VEHICLE NUMBER PLATE RECOGNITION SYSTEM

SEMINAR-1 REPORT

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Certified that the Seminar-I report titled **VEHICLE NUMBER PLATE RECOGINITION SYSTEM** is the bonafide work of AAKASH S [RA2011026020069], ANIKET KUMAR [RA2011026020074], G. SREEDHAR [RA2011026020083] submitted for the course 18CSP103L Seminar – I. This report is a record of successful completion of the specified course evaluated based on literature reviews and the supervisor. No part of the Seminar Report has been submitted for any degree, diploma, title, or recognition before.

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EXAMINER 1

EXAMINER 2

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DECLARATION

We hereby declare that the entire work contained in this project report titled **VEHICLE NUMBER PLATE RECOGNITION SYSTEM** has been carried out by **AAKASH S [RA2011026020069], ANIKET KUMAR [RA2011026020074], G. SREEDHAR [RA2011026020083]** at SRM Institute of Science and Technology, Ramapuram Campus, Chennai- 600089, under the guidance of Mr. G RAGU, Assistant Professor, Department of Computer Science and Engineering.

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ABSTRACT

The most successful and cost-effective method used for car identifying purposes is detection of the license plate. The paper proposes the use of the Faster R-CNN to detect the number plate in the vehicle from the surveillance camera which is placed on the traffic areas. **Vehicle Number Plate Recognition System (VNPRS)** is an image processing technology which uses number (license) plate to identify the vehicle.

The objective is to design an efficient automatic authorized vehicle identification system by using the vehicle number plate. The system is implemented on the entrance for security control of a highly restricted area like military zones or area around top government offices e.g., Parliament, Supreme Court etc. The developed system first detects the vehicle and then captures the vehicle image. Vehicle number plate region is extracted using the image segmentation in an image. Optical character recognition technique is used for the character recognition.

The resulting data is then used to compare with the records on a database to come up with the specific information like the vehicle's owner, place of registration, address, etc. The system is implemented and simulated in MATLAB, and its performance is tested on real image. It is observed from the experiment that the developed system successfully detects and recognize the vehicle number plate on real images.

Automatic Number Plate Recognition (ANPR) is a mass surveillance system that captures the image of vehicles and recognizes their license number. ANPR can be assisted 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 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. In this context, the number plate area is localized using a novel „feature-based number plate localization" method which consists of many algorithms. But our study mainly focusing on the two fast algorithms i.e., Edge Finding Method and Window Filtering Method for the better development of the number plate detection system. The proposed system first detects the vehicle and then captures the vehicle image.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Number plate recognition is a form of automatic vehicle identification. A number plate is the unique identification of vehicle. It is an image processing technology used to identify vehicles by their own number plates. 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, highly security areas, boarder's areas etc.

Number plate recognition is designed to identify the number plate and then recognize the vehicle number plate from a moving vehicle automatically. Automatic number plate recognition has three major parts: vehicle number plate extraction, character segmentation and Optical Character Recognition (OCR). Number plate extraction is that stage where vehicle number plate is detected.

The detected number plate is pre-processed to remove the noise and then the result is passed to the segmentation part to segment the individually characters from the extracted number plate. 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.

The Automatic Number Plate Recognition System (ANPR) plays an important role in addressing these issues as its application ranges from parking admission to monitoring urban traffic and to tracking automobile thefts. There are numerous ANPR systems available today which are based on different methodologies. In this paper, we attempt to review the various techniques and their usage.

1.1.1 PROBLEM STATEMENT

Automatic vehicle license plate detection and recognition is a key technique in most of traffic related applications and is an active research topic in the image processing domain. Different methods, techniques and algorithms have been developed for license plate detection and recognitions.

Automatic vehicle license plate detection and recognition is a key technique in most of traffic related applications and is an active research topic in the image processing domain. Different methods, techniques and algorithms have been developed for license plate detection and recognitions.

The most successful and cost-effective method used for car identifying purposes is detection of the license plate. The paper proposes the use of the Faster R-CNN to detect the number plate in the vehicle from the surveillance camera which is placed on the traffic areas. The focus in this research project is to find alternative solutions to the image segmentation and character recognition problems within the License Plate Recognition framework. Three main stages are identified in such applications.

First, it is necessary to locate and extract the license plate region from a larger scene image. Second, having a license plate region to work with, the alphanumeric characters in the plate need to be extracted from the background. Third, deliver them to an OCR (Optical Character Recognition) system. An OCR system is a computerized scanning system enabling to scan text documents into an electronic computer file which can then edit using a word processor or computer Optical Character Recognition.

To identify a vehicle by reading its license plate successfully, it is obviously necessary to locate the plate in the scene image provided by some acquisition system (e.g., video or still camera). Locating the region of interest helps in dramatically reducing both the computational expense and algorithm complexity. There is an escalating increase of contemporary local, urban, and national road networks over the last decades. This has emerged the need for efficient monitoring and management of road traffic.

1.2 AIM OF THE PROJECT

The main aim is to design an efficient vehicle identification system by using the vehicle number plate. The developed system first detects the vehicle and then captures the vehicle image. Vehicle number plate region is extracted using the image segmentation in an image.

Optical character recognition technique is used for the character recognition. The objective is to design an efficient automatic authorized vehicle identification system by using the vehicle number plate.

The system can be implemented on the entrance for security control of a highly restricted area like military zones or area around top government offices e.g., Parliament, Supreme Court etc.

The developed system first detects the vehicle and then captures the vehicle image. Vehicle number plate region is then converted into grayscale. The number plate is then extracted.

KNN (K- Nearest Neighbors) algorithm is used to recognize the digits and the alphabets. This data can be used to find vehicle's owner, place of registration, address, etc. The system is implemented using Python, and its performance is tested on real images. It is observed from the experiment that the developed system successfully detects and recognize the vehicle number plate on real images.

The number plate recognition is an image processing technique to extract the image of license plate on vehicle taken by digital camera or taken by either a color or a grayscale digital camera, as well as an infrared camera to identify the vehicles using their number plate.

The automatic number plate recognition market is expected to exhibit high growth in near future across the globe, some of the major driving factors contributing to the growth are rising acceptance of smart parking concept in developed as well as developing countries and infrastructure growth in emerging countries.

1.3 PROJECT DOMAIN

The domain of the project is Deep Learning. Deep learning is a particular kind of machine learning that achieves great power and flexibility by learning to represent the world as a nested hierarchy of concepts, with each concept defined in relation to simpler concepts, and more abstract representations computed in terms of less abstract ones.

Automated VLPNR is a computer vision-based technique which is employed in the recognition of automobiles based on vehicle number plates. The current research paper presents an effective Deep Learning (DL)-based VLPNR called DL-VLPNR model to identify and recognize the alphanumeric characters present in license plate.

1.4 SCOPE OF THE PROJECT

Vehicle Number Plate Recognition System (VNPRS) can be used in various fields such as vehicle tracking, traffic monitoring, automatic payment of tolls on highways or bridges, surveillance systems, tolls collection points, and parking management systems. The developed system first detects the vehicle and then captures the vehicle image.

The use of VNPRS systems is becoming more popular as the technology advances rapidly with the advent of machine learning and deep learning, the computational cost decreases, and the accuracy of applied image processing techniques increases.

1.5 METHODOLOGIES

The proposed methodology consists of the following phases:

- Image/Source
- Pre-processing
- Number plate Detection
- Number plate Recognition
- Searching in Database

CHAPTER 2

LITERATURE SURVEY

Paper – I

Title: License Plate Recognition System

Authors: Farheen Ali, Himanshu Rathore, Wasim Akram

Methodology: These approaches and methods differ depending on factors such as image quality, the vehicle at fixed locations, light conditions, single image, etc.

Technical Gap: Privacy Concerns

Description: The most successful and cost-effective method used for car identifying purposes is detection of the License Plate. These approaches and methods differ depending on factors such as image quality, the vehicle at fixed locations, light conditions, single image, etc. The differences in license plates from various nations and states should also be able to deal with it.

Paper – II

Title: Automatic Number Plate Recognition System for Entry

Authors: Vijaya Reddy , A. Balaji, S. Vanaja, Rahul Krishnan, Y. Deepika

Methodology: The main objective of the system is to monitor the vehicles that are entering and going out of the organization.

Technical Gap: Camera Mounting Variation

Description: The main objective of the system is to monitor the vehicles that are entering and going out of the organization. All vehicles have their own unique license plate number, so the abstraction of plate number plays a major role in this system. The vehicle number plate is taken by the tool like camera which is placed at the entrance.

Paper – III

Title: Automatic Recognition of License Plates

Authors: Tanushri Bhagat, Rahul Thakur

Methodology: This paper is a study of Automatic License Plate Recognition (ALPR) using various Python libraries and hence recognize the information from number plates.

Technical Gap: Extreme Circumstances e.g., Bad weather condition

Description: License Platform Detection is a computer technology that enables us to identify digital images on the platform automatically. Different operations are covered in this system, such as imaging, number pad locations, alphanumeric character truncation and OCR. The final objective of the system is to construct and create efficient image processing procedures and techniques to position a licensing platter on the Open Computer View Library picture. It was used and implemented the K-NN algorithm and python programming language.

Paper – IV

Title: A Hybrid System with Number Plate Recognition and Vehicle Type Identification

Authors: Nitesh Bharti, Mohit Kumar, V. M. Manikandan, Y. Deepika

Methodology: In this research paper, we propose a framework to ensure the entry of authorized vehicles in restricted areas such as the University campuses, townships.

Technical Gap: Due to Number Plate Variations

Description: Vehicle detection and number plate recognition approaches have been widely studied in recent years due to their wide applications. In this research paper, we propose a framework to ensure the entry of authorized vehicles in restricted areas such as the University campuses, townships, etc., where we are expecting the entry of a set of authorized vehicles.

Paper – V

Title: Comparative Transfer Learning Techniques for Plate Number Recognition

Authors: Rizki Rafiif Rifqi, Akmal Saputra, Faisal Dharma, Nur Ghaniaviyanto Ramadhan.

Methodology: This research could provide insight into the use of transfer learning techniques in the case of number plate recognition.

Technical Gap: Differences in number plate writing style

Description: Intelligent building is the inevitable outcome of information technology in today's world, and people's safety awareness is also improving with the development of society, and the safety issue has become an important proposition that everyone pays attention to. License plate number recognition technology is an important part of intelligent building security system, which plays an important role in the field of vehicle identification. This design is based on the deep learning method to realize the license plate recognition in the field of vehicle identification, including the preprocessing of license plate image, the location of license plate area, the segmentation of license plate characters and the recognition of license plate characters.

Paper – VI

Title: License Plate Recognition System using Yolov5 and CNN

Authors: Shreya Raj, Yash Gupta, Ruchika Malhotra

Methodology: The state-of-the-art YOLOv5 object detection model is used for number plate detection.

Technical Gap: Language of the license number plate

Description: The paper is aimed to identify the number plate in the vehicles during difficult situations like distorted, high/low light and dusty situations. The paper proposes the use of the Faster R-CNN to detect the number plate in the vehicle from the surveillance camera which is placed on the traffic areas etc. The created system is used to capture the video of the vehicle and then detect the number plate from the video using frame segmentation and image interpolation for better results. From the resulted image using the technique called optical character recognition is applied on that image for number recognition.

Paper – VII

Title: An Integrated Number Plate Recognition System through images

Authors: V Uma Maheswari, Rajanikanth Aluvalu, Swapna Mudrakola

Methodology: This paper presents automatic number plate detection with number diagnosis.

Technical Gap: Fast moving vehicles, illumination.

Description: The objective of VRNPR is to extract vehicle license plate information from number plate of vehicles. As the traffic control and vehicle proprietor recognizable proof is a significant issue in every country, it is important to develop such a device that automatically detects those vehicle owners who violates traffic rules and drives fast. There are many VRNPR systems are present but there is challenging factor like accuracy of extraction, speed of vehicles, lightening condition, quality of images. In this paper, different methods of VRNPR and emerging technologies are used to get accurate result. The important work is the detection and recognition of the number plate which is accomplished by the Convolution Neural Network (CNN).

CHAPTER 3

PROJECT DESCRIPTION

3.1 EXISTING SYSTEM

These systems use standard features of the license plates such as dimensions of the plate, border for the plate, color, and font of characters, etc. help to localize the number plate easily and identify the license number of the vehicle.

