

NUMBER PLATE DETECTION IN VEHICLES USING FASTER R-CNN

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ABSTRACT

Automatic Number Plate Recognition (ANPR) is a mass surveillance system that captures the image of vehicles and recognizes their license numbers. ANPR can be used in the detection of stolen vehicles. The detection of stolen vehicles can be done in an efficient manner by using the ANPR systems located in the highways. This method 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. An image of a vehicle is captured and processed using image pre-processing algorithm. In this context, the number plate area is localized using edge detection method and the characters acquired are segmented using segmentation method. The segmented characters are passed to Optical character reader (OCR) which gives exact characters of the number plate and are stored in database.

The image pre-processing is done using Gaussian Blur method, conversion of RGB (Red, Green, Blue) to grayscale, Edge detection using sobel followed by contour detection and license plate is extracted. OCR is run on the Region of Interest (ROI) given by the contour analysis. The OCR provides the vehicle's number obtained from the number plate and is stored in the database which is used for surveillance and tracking vehicle's location. The software used in the process is Python version 3 and different python libraries like Tesseract OCR, OpenCV.

Keywords: Automatic Number Plate Recognition (ANPR), surveillance, image pre-processing, Gaussian Blur method, Optical character reader (OCR).

1. INTRODUCTION

This chapter discusses the overview of the Automatic number plate recognition system. The need and objectives with the overview of techniques used are mentioned.

1.1 OVERVIEW

License Plate Recognition is an image processing system that recognizes the car using the number plate. With the use of the vehicle number plate, the aim is to design, an effective automatic approved vehicle identification system. The system is introduced for surveillance and safety monitoring at various regions, such as colleges, housing areas and public places. Organization or even individual may use this system for security purposes. Real time image of the vehicle's number plate is captured and is stored in data base. If there is a need to know the details of any car, it can be traced through processing license plate image. The developed device senses the vehicle and captures the picture of the vehicle. By segmenting the picture into an image, the region of the vehicle number plate is extracted. The Optical Character Recognition Technique (OCR) is used for character recognition. The resulting data can be used to compare the records on a database to provide unique information such as the location of the car. In several nations, such as Australia, Canada and South Korea, license plate recognition programs have been introduced. The early development of license plate recognition systems has been assisted by the stringent enforcement of license plate requirements in these countries. These systems use traditional license plate features such as plate height, plate boundary, character color, and font, etc. These systems help to accurately find the number plate and recognize the vehicle's license number. In terms of font styles, script, scale, location, and color of the number of plates, large variations are found. In a few instances, the number plate includes other unwelcome decorations amidst vehicle number plates in India. The overall goal of this research is to establish an Indian License Plate Identification deployable working method, which is a difficult challenge since there is no uniformity of the Indian License Plates since each state has followed its own design and structure. In addition to the challenges found by the General License Plate Recognition Algorithms, the Indian Algorithms for License Plate Recognition need to fix some complex problems.

1.2 NEED FOR THE PROJECT

- ANPR (Automatic number plate recognition system) has a wide range of applications since the license number is the primary and most widely accepted identifier of motor vehicles. Access Control License plate recognition brings automation of vehicle access control management providing increased security.
- Monitoring and Surveillance can be used to monitor vehicles near important areas for better security. To provide to the conventional system to monitor stolen vehicles.

1.3 OBJECTIVES

- To design an efficient automatic authorized vehicle identification system by using the vehicle number plate for surveillance in different scenarios.
- To provide efficient system to locate stolen vehicles using public surveillance cameras.

1.4 CHALLENGES

- Dealing with bright and dark objects: Many details present in an RGB image become less salient when we convert it into grayscale. To visualize the change in intensity and thus to deal with bright and dark objects in the image, converting it to grayscale works best.
- Dealing with noisy images: The image is convolved with a Gaussian filter in the pre-processing stage to reduce the noise present in the image. 3
- Dealing with cross-angled or skewed number plates :De-skewing, i.e. rotating the image to the required position can be done to detect the text present on the number plate.
- Dealing with non-standard number plates: The code we implemented won't give any results in case of non-standard/partially torn number plates. Hence, they won't be stored in the database and searching is not possible on it

