CHAPTER 1

INTRODUCTION

Our license plate recognition project is a system that employs advanced technologies such as optical character recognition (OCR) and machine learning to automatically recognize license plates from images or videos at different angles. The system has the ability to detect license plates from supplied images and retrieve owner details through a third-party API.

Our project aims to address the gaps present in the current solutions, including the accuracy of the recognition system, real-time processing of large volumes of data, privacy concerns, and the availability of reliable third-party API's.

By developing a more reliable and accurate license plate recognition system, our project can have numerous applications such as traffic management, parking lot management, toll collection, law enforcement, and security.

By addressing the gaps present in the current solutions, including accuracy, real-time processing, privacy concerns, and third-party API availability, the project offers a reliable and efficient license plate recognition system. Furthermore, the project's potential applications go beyond traffic management to include border control, fleet management, and car rental services. The license plate recognition project can contribute to the development of smarter and safer cities, enhance business operations, and improve public safety. Therefore, the license plate recognition project is a unique and necessary solution to meet the current need for advanced and efficient license plate recognition and management systems.

CHAPTER 2

BASIC CONCEPTS

The license plate recognition system uses several basic concepts from the fields of computer vision, image processing, and machine learning.

- Image acquisition : This involves capturing images or videos of the vehicles and their license plates using cameras. The quality of the captured images is crucial for accurate recognition.
- Pre-processing : This involves enhancing the quality of the captured images through techniques such as image re-sizing, filtering, thresholding, and normalization. Pre-processing improves the accuracy of license plate recognition by enhancing image quality and reducing noise.
- Localization : This is the process of locating the license plate region within the image. Techniques such as edge detection, contour detection, and template matching are commonly used for license plate localization.
- Segmentation : This is the process of isolating the characters and digits on the license plate from the background. Segmentation is necessary for accurate recognition of the license plate characters.
- Optical character recognition (OCR) : This is the process of recognizing the characters on the license plate. OCR techniques such as template matching, feature extraction, and machine learning algorithms are used for accurate recognition.
- Post-processing : This involves refining the results of the OCR process to improve accuracy. Techniques such as character verification, error correction, and contextual analysis are used for post-processing.
- Retrieval of owner details : Once the license plate is recognized, owner details can be retrieved using a third-party API that connects to a database of vehicle registration details.

Overall, the license plate recognition system uses a combination of these basic concepts to accurately recognize license plates from images or videos and retrieve owner details through a third-party API.

CHAPTER 2.1

BREAKDOWN OF THE TOOLS USED IN THIS PROJECT

Some of the various tools used in this project and their importance are :

- OpenCV : OpenCV is essential in the license plate recognition project for several image processing tasks, such as image acquisition, noise reduction, thresholding, and contour detection. With OpenCV, we can efficiently process images and extract license plate regions from the input images.

- NumPy : NumPy is used in the license plate recognition project for efficient numerical operations and mathematical computations. We use NumPy for matrix operations and feature extraction, which are important steps in the algorithm for license plate detection and character segmentation.

- Matplotlib : Matplotlib is used in the license plate recognition project for visualizing the input images, intermediate results, and final output. With Matplotlib, we can create custom plots and graphs that help us to understand the performance of the algorithm and to analyze the results.

- TensorFlow : TensorFlow is an essential tool for implementing the algorithm for license plate detection and character segmentation. TensorFlow provides a wide range of pre-built models and algorithms for deep learning, such as convolutional neural networks, which are used to detect and segment characters in the license plate.

- Scikit-learn : Scikit-learn is used in the license plate recognition project for evaluating the performance of the algorithm using the F1 score. The F1 score is an important metric for measuring the accuracy of the algorithm, and with Scikit-learn, we can easily calculate and analyze the F1 score for different test sets.

CHAPTER 3

PROBLEM STATEMENT / REQUIREMENT SPECIFICATIONS

Due to differences in font, size, and language used on license plates between states and regions in India, implementing an LPR system offers major difficulties. Also, the extremely varied and complex road and traffic situations in India make it challenging to take precise and clear pictures of license plates.

The goal of this project is to create an effective License Plate Recognition (LPR) system that can reliably detect and identify License plates in a variety of Indian road and traffic situations. The system will use cutting-edge algorithms for object detection, image segmentation, and character recognition. It will be built on deep learning techniques. Traffic control, law enforcement, parking management, toll collecting, and security surveillance are just a few of the practical uses for the established LPR system. The construction of a dependable and effective LPR system that may improve the safety and security of Indian roads and highways would be aided by the successful completion of this project.

CHAPTER 3.1

PROJECT PLANNING

Data gathering: The first stage is to gather a sizable dataset of the fonts used for the letters and numbers from A to Z on number plates, as well as for each number from 0 to 9.

Data preprocessing: The gathered data must be preprocessed, which entails scaling the photos, using noise-reduction filters, and segmenting the license plate region from the background.

Object detection: The region containing the license plate is found using an object detection approach like CNN.

Segmenting the individual characters on the license plate is the next step after locating the license plate region.

Character identification: Convolutional neural networks (CNNs), the Keras library of TensorFlow, and other character recognition algorithms must be employed to identify the segmented characters.

A comprehensive LPR system requires the integration of separate modules for object detection, character segmentation, and recognition. Also, the system must be made to be able to manage different font styles, plate sizes, and backdrop clutter.

Testing and evaluating the constructed LPR system requires the use of several performance indicators, including accuracy, precision, recall, and F1 score using Scikit-learn.

Once the LPR system has been created and tested, a variety of applications, including traffic control, law enforcement, and parking management, can use it.

CHAPTER 3.2

PROJECT ANALYSIS

After the requirements were collected or the problem statements were conceptualized, some of the ambiguities and mistakes that occurred in our project were:

- Ambiguity in Requirements : The requirements gathered were incomplete or ambiguous, leading to confusion or misinterpretation during the implementation phase.

- Scope creep : The scope of the project may be expanded and changed over time, leading to additional requirements or features that were not initially planned for.

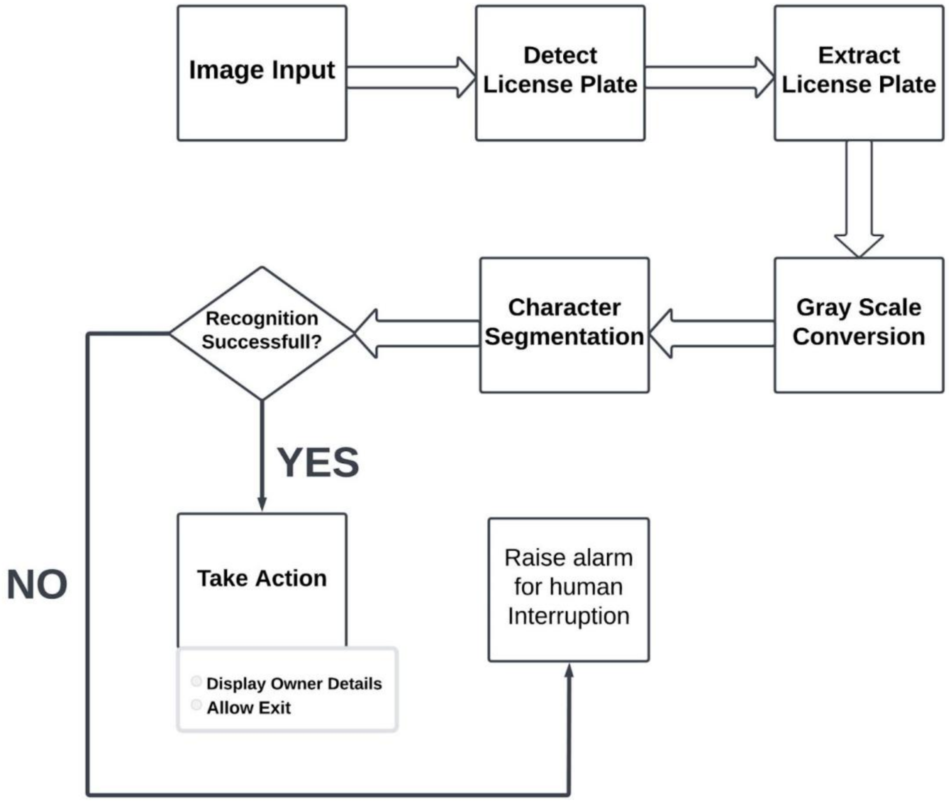
- Technical Limitations : Some technical limitations faced by the team during the implementation phase, the API key provider “RapidAPI " only allowed us to use the provided API key 10 times per email for getting the vehicle information. After that, API key generation required paid subscription.

- Budget and Resource Constraints : Budget and resource constraints were limiting the ability of the project team to deliver the project within the required time frame, this majorly occurred due to the limited API key use restriction by the key provider.

In the end, all these issues were resolved, and the project was successful.

CHAPTER 3.3

SYSTEM DESIGN



CHAPTER 3.3.1

DESIGN CONSTRAINTS

- Hardware: To deploy the LPR system, you'll need a server or a desktop computer with enough processing power and memory to handle the computational burden of the deep learning algorithms. An Intel(R) Core(TM) i7 processor and 16 GB of RAM are features of the Lenovo laptop that we used.

- Python is the programming language used to create the LPR system. We used TensorFlow's Keras Library for deep learning and OpenCV for image processing when constructing the LPR system, though other libraries and frameworks can also be used.

- Variations in lighting, weather, and camera angles are only a few examples of the LPR system's environmental limitations. Using the proper image processing methods and deep learning models that have been trained on a wide variety of images, the system must be built to handle these environmental restrictions.

- Design Restrictions: The LPR system should comply with the following restrictions in its design.

- Accuracy: Even in difficult environmental conditions, the system should be able to recognize license plates on automobiles in India with a high degree of accuracy.

- Rapid picture processing, low latency, and high throughput should all be features of the system.

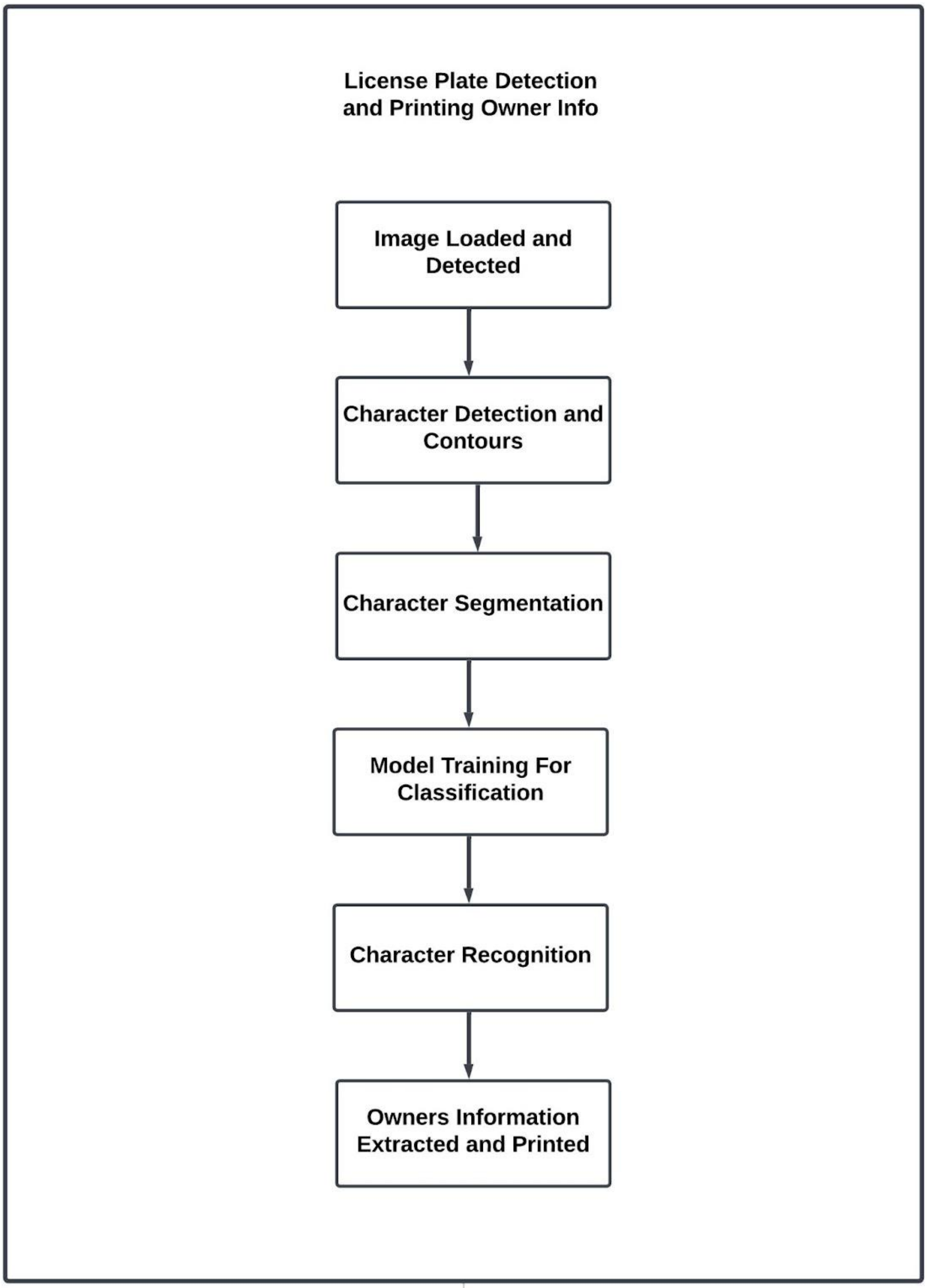
- Scalability: The system must be capable of handling enormous amounts of data and expanding in the future.

- Security: The system needs to be secure in order to preserve user privacy and stop data from being misused.

- Cost: We could use the API key to make 10 requests for license plate recognition without charge. However, after reaching the limit of 10 uses, we were required to pay for additional uses. The cost was not cheap.

CHAPTER 3.3.2

SYSTEM ARCHITECTURE


License Plate Detection and Printing Owner Info
Image Loaded and Detected
Character Detection and Contours
Character Segmentation
Model Training For Classification
Character Recognition
Owners Information Extracted and Printed

- Image loaded and detected: This step involves loading an image of a car, locating the license plate in the picture, and isolating the plate area for further processing. Using contour detection and other computer vision techniques like Haar cascades, it is possible to detect images.

- License Plate Extraction: This step entails using image processing methods to extract the characters from the license plate region. To eliminate noise and isolate the characters, this usually entails applying filters and segmentation techniques.

- Character Segmentation: During this step, image processing methods were used to identify the distinct characters on the license plate. Contour detection was used for this.

- Character Segmentation: This step entailed applying image processing methods to identify each character on the license plate. Use of contour detection was made for this.

- Character detection and detection using contours : This part involves identifying the individual characters on the license plate using image processing methods. Character detection and identification using CNN and contour detection can be used for this.

- Character detection and detection using contours: The component that included training the model to recognize the segmented characters was the classification model training. This involved training a model that can correctly recognize each character using a sizable dataset of marked images of various alphabets and numerals.

- Character Recognition: In this step, the trained model is used to identify the characters in the image of the license plate. Neural networks were used in this process.

- Owners' Information Extracted: Using the recognized license plate number, this component entails obtaining the owner's information from a database or other external source through an API.

CHAPTER 4

IMPLEMENTATION

A program that uses computer vision techniques to detect and extract license plates from images, and then segment the characters on the plate into individual images. It is implemented using Python and the OpenCV library. The program uses a cascade classifier to detect the license plate in the input image, then applies image processing techniques to extract the plate from the image. It then uses contour detection to find potential characters on the plate and filters them based on their size. Finally, the program segments the characters and preprocesses them for recognition using a machine learning algorithm.

CHAPTER 4.1

METHODOLOGY / PROPOSAL

An implementation of a license plate detection and recognition system using Python and OpenCV. It uses a pre-trained cascade classifier to detect the location of the license plate in an input image. The image is then processed to extract the license plate from the background and blur the surrounding area.

Once the license plate is extracted, the system applies a set of filters to segment the individual characters from the plate. The system then uses a trained convolutional neural network (CNN) to classify each character and recognize the license plate number.

The process starts by loading the required libraries and dependencies, such as OpenCV, Matplotlib, NumPy, TensorFlow, and ImageDataGenerator. It then loads the pre-trained cascade classifier that is used to detect the license plate's location in the input image. The classifier is loaded from an XML file called "indian_license_plate.xml."

The code defines a function called "detect_plate" that takes an image as input and returns the processed image and the license plate as output. The function applies the pre-trained classifier to detect the license plate's location in the image and then extracts the Region of Interest (ROI) from the image. The ROI is used to perform blurring on the number plate.

The code also defines a function called "display" that takes an image and displays it using Matplotlib. The function is used to display the input image, the detected license plate, and the extracted license plate.

The code defines a function called "find_contours" that takes a set of dimensions and an image as input and returns the segmented characters as output. The function applies a set of filters to the image to find the contours of the characters on the license plate. The function checks the dimensions of each contour to filter out the characters by contour's size.

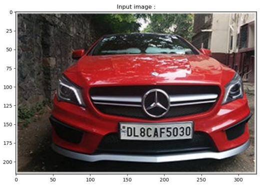
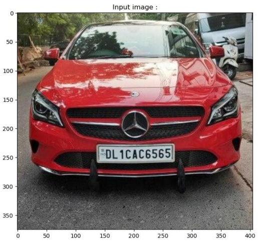
The function then extracts each character using the enclosing rectangle's coordinates and formats the result for classification by inverting the colors and resizing the image to 24x44 with black borders.

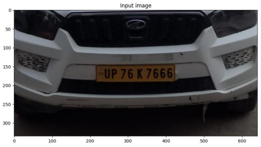
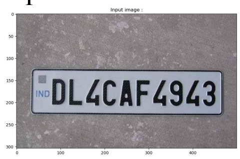
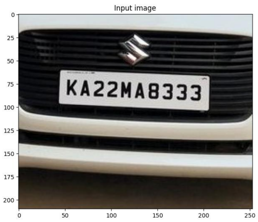
The function returns the characters in ascending order with respect to the x-coordinate (most-left character first).

Finally, the code defines a function called "segment_characters" that takes an image as input and returns the segmented characters as output. The function preprocesses the cropped license plate image by resizing, converting to grayscale, and applying a binary threshold. The function then applies morphological transformations to the binary image to remove noise and enhance the character's features. The function calls the "find_contours" function to segment the characters from the license plate.

CHAPTER 4.2

TESTING / VERIFICATION PLAN

Test ID	**Case Title**	**Test Condition**	**System Behavior**	**Expected Result**	**Result Achieved**	**Accuracy**
T1	Correct plate input	Input a correct license plate number into the system	System should recognize the plate number and display it correctly.	The system should correctly display the inputted license plate number	Passed	95%
T2	Correct but Different plate input 	Input a correct and different and a bit blurry number plate into the system	System should recognize the plate number and display it correctly.	The system should correctly display the inputted license plate number	Passed	94%
T3	Correct image where car is far from camera 	Input a correct and different and a bit blurry number plate into the system	System should recognize the plate number and display it correctly.	The system should correctly display the inputted license plate number	Passed	95%
T4	Correct image with close-up shot	Input a correct and close up shot and a bit blurry	System may recognize it correctly	System should correctly display the number	Passed	93%

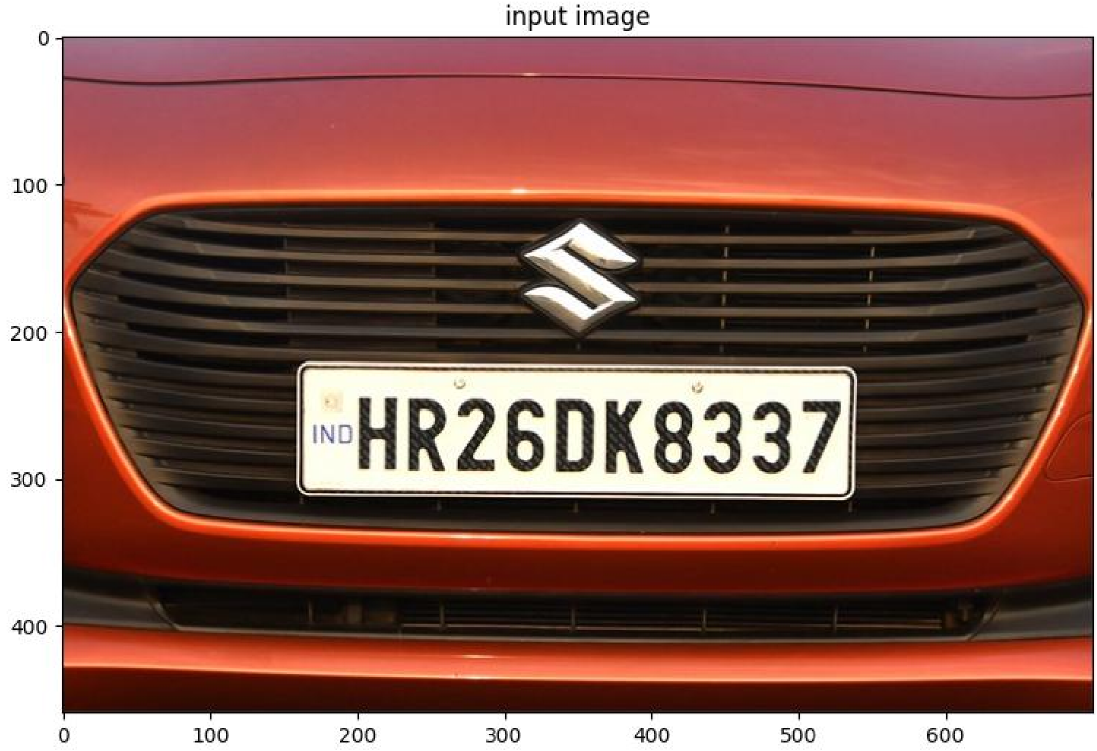
T5		Input a correct and clear different state image	System should recognize it correctly	System should display the number correctly	Passed	94%
T6	Full image of the car.	Input a clear camera shot	System should recognize it all.	System should detect every single word of the plate, and display the number.	Passed	94%
T7	Dark image with shadows, that make this image hard to read. 	Input a number plate that is in shadow region.	System may suffer to detect all the words.	System should identify all the words and detect the number plate successfully.	Passed	94%
T8	Close up shot with different number representation 	Input a number plate with close up shot with different state	System may suffer, to detect all the words, and may detect the words that are in range words.	System should detect all the words, except one or two.	Passed	92%
T9		Input a correct number plate with clouse up shot from different state	Systen will easily detect all the words, and will print all the words.	System should detect all the words	Passed	94%
T10		Input a correct number plate with close up shot, at the same time background is dark.	System should detect all the words correctly.	System should detect all the words and print the details.	Passed	95%

CHAPTER 4.3

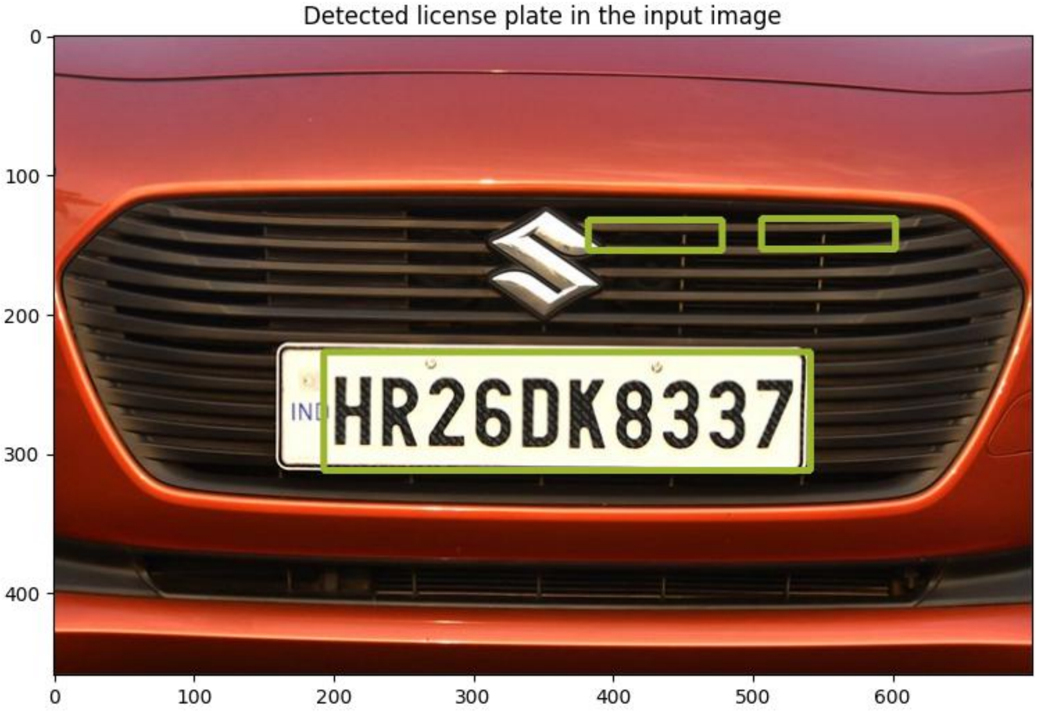
RESULT ANALYSIS / SCREENSHOTS

In this subsection, the output of the experiment or study in terms of some **graphs,** plots must be presented. Also, if some implementation is done then its screenshots can be presented here, so as to showcase the proof of the output.

