Vehicle Number Plate Identification By Using Existing General Surveillance Cameras

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Abstract

License plate recognition systems are widely used in modern smart cities, such as toll payment systems, parking fee payment systems and residential access control. Such electronic systems are not only convenient for people's daily life, but also provide safe and efficient services for managers. License plate recognition algorithm is a mature but imperfect technology. The traditional location recognition algorithm is easily affected by light, shadow, background complexity or other factors, resulting in the failure to meet the application of real scenes. With the development of deep learning, the license plate recognition algorithm can extract deeper features, thus greatly improving the detection and recognition accuracy. Therefore, this paper discusses the application of deep learning in license plate recognition, and the main work is as follows:

1)Introduce the most advanced algorithms from the three main technical difficulties: license plate skew, image noise and license plate blur;
2)According to the process, the deep learning algorithms are classified into direct detection algorithms and indirect detection algorithms, and the advantages and disadvantages of the current license plate detection algorithms and character recognition algorithms are analyzed;
3)The differences in data sets, workstation, accuracy and time of different license plate recognition systems are compared;
4)Compare and illustrate the existing public license plate datasets according to the number of pictures, resolution and environmental complexity, and make a prospect for the future research direction of license plate recognition

Index Terms: *license, plate, recognition, algorithms, systems, detection, learning, deep, algorithm, accuracy*

1. 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

Automatic number plate recognition (ANPR), also known as Automatic Vehicle Identification (AVI), can be implemented using existing multi-purpose CCTV surveillance cameras or dedicated ANPR cameras. These systems use optical character recognition (OCR) software to isolate and identify vehicle registration details. This technology is typically utilized for automatic toll collection, or to detect speeding violations, but can also be used to monitor vehicle movement and for access control.

A typical ANPR system includes hardware and software components including roadside camera systems, control center computer systems, software Applications to manage captured data, and a central database of vehicle registration details. There are two different approaches to data processing:

1.1 Images are captured by camera equipment and sent directly to the control center with time, date and location information without any pre-processing. The central computer system utilizes OCR software which uses a set of algorithms to isolate vehicle registration details, and then compares this information with a database of known vehicle registration numbers to display driver and vehicle information.

1.2 Images are captured by the camera equipment and processed immediately at the camera location by an embedded OCR processing unit on the camera. The isolated registration number is then transmitted to the control center along with time, date and location data where it is compared with a database to provide driver and vehicle information.

2. Literature survey

Year and Title	**Algorithm**	**Result**	**Limitations /Drawbacks**
[1]NUMBER PLATE RECOGNITION USING ARTIFICIAL INTELLIGENCE. 2021-IEEE Paper	1. YOLOv5 2. Data augmentation techniques such as grayscale 3. Optical Character Recognition (OCR)	This proposed methodology achieved a recognition rate of 92.2%, producing better results than commercially available systems, PlateRecognizer (67%) and OpenALPR (77%).	Having Low detection Rate of Plate Recognizer (67%)
[2]License Plate Recognition System Based on Deep Learning, 2020-IEEE papers	1. Optical Character Recognition Technique (OCR) 2. JAVA(framework) 3. OpenCV 4. CNN	the ability to recognize the characters correctly on license plate by neural network has probability of 95% even in presence of noise with 50% density	Required vehicle to be parked at a place
[3]License Plate Recognition System, International Conference on Advance Computing and Innovative Technologies in Engineering(ICACITE)-	1. Optical Character Recognition Technique (OCR) 2. JAVA(framework) 3. OpenCV 4. YOLOv4	the ability to recognize the characters correctly on license plate by neural network has probability of 95% even in presence of noise with 50% density	Required vehicle to be parked at a place
4]A Lightweight, High-Performance Multi-Angle License Plate Recognition Model IEEE-2019 paper	1. Tiny-YOLOv2 2. K-means Cluster method 3. multi-scaling	The model can recognize license plates with a slope of 0~60 degrees, and the recall rate in the range of 0~60 degrees is 89.5%.	Compared with the Tiny-YOLOv2, the calculation complexity of the proposed model is reduced by 60%, but the recall rate is slightly decreased.
[5]CNN based Automated Vehicle Registration	1. Convolution Neural Network (CNN).	We are testing our algorithm on a set of data	