In India, number plate standards are rarely followed. Wide variations are found in terms of font types, script, size, placement, and color of the number plates. Unlike other countries, there are no special features available on Indian number plates to ease the recognition process. Hence, currently, only manual recording systems are used and VNPR has not been commercially implemented in India.

Currently in many sectors vehicle is identified using the number plate which is manually noted by a human which is a slow process. Thus, vehicle number plate recognition is an intensive manual process which can perhaps be automated using deep learning which forms the basis of this project. This is all about the existing system of the project “Automatic Vehicle Number Plate Recognition System Using Machine Learning”.

The following are the drawbacks of the existing system in our project.

- More Manpower.
- More Expenditure.
- High Error Probability.
- Less Performance.
- More Dependency.
- Time Taking.

This is about the drawbacks of the existing system in the project “Automatic Vehicle Number Plate Recognition System Using Machine Learning”

3.2 PROPOSED SYSTEM

A rear image of a vehicle is captured and processed using various algorithms. The algorithm satisfactorily eliminates all the background image and preserves only the number plate area in the image.

This area is then segmented into individual characters using "**Image Scissoring**" algorithm. The image is further enhanced using some character recognition module. Statistical feature extraction is used to recognize the characters.

With the aim to connect all the smart vehicle number plate detection systems and to improve cost efficiency and reduce error. we are proposing a system which can be effectively reduce number of human resources and cost and detects vehicle number plates in a split of a second with no or negligible error.

This system can be used for multiple purposed with a minimum setup cost for the required hardware.

The following are the objectives of the proposed system in the project.

- To make of Vehicle management easier.
- To reduce redundancy and error in number plate recognition.
- To generate analytical reports based on vehicle recognition.
- To minimize manpower required.
- To enable easier provision of remuneration to number plate detection and logging.
- Scalable
- Maintenance cost reduction.
- Effective.
- Affordable.
- Reduction of manpower.
- Human Error avoidance.
- Secure.
- Low cost.

3.3 FEASIBILITY STUDY

A Feasibility study is carried out to check the viability of the project and to analyze the strengths and weaknesses of the proposed system. The application of usage of mask in crowd areas must be evaluated. A feasibility study is a detailed analysis that considers all the critical aspects of a proposed project to determine the likelihood of it succeeding.

Although feasibility studies can help project managers determine the risk and return of pursuing a plan of action, several steps should be considered before moving forward. Detailed investigation has really helped in knowing the feasibility of various Software and hardware components as well as the overall project model in terms of technical, operational, and economical respects. Thus, this project is feasible in all respect.

The feasibility study is carried out in three forms:

- **Economic Feasibility**

  The proposed system does not require any high-cost equipment. This project can be developed within the available software. This assessment typically involves a cost/ benefits analysis of the project, helping organizations determine the viability, cost, and benefits associated with a project before financial resources are allocated. It also serves as an independent project assessment and enhances project credibility—helping decision-makers determine the positive economic benefits to the organization that the proposed project will provide.

• **Technical Feasibility**

The proposed system is completely a Deep learning model. The main tools used in this project are Anaconda prompt, Visual studio, Jupyter Notebook, and the language used to execute the process in Python. This assessment focuses on the technical resources available to the organization. It helps organizations determine whether the technical resources meet capacity and whether the technical team can convert the ideas into working systems. Technical feasibility also involves the evaluation of the hardware, software, and other technical requirements of the proposed system.

• **Social Feasibility**

Social feasibility is a determination of whether project will be acceptable or not. our project is Eco-friendly for society and there are no social issues. Our project must not be threatened by the system instead must accept it as a necessity. This assessment investigates whether any aspect of the proposed project conflicts with legal requirements like zoning laws, data protection acts or social media laws. Let's say an organization wants to construct a new office building in a specific location. A feasibility study might reveal the organization's ideal location isn't zoned for that type of business. That organization has just saved considerable time and effort by learning that their project was not feasible right from the beginning.

3.4 SYSTEM SPECIFICATIONS

3.4.1 HARDWARE SPECIFICATIONS

• Processor - Intel i5-8250 CPU @1.60GHz 1.80GHz
• 512 GB SSD
• NVIDIA GEFORCE RTX
• CPU QUAD CORES

3.4.2 SOFTWARE USED

• ANACONDA
• JUPYTER NOTEBOOK
• PYTHON
• GIT

CHAPTER 4

MODULE DESCRIPTION

4.1 GENERAL ARCHITECTURE

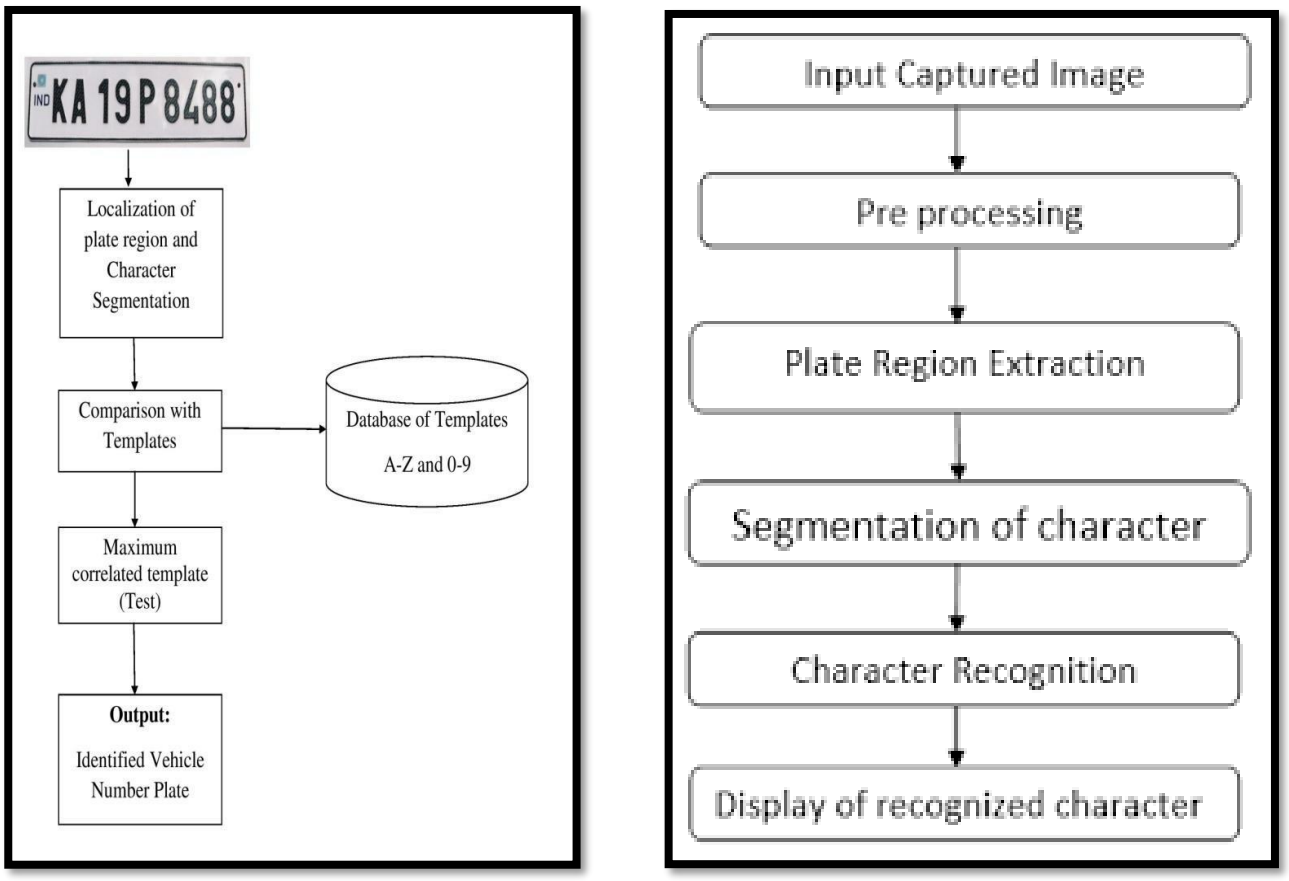


Figure 4.1: Architecture Diagram

A typical VNPRS system goes through the general process of image acquisition (input to the system), number plate extraction (NPE), character segmentation (CS) and character recognition (CR) (as output from the system). After successful recognition of the vehicle the data can be accessed and used for post processing operations as required.

4.2 DESIGN PHASE

4.2.1 DATA FLOW DIAGRAM

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. It shows how data enters and leaves the system, what changes the information, and where data is stored. It can be manual, automated, or a combination of both.

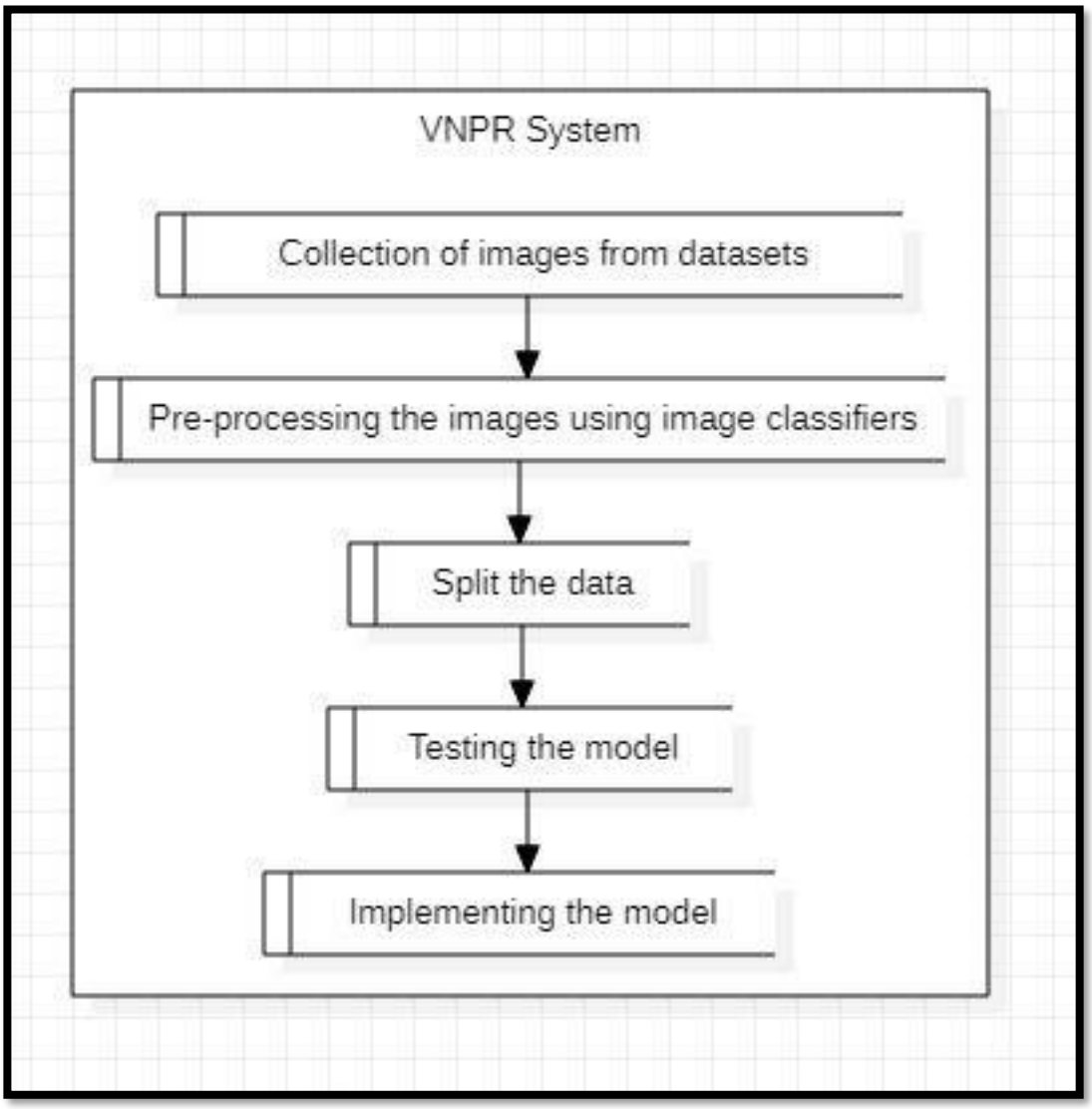


Figure 4.2: Data Flow Diagram

4.2.2 UML DIAGRAM

A UML diagram is a diagram based on the UML (Unified Modelling Language) with the purpose of visually representing a system along with its main actors, roles, actions, artifacts, or classes, to better understand, or document information about the system.

