Object Detection & OCR:

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1. Background:

Automated Number plate recognition (ANPR) technology was developed in 1976 in the Police Scientific Development Branch (PSDB), Home Office, United Kingdom . The European Secure Vehicle Alliance (ESVA) notes that the “Provisional Irish Republican Army (IRA) terrorist bombings in the City of London resulted in the establishment of the ‘ring of steel’ in 1993 – a surveillance and security cordon using initially CCTV cameras. In 1997, ANPR cameras, linked to police databases, were fitted at entrances to the ring of steel and gave feedback to monitoring officers within four seconds.” Implementation continued over the next several years with forces implementing ANPR systems.

Owners of motorized vehicles driven on open avenues are legally necessary to every year register their vehicles with their state agency or branch of engine vehicles, and to attach number plates that are publicly and legibly displayed. Vehicle license plates generally consist of a series of alpha numeric characters that reference the license plate to the specific vehicle registered (including the make, model, year, and vehicle identification number (VIN)) and the owner and/or lien holder of the vehicle.

2. Your Understanding:

Number plate recognition is a type of programmed vehicle recognizable proof. A number plate is the unique identification of vehicle. Number plate recognition is designed to identify the number plate and then recognize the vehicle number plate from a moving vehicle automatically. Vehicle number plate recognition has two noteworthy parts:

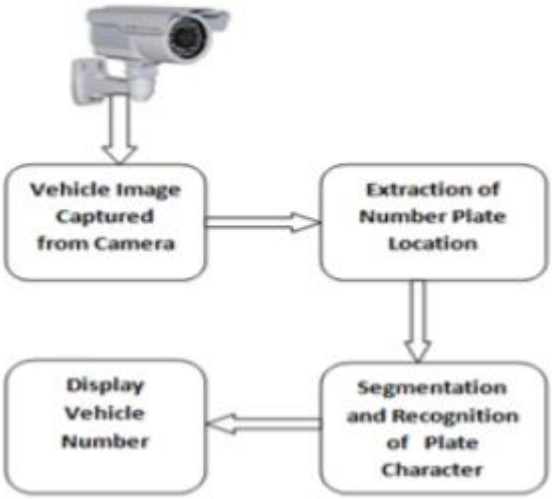
1 Vehicle number plate extraction,

2 Optical Character Recognition (OCR).

Number plate extraction is that stage where vehicle number plate is detected and extract the number plate text. The segmented characters are normalized and passed to an OCR algorithm. At last the optical character information will be converted into encoded text. The characters are recognized using Template matching. The final output must be in the form of string of characters.

This segment of the estimation referenced above helped in achieving faster character recognition of the license plate. This process of character recognition consists of steps

like Image processing, Defragmentation, Resizing and Character localization that are required to be performed on the image in order for Template Matching to be done.



3. Scope:

License Plate recognition is one of the techniques used for vehicle identification purposes. The sole intention of this project is to find the most efficient way to recognize the registration information from the digital image (obtained from the CCTV camera). This process usually comprises of three steps. First step is the license plate localization, regardless of the license-plate size and orientation. The second step is the segmentation of the characters and last step is the recognition of the characters from the license plate. Thus, this project uncovers the fundamental idea of various algorithms required to accomplish character recognition from the license plate during Template Matching.

Real time number plate recognition plays an important role in maintaining law enforcement and maintaining traffic rules. It has wide applications areas such as toll plaza, parking area, access control to restricted areas and tracking of wanted vehicles, boarder's areas etc.

The VPR (Vehicle Number plate Recognition) system is based on image processing technology In this day and age with the increasing number of vehicle step by step it's

unrealistic to physically track the whole vehicle. With the development of this system it becomes easy to keep a record and use it whenever required.

4. Out of Scope:

NPR system for Indian license plate is difficult compared to the foreign license plate s there is no standard followed for the aspect ratio of licence plate. The identification task is challenging because of the nature of the light.

Poor Image Resolution:

Poor image resolution can result from several factors. License plates can be too far away for the capabilities of the ANPR camera to capture and motion blur can also occur. Poor lighting and low contrast due to overexposure, reflection, adverse weather conditions, or shadows can also result in a poor image quality.