Number Plate Recognition System (ICACCCN) 2020 papers	2. Character Segmentation 3. Optical Character Recognition (OCR)	which comprises around 300 images and get the desired results with around 99% accuracy even when applying the images of vehicles from variou	
[6]R. Ghosh, A registration plate recognition system specially for vehicles of India. (ICACCCN)-2019 papers	1. Optical character recognition (OCR) 2. (CNN)Convolution Neural Network 3. YOLOv2	They proved about 92.31% robustness of their proposed system	
[7]Kashyap, He proposed an OCR based Number Plate Recognition system (ICACCCN)-2019 papers	1. Binary Image Processing 2. Gray-Level Processing 3. Optical character recognition (OCR)	He claims about 75-85% accuracy for Indian vehicle number plates.	The disadvantage of this is that it doesn't work with different Camera angle
[8]Automatic Number Plate Detection in Vehicles using Faster R-CNN 2019-IEEE	1. Optical character recognition (OCR) 2. (CNN)Convolution Neural Network 3. Image segmentation 4. Image interpolation	The proposed system is able to achieve a 99.1% accuracy to detect the number plate of the vehicle and show the vehicle's owner information.	It is difficult to detect the objects in the black or low light conditions. The distance of the camera and angle of the camera toward the vehicle also plays major role in the detection of the object
[9]Eyes on the Target: Super-Resolution and License-Plate Recognition in Low-Quality Surveillance Videos 2019-IEEE	1. Optical character recognition (OCR) 2. (CNN)Convolution Neural Network 3. Single-Image Super-Resolution (SISR) algorithms 4. K-NN	The Implemented-based variations found results higher than GSR4 result of 80% of the dataset	
[10]Multinational License Plate Recognition Using Generalized Character Sequence Detection 2020-IEEE papers	1. Tiny-YOLOv3 2. Optical character recognition (OCR) 3. (CNN)Convolution Neural Network 4. Character segmentation	They claim about 90-95% accuracy for Indian vehicle number plates.	It is difficult to detect the objects in the black or low light conditions. The distance of the camera and angle of the camera toward the vehicle also plays major role in the detection of the object

2. Overview of the proposed model

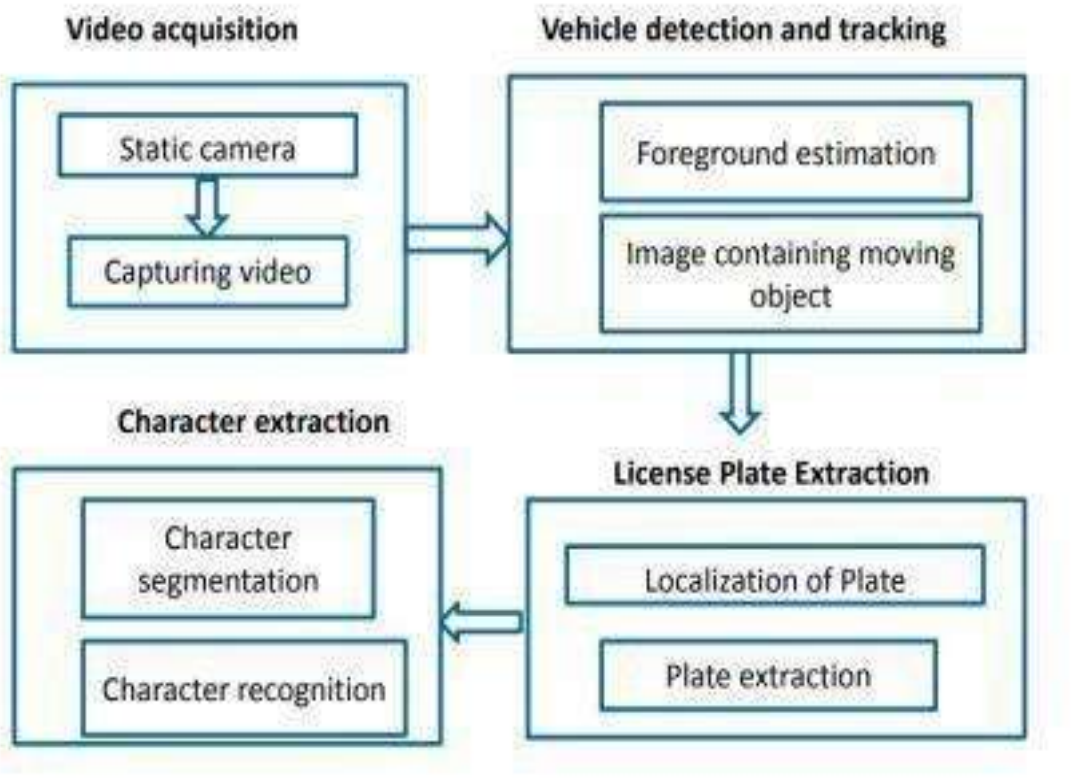
A typical surveillance system consists of a traffic camera network, which processes captured traffic video on-site and transmits the extracted parameters in real time. Here our focus is on the study of the algorithmic part of such a system.