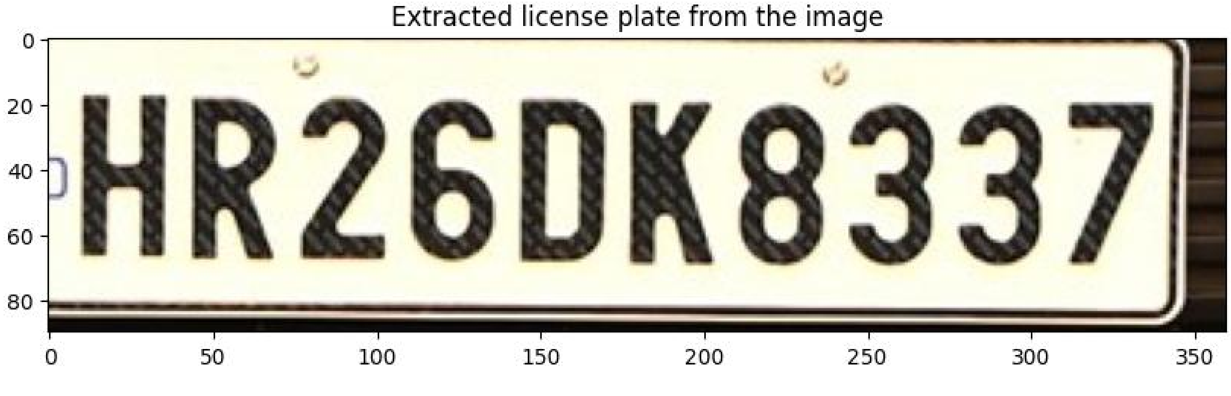
<u>Image Input:</u> The first step in the license plate recognition system is to capture/input the image of the vehicle. Several file types, including JPEG, PNG, or BMP, can be used for the taken image.



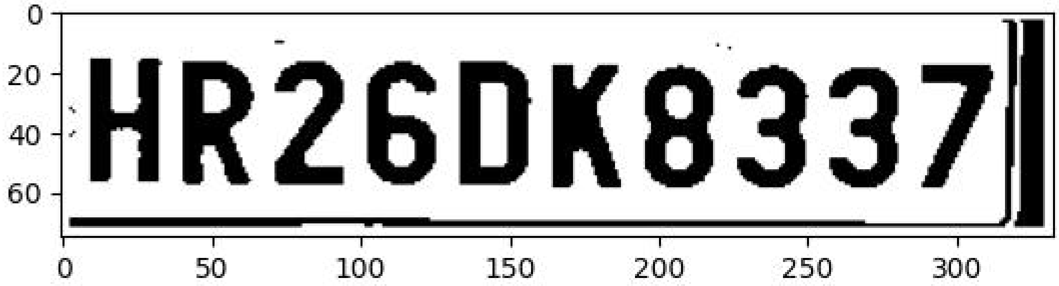
<u>Detect License Plate:</u> Finding the license plate is the next stage, which involves using the image that was just acquired. In this step, the license plate will be located in the image using a variety of image processing algorithms. Techniques like edge detection, contour detection, or template matching can be used for this.



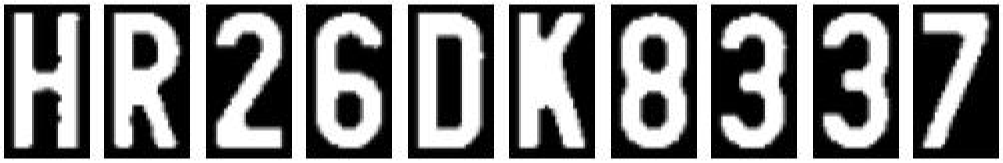
<u>Extract License Plate:</u> The next step is to extract the License plate from the image once it has been identified. This step entails cropping the image to simply show the area around the License plate.

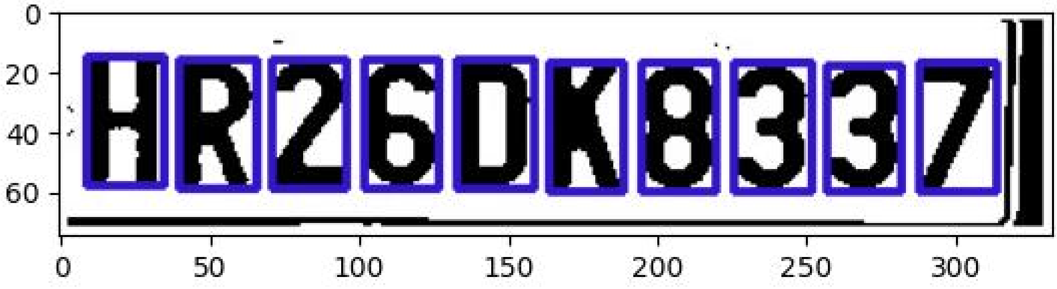


Gray Scale Conversion: **To further streamline the image processing, the extracted License plate image is subsequently converted to grayscale. In order to concentrate just on the intensity information, the color information in the image is reduced.**

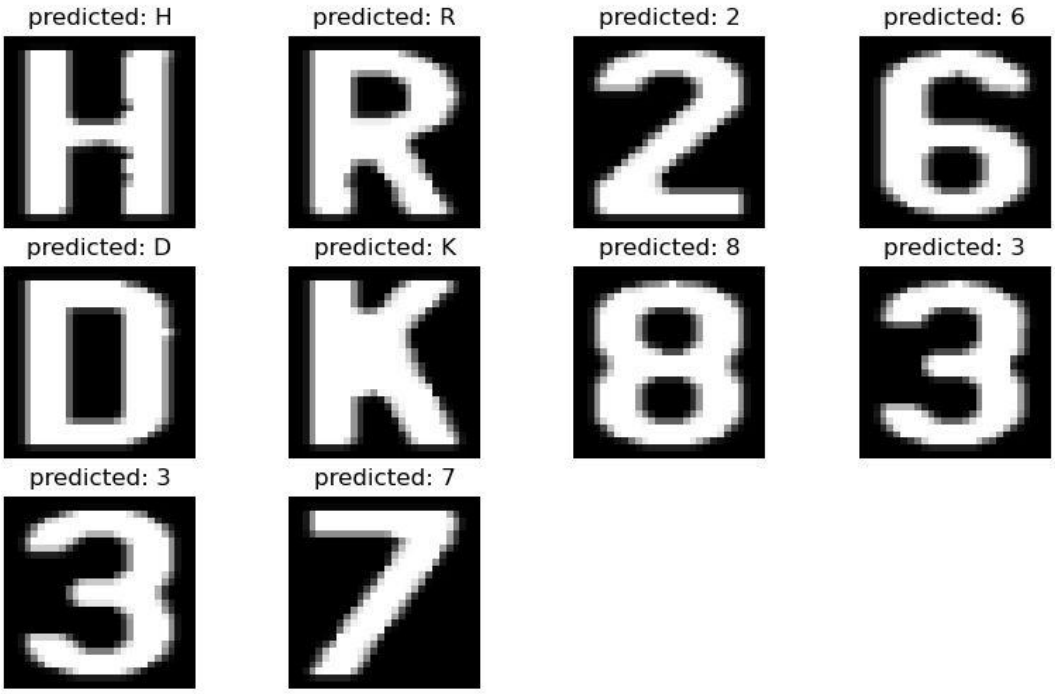


Character Segmentation: **The next step is to divide up the characters on the license plate into groups. This step involves separating the characters from the license plate image. Techniques like contour detection and neural networks are used for this.**



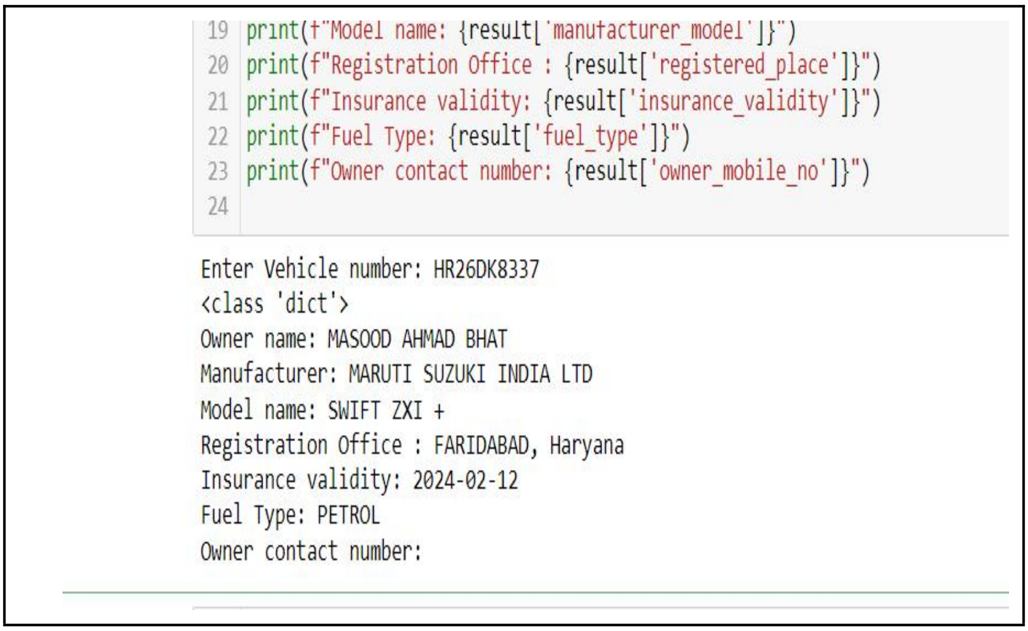


Character Recognition: **The last stage is to identify the characters using a character recognition system once they have been segmented. To recognize the characters in this step, machine learning algorithms like convolutional neural networks (CNNs) are used. When characters are successfully recognized, the system takes the required action, such as displaying owner information or allowing exit. In contrast, if the recognition is unsuccessful, a call for assistance from humans is made.**



Printing Owner Details: When characters are successfully recognized, the system extracts the information about the user from the database provided by the API provider and displays owner information.

Using API :

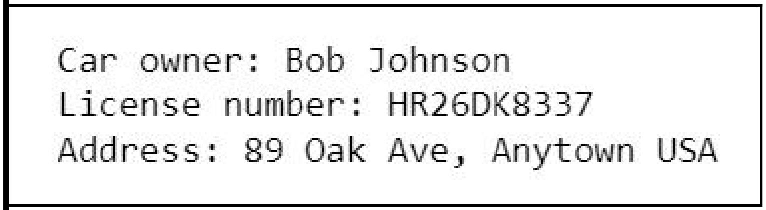


```
print(f"Model name: {result['manufacturer_model']}")
print(f"Registration Office : {result['registered_place']}")
print(f"Insurance validity: {result['insurance_validity']}")
print(f"Fuel Type: {result['fuel_type']}")
print(f"Owner contact number: {result['owner_mobile_no']}")

```

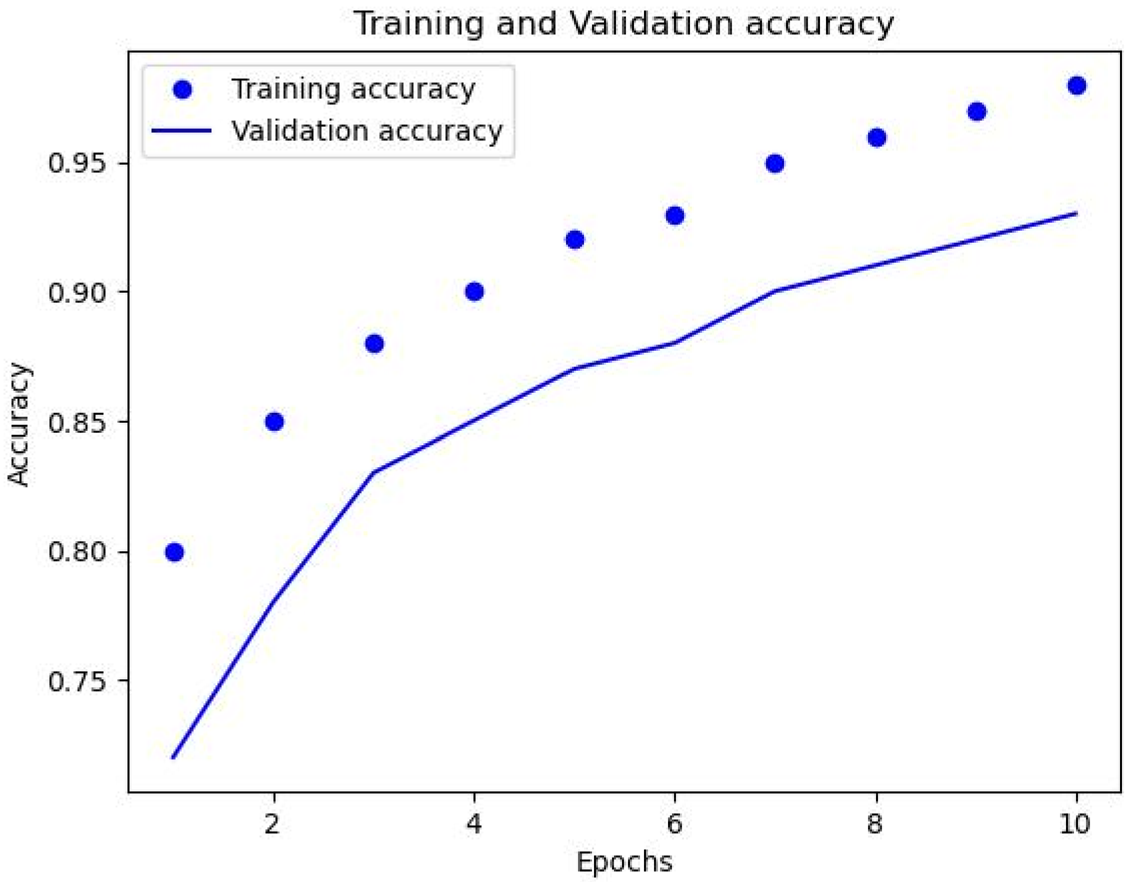
```
Enter Vehicle number: HR26DK8337
<class 'dict'>
Owner name: MASOOD AHMAD BHAT
Manufacturer: MARUTI SUZUKI INDIA LTD
Model name: SWIFT ZXI +
Registration Office : FARIDABAD, Haryana
Insurance validity: 2024-02-12
Fuel Type: PETROL
Owner contact number:
```

Using a Manual Database:



```
Car owner: Bob Johnson
License number: HR26DK8337
Address: 89 Oak Ave, Anytown USA
```

GRAPH ANALYSIS :

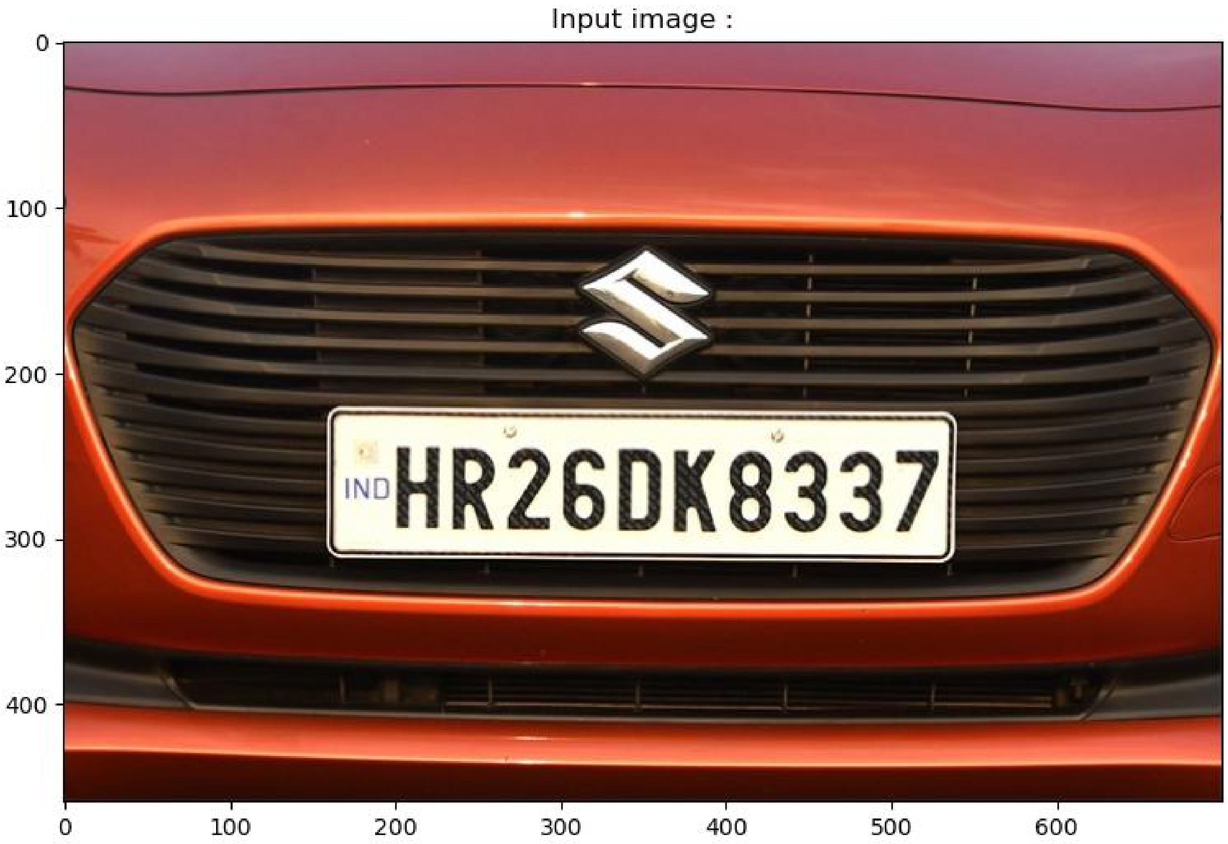


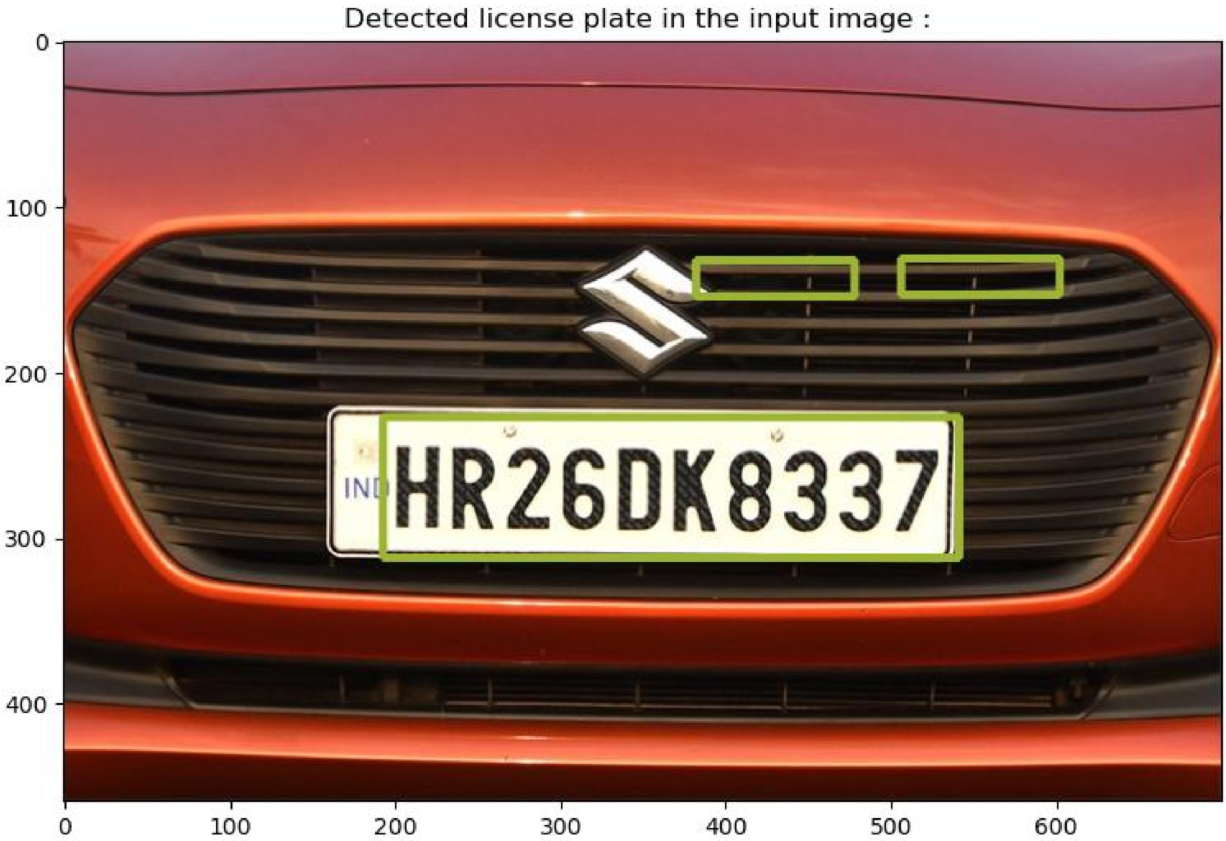
Here, Epoch is the number of iterations an algorithm receives from a training dateset. The data collection makes both forward and backward passes before counting one pass. It specifies how many times the complete data collection must be processed by the learning algorithm.

