# Automatic Number Plate Recognition- Approch for Detecting the Vehicle Number Plate On-The-Go

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**ABSTRACT**

**Automated Number Plate Recognition system would greatly enhance the ability of police to detect criminal activity that involves the use of motor vehicles. This is a potential future system. This system used by local authorities and commercial organizations in all aspects of security, surveillance, access control and traffic management. ANPR can also provide the protection petrol forecourts need against non-paying drive-offs. This paper discuses a method for the vehicle number plate recognition from the image using a special form of optical character recognition (OCR).ANPR systems use optical character recognition to read number plates through CCTV systems, which enables vehicle registration numbers to be stored, analyzed and retrieved, as required [Figure 1]. These systems can be fully automated to operate 24/7 and monitor unauthorized parking and vehicle movements in environments such as Access control points, Distribution centers, Hospitals and car parking areas.**

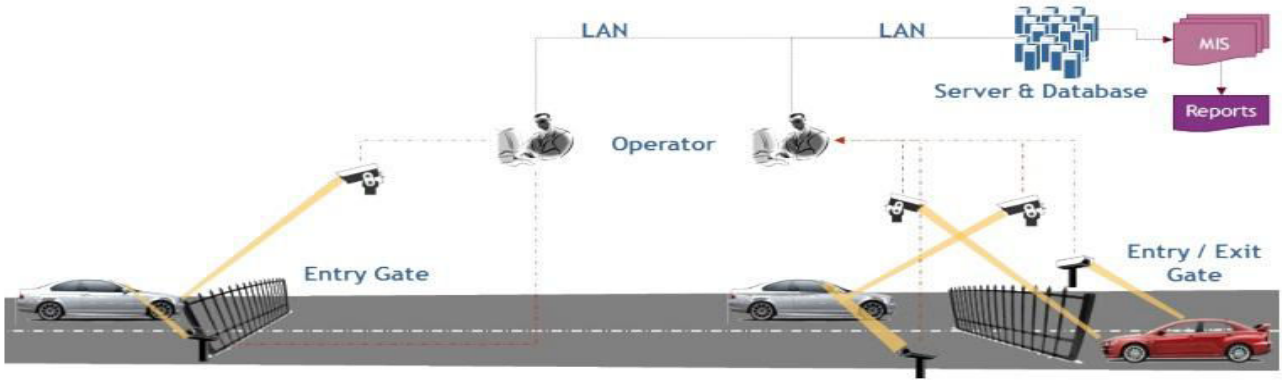


**Fig 1. ANPR system**

***Keywords: ANPR, Automatic Number Plate Recognition, Optical Character Recognition, Capture Unit, Process Unit*, CCTV, ANPR Engine, ANPR Equipment.**

## 1. INTRODUCTION

Automated Number Plate Recognition (ANPR) is also known as Automated License Plate Recognition (ALPR) [Figure 1]. Automatic Number Plate Recognition or ANPR is a technology that uses pattern recognition to 'read' vehicle number plates. In simple terms ANPR cameras 'photograph' the number plates of the vehicles that pass them. This 'photograph' is then fed in a computer system to find out details about the driver and owner of the vehicle and details about the vehicle itself. ANPR consists of cameras linked to a computer [1]. As a vehicle passes, ANPR 'reads' Vehicle Registration Marks - more commonly known as number plates - from digital images, captured through cameras located either in a mobile unit, in-built in traffic vehicles or via Closed Circuit Television (CCTV). The digital image is converted into data, which is processed through the ANPR system. In this paper, we proposed a method mainly based on edge detection, OCR operation and Finding Rectangles in a Vehicle Image. The technical method of artificial vision is optical character recognition (OCR) that allows the recognition of number plates in images of vehicles. Historically, it has been applied on security systems to control accesses of vehicles and car parks. Nowadays, the ANPR technology has improved its reliability; some systems are able to offer recognition rates between 65 and 75%. Also, some ANPR equipments are able to recognize the number plate of vehicles that drive up to 120km/h.

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

- The ANPR engine
- The ANPR equipment (Hardware + recognition engine)

The ANPR engine can recognize the number plate directly from the images stored in a hard disk. Software of this type allows for taking efficient use of images that have been received from other systems like CCTV or cameras.