In this thesis, we present a full-featured vehicle detection, tracking and license plate recognition system framework, particularly designed to work on video footage. This system mainly having four modules:-

1. Video Acquisition
2. Vehicle detection and tracking
3. License plate extraction
4. Character recognition unit

The system is designed for real time videos where a camera is used for continuous recording of videos. The view of the camera or the area covered by the camera is fixed between entry zone and exit zone. Each frame is continuously processed to check the presence of a vehicle. A distance is defined between the vehicle and the camera and when the vehicle comes within that range i.e vehicle's connected component area is maximum, these frames of video are passed to license plate recognition algorithm. After that recognition of character takes place and data is stored and compared with the database.

Block Diagram of the Proposed System:



3. Methodology

3.1 License Plate Detection: The first step is to detect the License plate from the car. We will use the contour option in OpenCV to detect rectangular objects to find the number plate. The accuracy can be improved if we know the exact size, color and approximate location of the number plate. Normally the detection algorithm is trained based on the position of camera and type of number plate used in that particular country. This gets trickier if the image does not even have a car, in this case we will take an additional step to detect the car and then the license plate.

Step 1: Resize the image to the required size and then grayscale it. Resizing we help us to avoid any problems

with bigger resolution images, make sure the number plate still remains in the frame after resizing. Gray scaling is common in all image processing steps. This speeds up other following processes since we no longer have to

deal with the color details when processing an image.

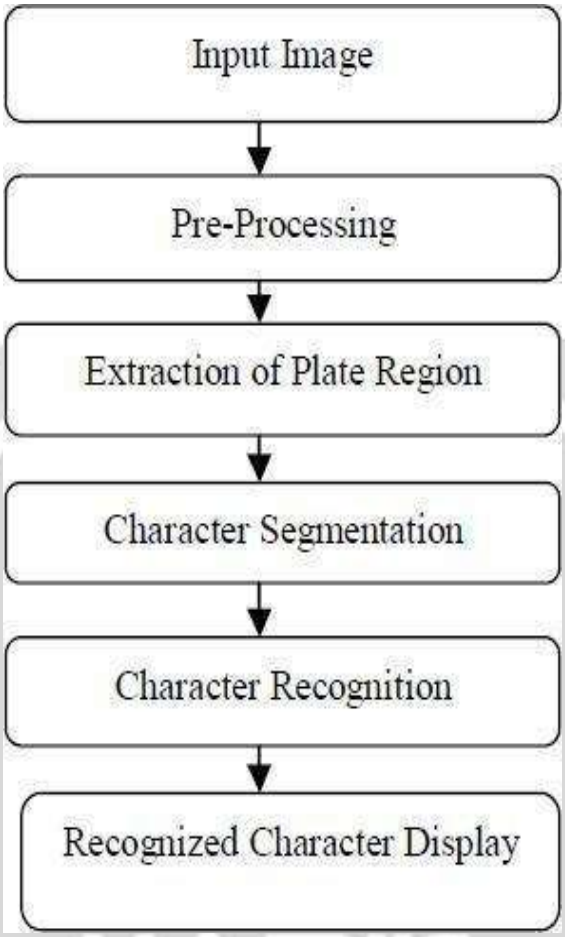
Step 2: **Using a bilateral filter (Blurring) will remove the unwanted details from an image**. Every image will

have useful and useless information, in this case for us only the license plate is the useful information, the rest

are pretty much useless for our program. This useless information is called noise

Step 3: Edge detection. Only the edges that have an intensity gradient more than the minimum threshold value

and less than the maximum threshold value will be displayed.



3.2 Number plate is a pattern with very high variations of contrast. If the number plate is very similar to the background .It's difficult to identify the location. Brightness and contrast 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:

3.2.1. Input raw image Input the image that is taken from the car.

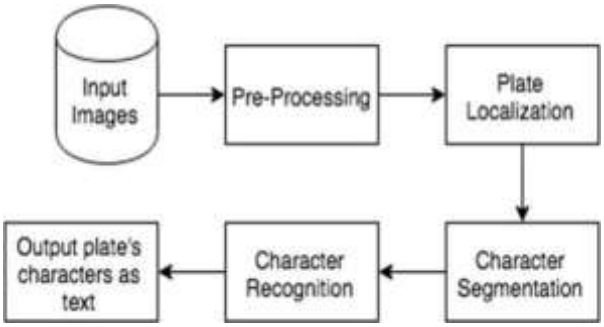
3.2.2. Gray scale conversion From the input RGB image it has to be converted to gray scale and the 8-bit gray value calculated.