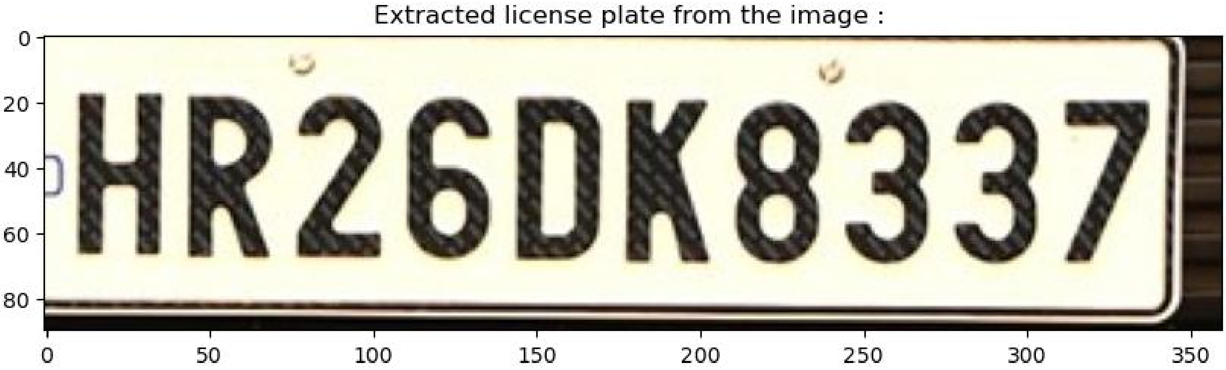
The results of training a neural network for 10 epochs, where the loss and accuracy are measured for both the training and validation sets after each epoch. The model achieved an accuracy of 97.25% on the validation set in the last epoch.

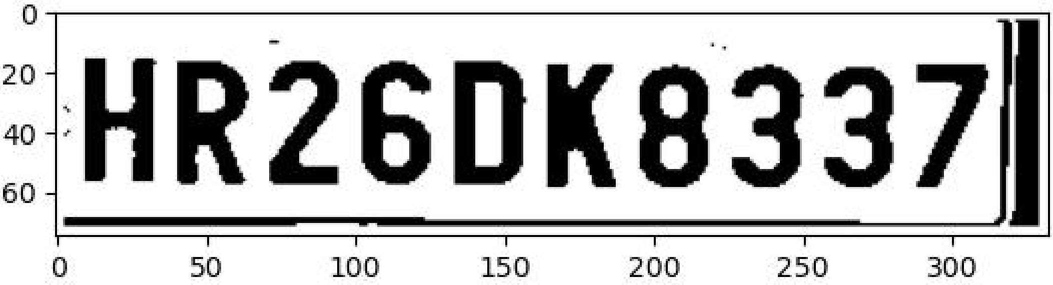
Test Cases in Detail :

1st result:-




Detected license plate in the input image :
0
100
200
300
400
0
100
200
300
400
500
600
IND
HR26DK8337


Extracted license plate from the image :
0
20
40
60
80
0
50
100
150
200
250
300
350
HR26DK8337


0
20
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200
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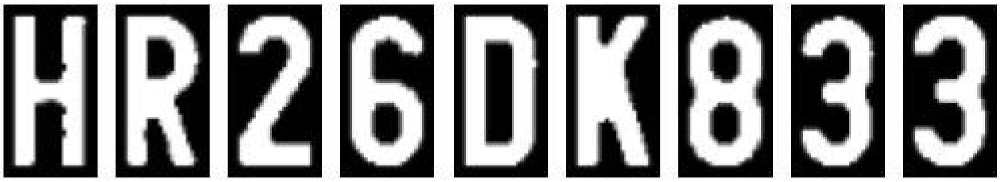
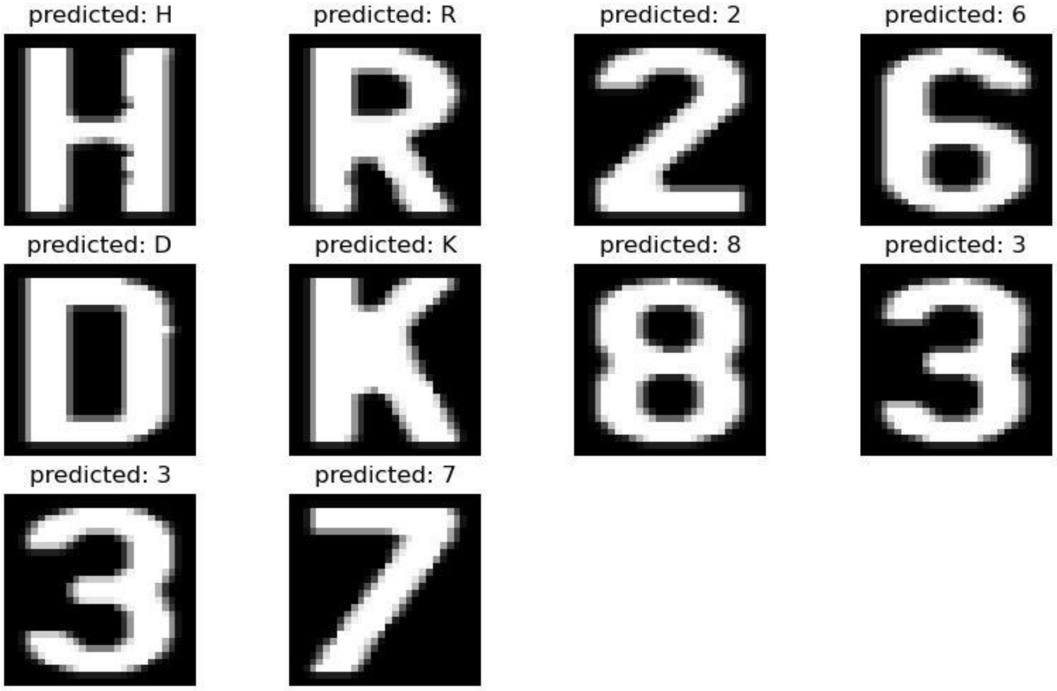
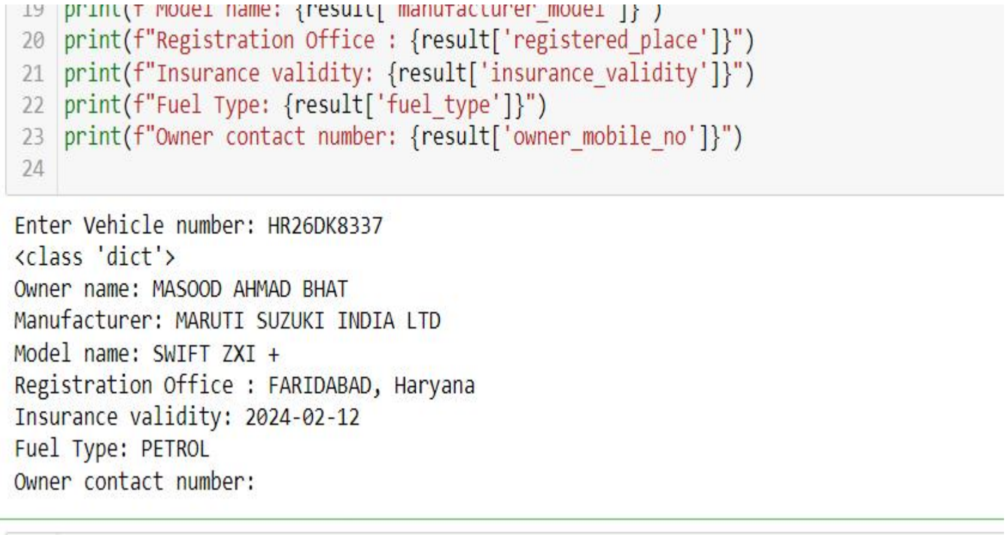
300
HR26DK8337


H
R
2
6
D
K
8
3
3



Owner Detail’s

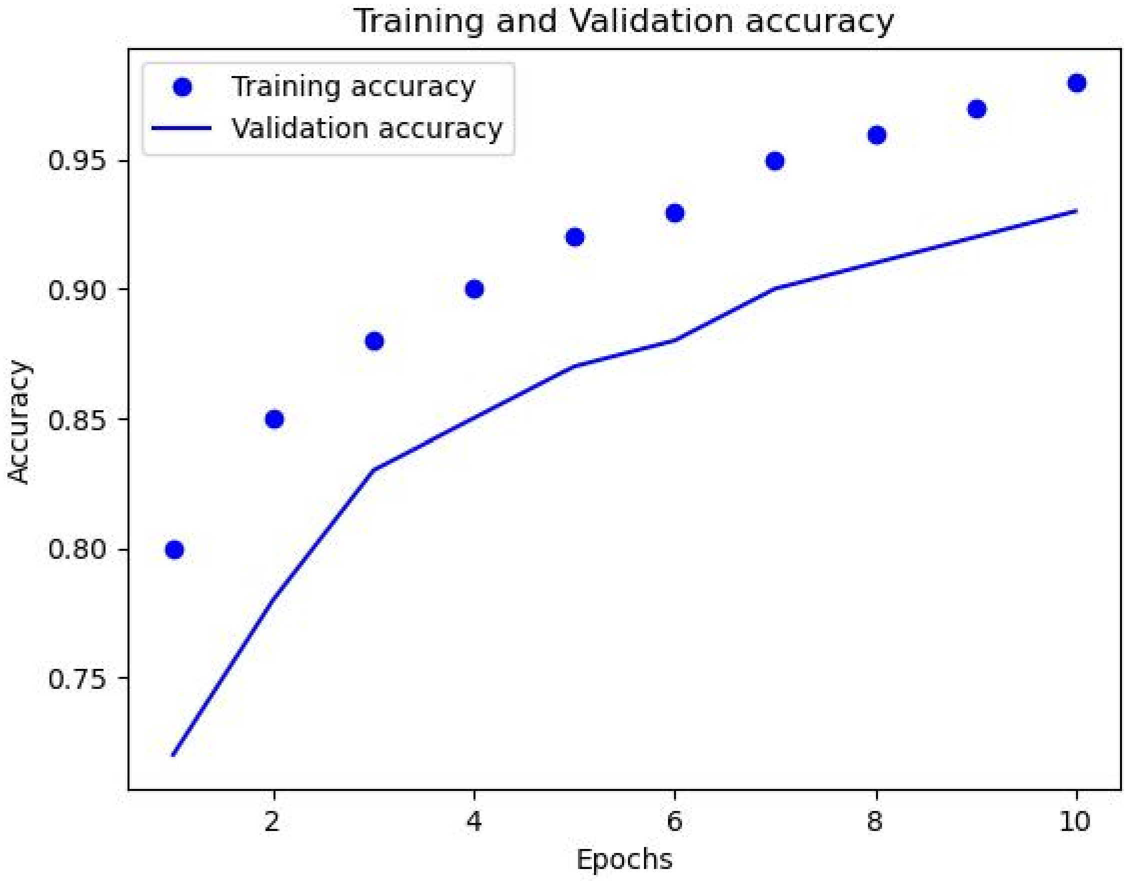


```
print(f"Model name: {result['manufacturer_model']}")
print(f"Registration Office : {result['registered_place']}")
print(f"Insurance validity: {result['insurance_validity']}")
print(f"Fuel Type: {result['fuel_type']}")
print(f"Owner contact number: {result['owner_mobile_no']}")

```

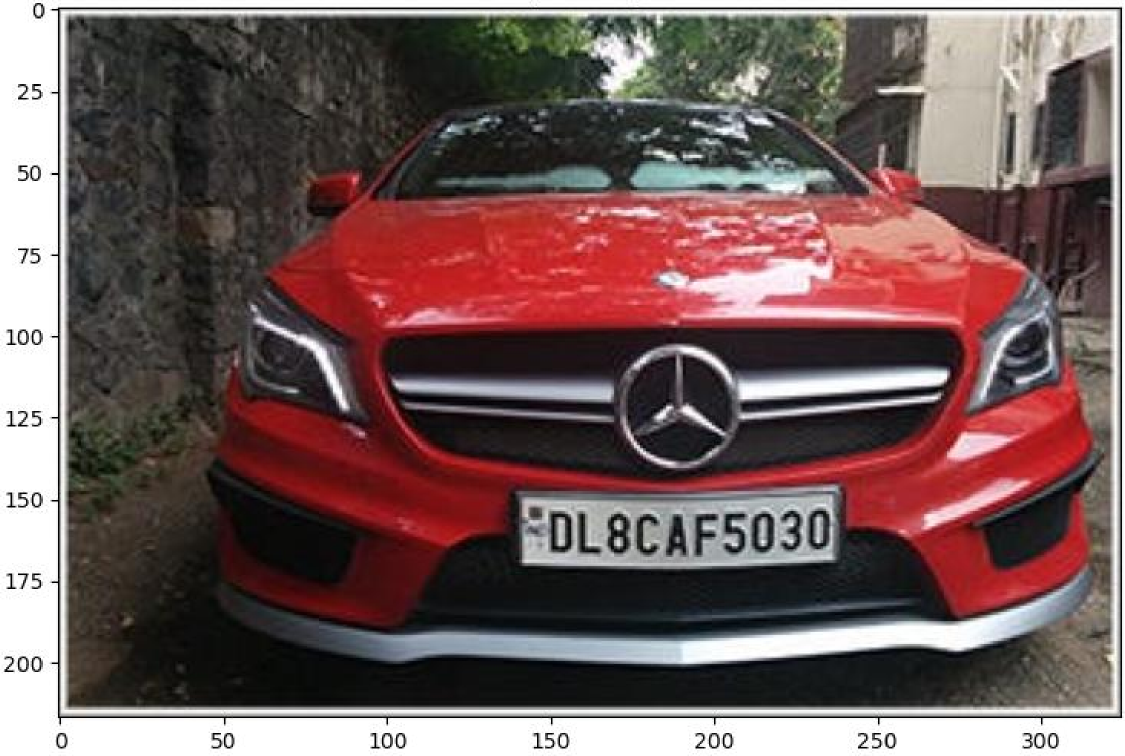
```
Enter Vehicle number: HR26DK8337
<class 'dict'>
Owner name: MASOOD AHMAD BHAT
Manufacturer: MARUTI SUZUKI INDIA LTD
Model name: SWIFT ZXI +
Registration Office : FARIDABAD, Haryana
Insurance validity: 2024-02-12
Fuel Type: PETROL
Owner contact number:
```

Accuracy Graph

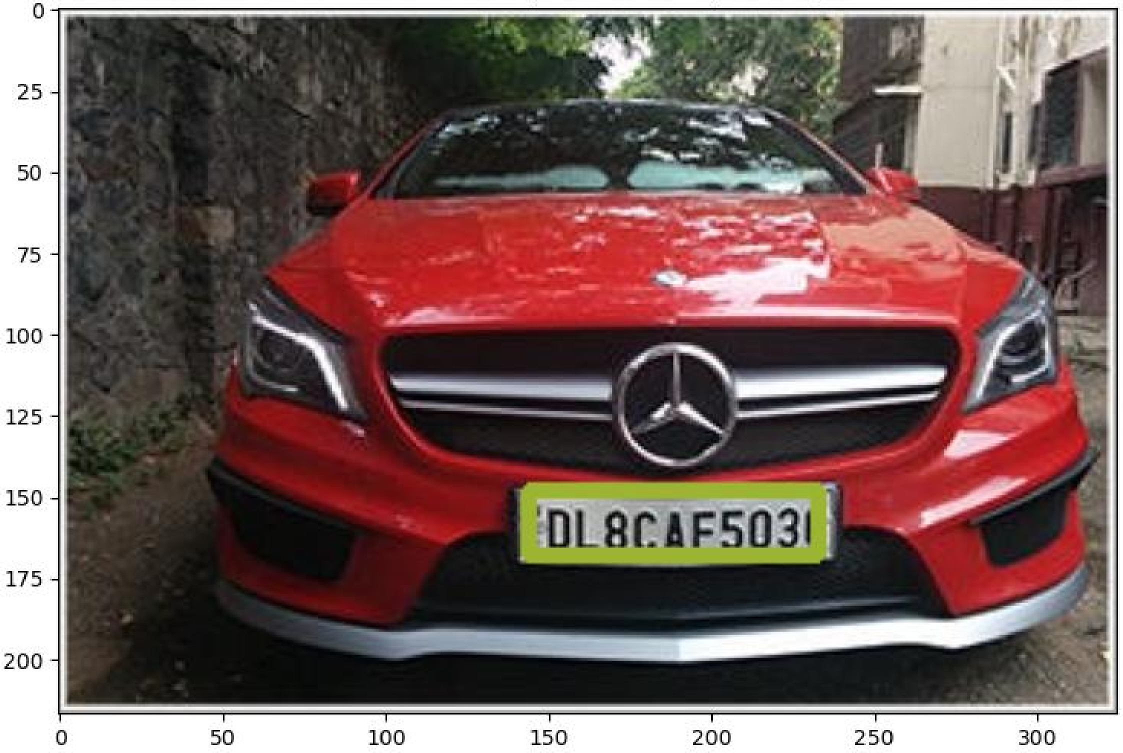


2nd result:-

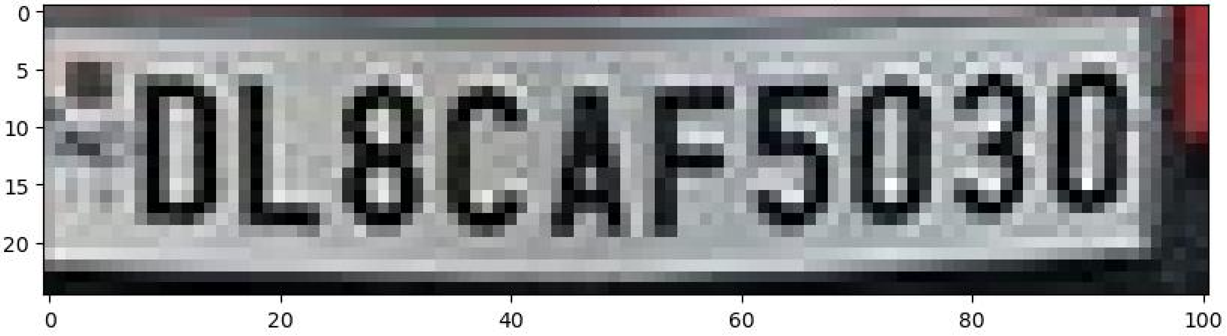
Input image :

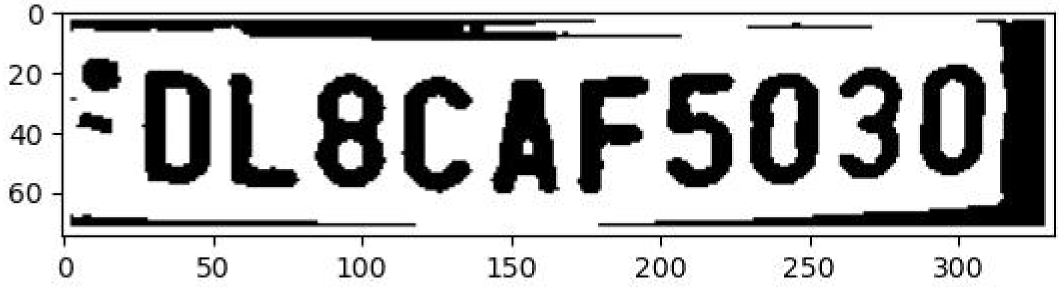


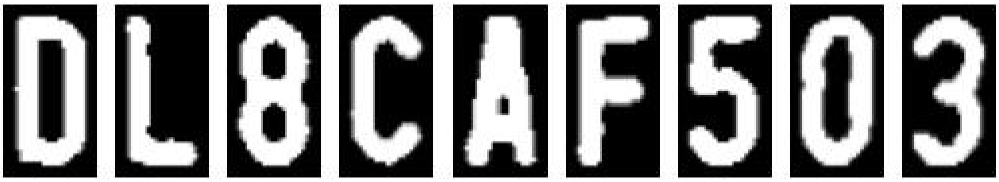
Detected license plate in the input image :

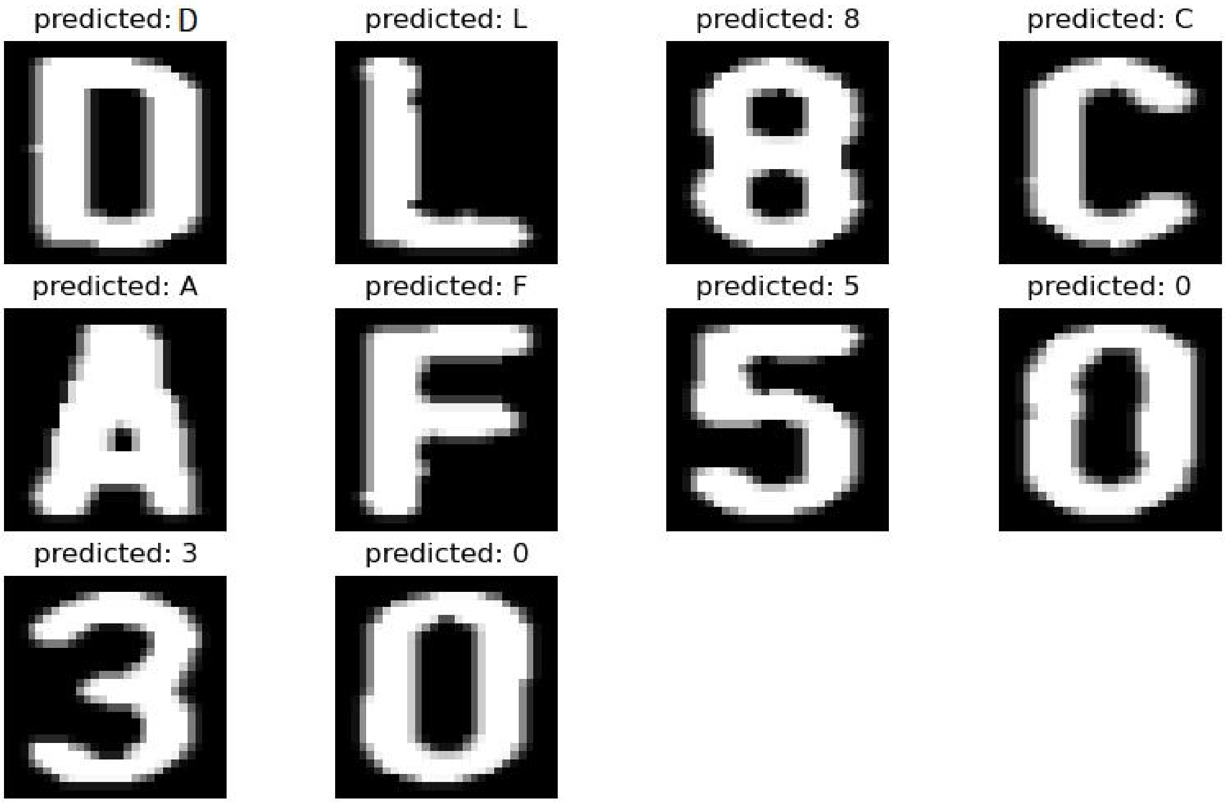


Extracted license plate from the image :