2. LITERATURE SURVEY

2.1 ANPR

- Monica Khinchi and Chanchal Aggarwal, 2016, discussed Automatic Number plate Recognition and stated its importance in today's world. Automatic Number Plate Recognition (ANPR) was first discovered by UK police in 1976. This technology is gaining popularity in the last decade. ANPR system identifies vehicle number plate. It has a camera that takes a picture, searches the position of the number plate and then identifies the features of characters using character detection methods. Another name for the ANPR system is vehicle number plate detection, license plate tracking, etc.
- An automatic number plate detection system is used in parking management and use for security purposes. The ANPR system has the following steps: Vehicle image capture, Pre-processing, Extraction of the number plate, Character segmentation and character recognition.

2.2 OCR

- Rishabh Mittal and Anchal Garg, presented a survey on Optical Character Recognition systems. Optical Character Recognition (OCR) is the computerized conversion of text or making a digital copy of the text through sources like handwritten documents, printed text, or natural images. DIP is the process in which digital images are processed through a computer algorithm. DIP is a field that has applications in pretty much every other field like in the Healthcare 5 division for PET sweeps, Banking segment, Robotics, and so forth and is yet developing with time. One of its major applications is pattern recognition which includes computer-aided diagnoses, handwriting recognition, and image recognition.
- The need for text recognition software came because the amount of data in the world is growing at an exponential rate. All this data cannot be stored physically and hence need to preserve digitally. Thus, it is done using Automatic Character Recognition, which utilizes OCR. OCR frameworks are these days normally used to extract text content from any computerized picture or natural image.

2.3 FUSION TECHNIQUE

- Farheen Ali, et al., 2013 have presented to improve the quality of the vehicles, the image fusion technique is used for the extraction of the license plate and isolating the characters which are present on the number plate and identifying the characters on the license plate using artificial neural network. License Plate Recognition is an image processing system that recognizes the car using the number plate. With the use of the vehicle number plate, the aim is to design, and effective automatic approved vehicle identification system. The system is introduced for safety monitoring at the entry to a highly confined region, such as combat zones and public areas.
- By segmenting the picture into an image, the region of the vehicle number plate is extracted. The Optical Character Recognition Technique (OCR) is used for character recognition. The resulting data is then used to compare the records on a database to provide unique information such as the identity of the owner, registration location, address, etc. The framework is implemented and simulated in Java, and it is tested on actual picture results.

3.4 ALPR

- Anumol Sasi and Swapnil Sharma presented a review by categorizing different techniques used in Automatic License Plate Recognition (ALPR) according to the features these techniques used in each stage. The author suggests recognition of plates with different styles, multiple plates and recognizing characters with ambiguity as to the future area of research in ALPR. The paper implements AS (Autonomous System) to solve various problems like Travelling Salesman Problem, Quadratic Assignment and Job Shop Scheduling. It proposes an ACO-based edge detection approach by exploiting Ant Colony System.
- The performance of this approach is proved to be better than that discussed earlier which is obtained by exploiting Ant System. The system proposes a weighted heuristic ACO algorithm. The proposed approach provides better accuracy by setting weights to the intensities of neighboring pixels. This is very well exploited by the ants, which move continuously over the image.

3.5 REGION BASED CNN

- N Palanivel , T Vigneshwaran, R Madhanraj and N Srivarappadhan presented work on Vehicle license plate detection using region-based convolutional neural networks. Automatic number plate detection is a well hot topic in the machine learning and image processing domains. This number plate detection is applied on the surveillance camera in the traffic areas. This system is used to increase the accuracy of the detection of the number plate over manual conditions. The core area of this system is frame separation from the input video to convert to an image and then techniques like image segmentation, image interpolation and OCR are applied to the image to get the information about the number plate in that image. Some of the important factors in number plate detection are frame separation and feature extraction.
- It is very difficult in handling in varying lighting conditions. So nonparametric models based on the kernel density estimation is used. Hoffmann based model is used which is by assigning adaptive randomness of parameters. The principal component analysis is a powerful method in background separation.