UML is a way of visualizing a software program using a collection of diagrams. The notation has evolved from the work of Grady Booch, James Rumbaugh, Ivar Jacobson, and the Rational Software Corporation to be used for object-oriented design, but it has since been extended to cover a wider variety of software engineering projects.

Today, UML is accepted by the Object Management Group (OMG) as the standard for modelling software development. UML stands for Unified Modelling Language. UML 2.0 helped extend the original UML specification to cover a wider portion of software development efforts including agile practices.

- Improved integration between structural models like class diagrams and behaviour models like activity diagrams.

- Added the ability to define a hierarchy and decompose a software system into components and sub-components.

- The original UML specified nine diagrams; UML 2.x brings that number up to 13. The four new diagrams are called: communication diagram, composite structure diagram, interaction overview diagram, and timing diagram. It also renamed state chart diagrams to state machine diagrams, also known as state diagrams.

UML is a standard modelling **language**, not a **software development process**. UML provides guidance as to the order of a team's activities,

- specifies what artifacts should be developed,
- directs the tasks of individual developers and the team, and
  offers criteria for monitoring and measuring a project's products and activities.

UML is intentionally **process independent** and could be applied in the context of different processes. Still, it is most suitable for use case driven, iterative and incremental development processes. An example of such process is **Rational Unified Process** (RUP).

For our project we have drawn 5 Diagrams:

4.3.3 USE CASE DIAGRAM

A use case diagram is a graphical depiction of a user's possible interactions with a system. A use case diagram shows various use cases and different types of users the system has and will often be accompanied by other types of diagrams as well.

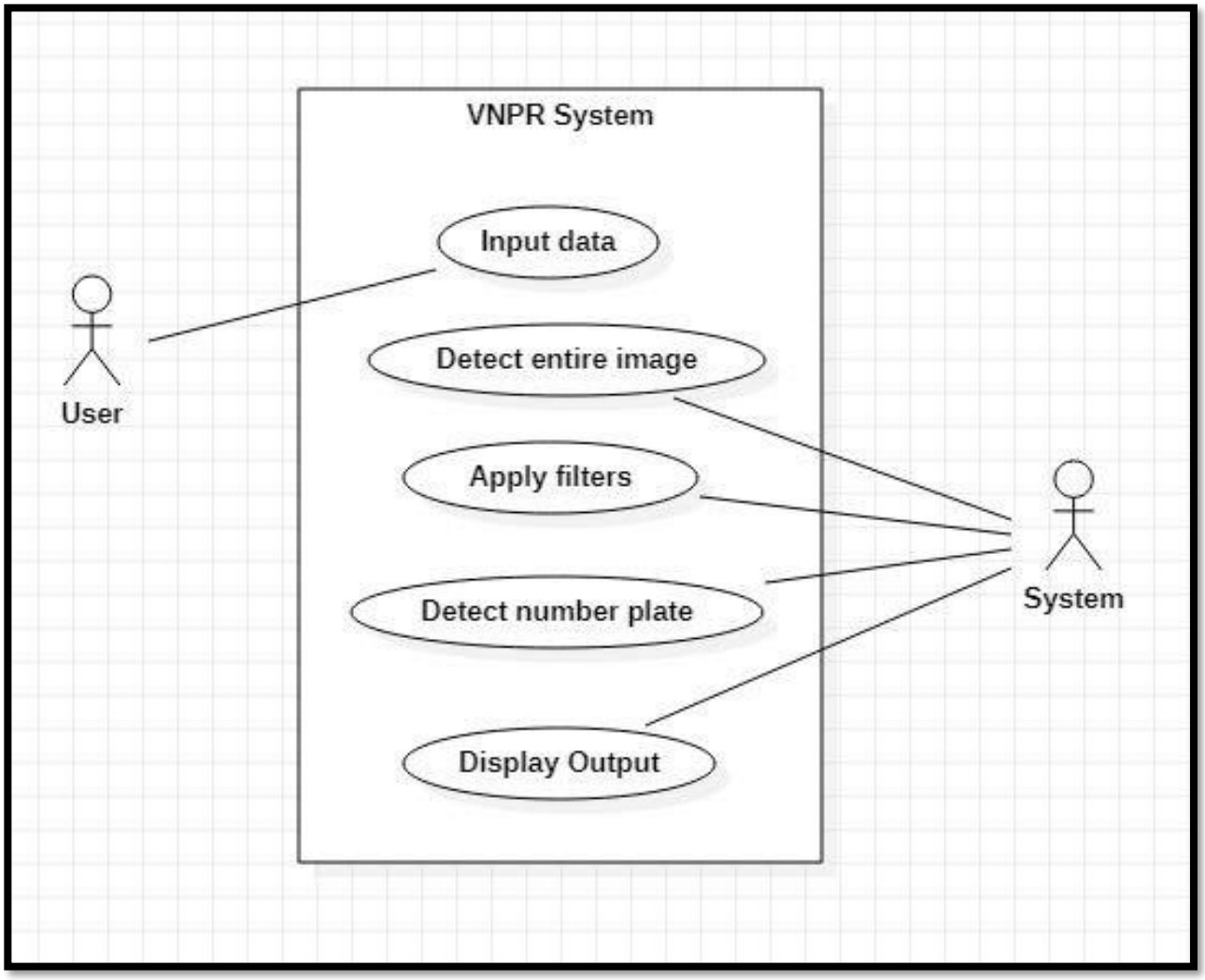


Figure 4.3: Use Case Diagram

4.3.4 SEQUENCE DIAGRAM

Sequence Diagrams are interaction diagrams that detail how operations are carried out. They capture the interaction between objects in the context of a collaboration. Sequence Diagrams are time focus, and they show the order of the interaction visually by using the vertical axis of the diagram to represent time what messages are sent and when.

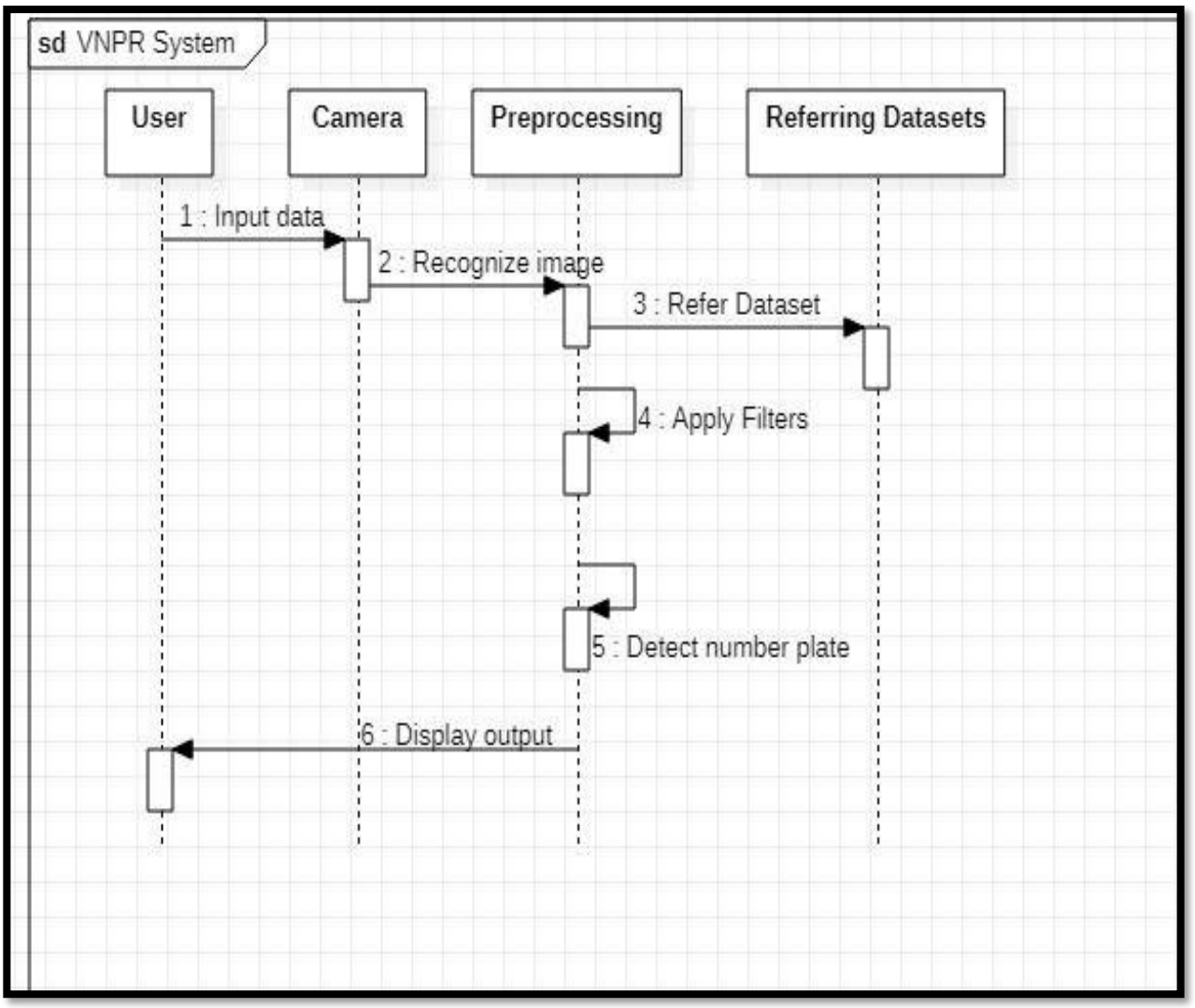


Figure 4.4: Sequence Diagram

4.3.5 COMMUNICATION DIAGRAM

A Communication diagram is a diagram that shows the interactions between elements at run-time in much the same manner as a Sequence diagram. However, Communication diagrams are used to visualize inter-object relationships, while Sequence diagrams are more effective at visualizing processing over time.