The ANPR equipment incorporates all the hardware necessary to capture the images of the vehicles and to recognize the number plate. Moreover, it incorporates the ANPR engine. The ANPR equipments are designed to offer the maximum reliability.

### 1.1 Structure

Number plate is a pattern with very high variations of contrast. If the number plate is very similar to background .It's difficult to identify the location. Brightness and contrast is changes as light fall changes to it. In this paper the morphological operations are used to extract the contrast feature within the plate.

The work is divided into several parts:

A. Input car image
B. Gray scale conversion
C. Reduce noise using mid-filtering method
D. License Plate Detection
E. Character segmentation
F. Character Recognition.

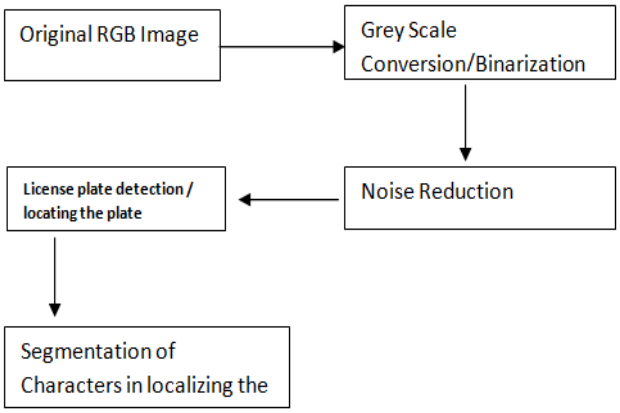


**Fig.2. Structure of ANPR system**

### A. Input raw image

Input the image that is taken from the car [Figure 2.2].


**Fig. 2.2 Input car image.**

### B. Gray scale conversion

From the input RGB image it has to be converted to gray scale and the 8-bit grey value calculated [Figure 2.3].


**Fig. 2.3 Grey scale car image**

### C. Noise reduction

We used median filtering technique to reduce the paper and salt noise [1]. We have used 3x 3 masks to get eight neighbors of a pixel and their corresponding gray value.

### D. License Plate Detection

The basic step in recognition of vehicle number plate is to detect the plate size. In general number plates are rectangular in shape. Hence we have to detect the edges of the rectangular plate. Mathematical morphology will be used to detect that region. Using Sobel edge detector we used to high light regions with a high edge magnitude and high edge variance are identified [Figure 2.4].


**Fig. 2.4 Number Plate recognition.**

### E. Segmentation of characters

The next step is segmentation of the license plate area into smaller parts which represent each character of the license plate [Figure 2.5]. This is done using the vertical projection which is shown in Fig. 2.5.


**Fig.2.5. Segmentation of characters**

### F. Recognition

The process of character recognition is repeated for each character image obtained in the last step. This process could be carried out in several steps. The output of this

process should be a recognized character. The set of possible outputs are characters that appear on license plates, which are letters of the alphabet, numbers from 0 to 9 and special characters like a dash. In order to simplify recognition, the initial step is to separate possible outputs into smaller groups counting the character end points [Figure 2.6]. For example, character 'I' has 2 end points, but on the other hand, character '9' has only 2 end points.

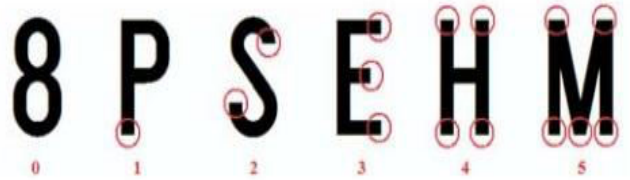


**Fig. 2.6 Characters with different number of end point.**

This character recognition allows us to use a 3×3 mask to find one of 8 possible types of end points [Figure 2.7]. Every 3×3 area of an image is compared to 8 masks shown in Fig.2.7.

