized. Such person can be punished easily and the traffic accidents can be avoided.

6-How number plate detection works and Code

Below diagram shows how number plate detection works:



At first the sensor detects the vehicle and sends the signal to camera to capture the image of front and back side of the vehicle.

After the image is captured it is processed and also image restoration is applied if the image is noisy or blurred.

After that the portion of area in which number plate is present is taken separately out of the image and thus the extraction of number plate is done.

After that image segmentation is done and the alphabets and number value number plate are given as output.

The checking of the number plate is done within the database of registered vehicle and then the entry is done in registry.

7-Project Code and function explanation:

Template Creation:

```
%CREATE TEMPLATES
%Alphabets
A=imread('alpha/A.bmp');B=imread('alpha/B.bmp');C=imread('alpha/C.bmp');
D=imread('alpha/D.bmp');E=imread('alpha/E.bmp');F=imread('alpha/F.bmp');
G=imread('alpha/G.bmp');H=imread('alpha/H.bmp');I=imread('alpha/I.bmp');
J=imread('alpha/J.bmp');K=imread('alpha/K.bmp');L=imread('alpha/L.bmp');
M=imread('alpha/M.bmp');N=imread('alpha/N.bmp');O=imread('alpha/O.bmp');
P=imread('alpha/P.bmp');Q=imread('alpha/Q.bmp');R=imread('alpha/R.bmp');
S=imread('alpha/S.bmp');T=imread('alpha/T.bmp');U=imread('alpha/U.bmp');
V=imread('alpha/V.bmp');W=imread('alpha/W.bmp');X=imread('alpha/X.bmp');
Y=imread('alpha/Y.bmp');Z=imread('alpha/Z.bmp');

%Natural Numbers
one=imread('alpha/1.bmp');two=imread('alpha/2.bmp');
three=imread('alpha/3.bmp');four=imread('alpha/4.bmp');
five=imread('alpha/5.bmp'); six=imread('alpha/6.bmp');
seven=imread('alpha/7.bmp');eight=imread('alpha/8.bmp');
nine=imread('alpha/9.bmp'); zero=imread('alpha/0.bmp');

%Creating Array for Alphabets
letter=[A B C D E F G H I J K L M N O P Q R S T U V W X Y Z];
%Creating Array for Numbers
number=[one two three four five six seven eight nine zero];

NewTemplates=[letter number];
save ('NewTemplates','NewTemplates')
clear all
```

At first we have to create a template of characters or say we have give predefined image of alphabetic letters and numbers in gray image.

We have to read all the 26 letter and 10 numerical image into different variables and store them in an array.

In the above code we are saving the images into a variable by using command **'*imread()*'**. This function is used to call the images from the folder or from any location of the PC into the MATLAB.

We have than created array named **letter** to

Then create a matrix of **'letter'** and **'number'** and save it in variable **'NewTemplates'** by using command **'save(filename,variables)'**.

Letter Detection:

```
function letter=readLetter(snap)

load NewTemplates
snap=imresize(snap,[42 24]);
rec=[ ];

for n=1:length(NewTemplates)
    cor=corr2(NewTemplates{1,n},snap);
    rec=[rec cor];
end

ind=find(rec==max(rec));
display(ind);

% Alphabets listings.
if ind==1 || ind==2
    letter='A';
elseif ind==3 || ind==4
    letter='B';
elseif ind==5
    letter='C';
elseif ind==6 || ind==7
    letter='D';
elseif ind==8
    letter='E';
elseif ind==9
    letter='F';
elseif ind==10
    letter='G';
elseif ind==11
    letter='H';
elseif ind==12
    letter='I';
elseif ind==13
    letter='J';
elseif ind==14
    letter='K';
elseif ind==15
    letter='L';
elseif ind==16
    letter='M';
elseif ind==17
    letter='N';
elseif ind==18 || ind==19
    letter='O';
elseif ind==20 || ind==21
    letter='P';
elseif ind==22 || ind==23
    letter='Q';
elseif ind==24 || ind==25
    letter='R';
elseif ind==26
```

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

After giving predefined character image we have to specify for what kind of detection what character image we have to compare and give the output.

After the number plate is detected the number by number or character by character comparison is done in this second code we specify that what out to give for character and number comparison.