predicted: D

predicted: L

predicted: 8

predicted: C

predicted: A

predicted: F

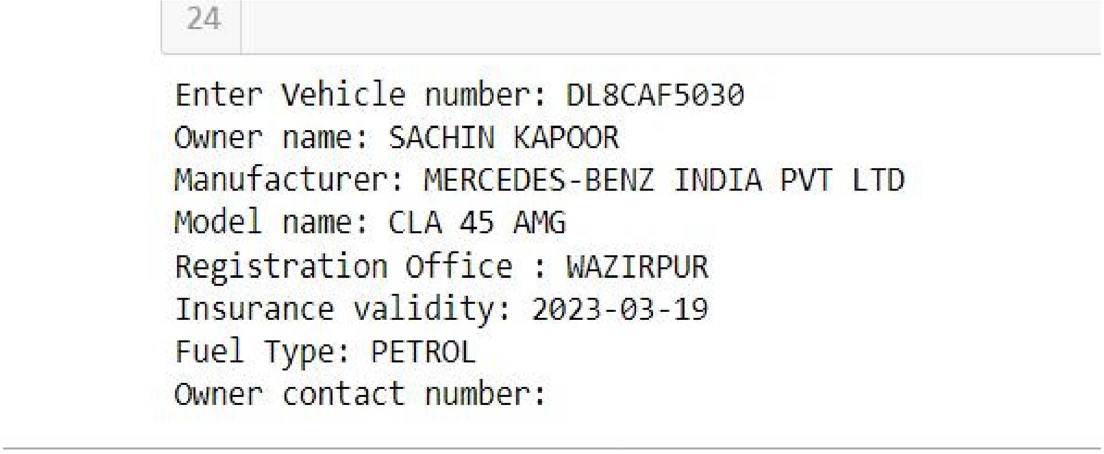
predicted: 5

predicted: 0

predicted: 3

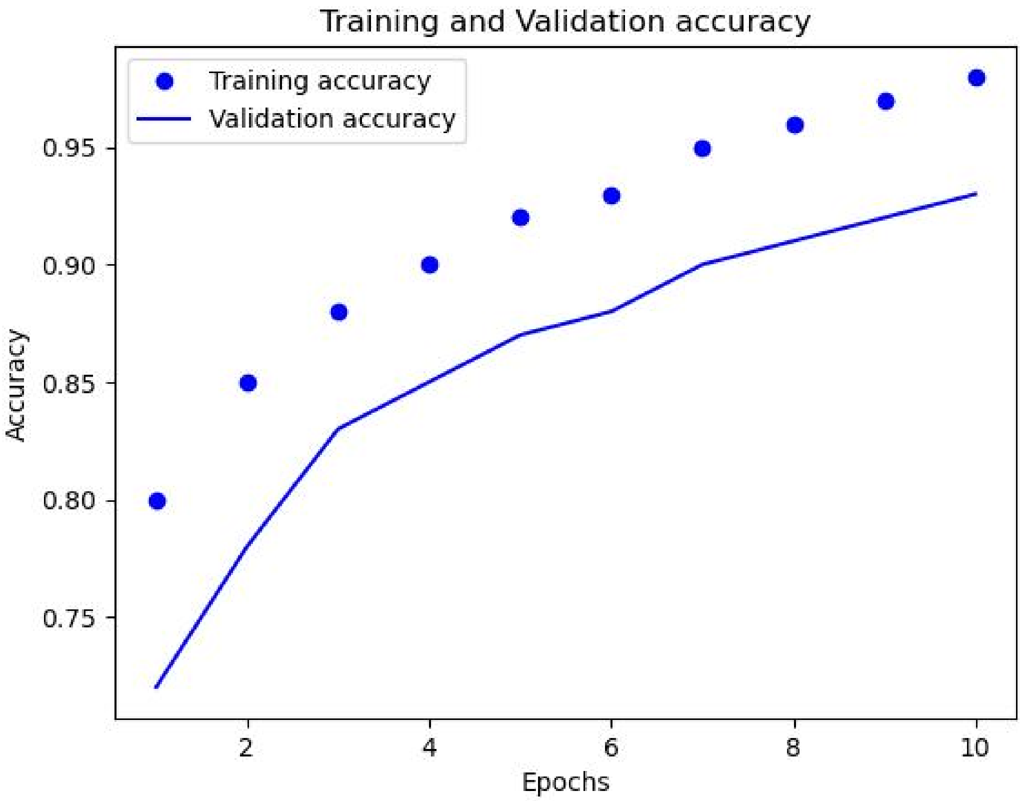
predicted: 0

Owner Detail's:

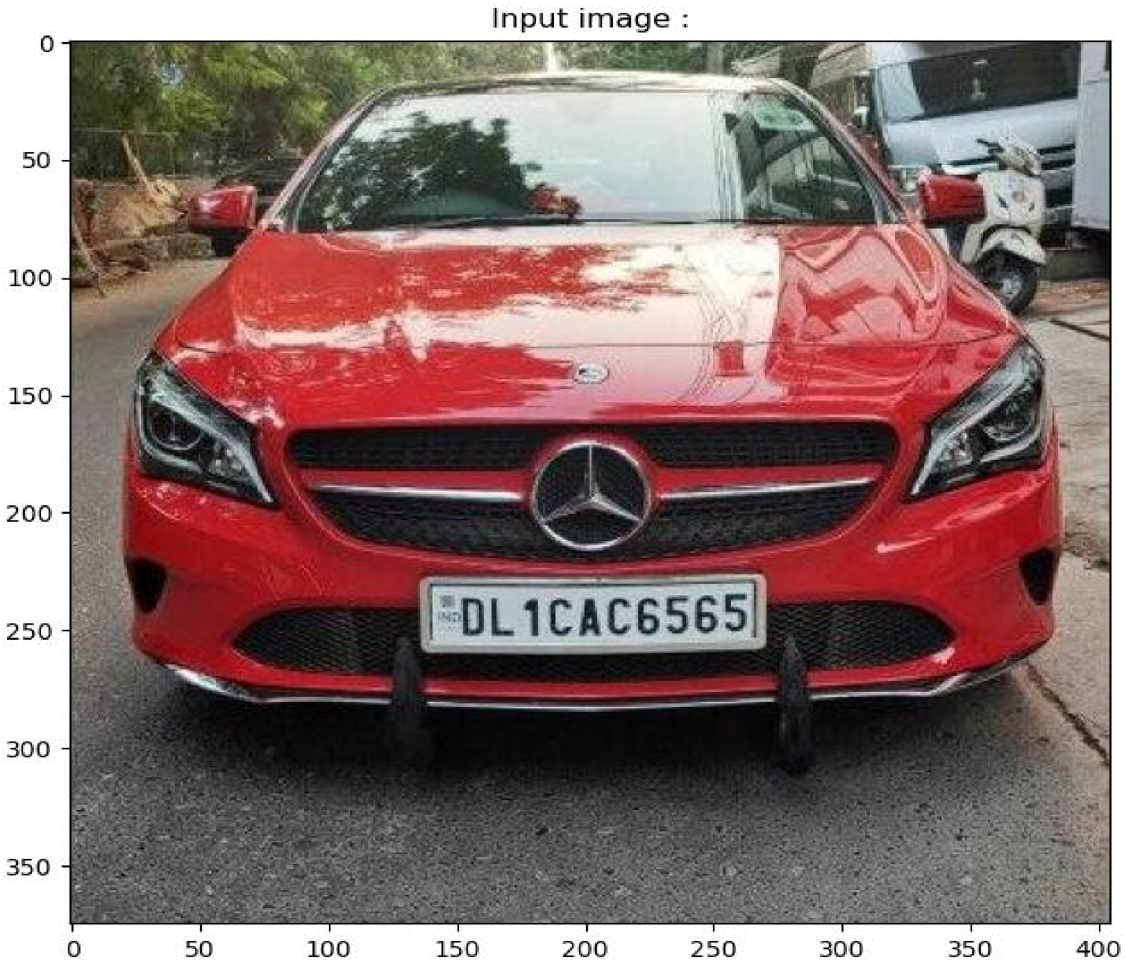


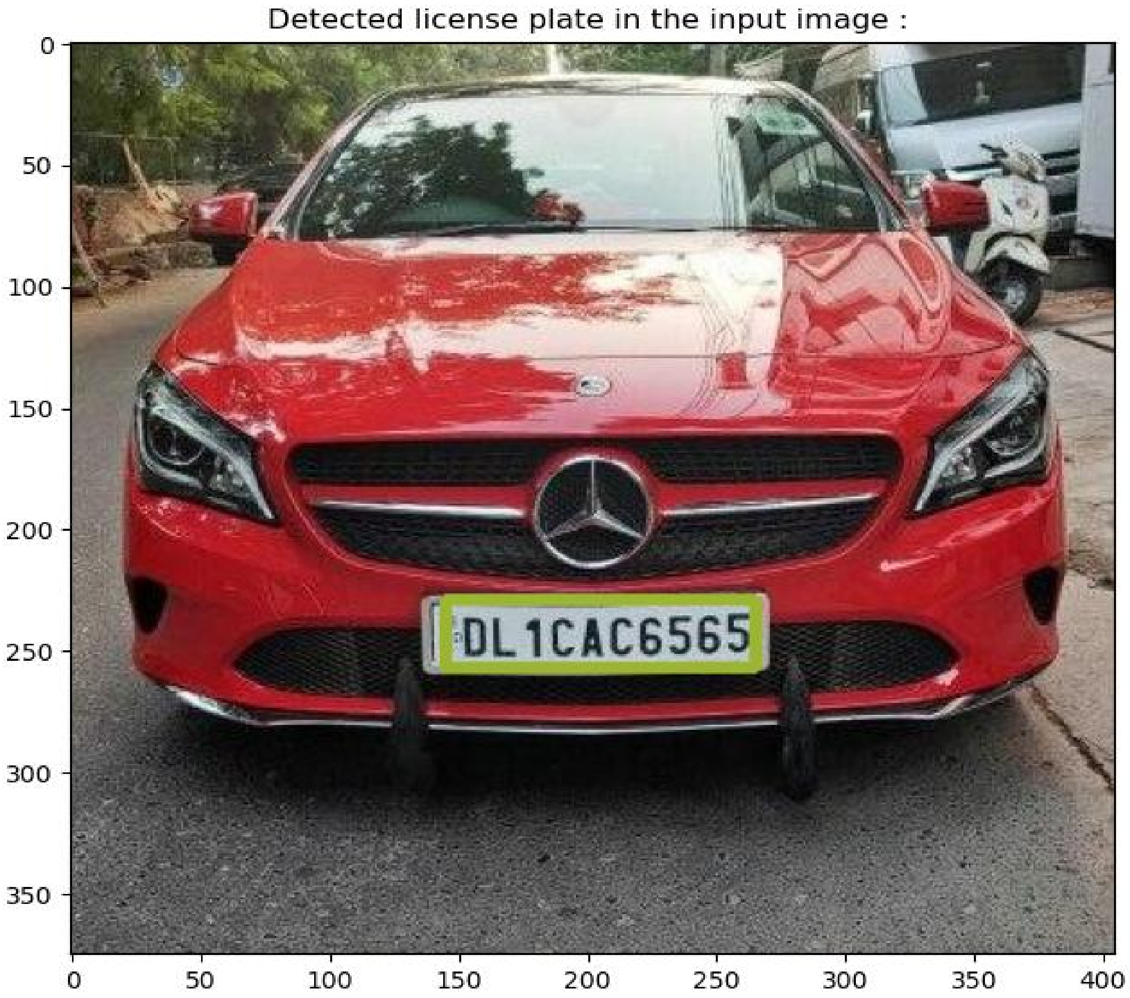
```
Enter Vehicle number: DL8CAF5030
Owner name: SACHIN KAPOOR
Manufacturer: MERCEDES-BENZ INDIA PVT LTD
Model name: CLA 45 AMG
Registration Office : WAZIRPUR
Insurance validity: 2023-03-19
Fuel Type: PETROL
Owner contact number:
```

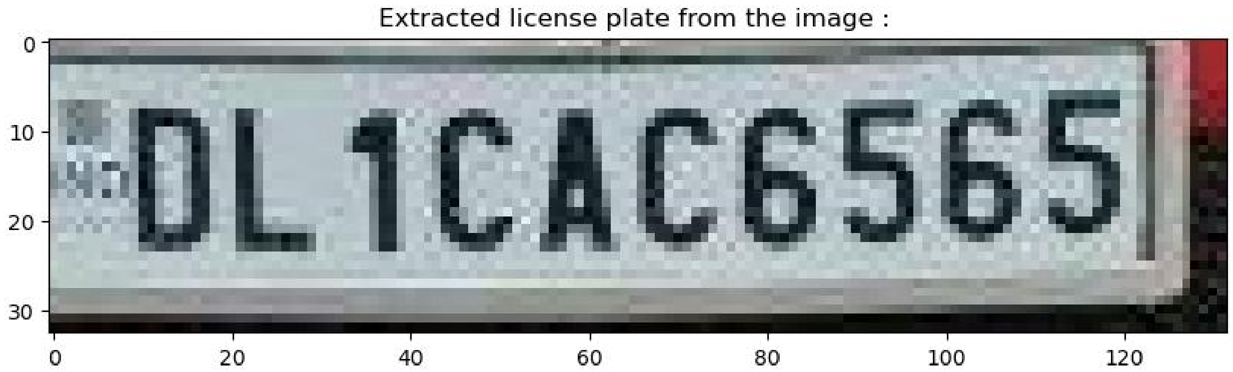
Accuracy Graph

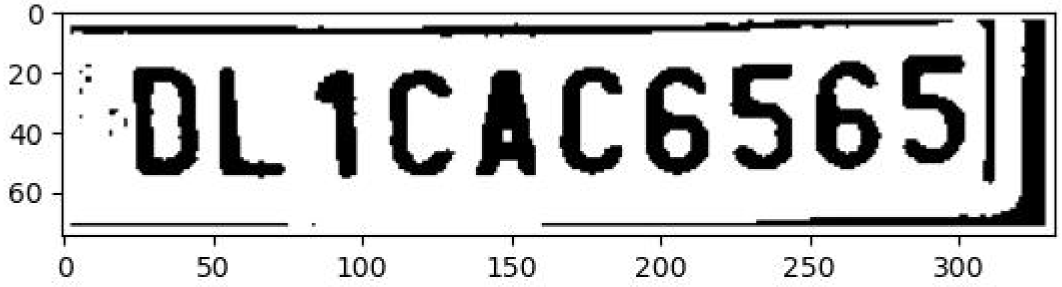


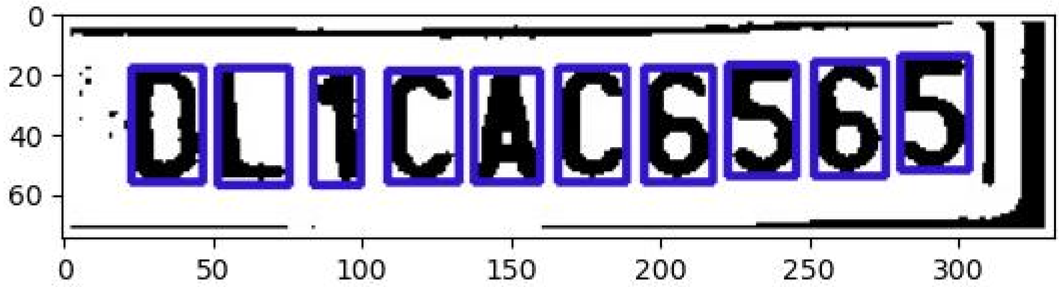
Third:-

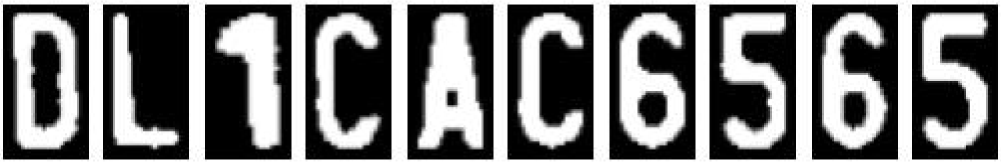

Input image :
0
50
100
150
200
250
300
350
0
50
100
150
200
250
300
350
400
IND
DL1CAC6565

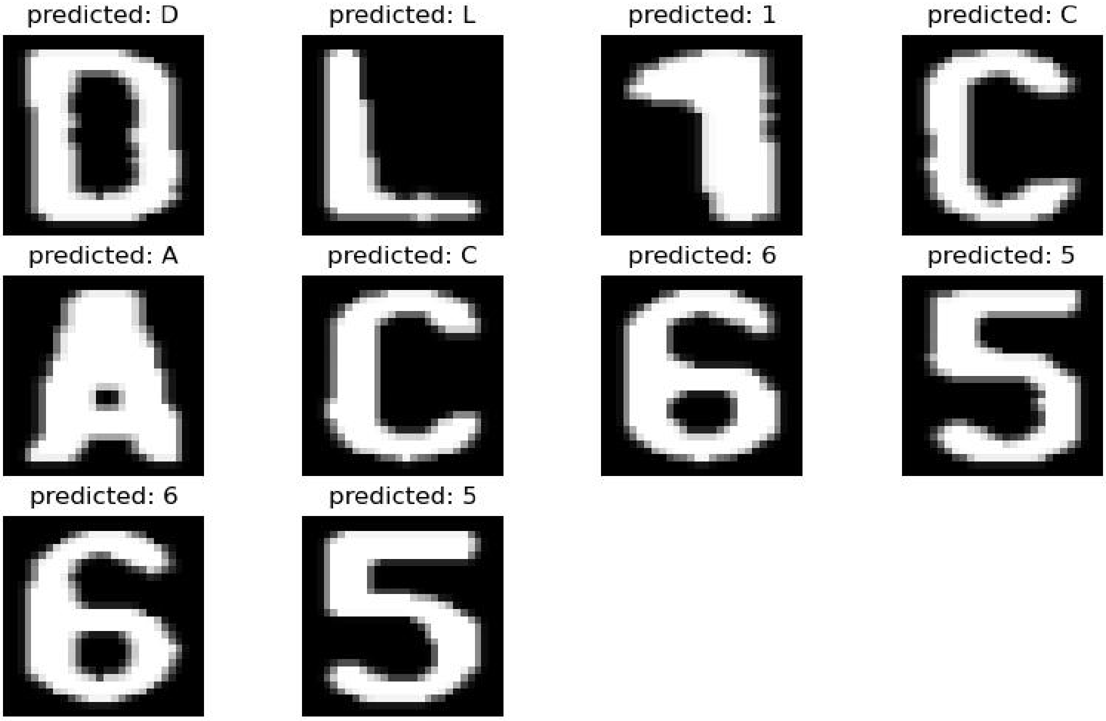

Detected license plate in the input image :
DL1CAC6565
0
50
100
150
200
250
300
350
400