Bent, Dirty, Damaged, Or Modified Plates:

Because many ALPR systems use reflectivity and the contrast created by the alphanumeric characters, plates that are bent, dirty, damaged, or modified may cause the ALPR software to misidentify a character.


Plate Location:

Occasionally, an object might obscure all or a portion of the license plate and interfere with accurate OCR. Oftentimes the object is a tow bar, dirt on the license plate, or a loaded bike rack; other times the object may be a ANPR circumvention device. The National Policing Improvement Agency (NPIA) and the Association of Chief Police Officers (ACPO) have specified minimum performance capabilities of ANPR technologies in capturing and reading number plate information for UK and Schengen Community plates.



5. Assumptions:

Automated Number plate recognition (ANPR) systems normally consist of the following units:

- **Camera(s)** - that take the images of the car (front or rear side)
- **Illumination** - a controlled light that can bright up the plate, and allow day and night operation. In most cases the illumination is Infra-Red (IR) which is invisible to the driver.

- **Computer** - normally a PC running Windows or Linux. It runs the LPR application which controls the system, reads the images, analyses and identifies the plate, and interfaces with other applications and systems.
- **Software** - the application and the recognition package. Usually the recognition package is supplied as a DLL (Dynamic Link Library).
- **Hardware** - various input/output boards used to interface the external world (such as control boards and networking boards)

Assumptions:

- Input is an image of a stationary Car.
- Only the most common type of license plates (single line)will be dealt with.
- The license Plate has a yellow background with text written in Black.

Constraints:

- If the image contains too much spoiled license plate or has designs on it, the program can fail to localize the license plate.
- If the license plate happens to be much tilted from horizontal, then again the result of segmentation of the license plate is very poor.

6. Solution Approach:

In this system we will be working on CCTV footage or input image of vehicle. The CCTV footage must be clean and clear to retrive the Vehicle number from the image taken as Input for the processing . The brightness and contrast must be clear and the number plate must be in format according to given by government. We tested the project only on the vehicles following Indian Government Rules and Regulations. The following methods is used in this technology: -

a) Image capturing from camera
b) RGB to GRAY scale
c) Detect license plate from image

d) Character segmentation from number plate
e) Character recognition
f) Display vehicle number

1.1 Image Capturing from Camera :

This is first phase of the system. We will be capturing the image from CCTV footage. It is a normal image from normal camera following RGB format.. We will be OpenCV library.

1.2 RGB to GRAY Scale :

This is second phase in the system. We will work on the image taken as the input from above step. It is in RGB format. We will be converting that image into gray scale using OpenCV.

1.3 Detect License plate from image :

This is the third phase in the number plate detection system. We will be working on the image which was converted to gray scale from RGB format in above phases.

1.4 Character segmentation from number plate:

This is the fourth phase in vehicle plate detection system. We will be working on the image which is extracted from the gray scale image which we obtained from above phases i.e. the number plate which is detected. We will divide each character of the number plate which is being detected to find the number from number plate. Now we will be implementing fifth phase of vehicle plate detection system. We will be performing further more methods on the segmented image.

1.5 Character Recognition :

This is the fifth phase for vehicle number plate detection. We will be working on the segmented image of each character that we obtained from above phases. We will be detecting each and single character using Optical Character Recognition

technique (OCR). Now each character is recognized individually in this phase. Then those character are combined to form a whole number i.e. vehicle plate number which is present on the number plate which is taken in the form of image.

1.6 Display Vehicle Number:

This is the final phase of the vehicle plate detection. We have performed all the methods of vehicle number plate detection using python. We will be displaying that number on the screen.

Implementation Framework:

Step1 : Licence plate detection*:*

In order to detect licence, we will use Yolo (You Only Look One) deep learning object detection architecture based on convolution neural networks

Yolo is a single network trained end to end to perform a regression task predicting both objects bounding box and object class.

First, we prepared a dataset composed of 237 images of cars that contains one licence plate or two or Zero using a python script from Json file provided with HumAIn TCS problem Statement.

Again I used a python script to store coordinate of licence plate in .txt file from provided Json file.