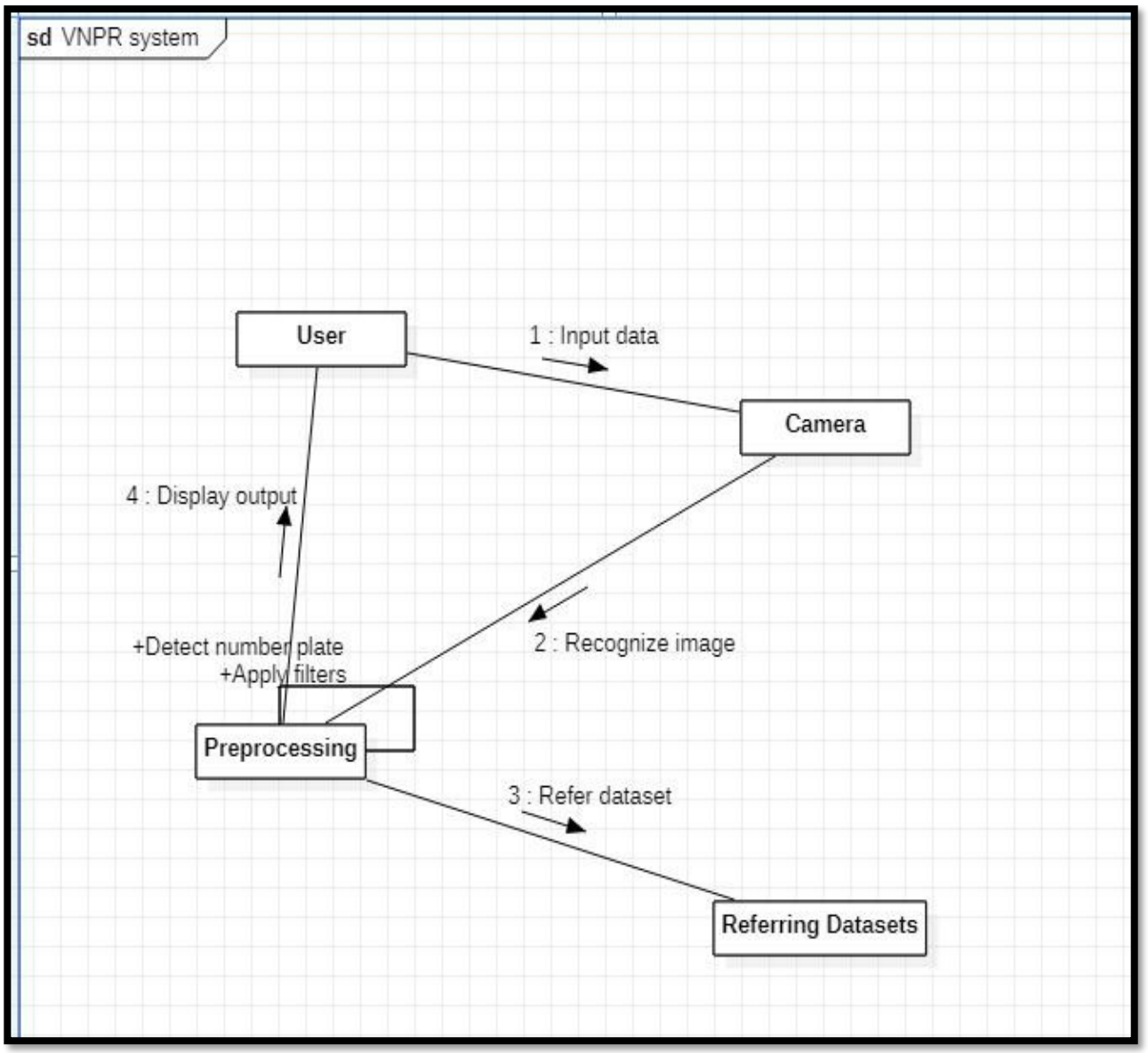


Figure 4.5: Communication Diagram

4.3.6 ACTIVITY DIAGRAM

Activity Diagrams describe how activities are coordinated to provide a service which can be at different levels of abstraction. Typically, an event needs to be achieved by some operations, particularly where the operation is intended to achieve several different things that require coordination, or how the events in a single use case relate to one another use cases where activities may overlap and require coordination.

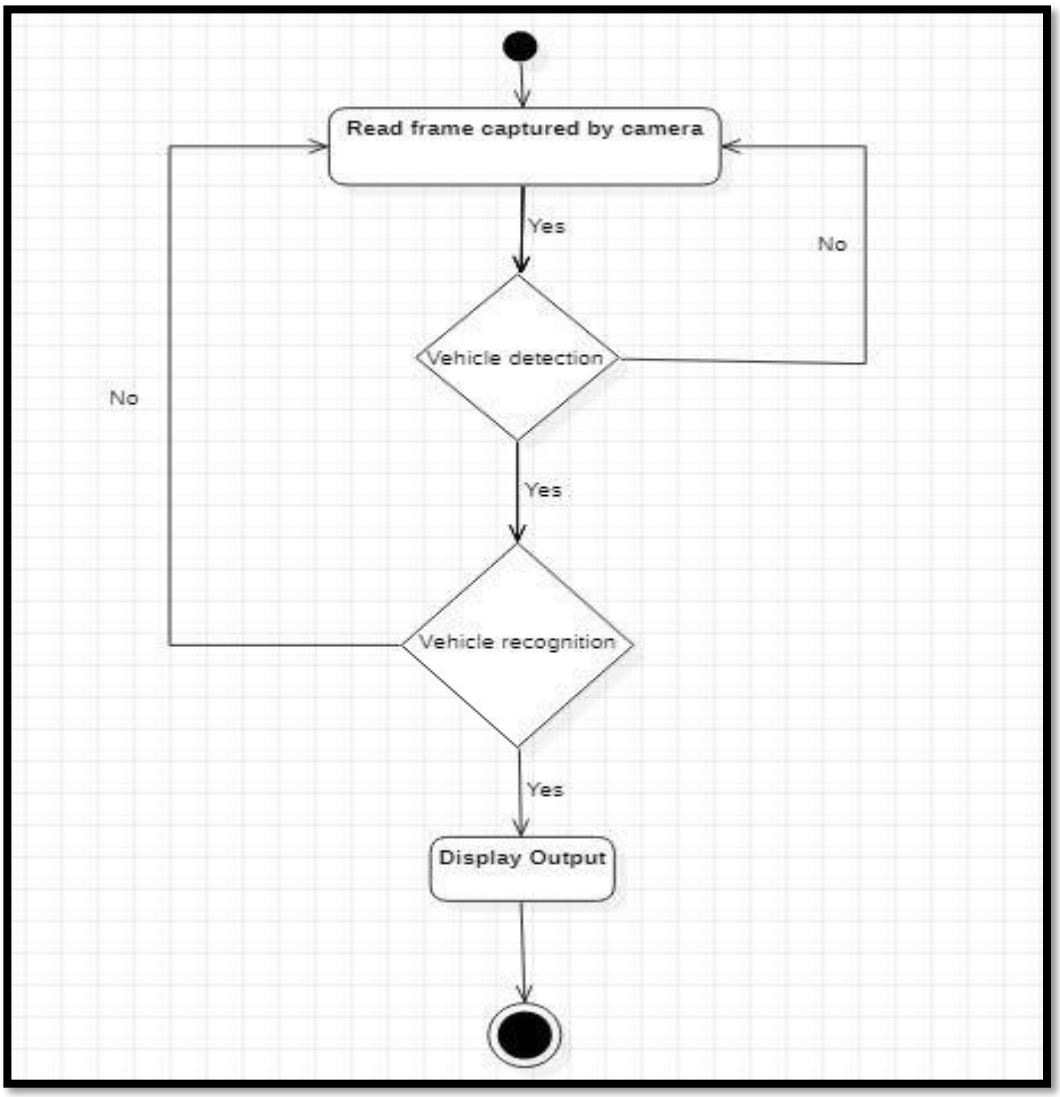


Figure 4.6: Activity Diagram

4.3.7 BLOCK DIAGRAM

A block diagram is a specialized, high-level flowchart used in engineering. It is used to design new systems or to describe and improve existing ones. Its structure provides a high-level overview of major system components, key process participants, and important working relationships. A block diagram is especially focused on the input and output of a system. It cares less about what happens getting from input to output.

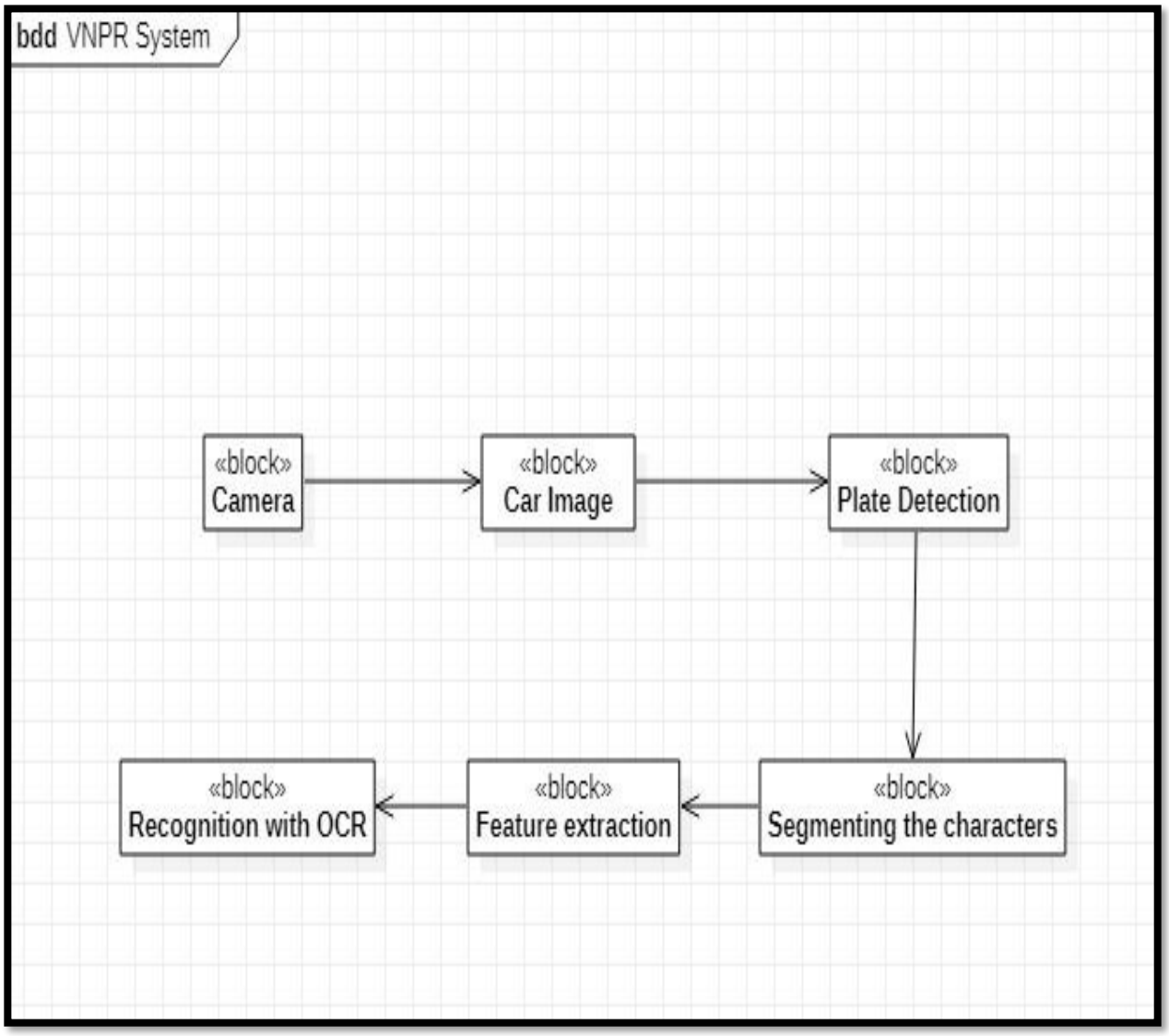


Figure 4.7: Block Diagram

4.3 MODULE DESCRIPTION

Our entire project is divided into six modules:

Step 1: Data Collecting

Step 2: Processing of Data

Step 3: Number Plate Localization

Step 4: Character Segmentation

Step 5: Character Recognition

Step 6: Output

MODULE	DESCRIPTION
Module1: License plate Detection.	Detecting, Tracker, Post Processing
Module2: License plate Character Recognition.	Segmentation, Classification, Post Processing

The License Plate Detection module consists of three parts: The Detecting, The Tracking And The Postprocessing Step.

- **Detector:** The license plate detector is based upon the framework proposed by Viola and Jones. Viola and Jones created a fast object detection system by combining the AdaBoost-algorithm with Haar-like features, a classifier cascade, and the integral image for fast feature computation.

  Unlike the original framework, the Real Boost is used for this detector, which provides confidence rated predictions instead of binary class-labels. Furthermore, the classifier cascade is improved by using inter stage feature propagation as proposed by Sochman and Matas. The feature-pool is extended with features based on edge orientation histograms as proposed by Levi and Weiss.

- **Tracker:** It is integrated into the system to limit the search of the detector to certain areas of the input image. This requires a rough calibration of the scene. Figure 2 illustrates a possible setting. Objects are assumed to enter from the top. A static region of interest is defined where the Viola and Jones detector search is performed on each frame.

  For each new detection a tracker is initialized, which predicts the new objects position on the next frame. This allows for scanning solely within a small area around the estimated position. The update and prediction operations of the tracker require less computation time than a detector scan for the whole image.

- **Post-processing:** The exhaustive search technique of the Viola and Jones detector leads to multiple detections for a single license plate. Therefore, post-processing methods must be applied to merge those detections. For this purpose, the rather simple non-maximum suppression is used.

  The non-maximum suppression merges multiple detections, considering the confidence value of each detection. In our case all overlapping detections are substituted by the single detection with the maximum confidence value. If the false positive rate is not too high, this method achieves sufficient results. Nonetheless, the final detection does not solely contain the license plate but parts of the surroundings as well.

The License Plate Character Recognition module consists of three parts: Segmentation, Classification, Post Processing.

- **Segmentation:** A region-based approach is used for character segmentation. Due to dark characters on white background, region-growing seeded with lowest intensity values is applied. To determine which regions, contain a character two approaches are used.