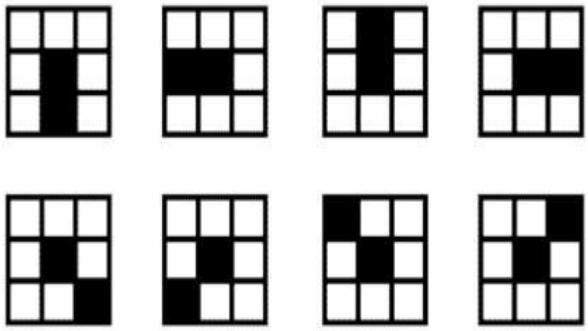

**Fig. 2.7. possible end points**

| End points | Characters | End points | Characters |
|---|---|---|---|
| 0 | 0, 8, B, D, O | 3 | 3, A, E, F, T, V, Y |
| 1 | 6, 9, P | 4 | H, K, N, X |
| 2 | 1, 2, 4, 5, 7, C, G, I, J, L, R, S, U, Z | 5 | M,W |

**Table 1. Characters sorted by the number of end points**

### 1.2. Features

1. Detects and reads license plates automatically 24 x 7 in real time.
2. High accuracy for heterogeneous number plates.
3. Vehicle Speeds up to 120 km/hr.
4. Simultaneous Multi-Lane processing.
5. Engine capable of detecting and recognizing different dimensions, contrast, colors license plates with variety of character font & style.
6. Transmits real-time stamp of entry/exit of the vehicle to the database.
7. Alerts/Alarms for stolen or marked vehicles.

## 2. PARTS OF GENERIC SYSTEM

**Capture Unit (CU) + Process Unit(PU):** Although there already exist some All-in-One equipment, the great majority of systems are still using "CU+PU" architecture:

- (CU) Capture unit

1. Camera housing
2. Camera
3. Infrared focus

- (PU) Process unit

4. Embedded computer
   A. Frame grabber
   B. Recognition engine

**ANPR Architecture:**

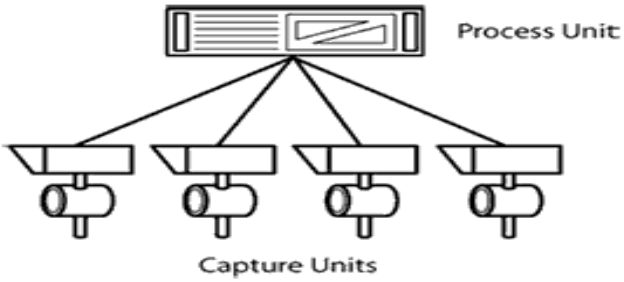


**Fig 3: ANPR Architecture**

**Operation of the system:**

The system "CU+PU" is the combination of two parts [3]. The Capture Unit that takes the image of the vehicle, and the Process Unit that receive the image from the Capture Unit and makes the recognition of the number plate. The Process Units can control one or more Capture Units simultaneously.

The quality of the solution depends on each manufacturer, although generally the "CU+PU" architecture has disadvantages respect the ANPR All-in-One, they are the following ones:

- Non robust architecture

The Capture Units controlled from the one only Process Unit will fall if the Process Unit does not work

- Complex installation and start-up

It is necessary to install video and control wire for each one of the cameras.

Furthermore, it is necessary to provide power supply cable to the cameras, focus and Process Units. If the distance between the lanes is too long, the signal of the cameras will not arrive with clearness to the Process Unit. For example:
If we have to control 4 lanes gathered in groups of two and separated by a distance of 2 km, It will not be possible to control the 4 lanes with the same Process Unit. Sometimes the cost of the installation may increase because of the limitation of distances between the Capture Unit and the Process Unit [5]. If the Process Units are installed directly on the lane it will be necessary to protect it with a weatherproof rack.

- High cost

The wiring and the time of installation are mulplied.
The maintenance of the system is multiplied.

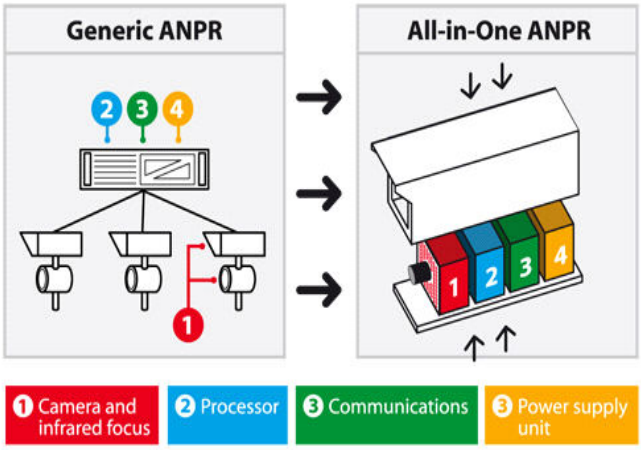


**Fig 4: Evolution to All-in-One equipment:**

By contrast to the generic ANPR, the ANPR equipment integrates directly in the housing the camera, the processor, the communications and the power supply unit