YOLOv2 needs files in the following format:

|category number| |object centre in X| |object center in Y| |object width in X| |object width in Y|

After run a python file .txt file looks like:-

```
0 0.274147727273 0.684027777778 0.0681818181818 0.0347222222222
```

If there are two bounding boxes in an image, it will be in the following format.

```
0 0.324573863636 0.747395833333 0.0610795454545 0.03645833333330
0 0.700994318182 0.603298611111 0.078125 0.0329861111111
```

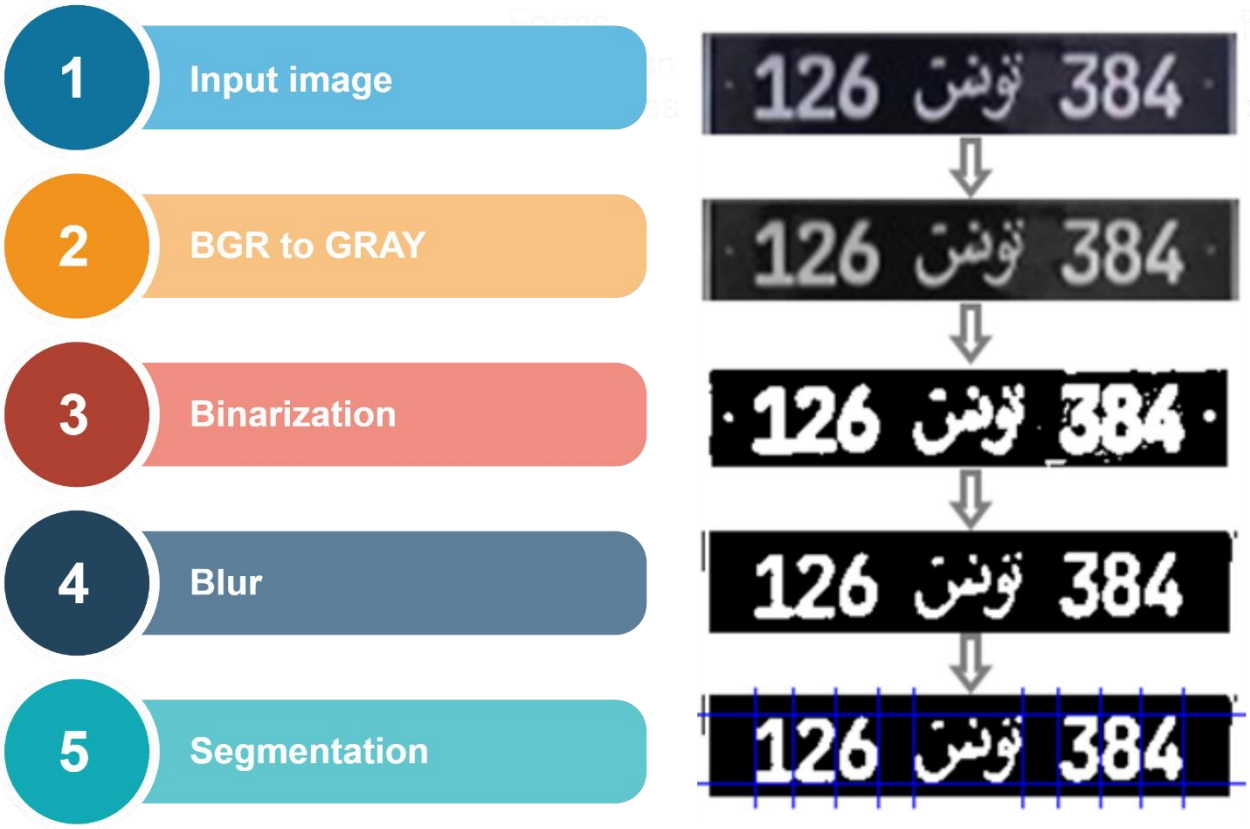
for each image, we make an xml file (Changed after that to text file that contains coordinates compatible with Darknet config file input. Darknet : project used to retrain YOLO pretrained models).

Step2 : Licence plate segmentation:

Segmentation is one of the most important processes for the automatic identification of license plates, because any other step is based on it. If the segmentation fails, recognition phase will not be correct.To ensure proper segmentation, preliminary processing will have to be performed.