  Like a region descriptor is computed incrementally, consisting of compactness, entropy of the grayscale histogram, and central invariant statistical moments. Descriptors are classified using support vector classification, knowledge about the expected license plates and information provided by the tracker is used to improve the classification result.

- **Classification:** Support vector classification is used for character classification. Segmented regions are scaled to a common patch size. The feature vector consists of direct pixel values. Since character recognition is a multi-class problem a combination of binary classifiers is required.

- **Post-Processing:** In this step a priori knowledge about the structure of license plates is exploited i.e., spacing between subsequent characters and furthermore the syntax of the final character string. Needless to mention that this applies only in cases where the nationality of the license plate is known in advance or can be derived beforehand.

  Additionally, classification results of subsequent frames are combined utilizing the history provided by the tracking module. A simple majority voting individually for each position within the character string is applied. The character achieving the highest count is selected.

4.3.1 CHARACTER SEGMENTATION

In this step get the output of extracted number plate using labeling components, and then separate each character and split the each and every character in the number plate image by using split and also find the length of the number plate, then find the correlation and database if both the value is same means it will generate the value 0-9 and A - Z, and finally convert the value to string and display it in edit box, and also store the character in some text file in this code.

The character recognition is now used to compare each individual character with the character stored in the database. OCR (Optical Character Recognition) uses the correlation method to match the characters. And if both the character matches then it displays the authorized otherwise it will display the unauthorized. After locating the LP and skew correction, next step is the segmentation of characters.

Character segmentation is the procedure of extracting the characters from the LP image. Almost all the papers that had been surveyed and used horizontal and vertical projection to segment the characters. Fig. 11 shows the result of character segmentation used. Vertical and horizontal scanning is used to dig out the characters.

Vertical scanning will scan the image vertically from [0, 0] to [height, width] which is executed on column-by-column basis. Width between the first and last column is computed, and each character is separated from the plate background and stored in separate array so that it is used for horizontal scanning. Horizontal scanning is performed to eradicate the extra upper and lower region from the image.

4.3.2 EDGE DETECTION

Edge helps to characterize the boundaries and therefore are a problem of fundamental importance while processing the image. Edges in images are the areas where strong intensity contrasts are present, a sudden variation in the intensity from one pixel to the next.

Detecting the edges of an image significantly reduces the amount of data and it helps in filtering out the useless information, while preserving the important structural properties of an image. There are many ways to perform the edge detection. However, most various methods can be grouped in to two different categories, gradient and Laplacian.

The gradient methods detect the edges by finding out the maximum and minimum in the first derivative of the image. The Laplacian method searches for the zero crossings in the second derivative of the image to find the edges. An edge has the one-dimensional shape of the ramp and calculation the derivative of the image can highlight its location.

The derivative shows maximum located at the center of the edge in the original signal. Such a method of finding an edge is characteristic of the gradient filter family of the edge detection filters and it includes the Sobel method.

4.3.3 PREPROCESSING STAGE

Before we can proceed with the segmentation stage, we must ensure that the plate obtained is cleared off most of the unwanted characters or graphics like state name or flags etc. We proceed to do so by scanning the plate vertically and horizontally and ignoring those rows and column which have too much white and black.

This is justified as those areas containing the numbers have black areas which be in a particular range. This range by experiments was found to be between 0.2 to 0.8 times the number of pixels horizontally and vertically.

The character segmentation process takes the extracted license plate region from the preceding module as the input. The input is a colored JPEG image. For our process, we work only binary images and thus the first part of segmentation is binarization of the image.

4.3.4 OPTICAL CHARACTER RECOGNITION

The neural networks are typically made up of many artificial neurons. An artificial neuron. An artificial neuron is an analogy to biological neuron. It is simply electronically modelled to the biological neuron. The number of neurons that are used depends on the task at hand.

The number of neurons used can be few as two or three or large as two or several thousand. There are many ways of connecting artificial neurons together to form a neural network. Some of the ways are discussed below.

- **Feedforward network**: In feedforward Neural Network each input into the neuron has its own weight associated with it. A weight can simply be a floating-point no. and it is these that we adjust when we come to train the network. The weights in most of the neural networks can be both negative and positive, therefore, it helps in providing excitor or else inhibitory influences on each input. As each of the input enters the nucleus it is then multiplied by its weight.

The nucleus sums up all these new input values and gives us the activation which is again a floating-point no. and can be negative or positive. The threshold value is decided and if the activation value is greater than a threshold value the neuron outputs 1(considering these are two outcomes 1 and 0 to the input) as a signal. If the activation is less than the threshold value, the neuron then outputs zero.

- **Back Propagation Network Algorithm**: A back propagation networks learn by example various sets of datasets are provided as input. The various inputs provided helps the network to calculate and recalculate the networks weight value so that when the network is trained it can give the required output. Its declaration of layers for neural networking. The network is initialized by first setting random weights which generally have very small value such as values between -1 and 1.

There are two passes in the Back Propagation Algorithm. After the networks is setup with the random weights the output is calculated this is called the forward pass the result obtained in the forward pass may not be equal to the required result or the target and so the error is calculated for each neuron which is Target-Actual Output. The error calculated for each neuron is then mathematically used to change the weights so the next time the forward pass will have minimum the error. The character is recognized after training the network with various datasets of the character to get maximum accuracy and minimum error.

4.3.5 EXTRACTION OF NUMBER PLATE

In this step, RGB to gray-scale conversion is adopted, to facilitate the plate extraction, and increase the processing speed. Color image (RGB) acquired by a digital camera is converted to gray-scale image based on the RGB to gray-scale conversion technique.

The basic idea of this conversion is performed by eliminating the hue and saturation information while retaining the luminance. The following equation shows an optimal method for RGB to gray-scale conversion, as follows:

Gray= 0.299 * R + 0.587 * G + 0.114 * B ... (1)

where R is red color intensity value, G is green color intensity value, B is blue color intensity value.

The gray-scale image is converted to binary image (Black & White). This conversion is the most important stage in all phases of the NPR system, and more specifically for plate extraction phase. As known, the foreground and background colors of vehicle number plates are quite distinct.

However, images of the vehicle number plate system often contain unevenly distributed gray intensities, or all the intensity values could lie within a small range, such as the images with poor contrast, or poor illumination. Therefore, the crucial point is to use an effective technique for binarization; otherwise, the method would fail to extract the license plate region from the vehicle image correctly.

To overcome the illumination problems, our method performs this task. As a result, the plate characters are appearing clearly after binarization. The next step removes any object contiguous to the border of the image. Thus, unnecessary objects are removed, while the plate characters will not be affected because they are surrounded by a black background.

After removing the unwanted objects, a specific filter is used for illuminating the very small objects based on the size of each one. The binary gradient mask shows lines of high contrast in the image. Compared to the original image, gaps in the lines are observed that surrounds the object in the gradient mask.

This linear gap disappears if the Sobel image is dilated using linear structuring elements. The binary gradient mask is dilated using the vertical structuring element followed by the horizontal structuring element.

4.3.6 CHARACTER RECOGNITION

After the segmentation of elements (characters and numbers), the final module in the recognition process is character recognition. In the last module, character recognition is done by utilizing a template matching technique. During this phase, the Gray scale image is binarized by using binarization algorithm, after that, the blurring is applied to overcome the noise and distortion and finally, each character in the image is segmented into a separate image.

Furthermore, each segmented character from the will be matched with the stored templates of the character. These stored templates consist of pixels. These pixels are termed as test point. There are two types of test points. One test point is called white test point and the other is termed as a black test point.

The white area of the character image from the segmentation stage is tested by the white test point. The black test point is used to test the black area of the character image. The result of the test point is given by:

$$Result = \frac{\sum Matched\ Points}{\sum Test\ Points} \text{ X } 100\%$$

Matched Point = White test points fall in white pixel of the character image and black test points fall in the black pixel of the character image. A predefined value has been allocated for black test points (80%) and white test points (90%). The character will be matched if the result is larger than these predefined values.

Finally, after the individual characters are separated, they are sent to the optical character recognition engine. Some common techniques of character recognition are pattern matching.

The technique used by this system is KNN (supervised learning), which is a simple algorithm and is capable of learning nonlinear high complex decision boundaries. In the next subsequent section, a detailed analysis of the proposed ANPR approach is presented to show the supremacy of the proposed system.