**Benefits of the ANPR equipment:**
The ANPR equipment with an All-in-One architecture deletes the disadvantages of the generic ANPR equipments, these are the following ones:

- It is simpler: All the necessary elements for the ANPR process are integrated in the same housing. Only one device is necessary for each lane to be controlled. The equipment may be connected by Ethernet or serial communication with the client application
- Modular architecture: If equipment with All-in-One architecture does not work, its fall does not affect to the other lanes, because the Process Unit are deleted.

Installation and start-up is easier:

- It is only necessary to provide 220v, Ethernet network or serial communication to each equipment.
- The installation is as easy as to screw the equipment with the support, to identify ANPR equipment with an IP and to adjust the optics
- If one equipment falls, it is possible to replace it by another one

It reduces the cost:

- The wiring is reduced
- The installation and start-up time is reduced
- The maintenance of the system is reduced

**2.1 How does it work?**
The ANPR process is divided into three steps. The detection of the vehicle, the capture of the images and the process of recognition. Next, we will detail step by step how it works and depending on each case what the advantages and disadvantages are

- Detection of the vehicle. The first step is to take an image of the vehicle at the right time. Thus, the number plate of the vehicle will be visible in the image. Nowadays, three kind of trigger control exist

1. Hardware trigger: The ANPR equipment controls physically a sensor directly installed in the lane. Whenever a vehicle has been detected by the sensor, the ANPR equipment will know its presence, and then the process of the capture begins
2. Software trigger: The ANPR equipment communicates with the client application, which physically controls a sensor directly installed in the lane. Whenever a vehicle has been detected by the sensor, the client application knows the presence of the vehicle and communicates it to the ANPR equipment. At this moment the process of the capture begins
3. Free flow: The ANPR equipment does not need to receive signal from any external sensor. The ANPR equipment takes images continuously and it is able to detect the vehicles automatically

- Capture of the images. Once the vehicle is detected, the following step is the capture of the vehicle. In order to take a right image, the following points will have to be considered

**Type of cameras**:

i. Interlace camera: The capture of the images is made in two steps. First uneven lines and later the even lines. This type of cameras are cheaper but its use is not recommended for ANPR because if the vehicle is in movement, the number plate appears defocused
ii. Progressive cameras: The use of this type of cameras is totally recommended because if the vehicle is in movement the number plate always appears focused

**Type of light:**
Infrared light is used generally for the ANPR equipment. *Although some ANPR equipment are able to use the daylight and the infrared light during the night.

i. Infrared light: The ANPR systems use infrared light because the human eye cannot detect it without other devices [Figure 5]. One infrared filter located in the camera allows to emphasize the number plate, but, in the other hand, the rest of elements of the image are darkened


**Fig 5: Examples of Infrared Light**

- Daylight: It is perceived by the human eye [Figure 6]. It allows taking images in which the vehicle is distinguished.


**Fig 6: Examples for Daylight**

**Light management:** The type of light is as important as how it is managed. It is possible to use any typical technique of photography, but the ANPR manufacturers have chosen two great ways:

- To control the light emitted by the focus.
- To control the light that enters in the camera.

**Number plate recognition process**: Each ANPR manufacturer has developed its own recognition algorithms, although, these are the main ones and the common ones.

- To locate and to isolate the number plate in the image.
- To correct the brightness and the contrast of the number plate.
- To separate each character of the number plate.
- To recognize each character of the number plate.

## 3. ANPR APPLICATIONS:

### 3.1 Car parks

In some countries like Spain or Greece, the law binds the recording of the number plate on the ticket. In this way, the number plate and the ticket number are linked. Thus, car parks improve their management.