3. MOTIVATION

- The adoption of electronic health records has revolutionized the healthcare industry, allowing for increased efficiency, accuracy, and accessibility. However, the security and privacy of these records remain a major concern, as sensitive personal and medical information is involved. The frequency of data breaches and cyber attacks targeting healthcare systems has raised alarm bells and highlighted the urgent need for more secure and privacy-preserving solutions. Blockchain technology has emerged as a potential solution to these challenges, offering a secure and decentralized platform for storing and sharing health records. The potential benefits of using blockchain for health records are numerous, including improved security, privacy, and interoperability. As such, there is a growing interest in exploring the use of blockchain technology in healthcare, with many researchers and industry players actively investigating its potential. Therefore, understanding the benefits and limitations of blockchain technology for online health records is crucial for informing future research and development in this area.

4. LIMITATIONS IN EXISTING SYSTEM

Lack of Manned Surveillance

The availability of an automatic system has reduced the importance of manned surveillance. Not only is there less traffic personnel on the streets and major crossroads but those that are there don't bother to check number plates. This may lead to lapse in manned security.

Bad Weather or Hindrances

Coupled with the lack of manned surveillance, bad weather or any kind of hindrances and obstructions can make automatic number plate recognition systems ineffective. In such cases, the security measures may go kaput.

Privacy Concerns

The fact that images and records are kept and stored for a long time raises privacy concerns. The records of a person's whereabouts in all the footages can be misused. Stalkers, data thefts and people with various nefarious intentions can misuse all such data.

5. METHODOLOGY

SYSTEM DESIGN

This chapter discusses the proposed system model and working principle of the system. The methodologies include Gaussian blur, grey-scaling, Sobel edge, morphological transformation, and counter detection.

PROPOSED SYSTEM MODEL

Fig 3.1 depicts a block diagram of the system. It provides an overview of image pre-processing techniques and the storage of data in the database after successful character recognition using OCR. The data can be fetched by a user through a Graphics User Interface provided in order to view the data.

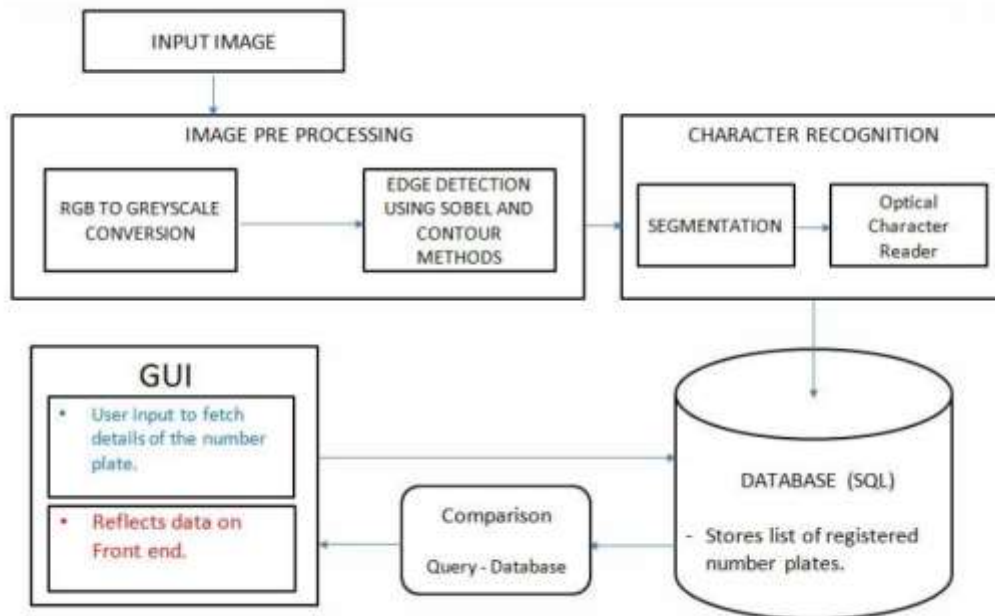


Fig 3.1– Proposed system model

IMAGE PRE-PROCESSING

Fig 3.1 depicts a custom RGB image taken to explain different phases of image Pre-Processing.