4.3.7 DATASETS SAMPLE

DATABASE SAMPLE 1

DATABASE SAMPLE 2

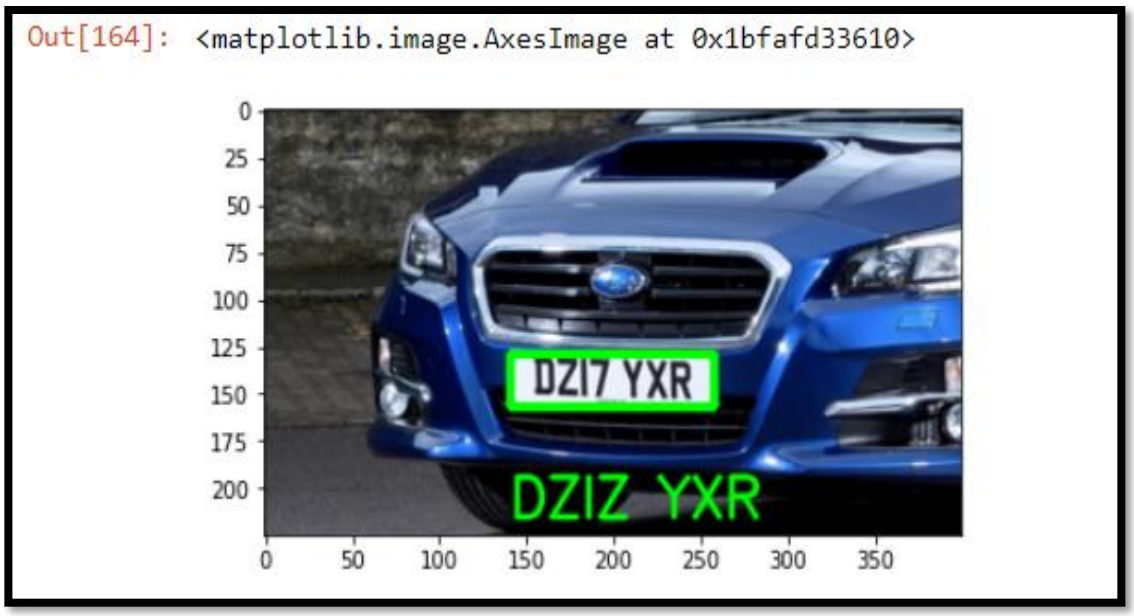
CHAPTER 5

IMPLEMENTATION AND TESTING

5.1 INPUT AND OUTPUT

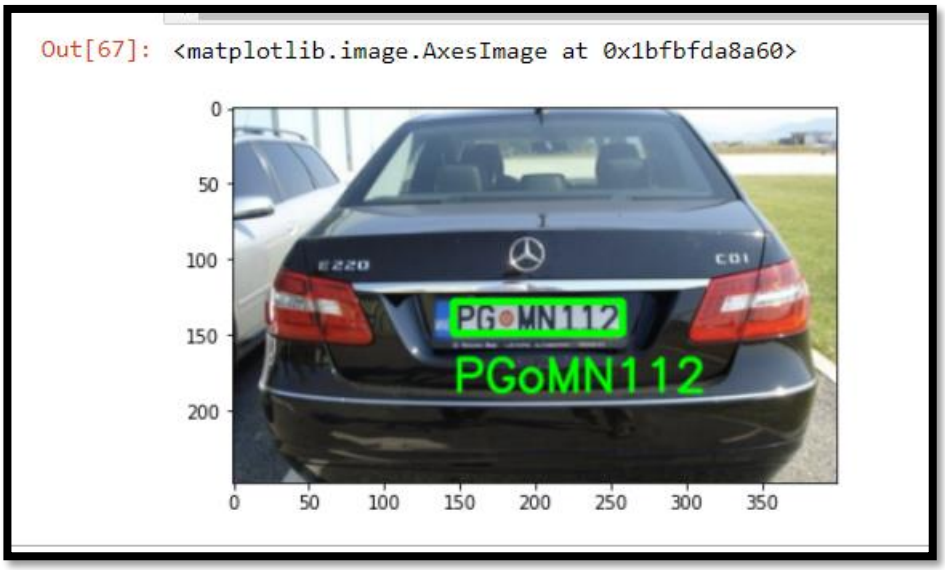
INPUT 1: -

OUTPUT 1: -



INPUT 2: -

OUTPUT 2: -

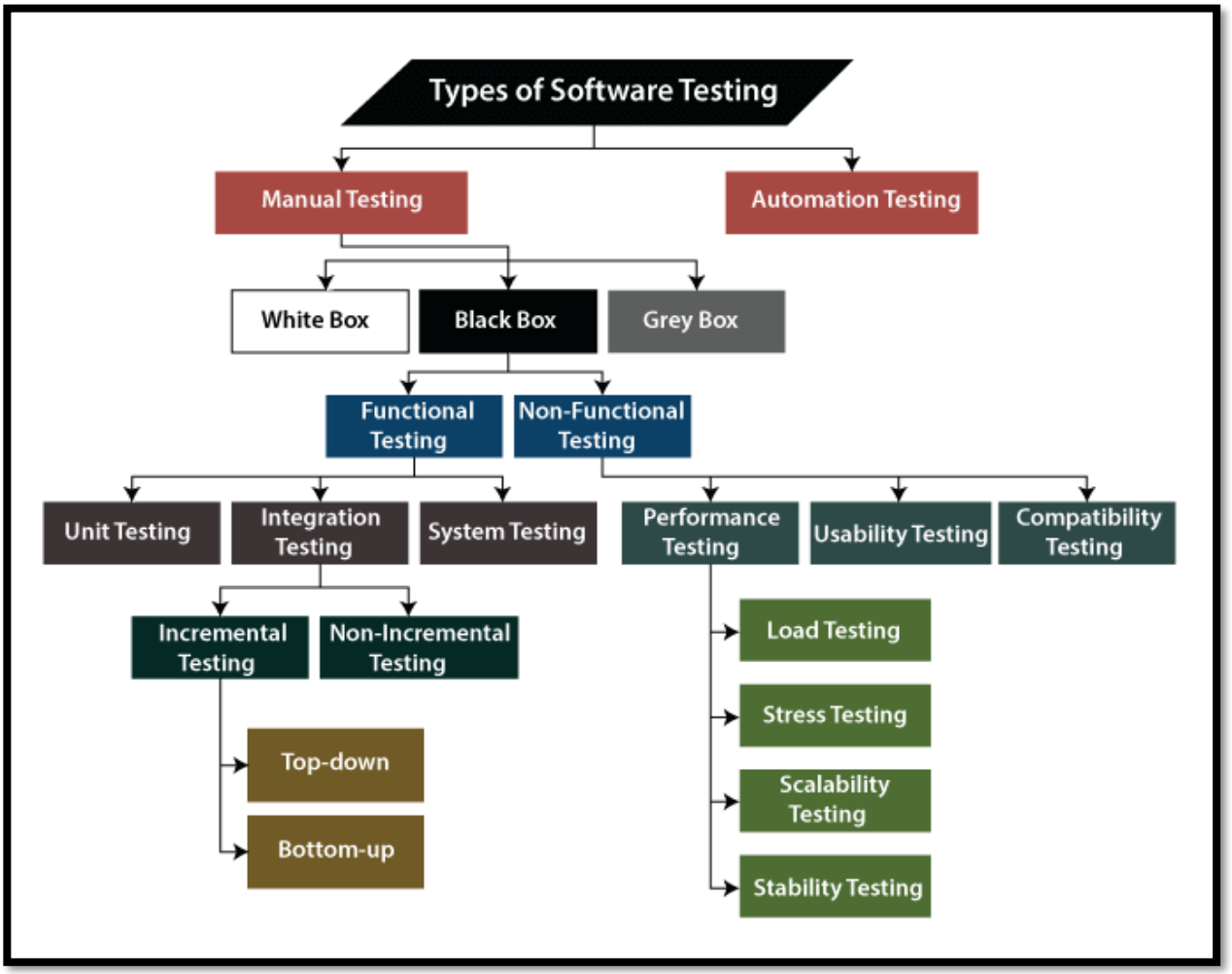


5.2 TESTING

Testing is the process of evaluating a system or its component(s) with the intent to find whether it satisfies the specified requirements or not.

Software testing can be stated as the process of verifying and validating whether a software or application is bug-free, meets the technical requirements as guided by its design and development, and meets the user requirements effectively and efficiently by handling all the exceptional and boundary cases.

The process of software testing aims not only at finding faults in the existing software but also at finding measures to improve the software in terms of efficiency, accuracy, and usability. It mainly aims at measuring the specification, functionality, and performance of a software program or application.



5.2 SAMPLE CODES

jupyter Vehicle Number plate Recognition system Last Checkpoint: Last Sunday at 04:23 (unsaved changes)

Logout

File Edit View Insert Cell Kernel Widgets Help

Trusted env

Run Markdown

0. Install and Import Dependencies

In [1]:
```
!pip install easyocr
!pip install imutils
!pip install matplotlib
!pip install numpy
```

```
Collecting easyocr
  Downloading easyocr-1.6.2-py3-none-any.whl (2.9 MB)
     ---------------------------------------- 2.9/2.9 MB 1.3 MB/s eta 0:00:00
Requirement already satisfied: numpy in c:\users\sreedhar\appdata\roaming\python\python310\site-packages (from easyocr) (1.22.
3)
Collecting Shapely
  Downloading Shapely-1.8.5.post1-cp310-cp310-win_amd64.whl (1.3 MB)
     ---------------------------------------- 1.3/1.3 MB 1.4 MB/s eta 0:00:00
Collecting ninja
  Downloading ninja-1.10.2.4-py2.py3-none-win_amd64.whl (293 kB)
     ---------------------------------------- 293.9/293.9 kB 1.4 MB/s eta 0:00:00
```

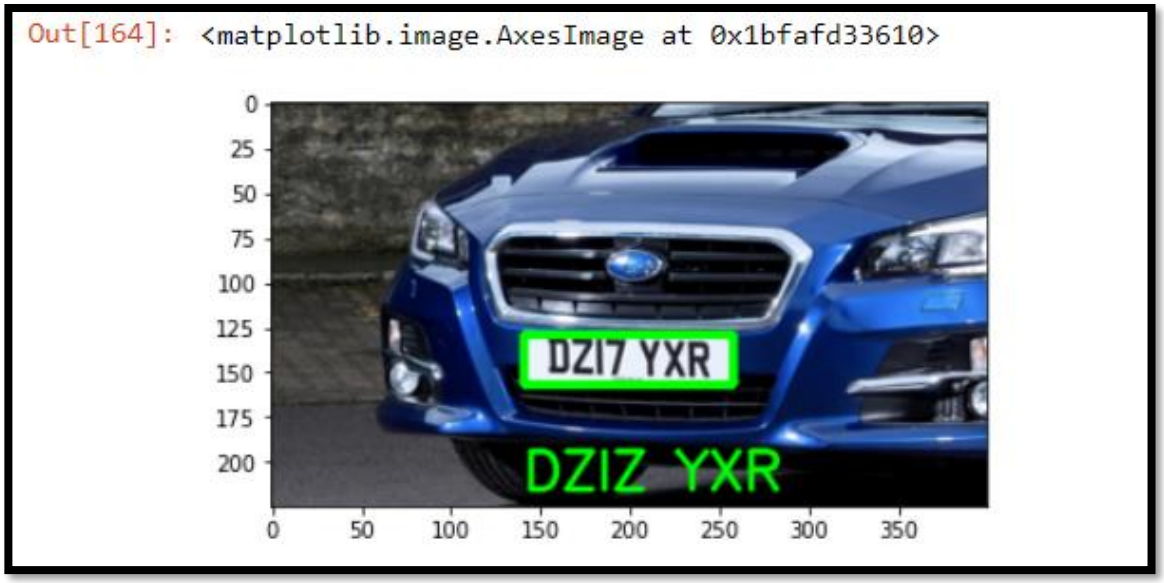
```
Requirement already satisfied: urllib3<1.27,>=1.21.1 in c:\users\sreedhar\appdata\roaming\python\python310\site-packages (from
requests->torchvision>=0.5->easyocr) (1.26.9)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\sreedhar\appdata\roaming\python\python310\site-packages (from req
uests->torchvision>=0.5->easyocr) (2022.5.18.1)
Installing collected packages: pyclipper, ninja, torch, Shapely, PyYAML, python-bidi, opencv-python-headless, torchvision, easy
ocr
Successfully installed PyYAML-6.0 Shapely-1.8.5.post1 easyocr-1.6.2 ninja-1.10.2.4 opencv-python-headless-4.5.4.60 pyclipper-1.
3.0.post3 python-bidi-0.4.2 torch-1.13.0 torchvision-0.14.0
Requirement already satisfied: imutils in c:\users\sreedhar\appdata\roaming\python\python310\site-packages (0.5.4)
```

Importing dependencies

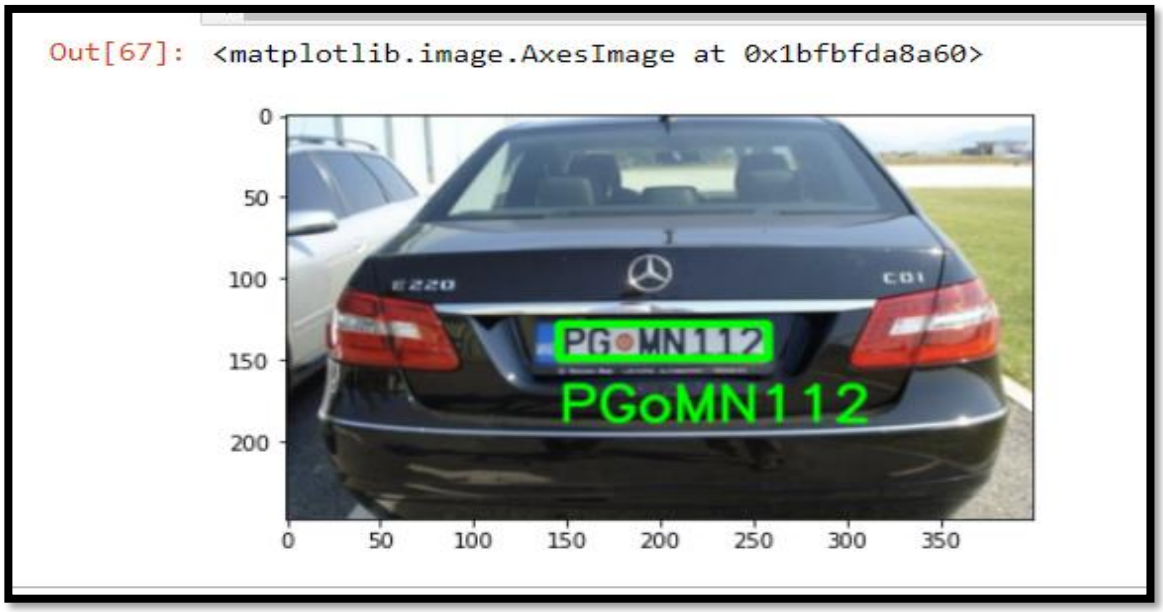
In [1]:
```
import cv2
from matplotlib import pyplot as plt
import numpy as np
import imutils
import easyocr
```

5.3 TEST RESULT

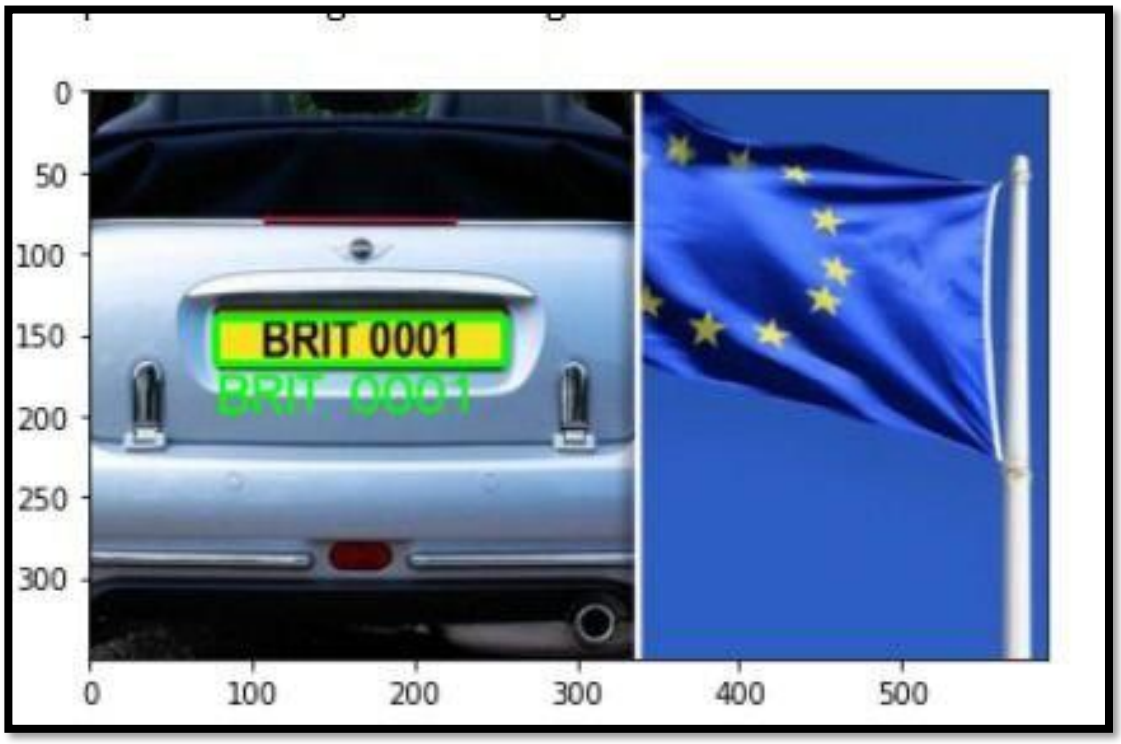
1.