3.2.3. Noise reduction We used median filtering technique to reduce the paper and salt noise. We have used 3x3 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 highlight regions with a high edge magnitude and high edge variance are identified

3.2.4. Segmentation of characters The next step is segmentation of the license plate area into smaller parts which represent each character of the license plate. This is done using the vertical projection

3.2.5. 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 .



4. Algorithm

Step 1: *Load and configure the YOLOv5 object detection model.*

Step 2: *Load the input image.*

Step 3: *Use the YOLOv5 model to detect the number plate in the image.*

Step 4: *If the number plate is detected, extract the region of interest (ROI) containing the number plate.*

Step 5: *Use EasyOCR to recognize the text on the number plate.*

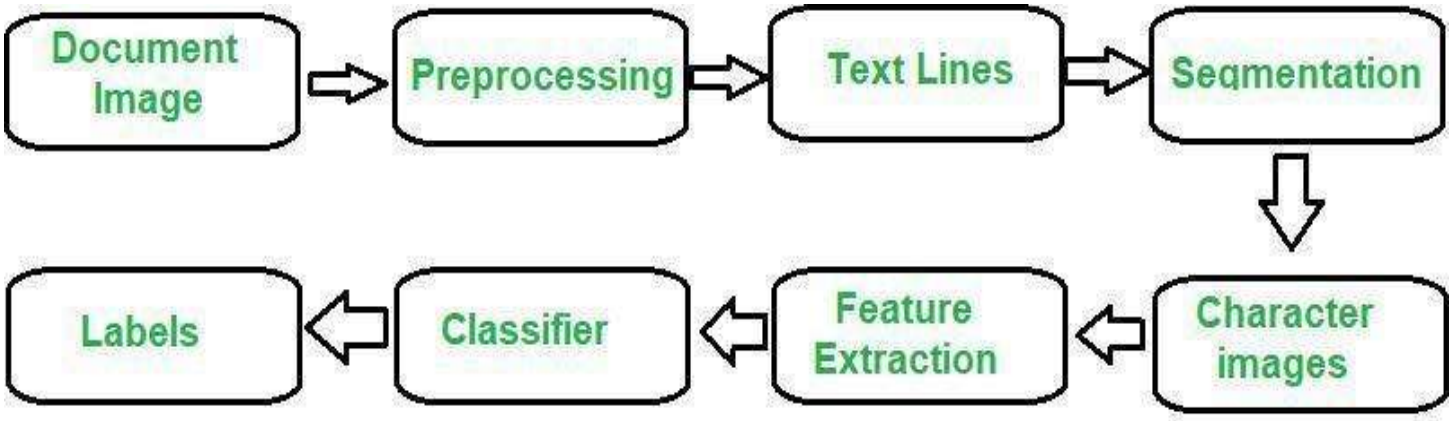
Step 6: *Display or save the output image with the recognized number plate text.*

4.1. OCR: Optical character recognition (OCR) is sometimes referred to as text recognition. An OCR program extracts and repurposes data from scanned documents, camera images and image-only pdfs. OCR software singles out letters on the image, puts them into words and then puts the words into sentences, thus enabling access to and editing of the original content. It also eliminates the need for manual data entry.

4.2. OCR systems use a combination of hardware and software to convert physical, printed documents into machine-readable text. Hardware — such as an optical scanner or specialized circuit board — copies or reads text; then, software typically handles the advanced processing.

The benefits of employing OCR technology include the following:

- *Reduce costs*
- *Accelerate workflows*
- *Automate document routing and content processing*
- *Centralize and secure data (no fires, break-ins or documents lost in the back vaults)*
- *Improve service by ensuring employees have the most up-to-date and accurate information*



Flow Diagram of OCR

5. Applications

5.1. Access control

Once an ANPR system is connected to action or image analysis technology, it may be used in a variety of domains, including access control broadly speaking:

i)Get visitor statistics

ii)Monitoring private parking lots to stop uninvited cars from accessing a designated parking space

iii)Monitoring public parking lots, such as automating the gates' opening during the free time

iv)Toll sections: to sanction fraud and approve the lowering of the barrier upon payment

To allow gasoline or wash to be dispensed after payment at gas stations or auto washes, or to report fraud

v)Drive: to stop theft and fraud

5.2. Manage traffic and road safety

An ANPR system can also help with traffic management or road safety, especially if the image is examined using a software package that includes Artificial Intelligence:

i)Get information on the number of visitors to a city, such as the rate of foreign cars, seasonality, and the appeal of a place or an event.

ii)Calculates the trip time required to activate the carpooling lane.

iii)Traffic control is used to operate alternate routes and checkpoints.

iv)Automobile in a prohibited or restricted zone

v)Information on traffic congestion to help decongest the region

vi)Vehicle detection in the incorrect direction

5.3. Provide support to law enforcement

i)Law enforcement uses ANPR solution plates for drivers.