In the above code we have created a function named *letter* which gives us the alphanumeric output of the input image from class '*alpha*' by using command '*readLetter()'*. And then load the saved templates by using command *load 'NewTemplates*.

After that, we have resized the input image so it can be compared with the template's images by using the command *'***imresize(filename,size)***'*. Then **for** loop is used to correlates the input image with every image in the template to get the best match.

A matrix '**rec**' is created to record the value of correlation for each alphanumeric template with the characters template from the input image.

Then '**find()**' command is used to find the index which corresponds to the highest matched character. Then according to that index, corresponding character is printed using *'if-else'* statement.

Number plate detection:

```
close all;
clear all;

im = imread('Number Plate Images/image1.png');
imgray = rgb2gray(im);
threshold = graythresh(imgray);
imbin=im2bw(imgray,threshold);
im = edge(imgray, 'prewitt');

%Below steps are to find location of number plate
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

im = imcrop(imbin, boundingBox);%crop the number plate area
im = bwareaopen(~im, 500); %remove some object if it width is too long or too
small than 500

 [h, w] = size(im);%get width

imshow(im);

Iprops=regionprops(im,'BoundingBox','Area', 'Image'); %read letter
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=Letter_detection(Iprops(i).Image); % Reading the letter
corresponding the binary image 'N'.
       noPlate=[noPlate letter] % Appending every subsequent character in
noPlate variable.
```

```
    end
end
```

This is the main code in which we read the vehicle number plate image into a variable. Then we convert the image into gray. After that we apply image thresholding into the converted gray image.

After that we convert the image into binary image by replacing all the pixels in the input image with luminance greater than level with the value 1 (which is white color) and replacing all other pixels with the value 0.

After applying thresholding:

After that we apply prewitt edge detection.

Than we detect the location of the number plate in the entire input image**.**

After that crop the number plate and remove the small objects from the binary image by using command *'*imcrop()*'* and *'*bwareaopen()*'* respectively.

Then, the cropped license plate is processed to display the detected number in image and text format in the command window.

```
noPlate =

HR26DK83
```

The functions used in the code:

imread() – This command is used to open the image into the MATLAB from the target folder.

rgb2gray() –This command is used to convert the RGB image into grayscale format.

graythresh() – This computes a global threshold from grayscale image , using Otsu's method . Otsu's method chooses a threshold that minimizes the intraclass variance of the thresholded black and white pixels.

im2bw() – converts the grayscale image I to binary image BW, by replacing all pixels in the input image with luminance greater than level with the value 1 (white) and replacing all other pixels with the value 0 (black).

edge() – This command is used to detect the edges in the image, by using various methods like Roberts, Sobel, Prewitt and many others.

regionprops() – This command is used to measure properties of image region.

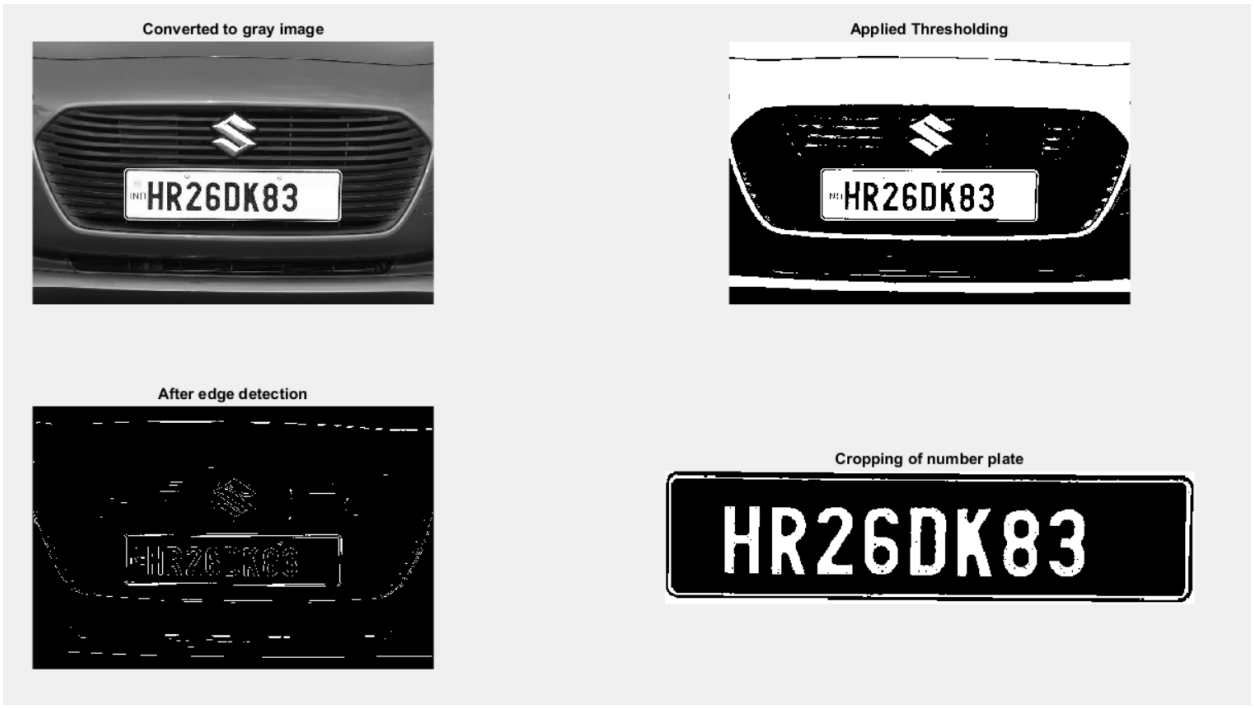
numel() – This command is used to calculate the number of array elements.