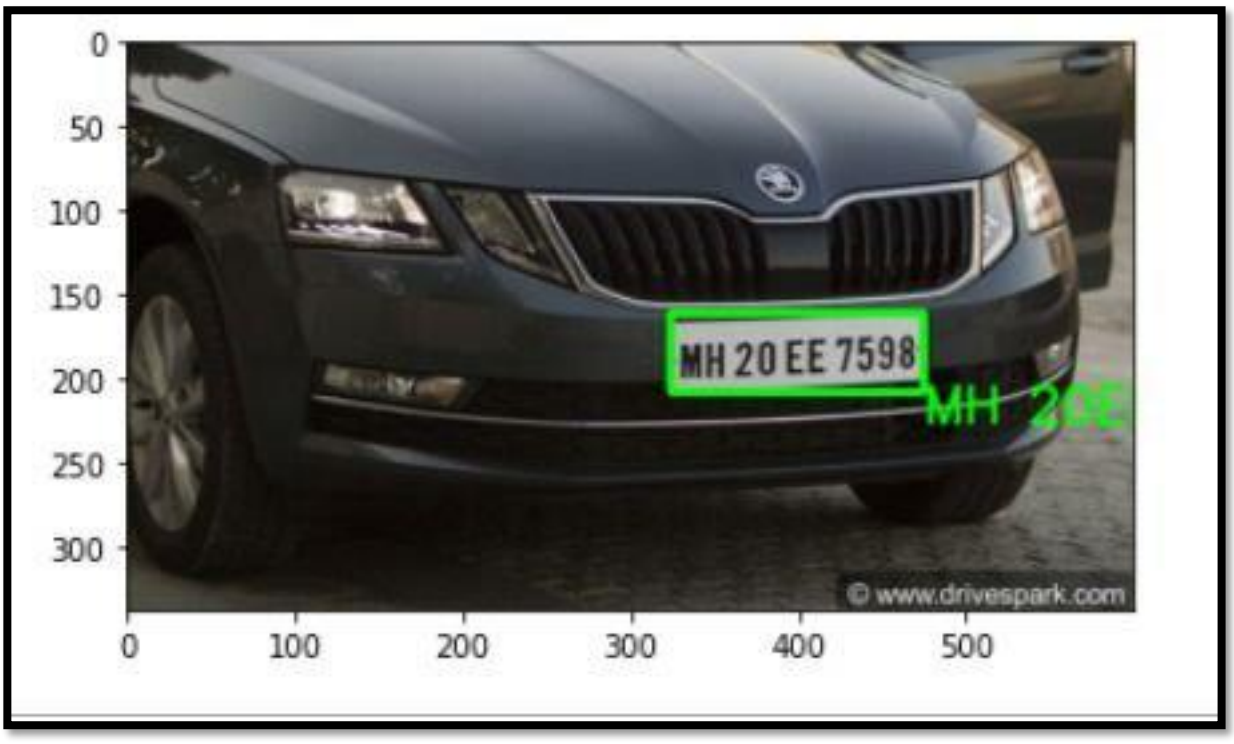
2.



3.


BRIT 0001
0
50
100
150
200
250
300
0
100
200
300
400
500

4.


MH 20 EE 7598
© www.drivespark.com
0
50
100
150
200
250
300
0
100
200
300
400
500

CHAPTER 6

RESULTS AND DISCUSSIONS

6.1 EFFICIENCY OF PROPOSED SYSTEM

VNPRS largely acts as a deterrent. The knowledge that their number plate is being recorded and checked is usually enough to stop criminal behavior in advance. VNPRS 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, VNPRS data can provide both alibis and incriminating data. VNPRS also provides security on a lower level, such as open workplace parking where it can manage permit parking for staff vehicles or recognize a vehicle that has previously been banned from your premises. VNPRS offers an extra measure of security for both public and private use.

A segmentation free automatic license plate recognition method, based on a Convolutional neural network, has been proposed in a study. They used convolutional neural network layers to extract the features of the license number plate and then mapped this layer to fully connected layers with seven branches.

Each branch out of the seven branches represents a specialized classifier for a character that resides on a specific position of the input license plate image. This work was very helpful because the possible errors generated in the segmentation step can be minimized and end-to-end support can also be provided.

Automatic number plate detection, for an intelligent transport system, by using an image processing technique has been proposed in a study. The image processing techniques include counter matching and edge detection. An average accuracy of 96.67% has been achieved in the proposed method.

The detection of license number plate, based on the color edge detection method, with different channel scale-space techniques, has been proposed in a study.

6.2 COMPARISON OF EXISTING SYSTEM AND PROPOSED SYSTEM

Currently in many sectors vehicle is identified using the number plate which is manually noted by a human which is a slow process. Thus, vehicle number plate recognition is an intensive manual process which can perhaps be automated using deep learning which forms the basis of this project.

This is all about the existing system of the project “Automatic Vehicle Number Plate Recognition System Using Machine Learning”.

The following are the drawbacks of the existing system in our project.

• More Manpower.
• More Expenditure.
• High Error Probability.
• Less Performance.
• More Dependency.
• Time Taking.

This is about the drawbacks of the existing system in the project “Automatic Vehicle Number Plate Recognition System Using Machine Learning”

With the aim to connect all the smart vehicle number plate detection systems and to improve cost efficiency and reduce error. we are proposing a system which can be effectively reduce number of human resources and cost and detects vehicle number plates in a split of a second with no or negligible error.

This system can be used for multiple purposed with a minimum setup cost for the required hardware. This is all about the proposed system of the project “Automatic Vehicle Number Plate Recognition System Using Machine Learning”.

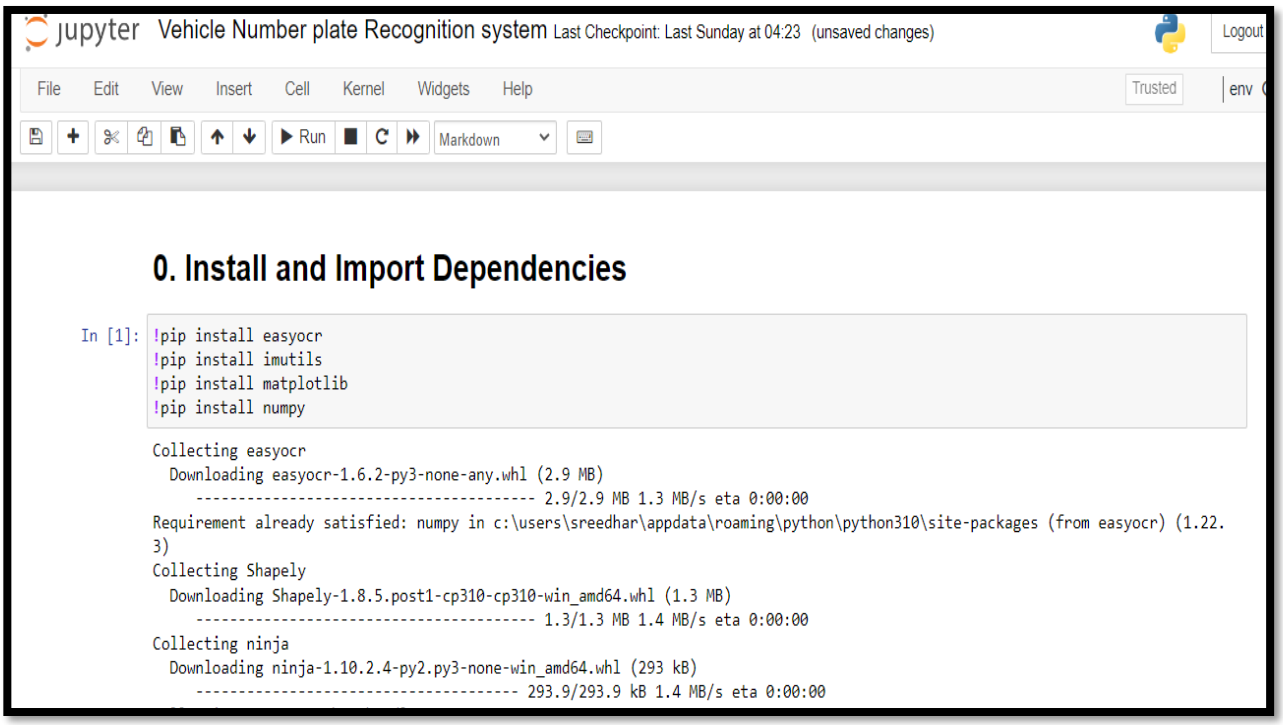
The following are the objectives of the proposed system in the project.

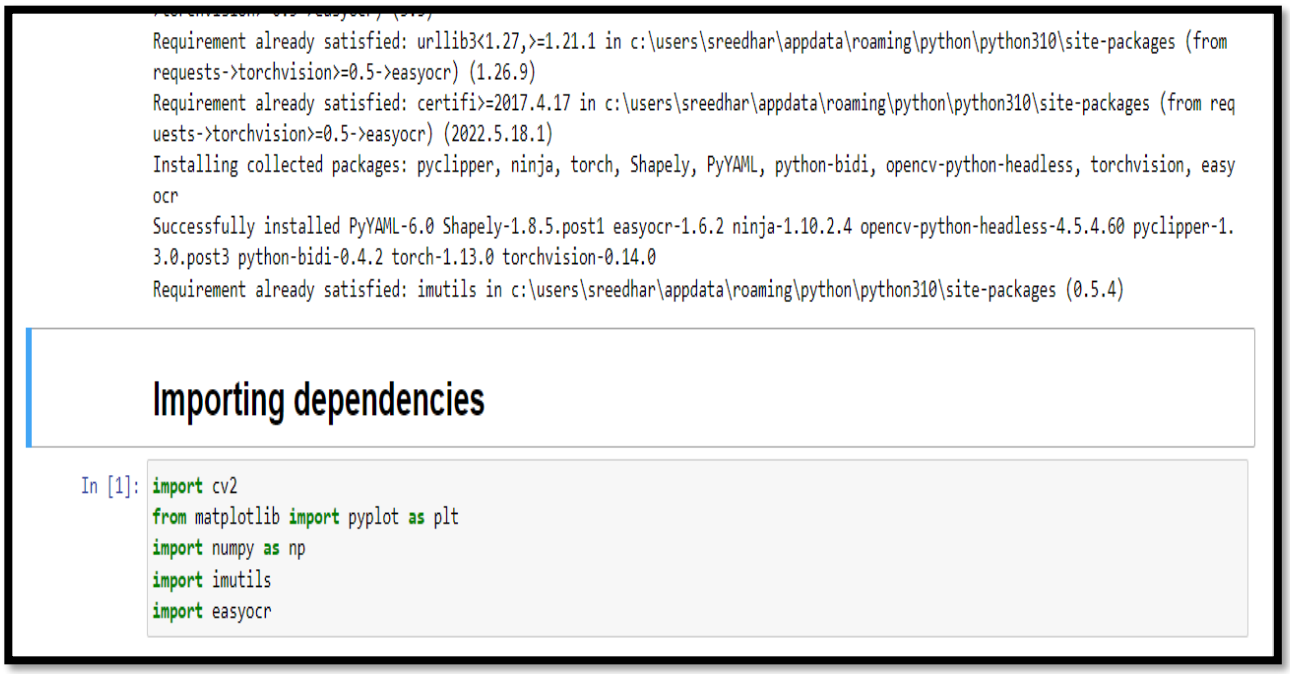
- To make of Vehicle management easier.
- To reduce redundancy and error in number plate recognition.
- Maintenance cost reduction.
- Affordable.
- Reduction of manpower.
- Human Error avoidance
- Product excellence due to minimum requirements
- Optimized solution
- Increased reliability and faster reaction time compared to human workers