**Fig 7 : Car Parking**

These are some direct benefits:

**Number plate register**: The ticket number, day and the time, and the number plate are linked and registered in the management application.

**Finding a lost ticket**:Thanks to the registry of the number plates it is possible to find a lost ticket and to receive the correct amount.

**Ticket interchange is avoided**: It is possible to block the exit of a vehicle, if the number plate of the vehicle does not match with the number plate in the entrance ticket.

**3.2Access control:** The ANPR equipment has been used for the access control of vehicles, it was thought as one more tool that allows increasing the security [Figure 8]. The client application could control users through personal cards, and the ANPR allows vehicles control.

**Fig 8: Access Control**

Nowadays, the ANPR equipments are used to automatize the accesses of vehicles.

#### 3.2.1 ANPR access control:

These are the main advantages to incorporate ANPR equipment in access control:

**Security increased**: Integrating the ANPR technology in access control applications together with the traditional control devices, allows vehicle and people control. Thanks to this convention the security is increased.

**Dynamic access of vehicles:** Automatizing vehicle access is possible through ANPR equipment. If the data base knows the vehicle, the client application will open the barrier automatically. By contrast, if the data base does not know the vehicle, it will not open the barrier.

**Vehicle images**: It is possible to store the image used for the ANPR equipment during the recognition process. It allows to have more information about the vehicle in the client application.

**3.3. Traffic Control:** Some ANPR equipment are able to recognize the number plate of vehicles that circulate up to 200 km/h with a reliability of 95%. Thanks to this, the use of ANPR equipment for traffic control has increased significantly in the last years.

These are some examples of ANPR application on traffic control:
Detecting vehicles in a black list
It is possible to control vehicles that are in search and capture, through the installation of the ANPR equipment in the main accesses to cities, such as highways and roads.

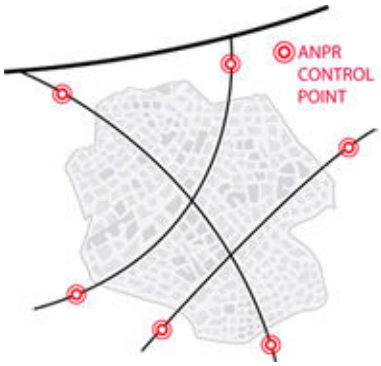


**Fig 9: ANPR Control Point**

**3.4. Average speed control:**
The majority of speed control devices, such as radars or speed traps, control the vehicle instantaneous speed. With the ANPR equipment it is possible to control the average speed during an itinerary. By means of the installation of two ANPR equipments in different points in the same lane, it is possible to make two consecutive recognitions of the number plate and to calculate the average speed of the vehicle.

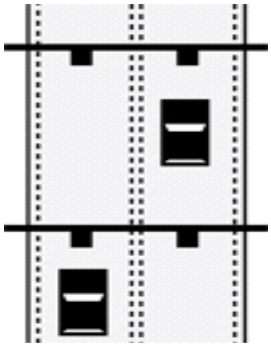

**Fig 10: Average Speed Control**

**3.5 Traffic optimization:**
It is important to improve the vehicles mobility during rush hours and traffic jam.

The installation of ANPR equipment allows to know how many time a vehicle spends to cross an itinerary. This way, the average time can be informed.


**Fig 11: Traffic Optimization**

**3.6 Toll enforcement:**
Although the use of ANPR equipment in tolls is a logical application, today, the ANPR equipment are only used to control the vehicles that circulate in the toll, as a data base that increases the security

**Fig 12: Toll Enforcement**

**3.7 Red light control:**
To jump a red light is a really dangerous infraction with consequences for others drivers and pedestrians. Nowadays, it is possible to control when a vehicle jumps a red light. This system combines sensors and image capture equipment, such as cameras or video recorders. The ANPR systems reinforce the red light control systems. Thanks to ANPR technology the fine process can be done automatically.

**Fig 13: Red Light Control**

## 4. CONCLUSION

This paper presents a recognition method in which the vehicle plate image is obtained by the digital cameras and the image is processed to get the number plate information. A rear image of a vehicle is captured and processed using various algorithms. Further we are planning to study about the characteristics involved with the automatic number plate system for better performance.

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