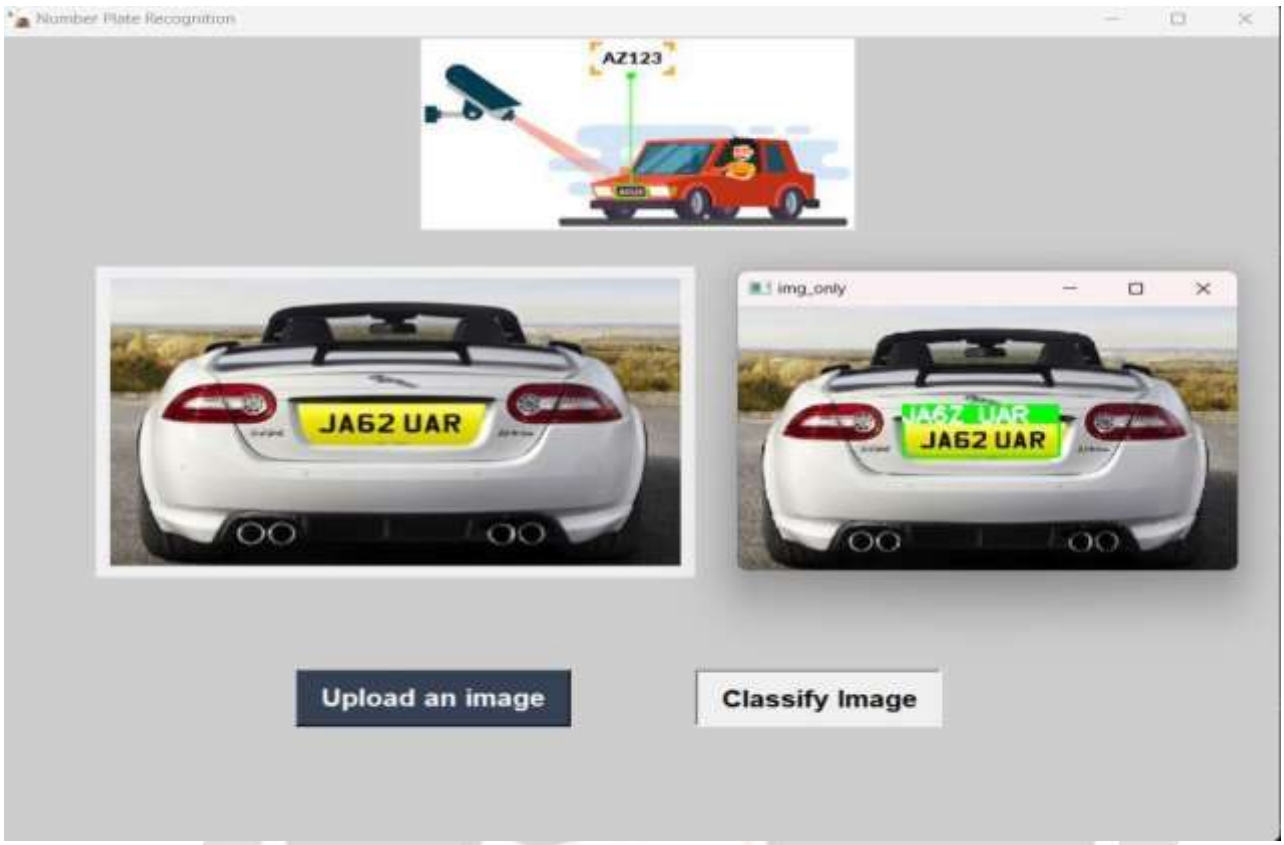
ii)Combat against fraud to identify a vehicle that engaged in fraud to match a license plate to a driver.

iii)To manage the flow of incoming and exiting cars, check border crossings.

iv)Vehicle theft search with real-time database comparison

6. *Final Output*

6.1. GUI Output :



7. Conclusion

In this paper, the automatic vehicle identification system using vehicle license plates is presented. The system uses a series of image processing techniques for identifying the vehicle from the database stored in the PC. The system is implemented in Matlab and its performance is tested on real images. The simulation results show that the system robustly detects and recognizes the vehicle using the license plate against different lighting conditions and can be implemented on the entrance of 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 increased if a high resolution camera is used. The OCR methods used in this project for the recognition are sensitive to misalignment and to different sizes, the affine transformation can be used to improve the OCR recognition from different sizes 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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