Extracted license plate from the image :
DL1CAC6565
0
10
20
30
40
60
80
100
120

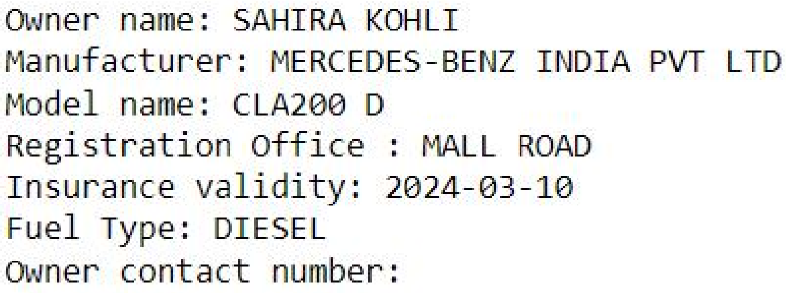

DL1CAC6565
0
20
40
60
50
100
150
200
250
300





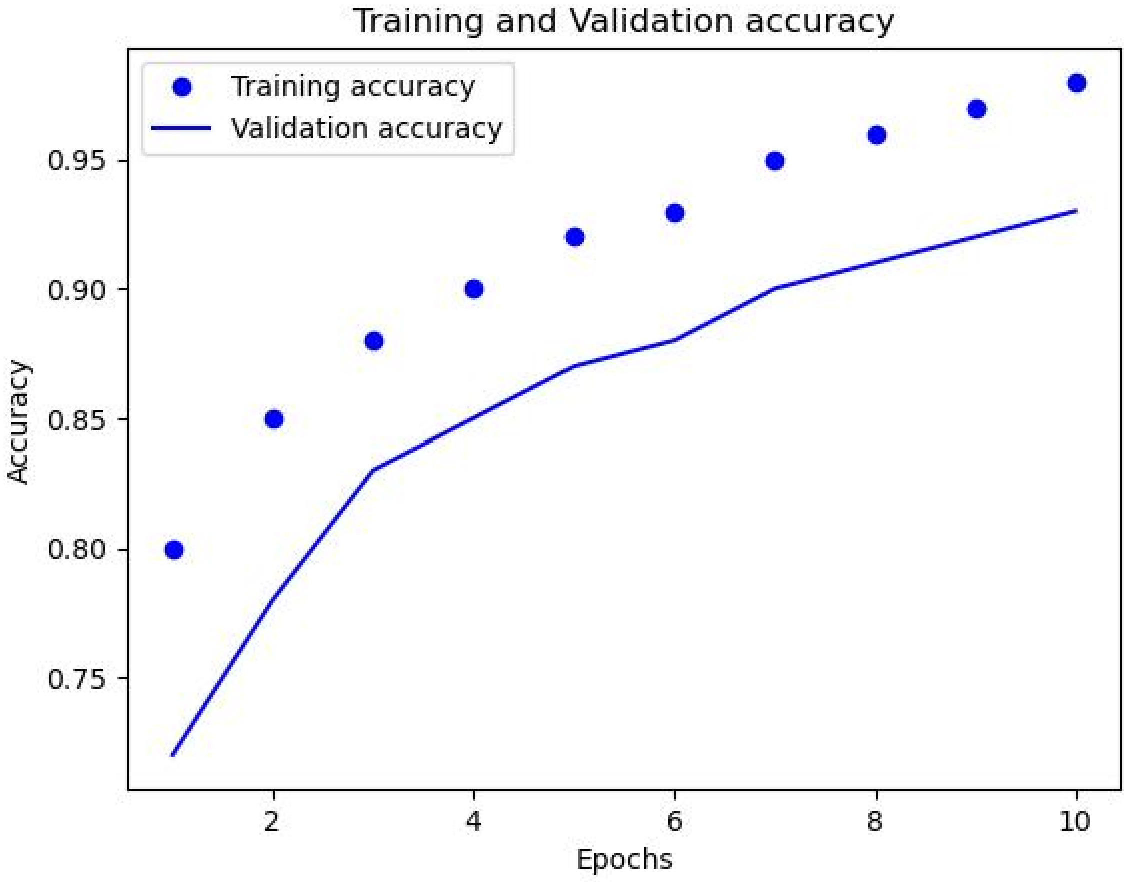


<u>Owner Detail’s :</u>

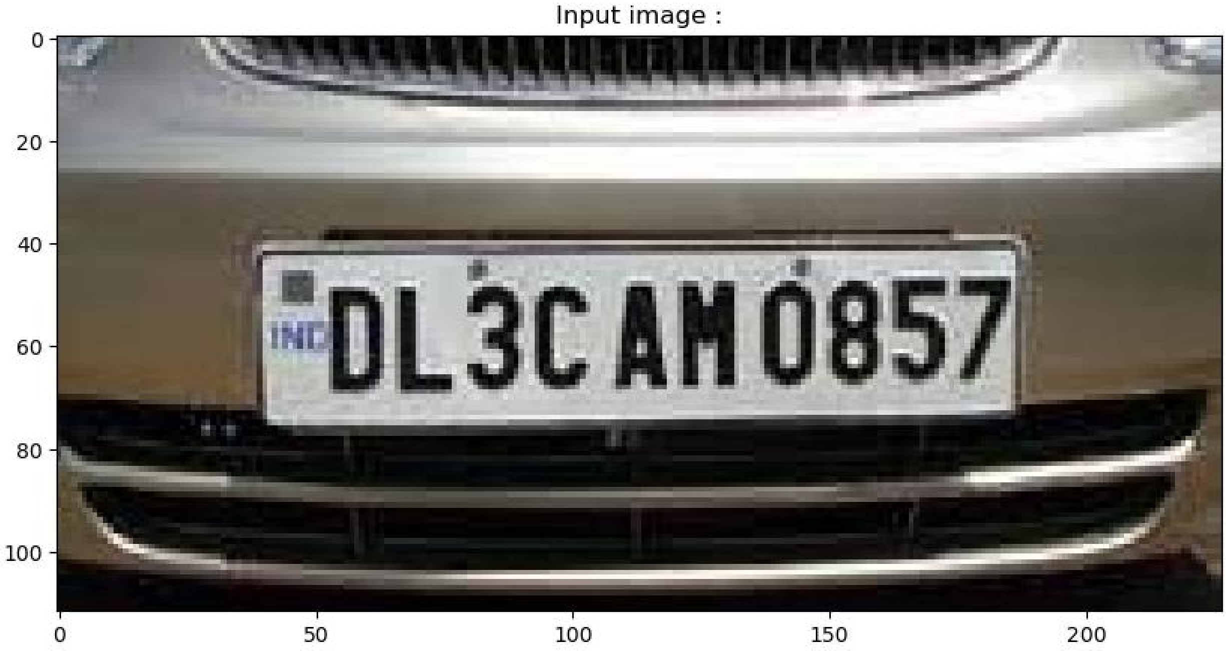


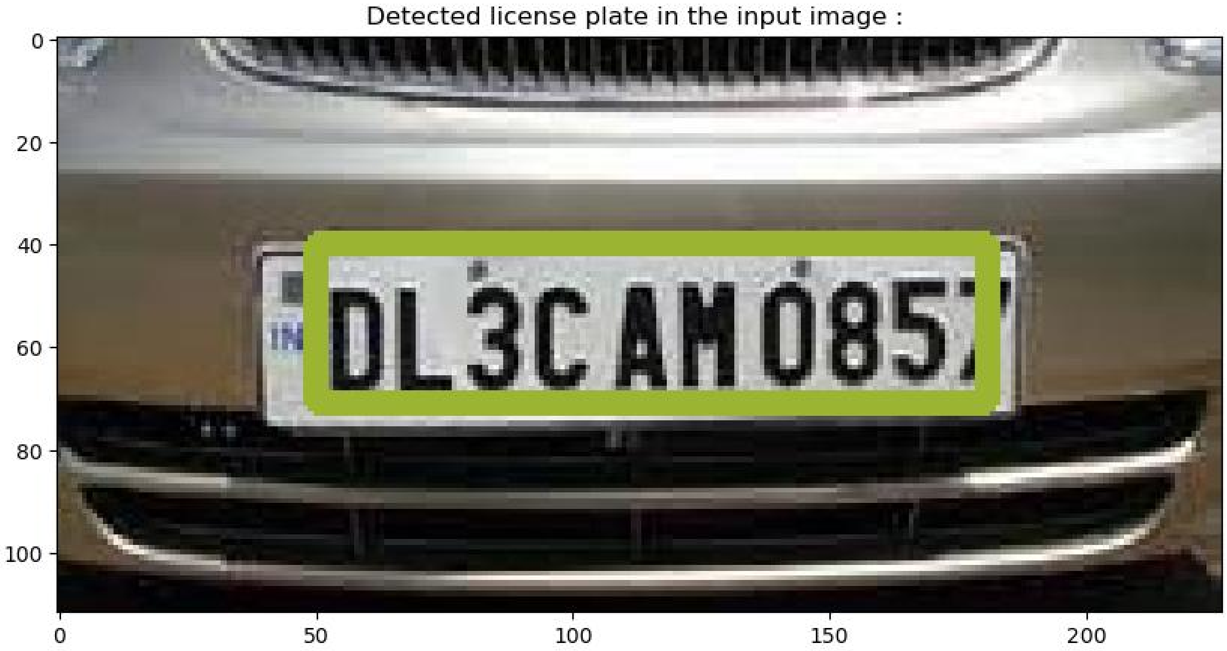
```
Owner name: SAHIRA KOHLI
Manufacturer: MERCEDES-BENZ INDIA PVT LTD
Model name: CLA200 D
Registration Office : MALL ROAD
Insurance validity: 2024-03-10
Fuel Type: DIESEL
Owner contact number:
```

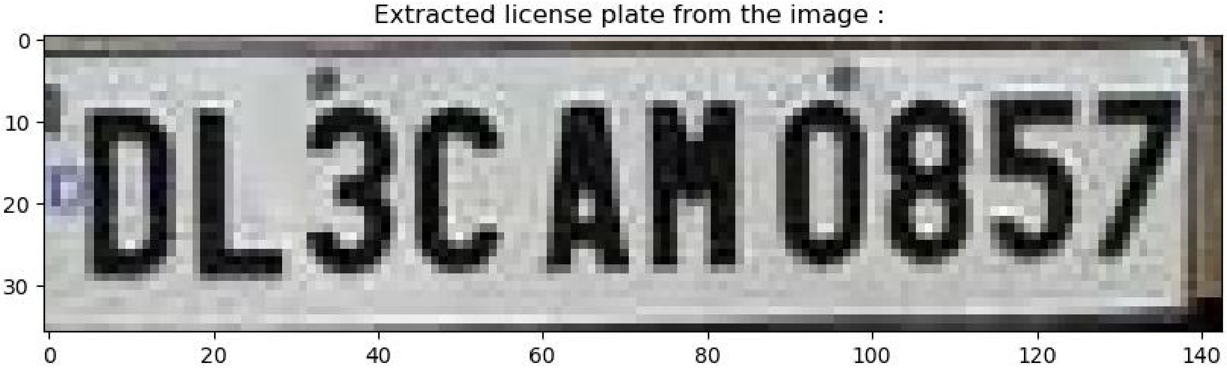
Accuracy Graph

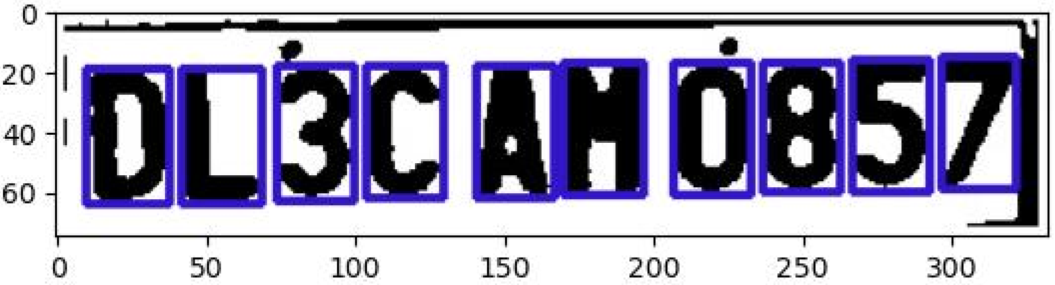


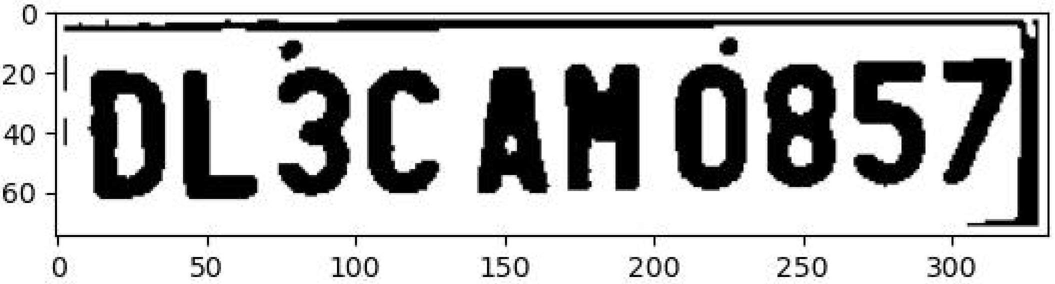
4Th:-

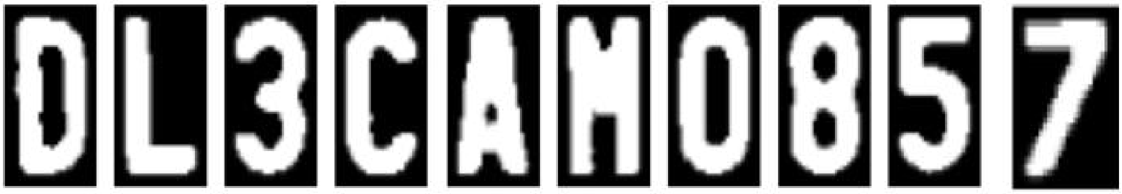


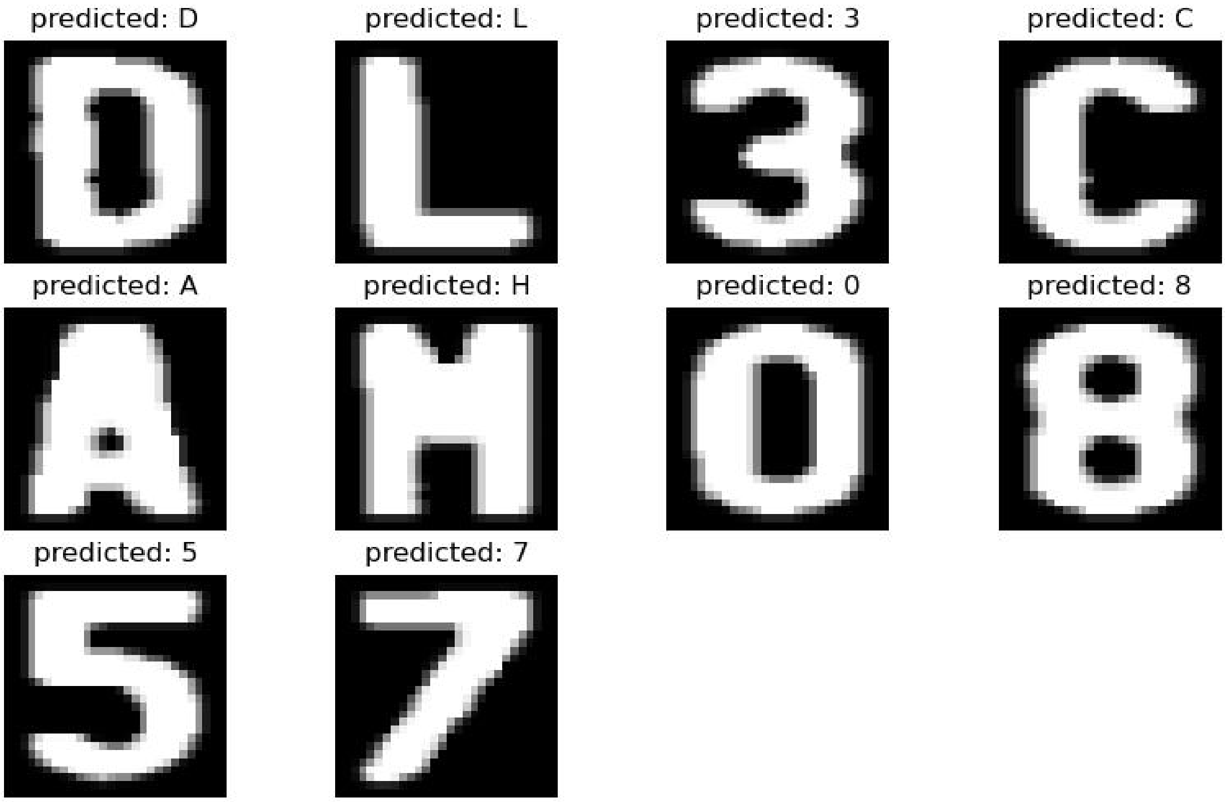

Detected license plate in the input image :
DL3CAM085
0
20
40
60
80
100
0
50
100
150
200


Extracted license plate from the image :
DL3CAM0857
0
10
20
30
0
20
40
60
80
100
120
140

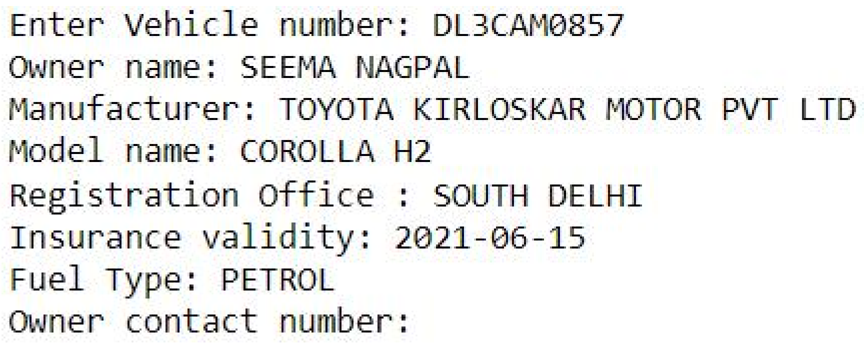






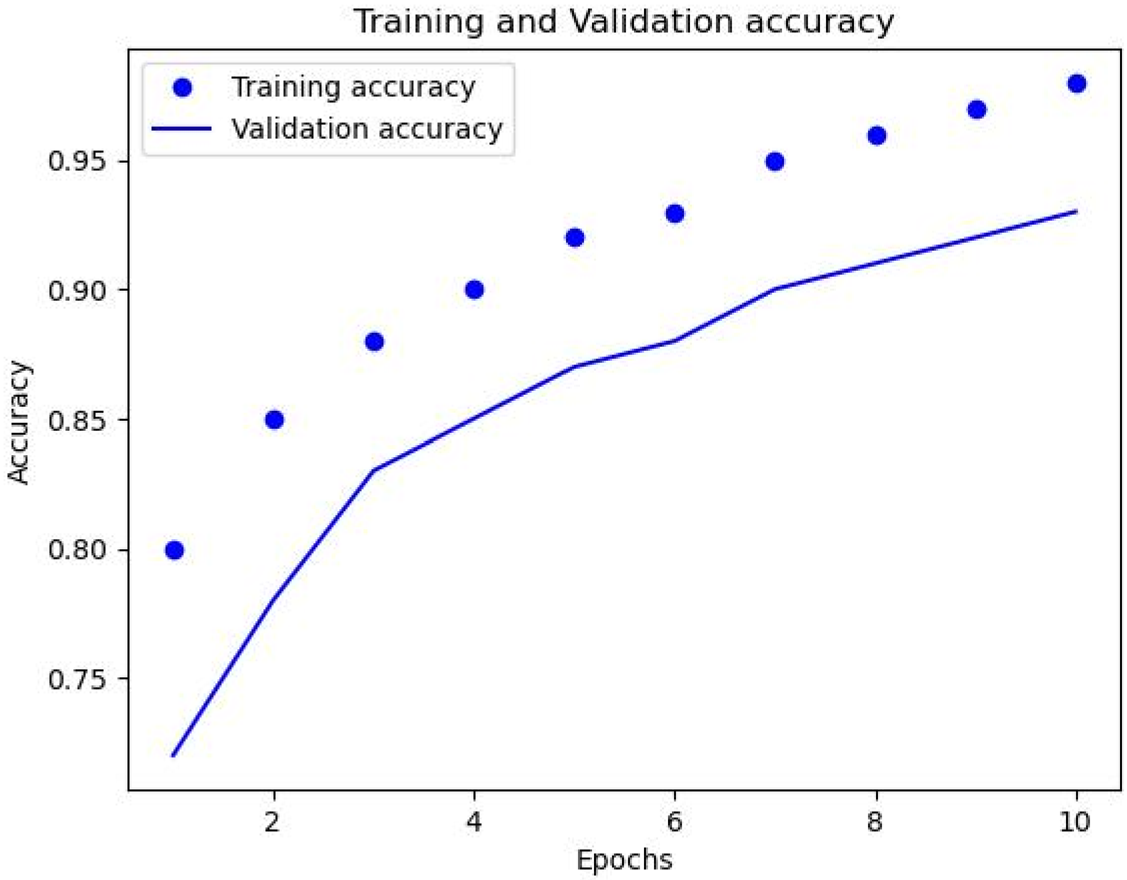


Owner details':-

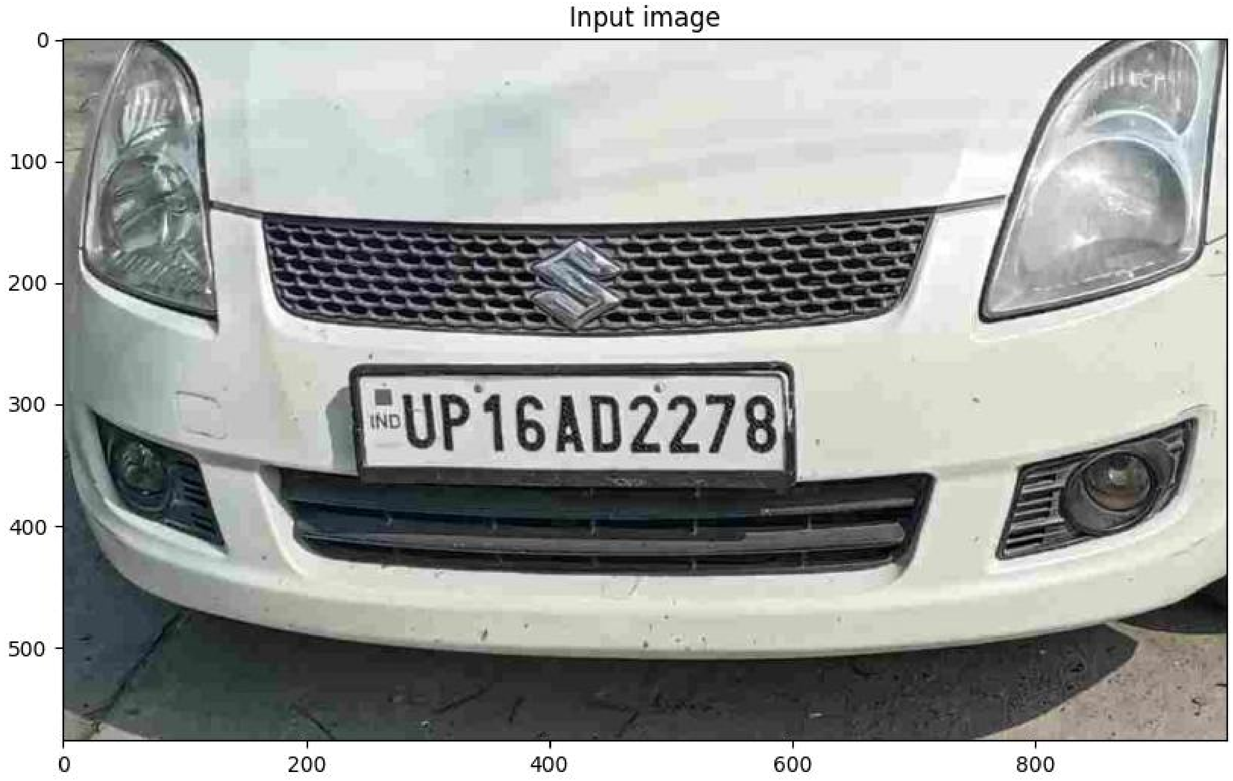


```
Enter Vehicle number: DL3CAM0857
Owner name: SEEMA NAGPAL
Manufacturer: TOYOTA KIRLOSKAR MOTOR PVT LTD
Model name: COROLLA H2
Registration Office : SOUTH DELHI
Insurance validity: 2021-06-15
Fuel Type: PETROL
Owner contact number:
```

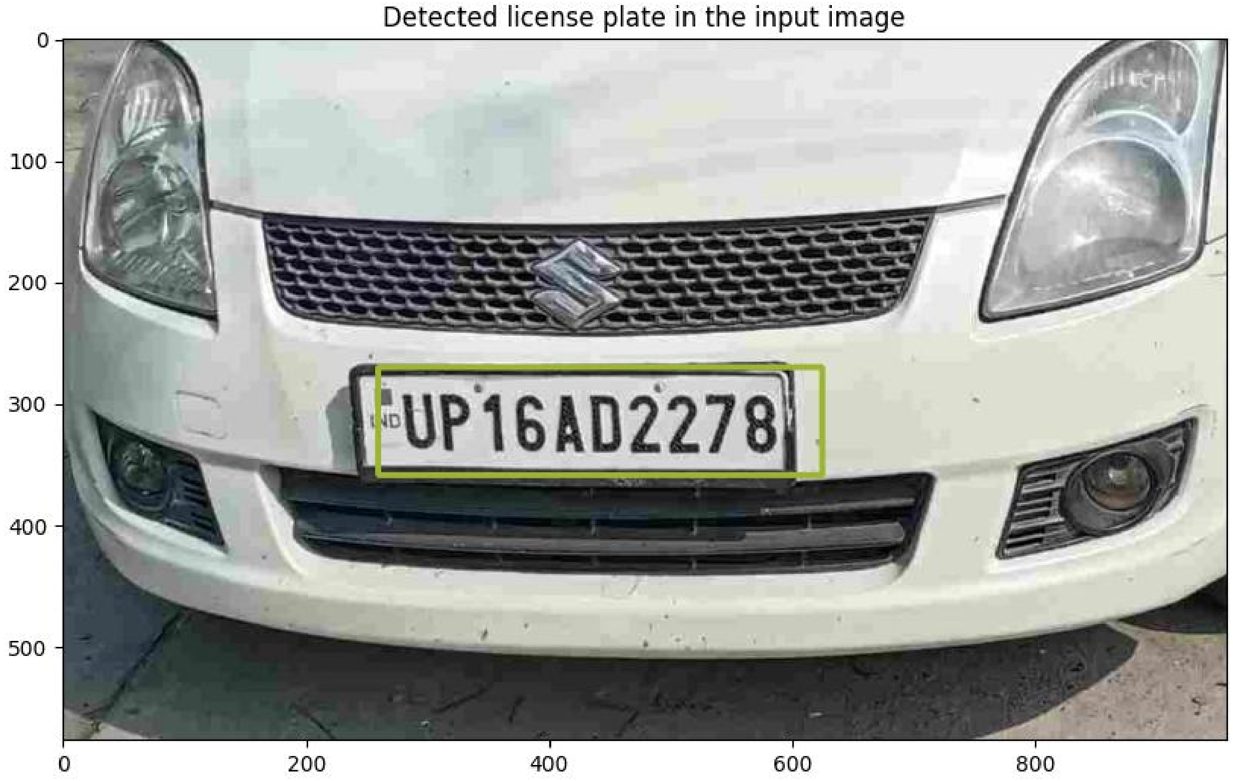
Accuracy Graph



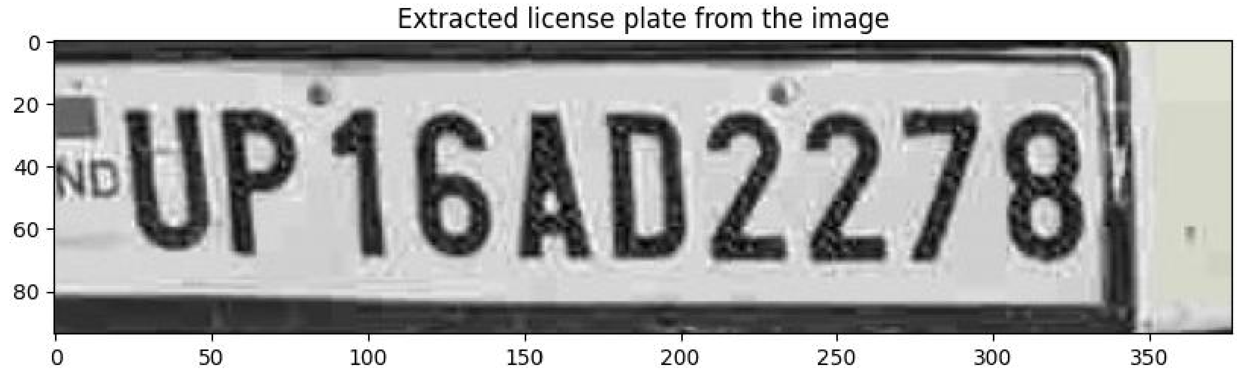
5th:-

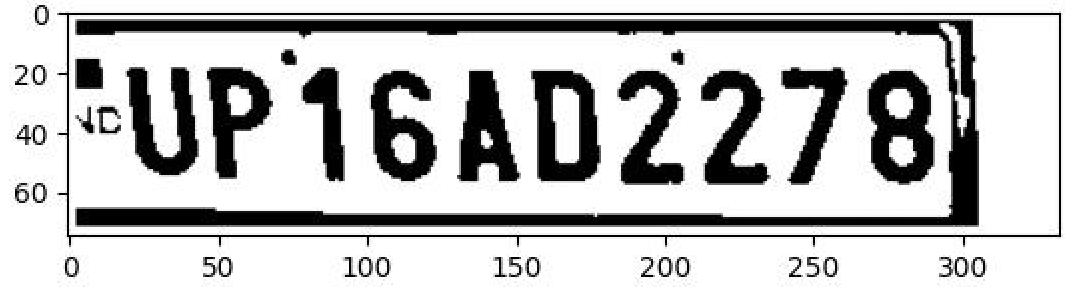


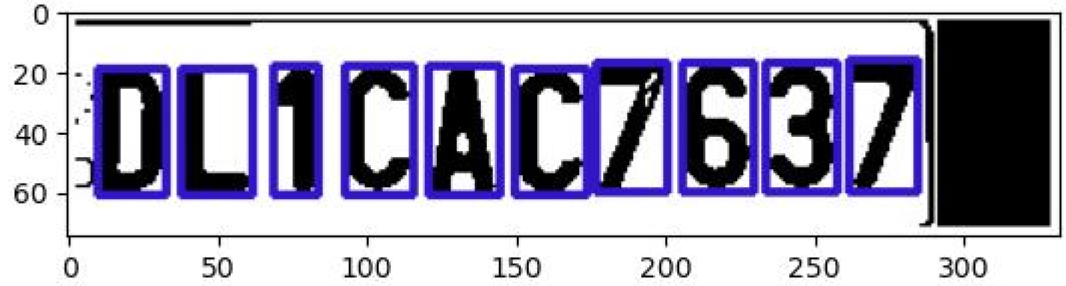
Input image



Detected license plate in the input image


Extracted license plate from the image
UP16AD2278
0
20
40
60
80
0
50
100
150
200
250
300
350