Fig 3.2- RGB image

- **Noise reduction:** The objective of Gaussian filtering/ Gaussian smoothing is to reduce noise and detail. This will serve well for further image processing steps. Fig 3.2 depicts the image after applying Gaussian filtering. The input image is made to convolve with this 2-D 'G' matrix to obtain a smoothened image in OpenCV.



Fig 3.3 – Image after Gaussian filtering

- **RGB to Grayscale conversion:** Converting RGB image to grayscale saves a lot of time since convolution is performed with the image with Sobel filter over only one 2D matrix rather than RGB image having 3 dimensions and making it complicated. Another reason is, that in the case of image edge detection the focus is on the intensity change and it is easier to analyze it in a gray-scaled image. Fig 3.3 depicts the conversion of RGB to grayscale in order to make the image into a 2D Matrix which is convenient to use for further processing.
- **Edge detection using the Sobel method:** Sobel edge detection works by calculating the gradient of image intensity at each pixel within the image. It finds the direction of the largest increase from light to dark and the rate of change in that direction. Fig 3.4 depicts the Sobel Edge result after being converted to grayscale.



Fig 3.4 – Grayscale image



Fig 3.5 – Sobel Edge detection

- **Morphological transformation:** Top-hat and Black-hat filters are part of Morphological transformations. The Top-hat operation is used to enhance bright objects of interest in a relatively dark background, while the black-hat operation (also known as bottom-hat) is used to enhance dark objects of interest in a relatively bright background. In this work, top-hat results are added to the original image and black-hat results are subtracted from it. Fig 3.5 depicts the morphological Transformation of the image after Sobel edge detection.



Fig 3.6 – Morphological transformation

NUMBER PLATE EXTRACTON

Apply Counters: Contour Tracing, also called Border following is the algorithm used for generating Contours. A contour is a link of equal intensity points along the boundary. In OpenCV, finding contours is like finding a white object from a black background, therefore during the Adaptive Gaussian Thresholding stage, the inversion operation has to be applied. Fig 3.6 depicts the counters drawn around the number plate of the car for further processing and extraction of number plate.



Fig 3.7 - Apply Counters

Filter Contours and extract region of interest: For small regions, especially sharp edges and noise outliers, contours are applied. A human eye can easily figure out that such contours are unnecessary, but this must be incorporated into a program. Initially, Bounding boxes were applied to each contour. Then, for each contour, the factors such as minimum contour area, minimum contour width and height, minimum and maximum possible aspect ratios are considered. This resulted in the filtering of most of the unnecessary contours, propelling us near to the objective, ie, detect number plate. Fig 3.7 depicts the extracted region of interest which was successfully extracted after image Pre-Processing and counter detection.



Fig 3.8 – Region of interest

NUMBER PLATE RECOGNITION

- Number plate de-skewing: Skew is the amount of rotation necessary to return an image to horizontal and vertical alignment. Skew is measured in degrees. Deskewing is a process whereby skew is removed by rotating an image by the same amount as its skew but in the opposite direction. This results in a horizontally and vertically aligned image where the text runs across the page rather than at an angle. In our project, this step is done using ratio_and_rotation().
- Pre-process region of interest: It is possible that two or more contours may completely overlap with each other, as in the case with the number 'zero'. The inner contour, if detected in the contour process, may lie completely inside its outer contour. Due to this phenomenon, both contours may get recognized as separate characters during the recognition process. If needed, images are resized before doing the recognition step.

CHARACTER SEGMENTATION

The objective of character segmentation method is to separate each letter and extract the character and left the other unwanted components. The use of this method is to decide the outline of character in image.

NUMBER PLATE TEXT RECOGNITION

Python-tesseract is an optical character recognition (OCR) tool for python. That is, it will recognize and "read" the text embedded in images. Hence this tool is used to obtain the text present in the filtered, de-skewed contour.

SUMMARY

A step by step methodology is given to Pre-process the image and extract the number plate from the rest of the image and successful application of OCR on the extracted area to recognize characters is done.

6. RESULTS

Experimental results show that the proposed system detects number plates and recognise characters successfully. The overall success rate of plate localisation is 97.21% and recognition of number is 95.06%. Content may be subject to copyright.