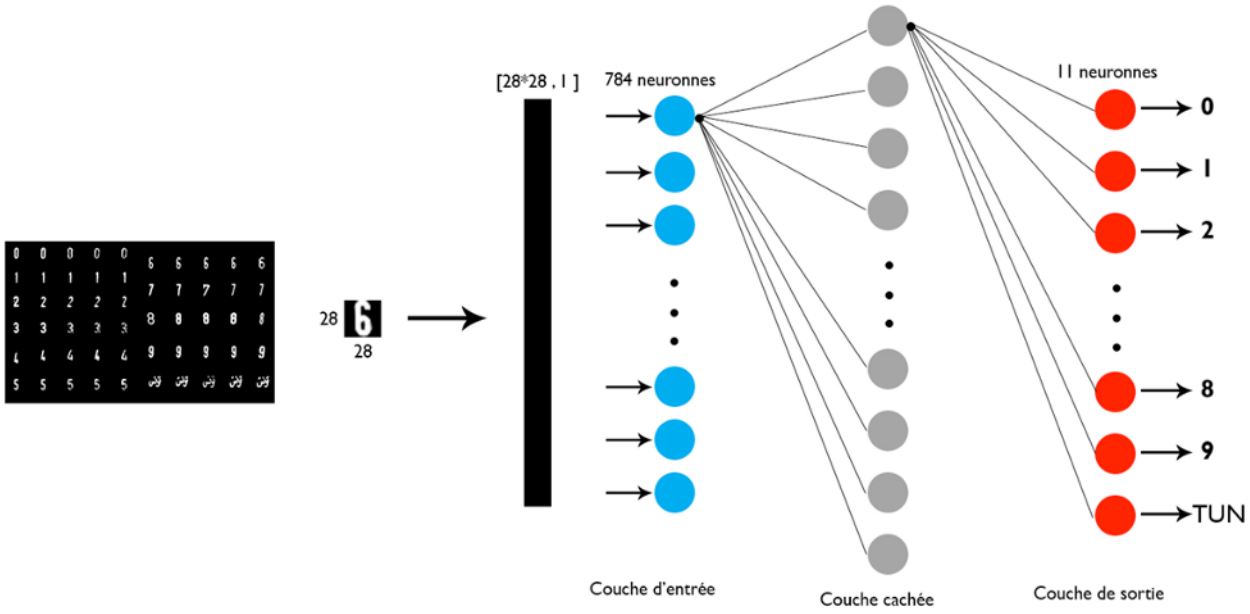
The histogram of pixel projection consists of finding the upper and lower limits, left and right of each character. We perform a horizontal projection to find the top and bottom positions of the characters. The value of a group of histograms is the sum of the white pixels along a particular line in the horizontal direction. When all the values

along all the lines in the horizontal direction are calculated, the horizontal projection histogram is obtained. The average value of the histogram is then used as a threshold to determine the upper and lower limits.



The central area whose segment of the histogram is greater than the threshold is recorded as the area delimited by the upper and lower limits. Then in the same way we calculate the vertical projection histogram but by changing the rows by the columns of the image to have the two limits of each character (left and right).

Step3 : Licence plate recognition:

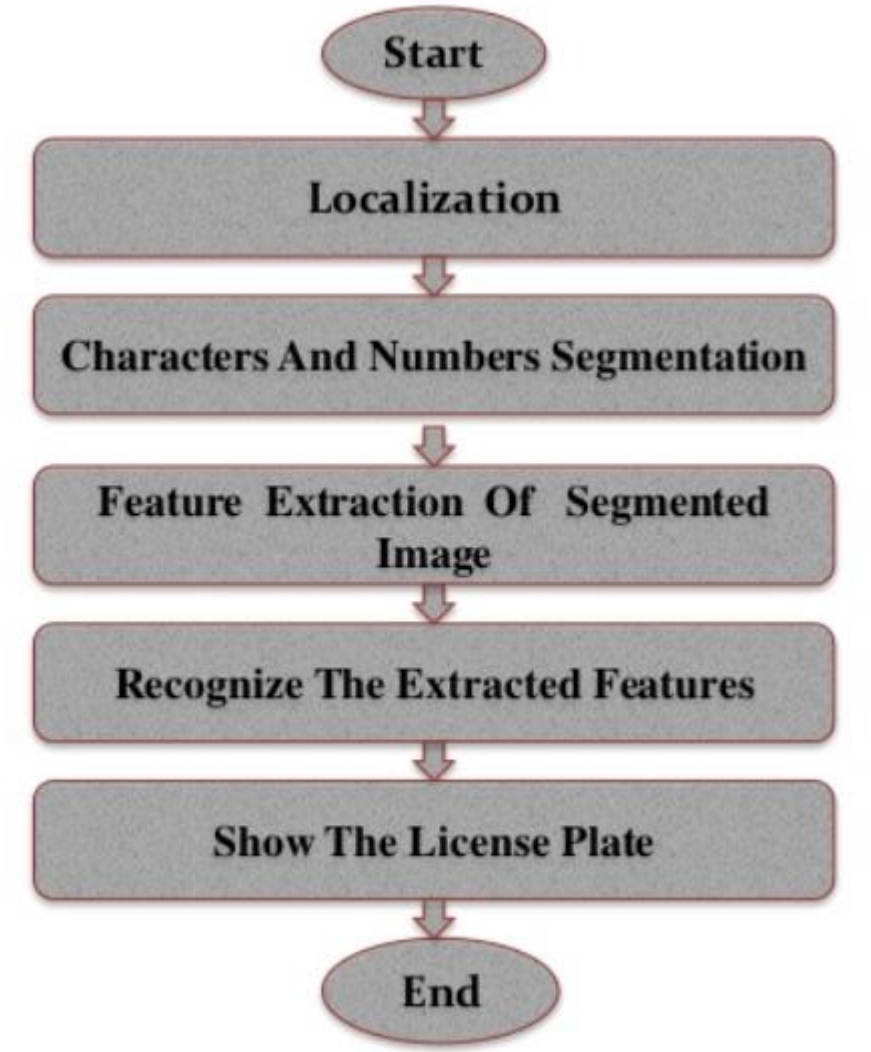


The recognition phase is the last step in the development of the automatic license plate recognition system. Thus, it closes all the processes passing by the acquisition of the image, followed by the location of the plate until the segmentation. The recognition must make from the images characters obtained at the end of the segmentation phase. The learning model that will be used for this recognition must be able to read an image and to render the corresponding character.

In order to make the most of the data available for learning, we cut each character individually by resizing it in a square after applying the same image processing steps used before segmentation of the license plate.

Then, we made some researches based on scientific articles that compare the multilayer perceptron (MLP) and the classifier K nearest neighbors (KNN) and as a result we have found that: performance is increased if the number of hidden layer neurons is also increased when using the MLP classifier.

Flow diagram:



Hardware Components:

1.Camera: Digital camera is used in image Acquisition stage

2. Infra-Red: light source at night may be provided by Infra-Red in order to provide illumination from camera.

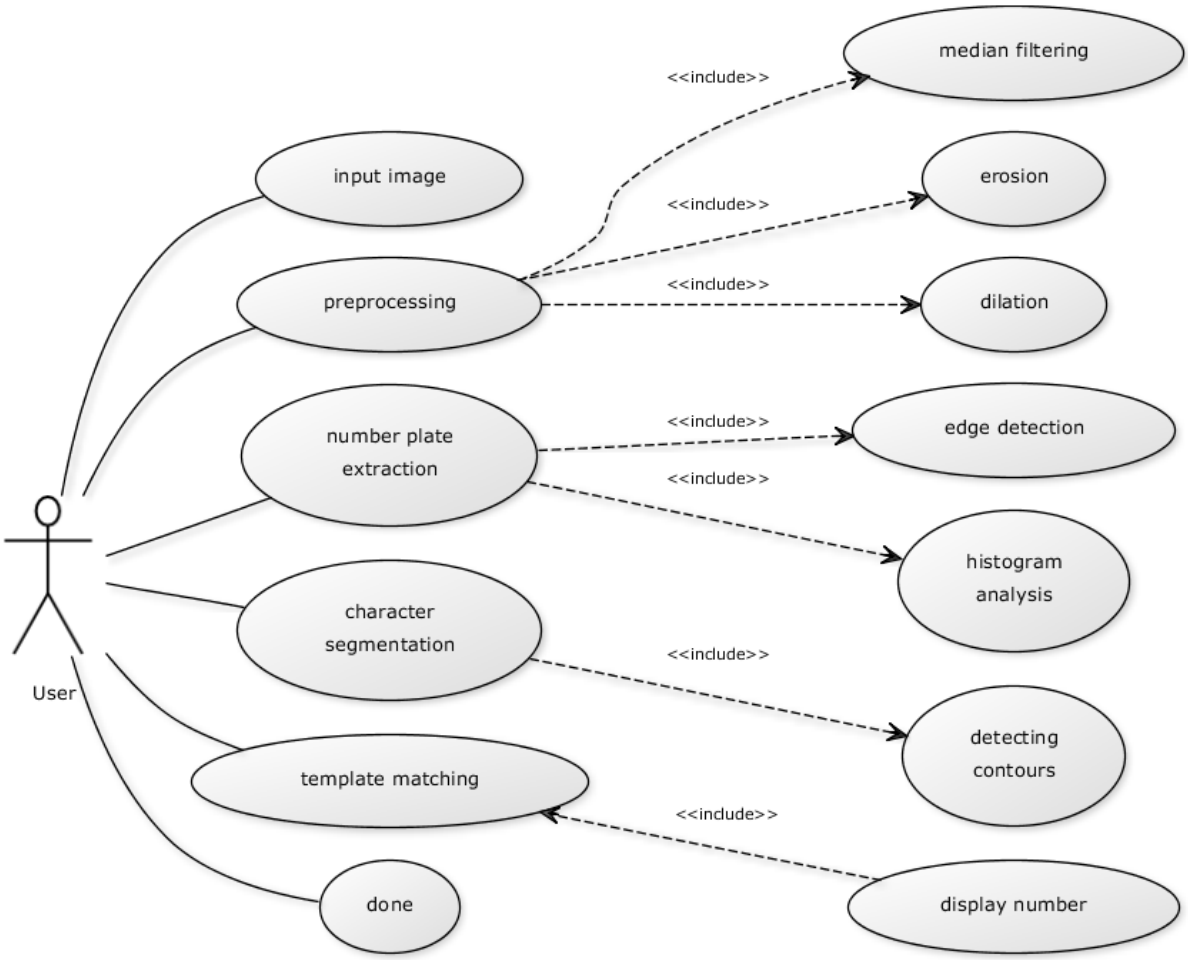
3. Frame Grabber: Hardware interface between camera and computer.

4. computer: The computer has ALPR system installed in it. it must contain a good processor or GPU .

Software Components:

1. ALPR Software:
2. Database: this provides storage of data (number plates that have been read by ANPR.
3. Back End Software: It is located on server and provides following functionalities:-
   a. Data Collection from Cameras
   b. Data mining from previously collected data for investigation & pattern analysis
   c. Allowing for sharing of data with other agencies

Use Case Diagram:



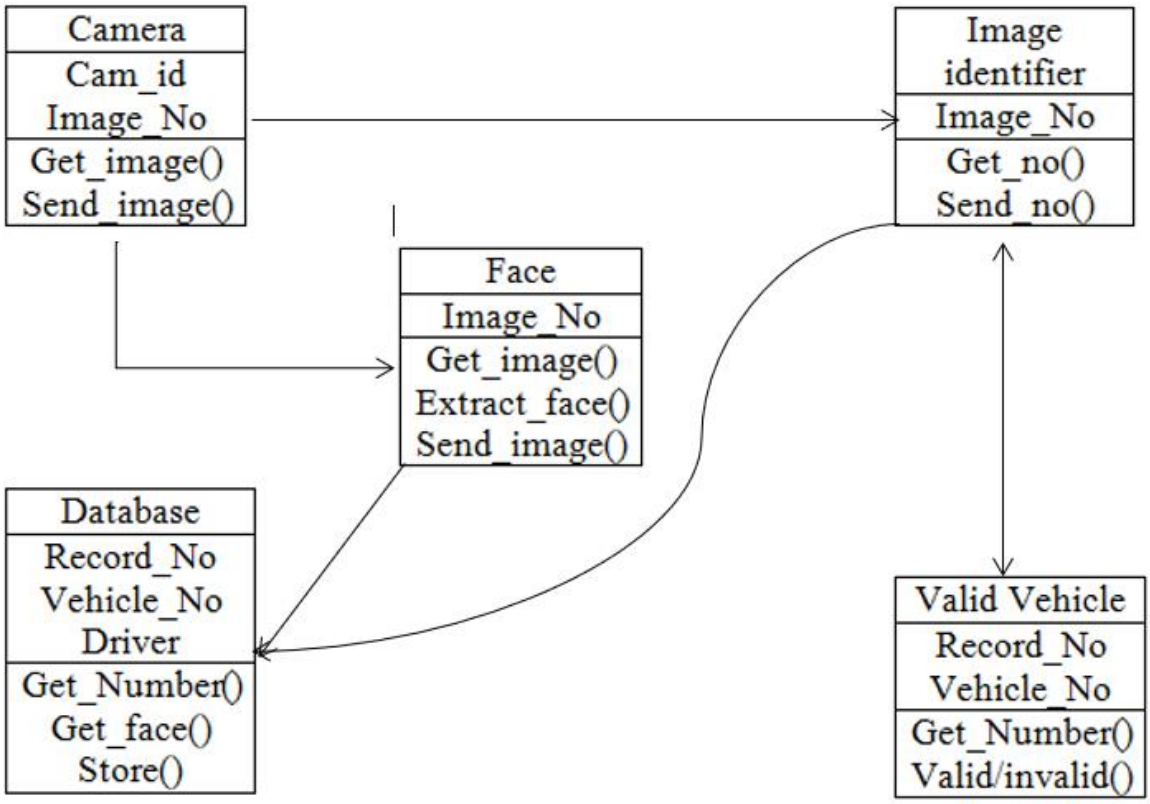
Actor:

- User

Use Case:

- Capture image C1
- Verify Vehicle
- Identify Number

Class Diagram:



Class Diagram

The entities in the use case are camera, Image identifier, Database, Valid vehicle.

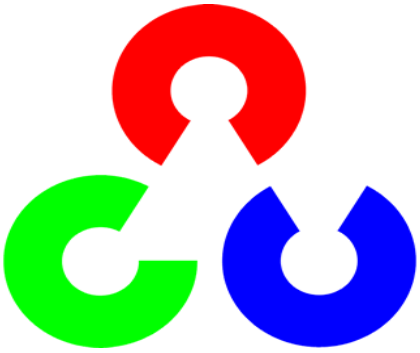
7. Solution Submission:

Here is the link of Submitted solution on GitHub:
https://github.com/ultimategarg/TCS-HumAIn-2019

8. Appendix:

OpenCV:

OpenCV is a computer vision library initially developed by Intel and now supported by Willow Garage. It is free for use under the open source BSD license. The library is cross-platform. It focuses mainly on *real-time* image processing. If the library finds Intel's Integrated Performance Primitives on the system, it will use these commercial optimized routines to accelerate it. OpenCV isn't a bit of programming that you run and procedure pictures. You have to compose code.



Camera Positioning:

Where the camera is positioned other than directly in the line of the approaching vehicle the ANPR provider must be consulted. Numerous frameworks won't work with more than increasingly 1 or 2 degrees of even slant or vertical rotation.

The positioning of the camera is a most important consideration for satisfactory operation of an ANPR system. This can vary the percentage of recognitions to number of vehicles from 30% or 40% to near on 100%.

9. References:

[1] Dr. P.K.Suri, Dr. Ekta Walia, Er. Amit Verma," Vehicle Number Plate Detection using Sobel Edge Detection Technique", International Journal of Computer Science and Technology, ISSN : 2229 – 4333, IJCST Vol. 1, Issue 2, December 2010.

[2] Kumar Parasuraman and P.Vasantha Kumar, " An Efficient Method for Indian Vehicle License Plate Extraction and Character Segmentation", IEEE International Conference on Computational Intelligence and Computing Research,2010.

[3] here is the link: https://arxiv.org/abs/1612.08242