UP16AD2278
0
20
40
60
0
50
100
150
200
250
300


DL1CAC7637
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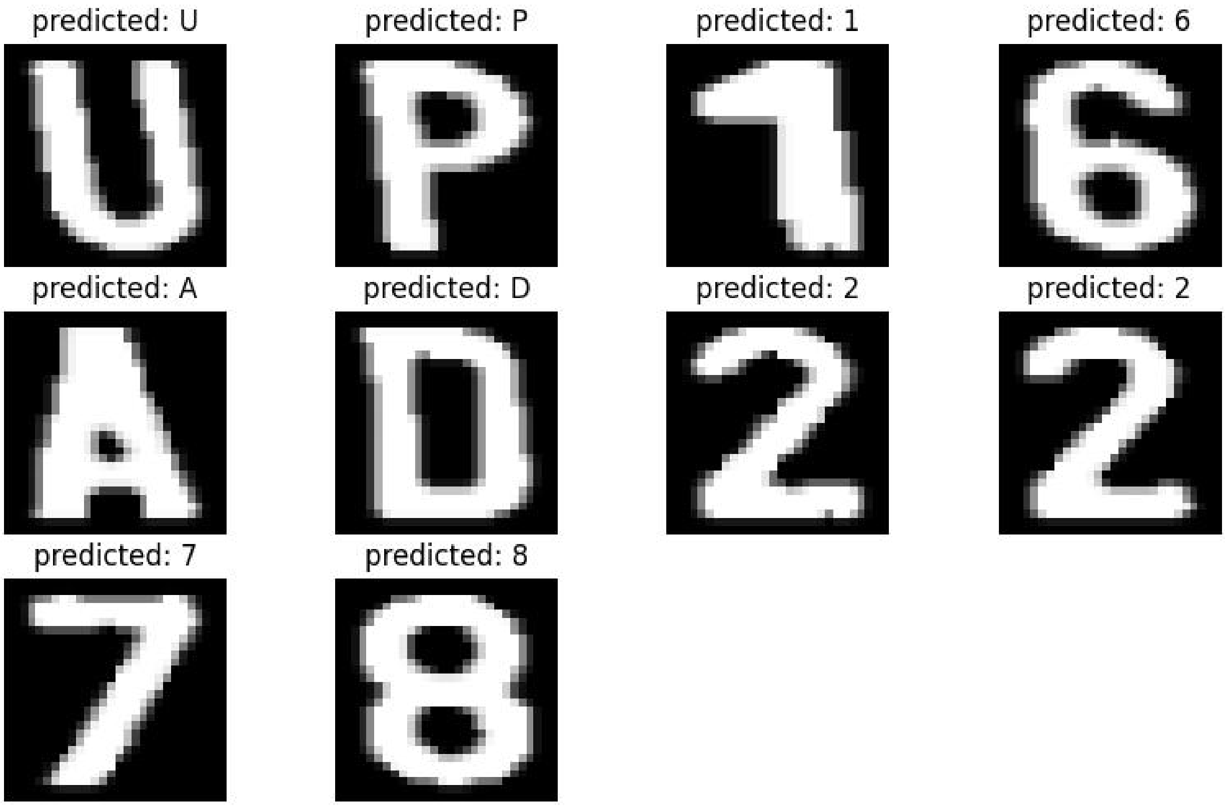
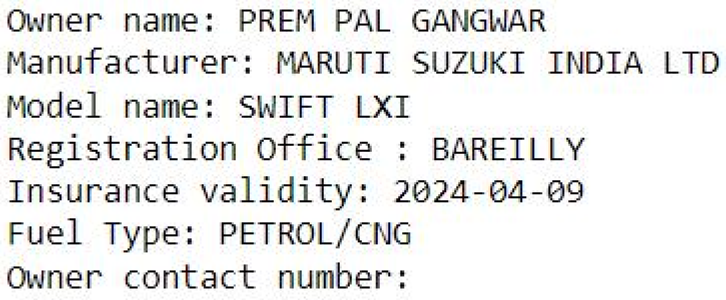
20
40
60
0
50
100
150
200
250
300

U P 1 6 A D 2 2 7

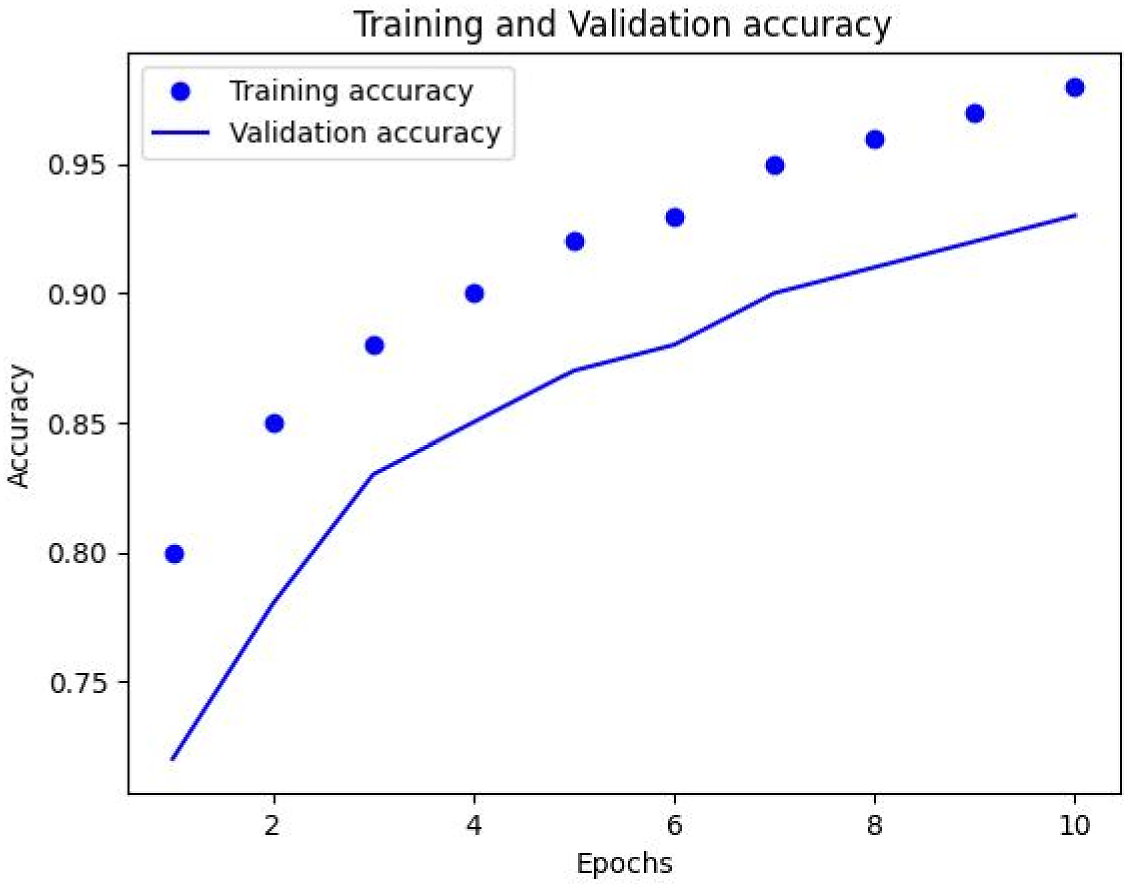


Owner Detail's:-

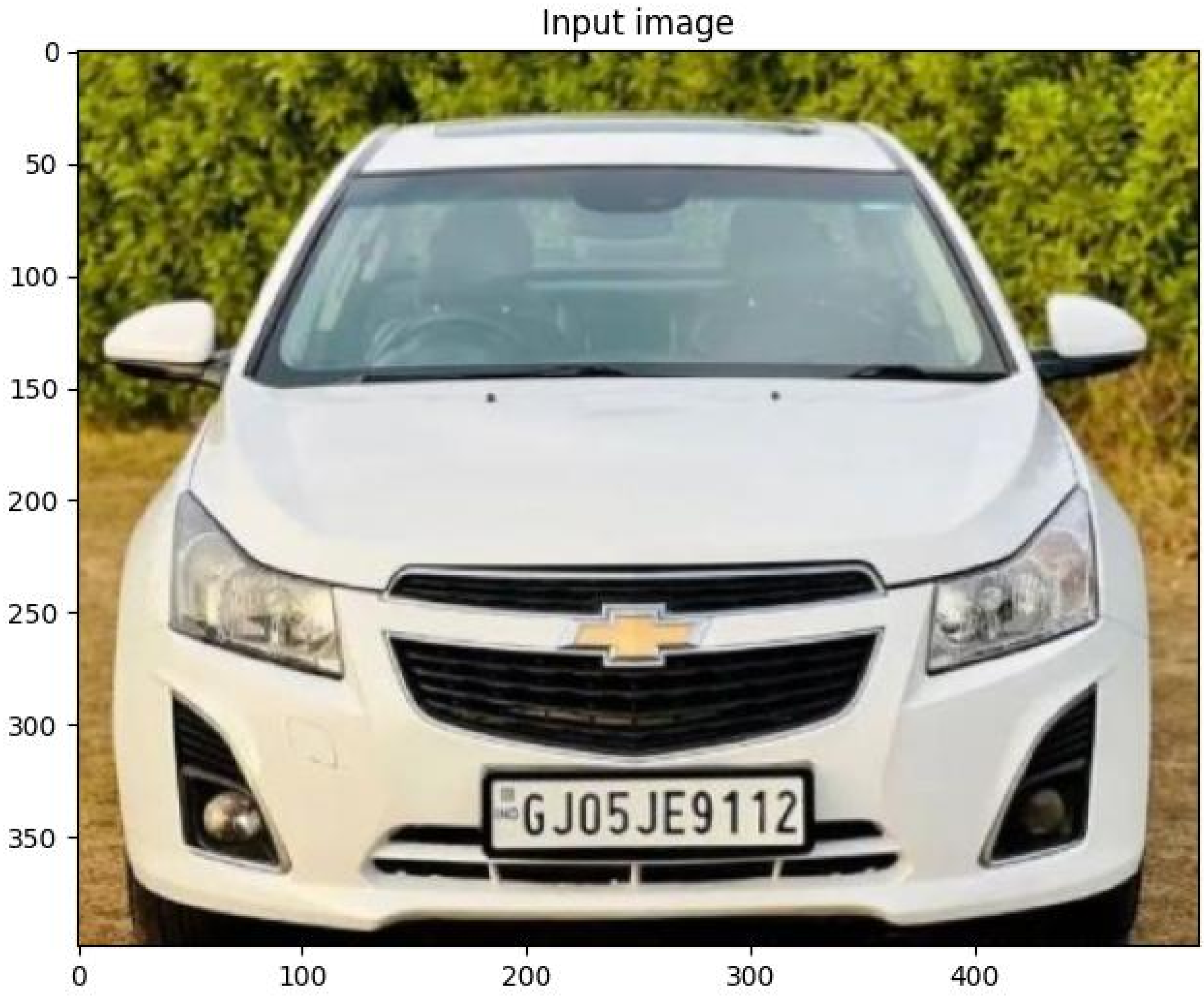


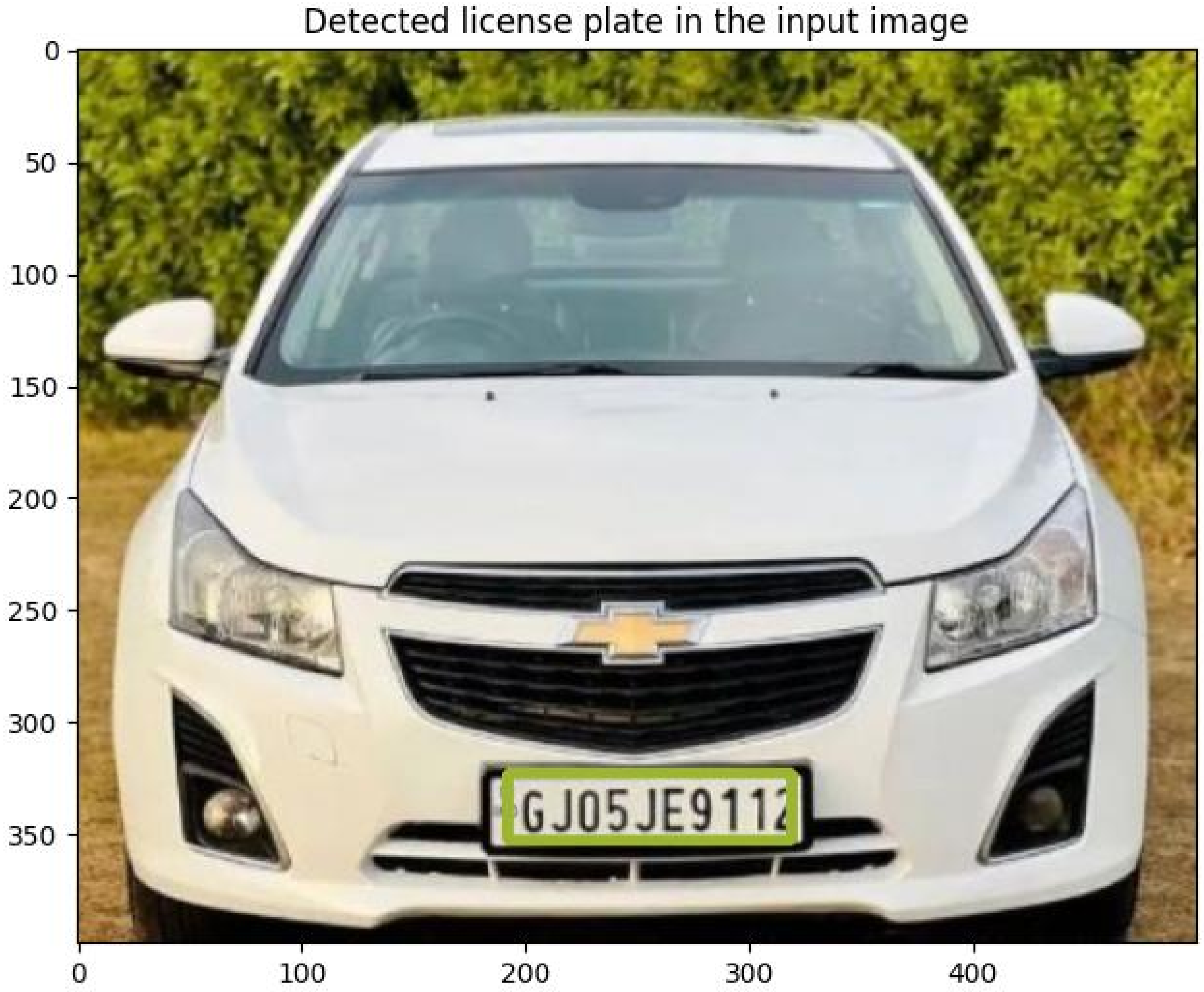
```
Owner name: PREM PAL GANGWAR
Manufacturer: MARUTI SUZUKI INDIA LTD
Model name: SWIFT LXI
Registration Office : BAREILLY
Insurance validity: 2024-04-09
Fuel Type: PETROL/CNG
Owner contact number:
```

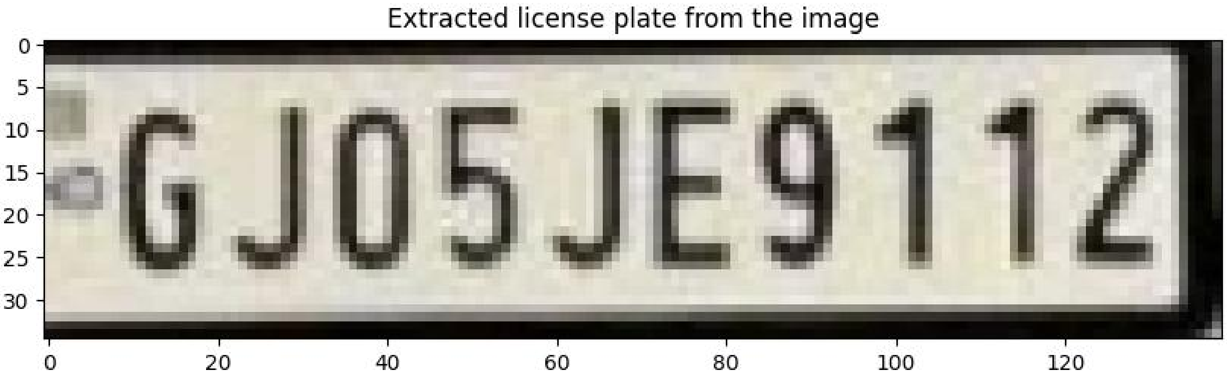
Accuracy Graph

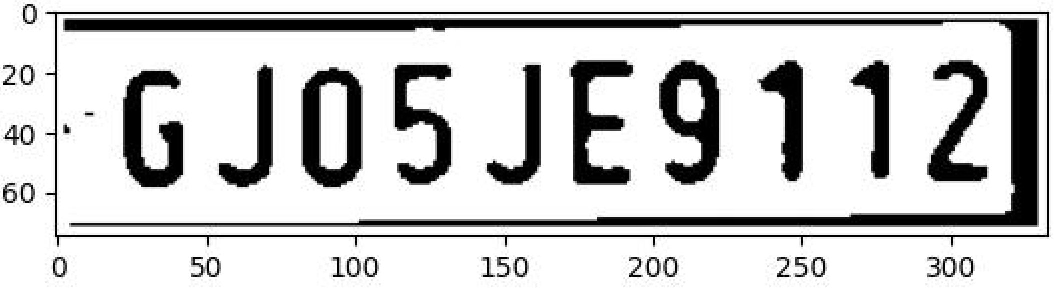


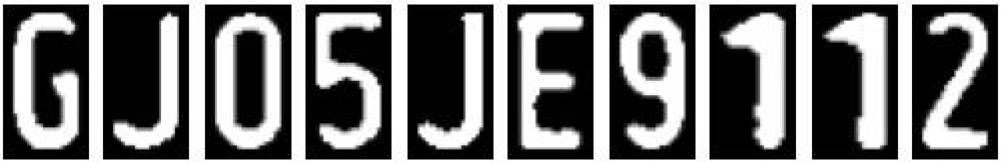
6th:-

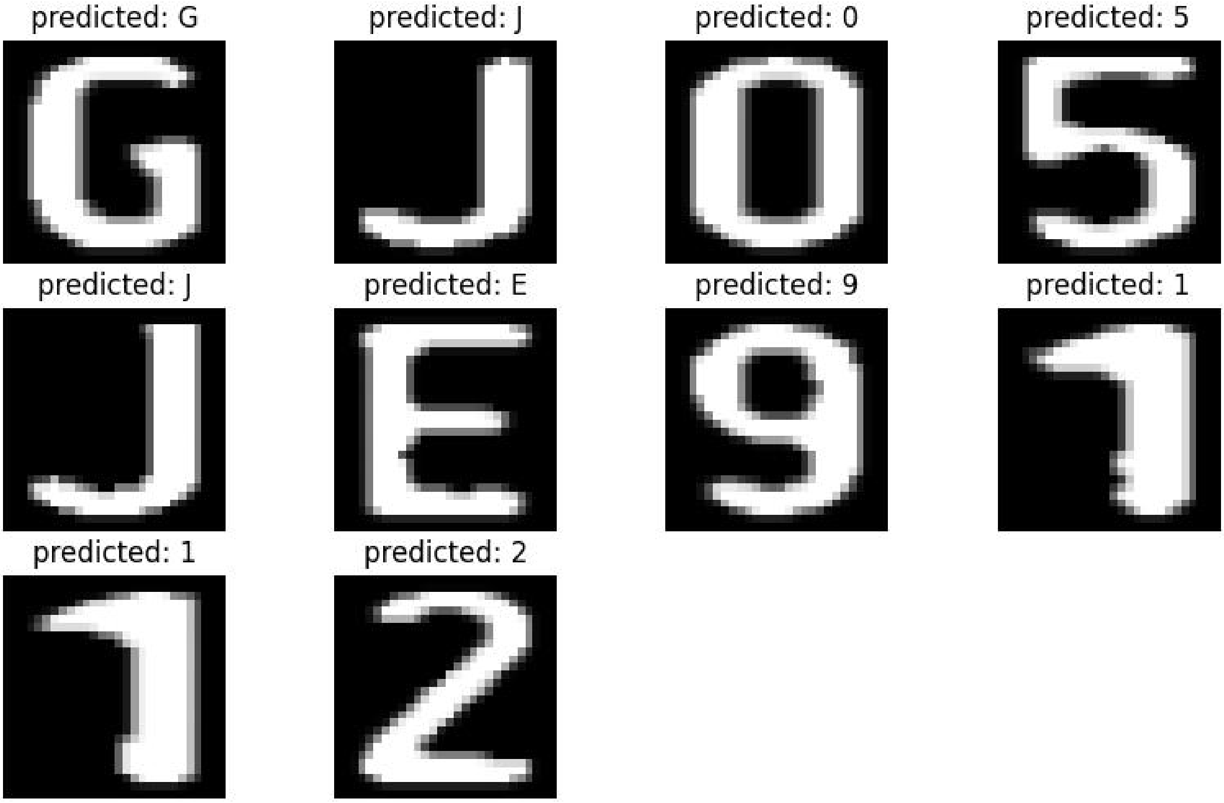

Input image
0
50
100
150
200
250
300
350
0
100
200
300
400
GJ05JE9112


Detected license plate in the input image
0
50
100
150
200
250
300
350
0
100
200
300
400
GJ05JE9112