CHAPTER 7

SOURCE CODE IMPLEMENTATION & POSTER PRESENTATION

7.1 SOURCE CODE IMPLEMENTATION

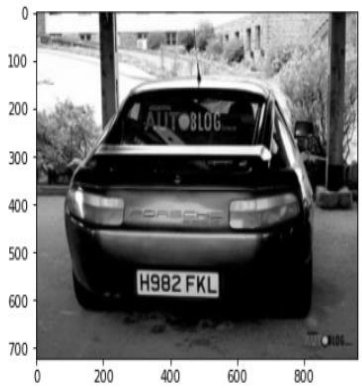




1. Read in Image, Grayscale and Blur ¶

In [5]:
```
img = cv2.imread('image4.jpg')
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
plt.imshow(cv2.cvtColor(gray, cv2.COLOR_BGR2RGB))
```

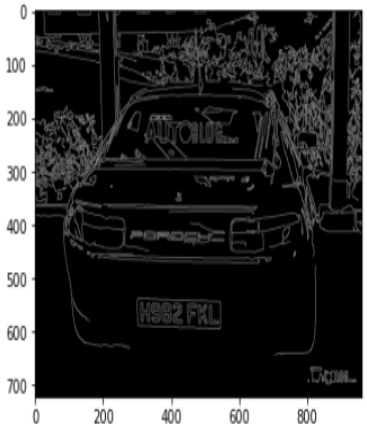
Out[5]: <matplotlib.image.AxesImage at 0x1bfa871c8b0>



2. Apply filter and find edges for localization

In [6]:
```
bfilter = cv2.bilateralFilter(gray, 11, 17, 17) #Noise reduction
edged = cv2.Canny(bfilter, 30, 200) #Edge detection
plt.imshow(cv2.cvtColor(edged, cv2.COLOR_BGR2RGB))
```

Out[6]: <matplotlib.image.AxesImage at 0x1bfa87e81f0>



3. Find Contours and Apply Mask

In [7]:
```
keypoints = cv2.findContours(edged.copy(), cv2.RETR_TREE, cv2.CHAIN_APPROX_SIMPLE)
contours = imutils.grab_contours(keypoints)
contours = sorted(contours, key=cv2.contourArea, reverse=True)[:10]
```

In [8]:
```
location = None
for contour in contours:
    approx = cv2.approxPolyDP(contour, 10, True)
    if len(approx) == 4:
        location = approx
        break
```

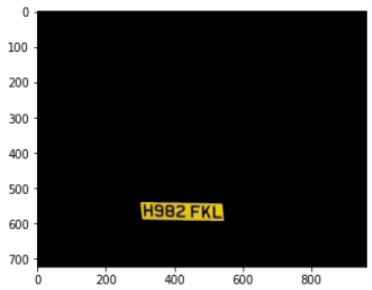
In [9]:
```
location
```

Out[9]:
```
array([[[300, 540]],

       [[306, 589]],

       [[543, 592]],

       [[538, 543]]], dtype=int32)
```

In [10]:
```
mask = np.zeros(gray.shape, np.uint8)
new_image = cv2.drawContours(mask, [location], 0,255, -1)
new_image = cv2.bitwise_and(img, img, mask=mask)
```

In [15]:
```
plt.imshow(cv2.cvtColor(new_image, cv2.COLOR_BGR2RGB))
```

Out[15]:
```
<matplotlib.image.AxesImage at 0x1bfa93a5690>
```



In [16]:
```
(x,y) = np.where(mask==255)
(x1, y1) = (np.min(x), np.min(y))
(x2, y2) = (np.max(x), np.max(y))
cropped_image = gray[x1:x2+1, y1:y2+1]
```

In [17]:
```
plt.imshow(cv2.cvtColor(cropped_image, cv2.COLOR_BGR2RGB))
```

Out[17]:
```
<matplotlib.image.AxesImage at 0x1bfa9403520>
```

4. Use Easy OCR To Read Text

In [18]:
```
reader = easyocr.Reader(['en'])
result = reader.readtext(cropped_image)
result
```

```
CUDA not available - defaulting to CPU. Note: This module is much faster with a GPU.
```

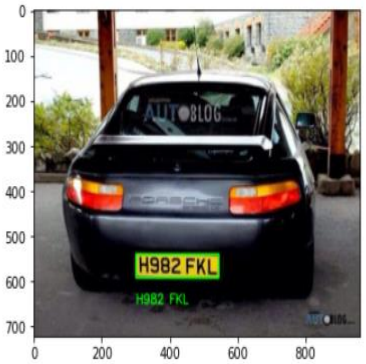
Out[18]:
```
[([[0, 0], [244, 0], [244, 53], [0, 53]], 'H982 FKL', 0.9769778047590311)]
```

OUTPUT: -

5. Render Result

In [19]:
```
text = result[0][-2]
font = cv2.FONT_HERSHEY_SIMPLEX
res = cv2.putText(img, text=text, org=(approx[0][0][0], approx[1][0][1]+60), fontFace=font, fontScale=1, color=(0,255,0), thickne
res = cv2.rectangle(img, tuple(approx[0][0]), tuple(approx[2][0]), (0,255,0),3)
plt.imshow(cv2.cvtColor(res, cv2.COLOR_BGR2RGB))
```

Out[19]:
```
<matplotlib.image.AxesImage at 0x1bfafe0bd30>
```



7.2 POSTER PRESENTATION

CHAPTER 8

CONCLUSION AND FUTURE ENHANCEMENTS

8.1 CONCLUSION

The proposed VNPRS Model has both time and money-saving profit for law enforcement agencies and private organizations for improving homeland security. There is a need to expand the types of vehicles that can be detected: trucks, buses, scooters, bikes. This technology can be further improved to detect the crashed vehicle's number plate in an accident and alert the closest hospital and police station about the accident, thus saving lives.

This VNPRS system works quite well however, there is still room for improvement. This VNPRS system speed can be increase with high resolution camera. Which can be able to capture clear images of the vehicle. The OCR method is sensitive to misalignment and to different sizes, so we must create different kind of templets for different RTO specifications.

At present there are certain limits on parameters like speed of the vehicle, script on the vehicle number plate, skew in the image which can be removed by enhancing the algorithms further. Although there are a lot of running vehicle plate recognition systems for countries like China, Saudi Arabia, Korea, and Malaysia, there is no such LPR for Pakistani license plates.

Although some work exists for Pakistani vehicle number plate identification it still needs more attention due to the variety of number plates and an increasing number of vehicles on the roads. The proposed research work is, therefore, targeting the identification and visualization of the Pakistani vehicle number plates. The proposed algorithm is tested over a huge image dataset, consisting of about 900 vehicles of different types and from various states of Pakistan.

The collected images have captured in various illumination conditions and are verified to generate a high recognition rate. This Project is based on automatic vehicle license plate recognition, in which it is observed that the existing techniques don't pay much attention towards improving the system's efficiency in terms of its power consumption.

As the objective in our proposed design is to reduce power consumption of the system, with the successful implementation of the same it will play a very important role in traffic management and security systems such as automobile theft prevention, parking lot management etc. implementations of the software algorithm have shown promising results.

8.2 FUTURE ENHANCEMENTS

The future scope is that the automatic vehicle recognition system plays a major role in detecting threats to defense Also it can improve the security related to the women's as they can easily detect the number plate before using cab or other services. The system robustness can be increase if bright and sharp camera is used.

Government should take some interest in developing this system as this system is money-saving and eco- friendly, if applied effectively in various areas. Today advances technology took Vehicle Number Plate Recognition (VNPRS) systems from hard to set up, limited expensive, fixed based applications to simple mobile ones in which "point to shoot" method can be used.

This is possible because of the creation of software which ran on cheaper PC based and non-specialist hardware in which their no need to give pre- defined direction, angels, speed, and size in which the plate would be passing the camera field of view. Also, Smaller cameras which can read license plates at high speed, along with smaller, more durable processors that can fit in police vehicles, allowed law enforcement officers to patrol daily with the benefit of license plate recognition in real time.

ANPR can be further exploited for vehicle owner identification, vehicle model identification traffic control, vehicle speed control and vehicle location tracking. It can be further extended as multilingual ANPR to identify the language of characters automatically based on the training data It can provide various benefits like traffic safety enforcement, security- in case of suspicious activity by vehicle, easy to use, immediate information availability - as compare to searching vehicle owner registration details manually and cost effective for any country.

For low resolution images some improvement algorithms like super resolution of images should be focused. Most of the ANPR focus on processing one vehicle number plate but in real-time there can be more than one vehicle number plates while the images are being captured. In multiple vehicle number plate images are considered for ANPR while in most of other systems offline images of vehicle, taken from online database. To segment multiple vehicle number plates a coarse-to-fine strategy could be helpful.

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Nitesh Bharti; Mohit Kumar

2022 2nd International Conference on Emerging Frontiers in Electrical and Electronic Technologies (ICEFEET).

Year: 2022 | Conference Paper | **Publisher:** IEEE

2. Automatic Number Plate Recognition System for Entry and Exit Management.

Vijaya Vardan Reddy SP; B. Sathyasri ; A. Balaji; S. Vanaja; Rahul Krishnan;
Y. Deepika

2021 6th International Conference on Communication and Electronics System

Year: 2021 | Conference Paper | **Publisher:** IEEE

3. Automatic Number Plate Detection in Vehicles using Faster R-CNN

N.Palanivel Ap; T. Vigneshwaran; M.Sriv Arappradhan; R. Madhanraj

2020 International Conference on System, Computation, Automation and Networking (ICSCAN)

Year: 2020 | Conference Paper | **Publisher:** IEEE

4.CNN based Automatic Number Plate Recognition System

Sachin Shrivastava; Sanjeev Kumar Singh; Kapil Shrivastava; Vishnu Sharma

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Year: 2020 | Conference Paper | **Publisher:** IEEE\

5. License Plate Recognition System

Faheen Ali; Himanshu Rathore; Wasim Akram

2021 International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE)

Year: 2021 | Conference Paper | **Publisher:** IEEE

6. Real Time Number Plate Recognition using Computer Vision and Convolutional Neural Network

Md. Naimul Islam Suvon; Riasat Khan; Mehebuba Ferdous

2020 IEEE 2nd International Conference on Artificial Intelligence in Engineering and Technology (IICAIET)

Year: 2020 | Conference Paper | **Publisher:** IEEE

7. Indian Vehicle Number Plate Recognition using OCR

Sparsh Jain; Rishikesh Rathi; Rahul Kumar Chaurasiya

2021 IEEE India Council International Subsections Conference (INDISCON)

Year: 2021 | Conference Paper | **Publisher:** IEEE

8. Image Processing based Number Plate Recognition System Using LabVIEW

Pon Nithis V.S. Kumar; R. Mithun; Sankar Shravan; C. Ashwin; M.B. Hariharan

2020 Third International Conference on Smart Systems and Inventive Technology (ICSSIT)

Year: 2020 | Conference Paper | **Publisher:** IEEE

9. Automatic Car License Plate Detection Based on the Image Weight Model

Zinnur M. Gizatullin; Maya M. Lyasheva; Mikhail P. Shleymovich; Stella A. Lyasheva

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10. Detection of License Plate Numbers and Identification of Non-Helmet Riders using Yolo v2 and OCR Method

B. Srilekha; K. V. D. Kiran; Venkata Vara Prasad Padyala

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