7. IMPLICATION

Added security

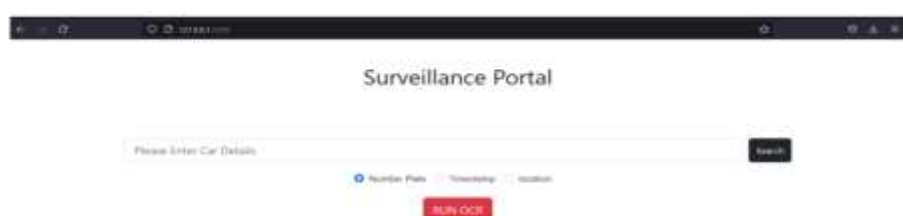
ANPR largely acts as a deterrent. The knowledge that their number plate is being recorded and checked is usually enough to stop criminal behaviour in advance. ANPR is also useful for the police, who can browse the data collected and check for suspicious vehicles, or vehicles that were involved in a crime. Thanks to the need to store the data for a short while, ANPR data can provide both alibis and incriminating data. ANPR also provides security on a lower level, such as open workplace parking where it can manage permit parking for staff vehicles, or recognise a vehicle that has previously been banned from your premises. ANPR offers an extra measure of security for both public and private use.

Automated service

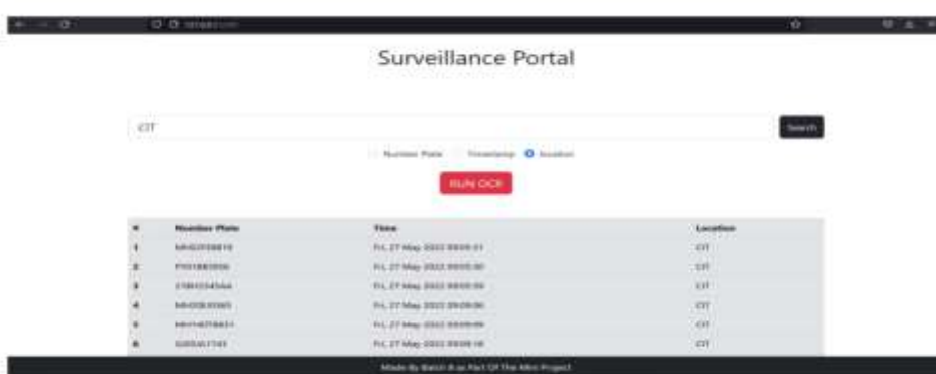
ANPR cameras are an efficient and cost-effective way to monitor parking solutions. In car parks, they negate the need for parking wardens. Thanks to their high-accuracy readings and 24/7 operation, they are more efficient than most individuals and therefore provide a more dependable service. They also offer a confrontation-free parking solution, which some have found to be beneficial when delivering fines to drivers. Parking management teams often find that both traffic personnel and ANPR cameras work well together, especially in traffic and parking enforcement, where staff can rely on ANPR to provide the necessary information, minimising the time they spend on the streets.

Real-time benefits

ANPR is beneficial to many industries thanks to the real-time imaging it offers. Historically, number plate recording would take time, and then longer still to send out penalty notices to those who violate traffic laws. With ANPR however, number plates can be recognised and checked against the database almost instantaneously. From this, it takes as little as 48 hours to issue a penalty notice. The fast nature of these cameras allows for an immediate response to criminal activity, making sure no unwanted behaviour goes unchecked.



Frontend index page



Searching by location

8. DISCUSSION

ANPR is an image processing technology that can capture images of vehicles and from the images extract information of their number (license) plates, and translate them into machine-readable formats, such as text string, which can then be processed and indexed into a database (ANPR International, 2021).

9. CONCLUSION

A method to recognize the number plates of Indian vehicle number plates is proposed which is less time consuming and applied to various types of pictures. Edges could be recognized through the use of the SOBEL edge detection method. To retrieve the vehicle's number plate, ROI and OCR is applied. The proposed system is mainly based on the Indian car number plate scheme, the accuracy of extracting the number plate for low light images can be increased, as well as the number plate that has different font size and also different font type can be recognized.

10. REFERENCE

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