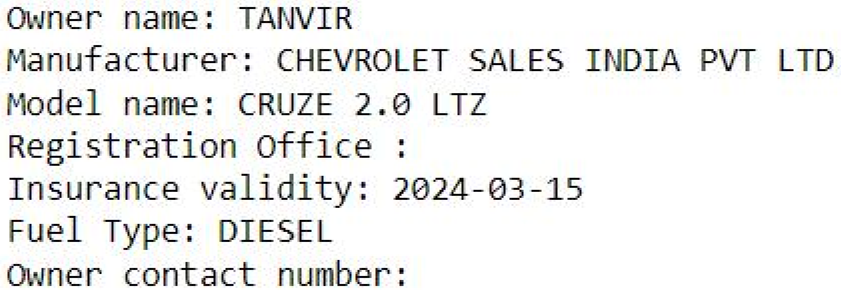

Extracted license plate from the image
0
5
10
15
20
25
30
0
20
40
60
80
100
120
GJ05JE9112


0
20
40
60
0
50
100
150
200
250
300
GJ05JE9112



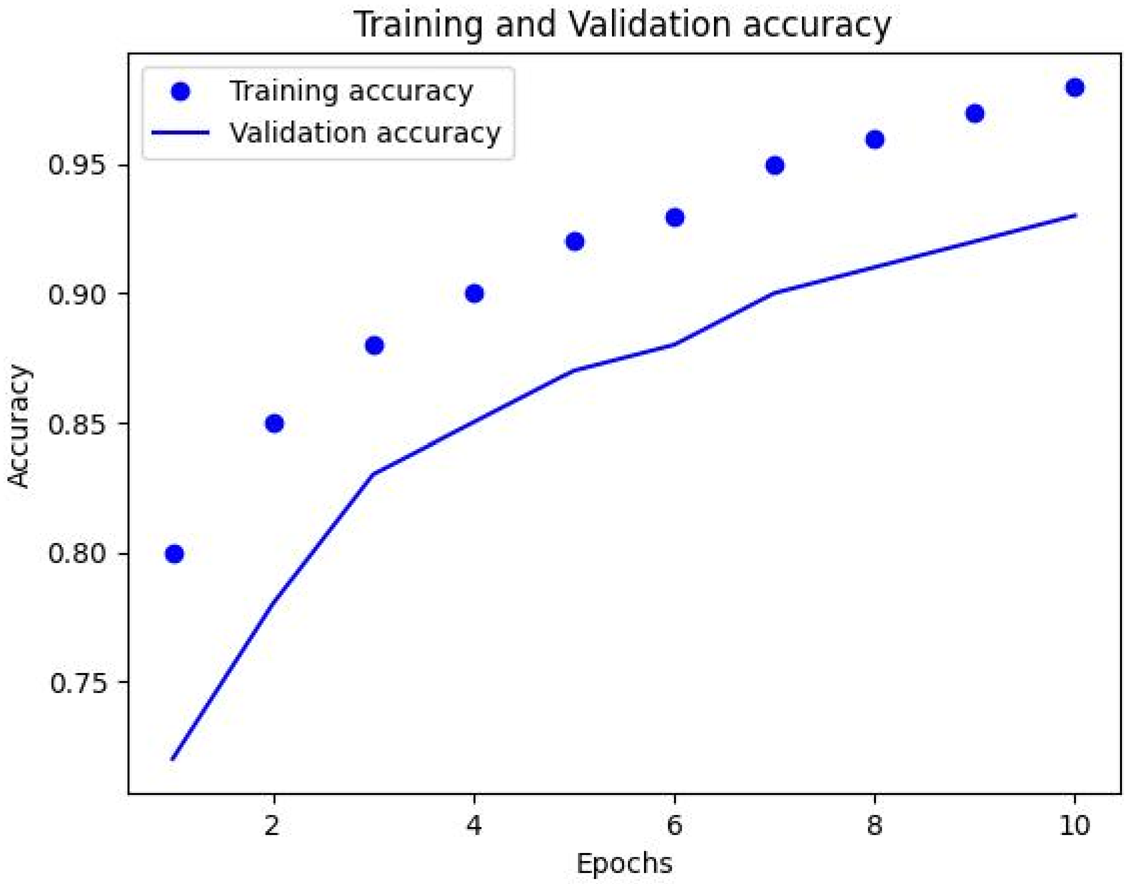


<u>Owner Detail's:-</u>

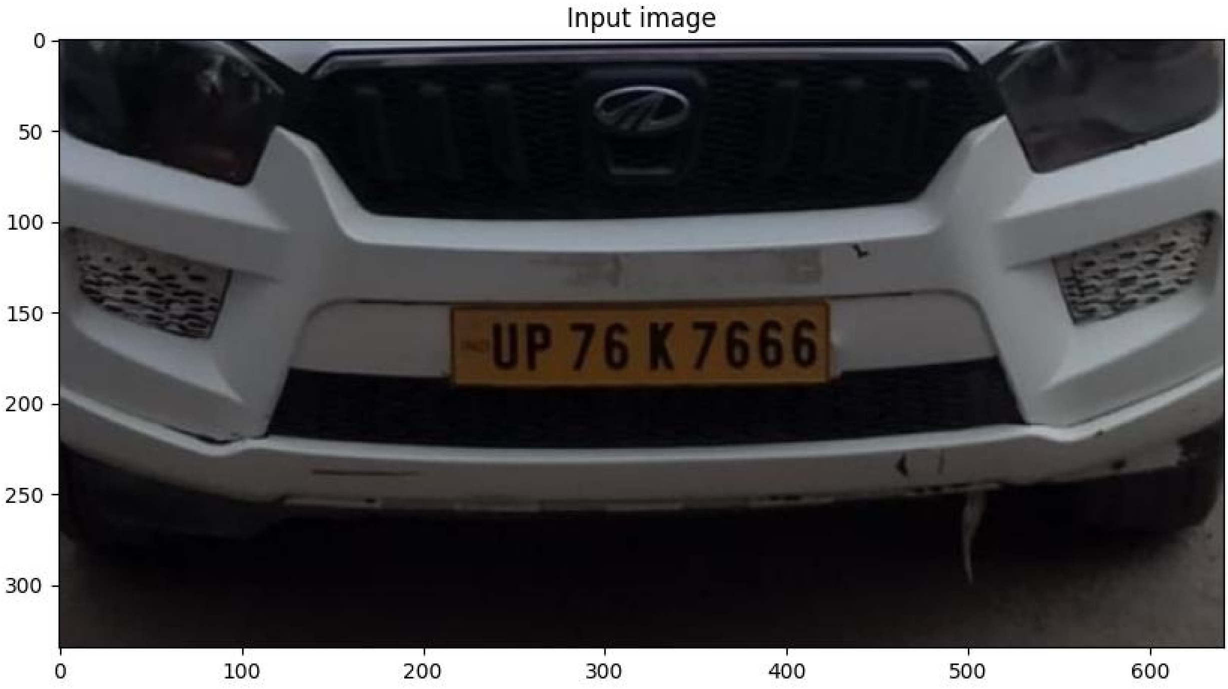


```
Owner name: TANVIR
Manufacturer: CHEVROLET SALES INDIA PVT LTD
Model name: CRUZE 2.0 LTZ
Registration Office :
Insurance validity: 2024-03-15
Fuel Type: DIESEL
Owner contact number:
```

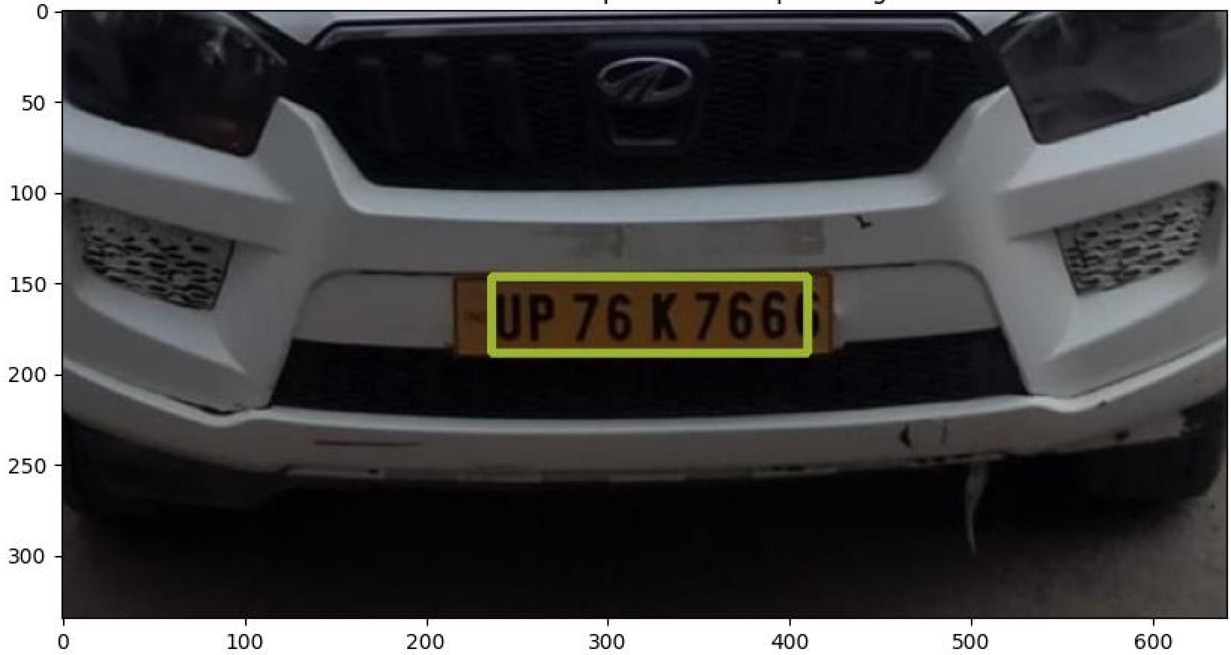
Accuracy Graph



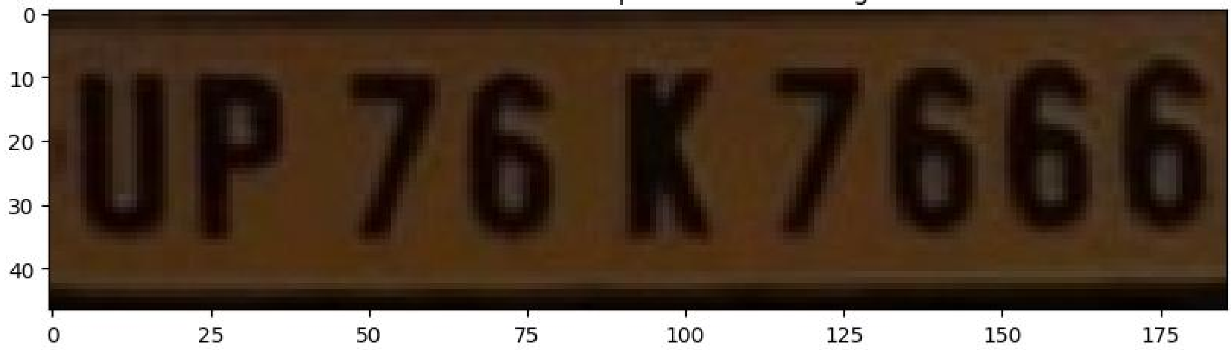
7th:-

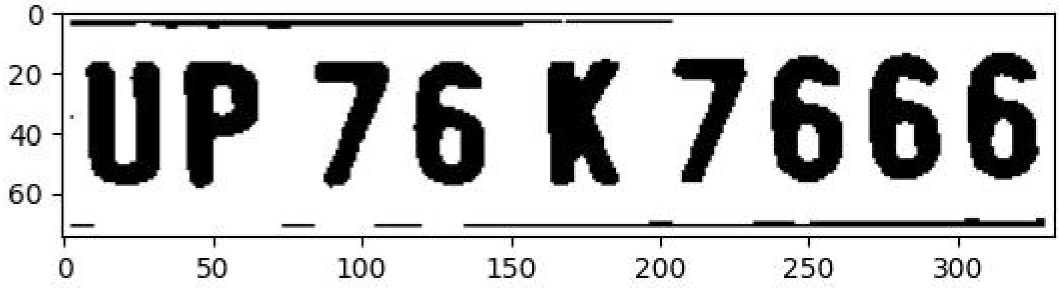


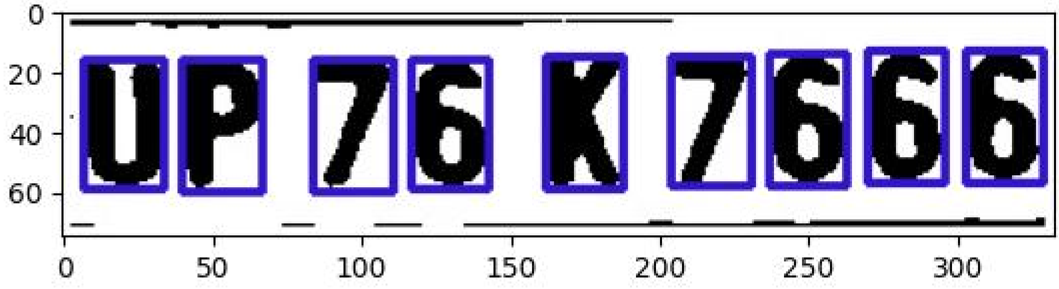
Detected license plate in the input image

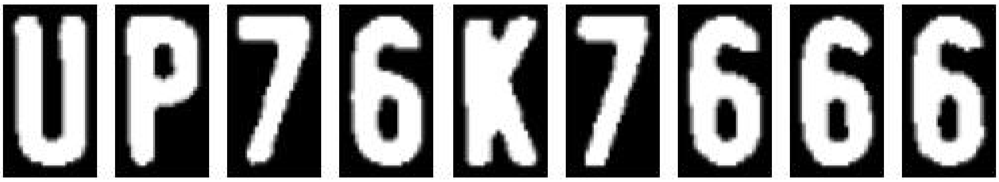


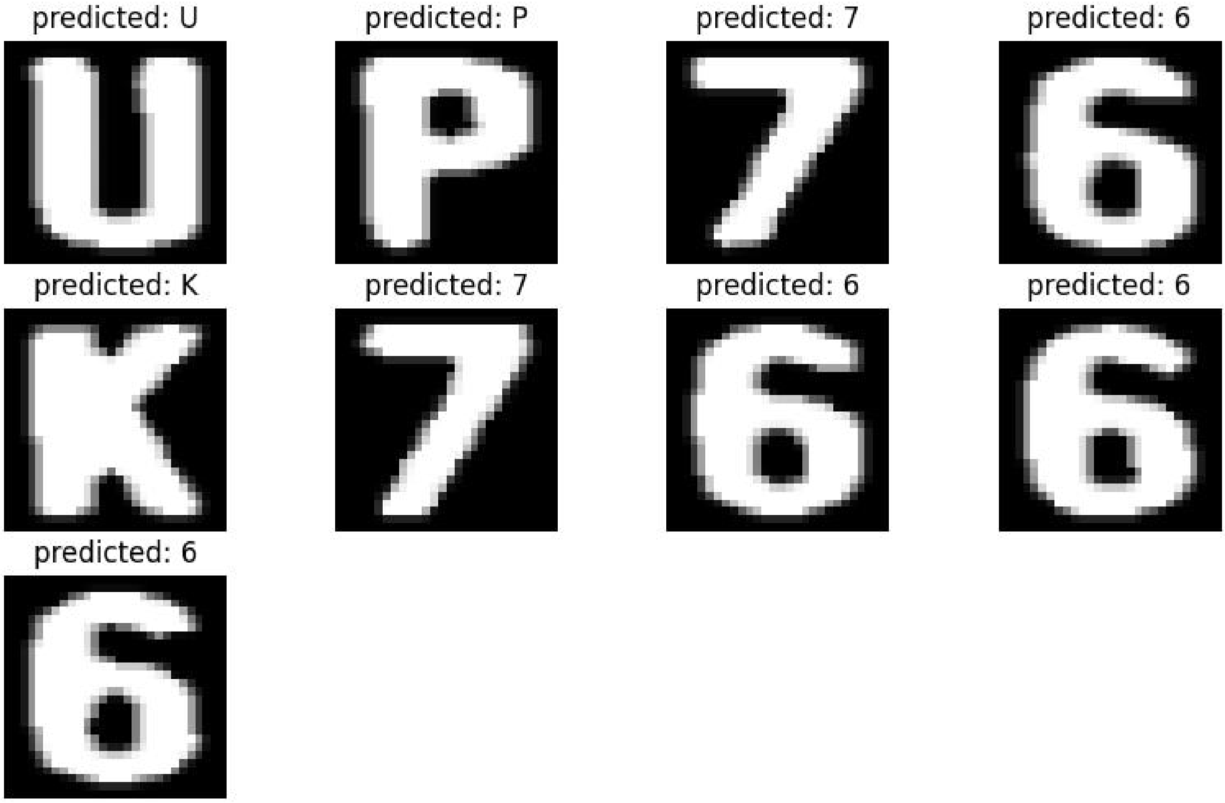
Extracted license plate from the image

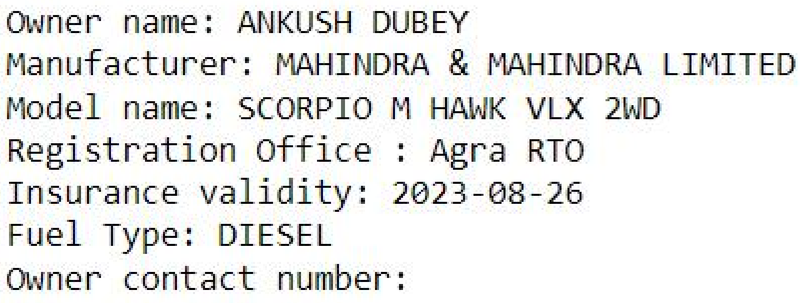






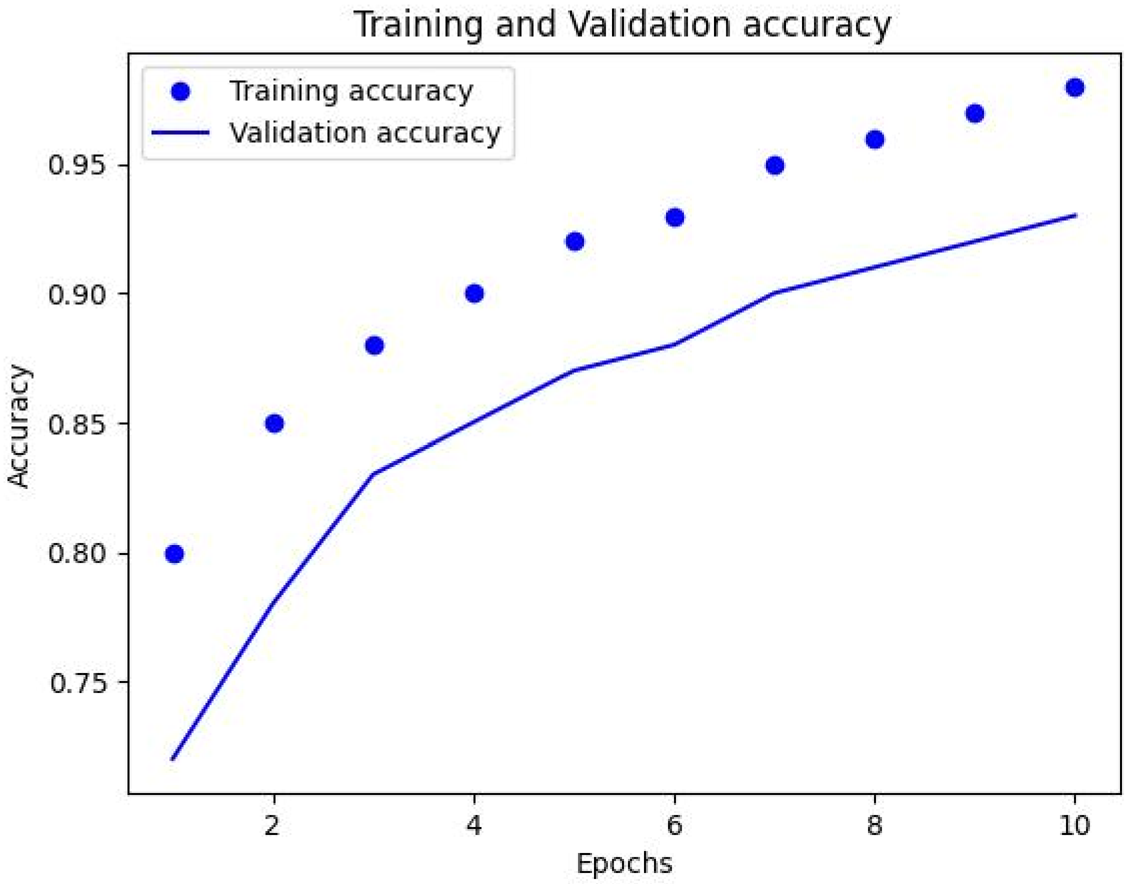




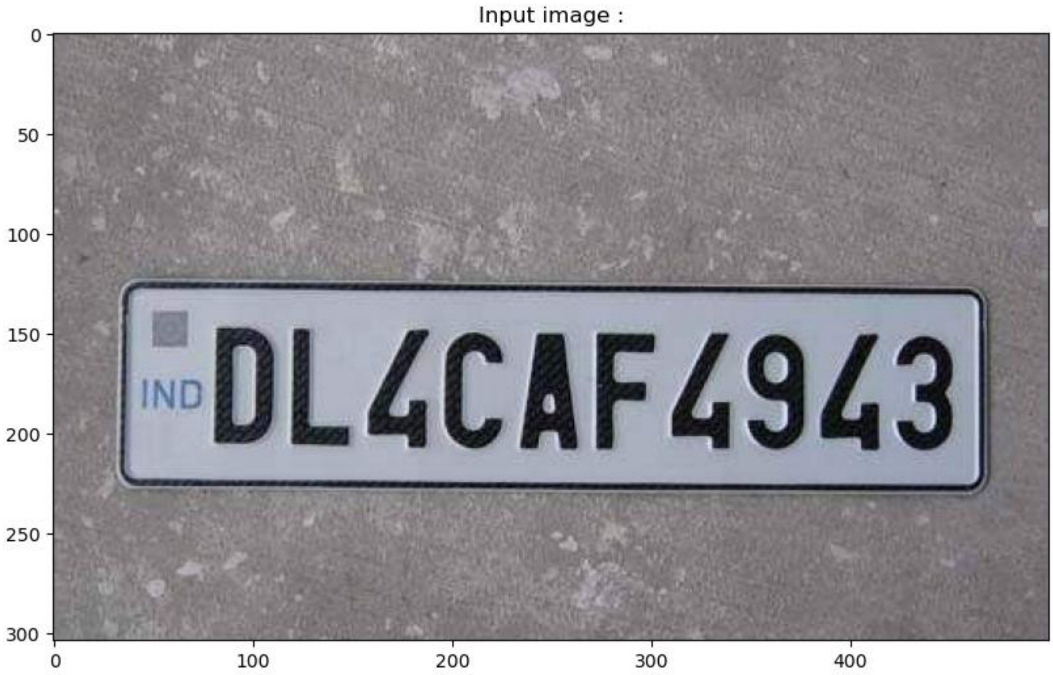


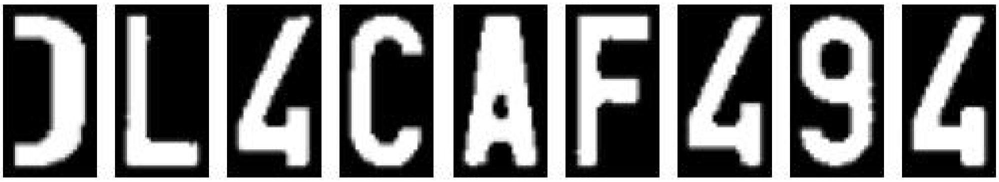
```
Owner name: ANKUSH DUBEY
Manufacturer: MAHINDRA & MAHINDRA LIMITED
Model name: SCORPIO M HAWK VLX 2WD
Registration Office : Agra RTO
Insurance validity: 2023-08-26
Fuel Type: DIESEL
Owner contact number:
```