imcrop() – This command is used to crop the image in the entered size.

bwareaopen() – This command is used to remove small objects from binary image.

Thus for given below image we get output of the number plate.

Output:



```
noPlate =

HR26DK83
```

For another image:

Output:


```
noPlate =

MH12DE14
```

8-Application of project

Automatic Number Plate Recognition has a wide range of applications since the license number is the primary, most widely accepted, human readable, mandatory identifier of motor vehicles.
Automatic Number Plate Recognition provides automated access of the content of the number plate for computer systems managing databases and processing information of vehicle movements.
Below we indicated some of the major applications, without the demand of completeness.

Parking
One of the main applications of ANPR is parking automation and parking security: ticketless parking fee management, parking access automation, vehicle location guidance, car theft prevention, "lost ticket" fraud, fraud by changing tickets, simplified, partially or fully automated payment process, among many others.

Access Control
Access control in general is a mechanisms for limiting access to areas and resources based on users' identities and their membership in various predefined groups. Access to limited zones, however, may also be managed based on the accessing vehicles alone, or together with personal identity. License plate recognition brings automation of vehicle access control management, providing increased security, car pool management for logistics, security guide assistance, event logging, event management, keeping access diary, possibilities for analysis and data mining.

Motorway Road Tolling
Road Tolling means, that motorists pay directly for the usage of particular segment of road infrastructures. Tolls are a common way of funding the improvements of highways, motorways, roads and bridges: tolls are fees for services. Efficient road tolling increases the level of related road services by reducing travel time overhead, congestion and improve roadways quality. Also, efficient road tolling reduces fraud related to non-payment, makes charging effective, reduces required manpower to process events of exceptions. License plate recognition is mostly used as a very efficient enforcement tool, while there are road tolling systems based solely on license plate recognition too.

Border Control
Border Control is an established state-coordinated effort to achieve operational control of the country's state border with the priority mission of supporting the homeland's security agains terrorism, illegal cross border traffic, smuggling and criminal activities. Efficient border control significantly decreases the rate of violent crime and increases the society's security. Automatic number plate recognition adds significant value by event logging, establishing investigate-able databases of border crossings, alarming on suspicious passing, at many more.

Journey Time Measurement

Journey Time Measurement is a very efficient and widely usable method of understanding traffic, detecting conspicuous situations and events, etc. A computer vision-based system has its well-known downfalls in Journey Time Measurement, while Automatic Number Plate Recognition has provided its viability: vehicle journey times can be measured reliably by automatic number plate recognition-based systems. Data collected by license plate recognition systems can be used in many ways after processing: feeding back information to road users to increase traffic security, helping efficient law enforcement, optimizing traffic routes, reducing costs and time, etc.

Law Enforcement

Automatic number plate recognition is an ideal technology to be used for law enforcement purposes. It is able to automatically identify stolen cars based on the up-to date blacklist. Other very common law enforcement applications are red-light enforcement and overspeed charging and bus lane control.