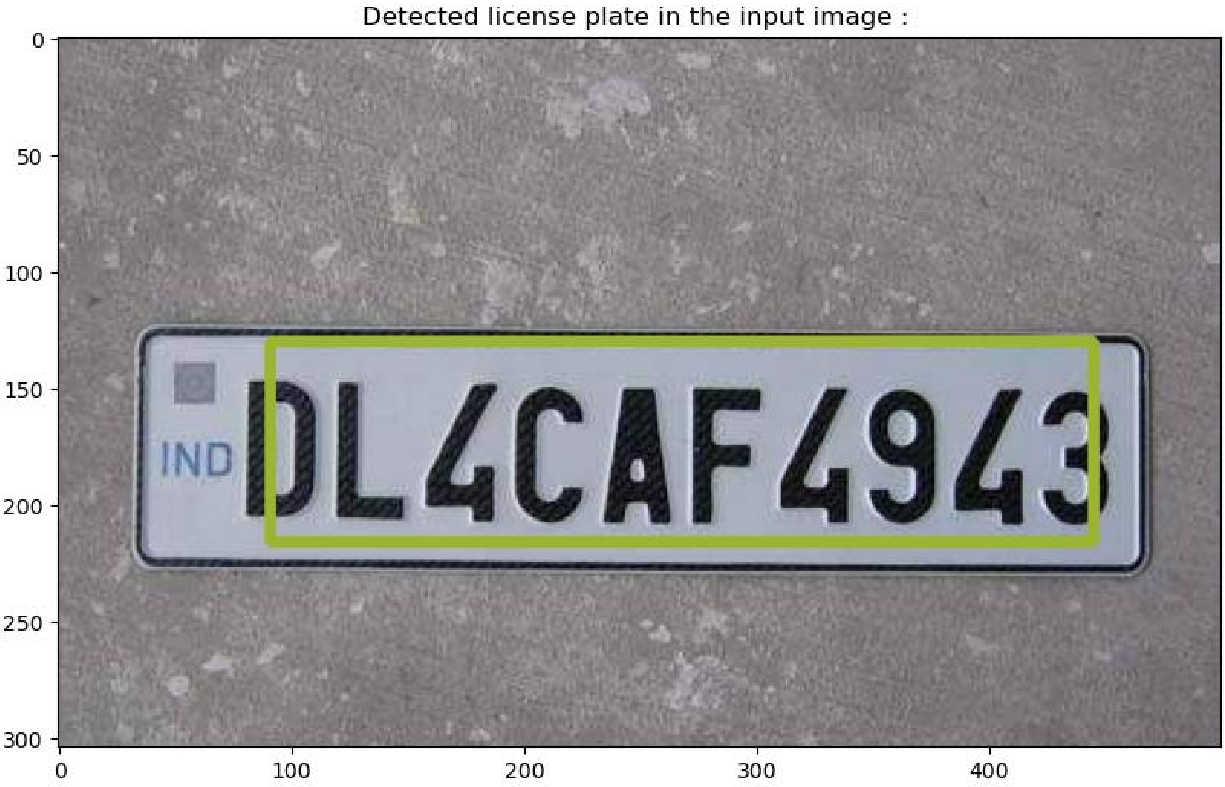
Accuracy Graph

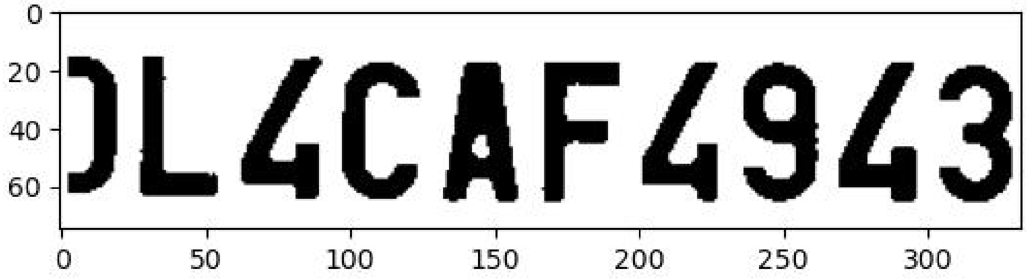


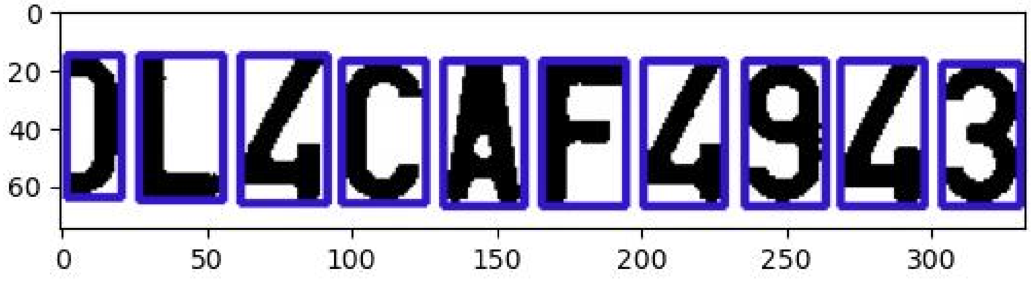
8th:-

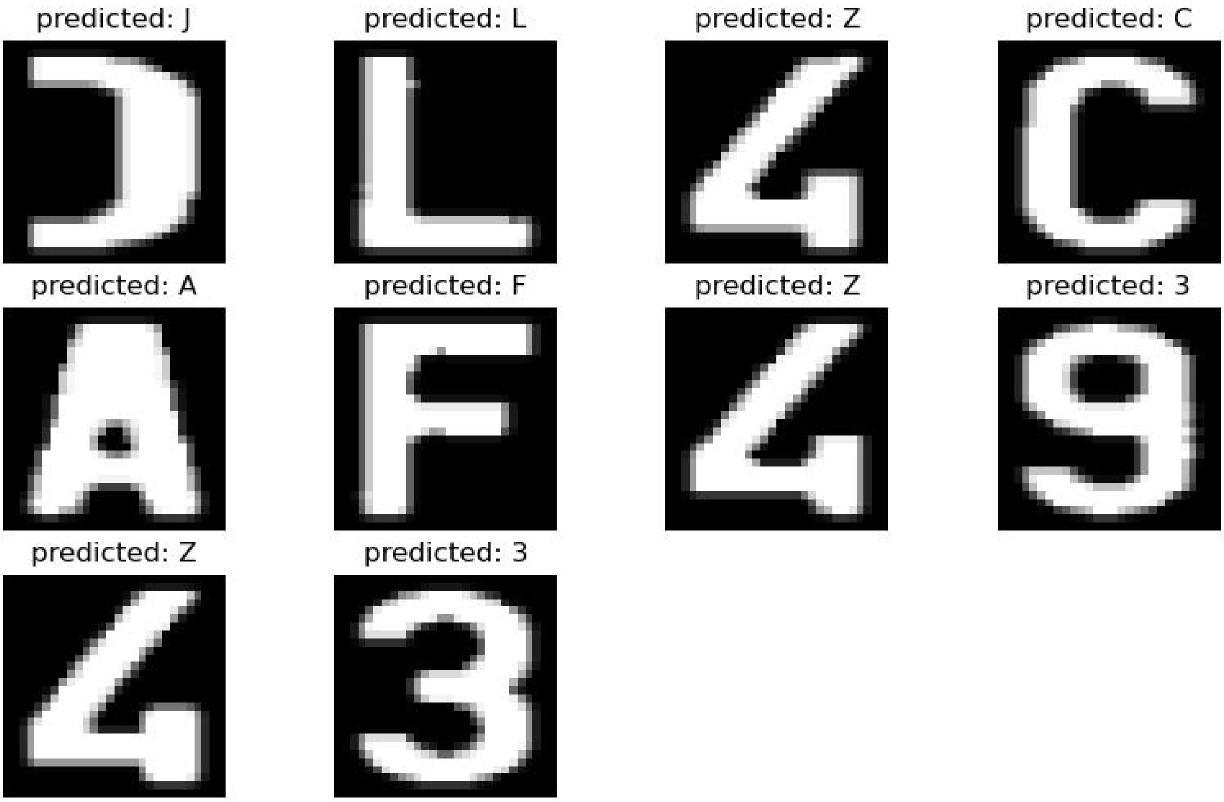



D
L
4
C
A
F
4
9
4


Detected license plate in the input image :
0
50
100
150
200
250
300
0
100
200
300
400
IND
DL4CAF4943


0
20
40
60
0
50
100
150
200
250
300
DL4CAF4943

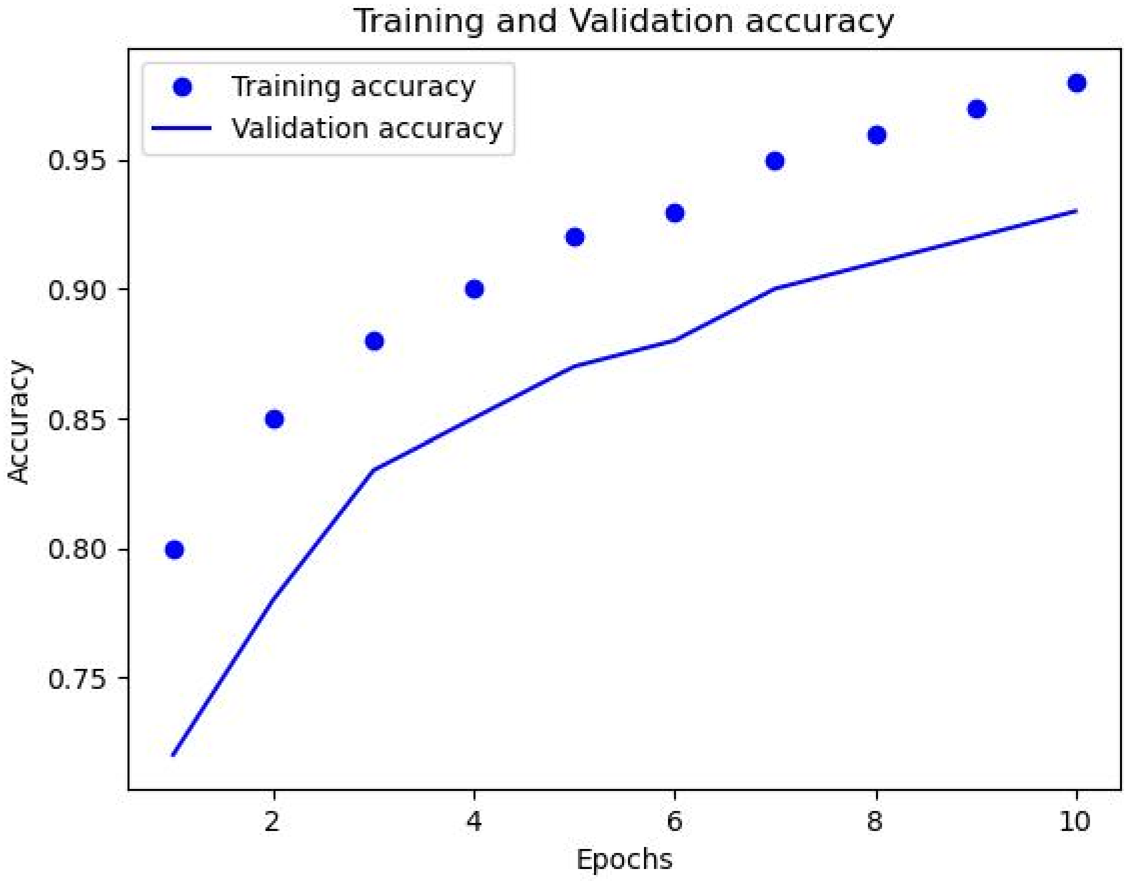

0
20
40
60
0
50
100
150
200
250
300
DL4CAF4943



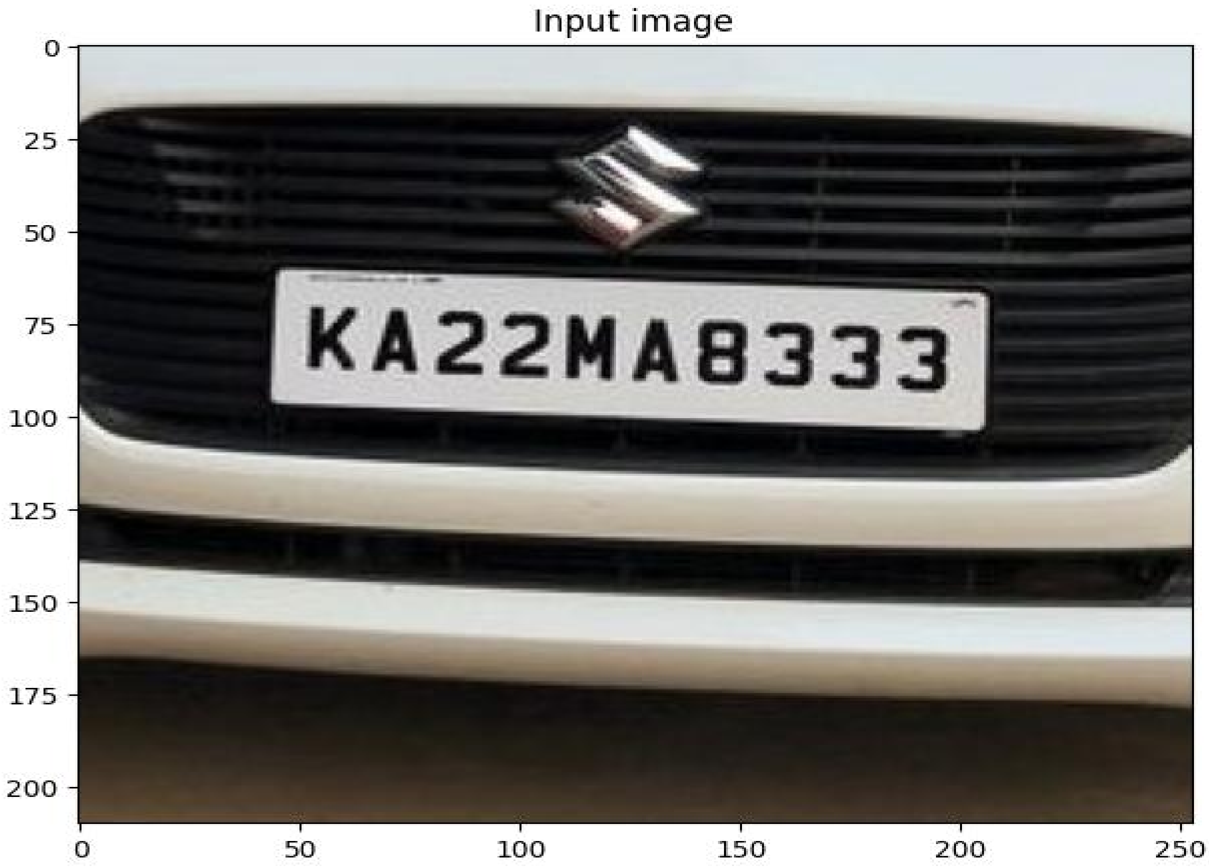
Owner Detail’s:

No value returned by call function depicting invalid format.

Accuracy Graph



9th:


Input image
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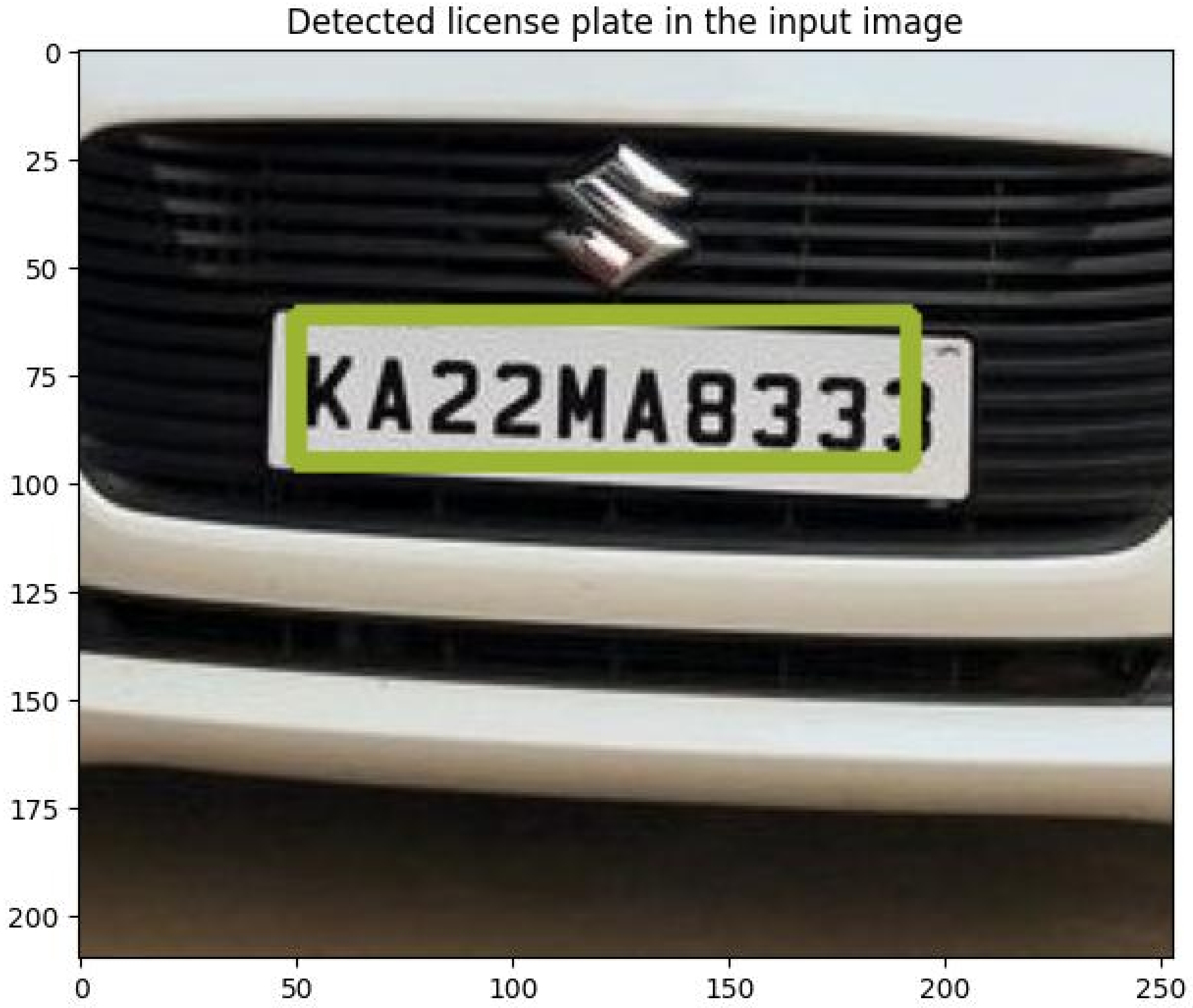
25
50
75
100
125
150
175
200
0
50
100
150
200
250
KA22MA8333


Detected license plate in the input image
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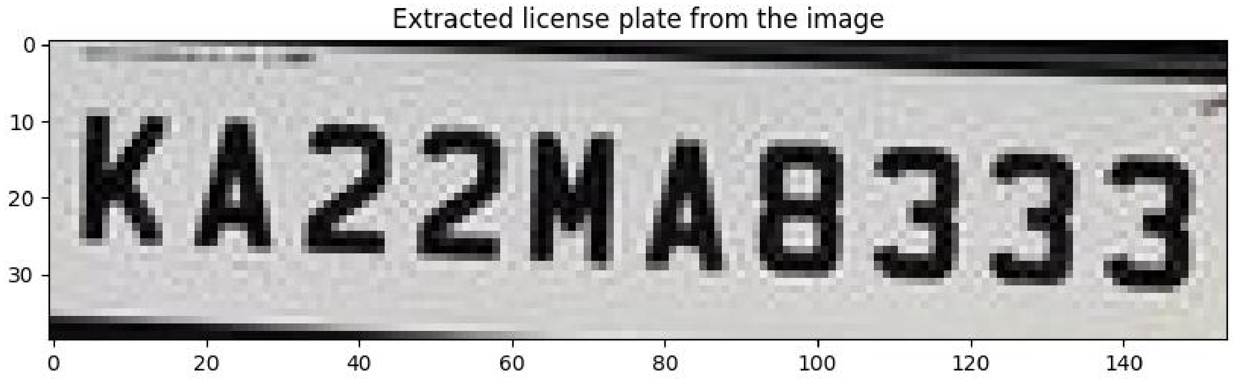
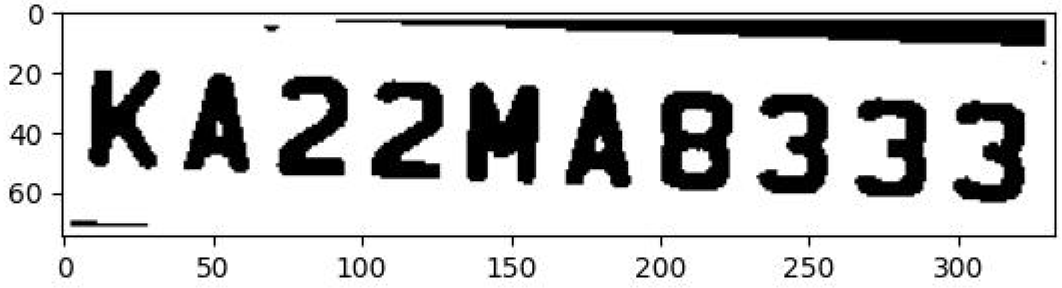
25
50
75
100
125
150
175
200
0
50
100
150
200
250
KA22MA8333


Extracted license plate from the image
0
10
20
30
0
20
40
60
80
100
120
140
KA22MA8333


0
20
40
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100
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250
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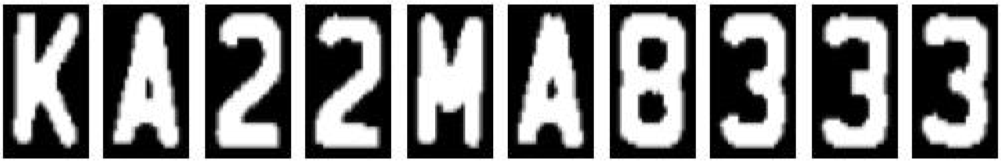
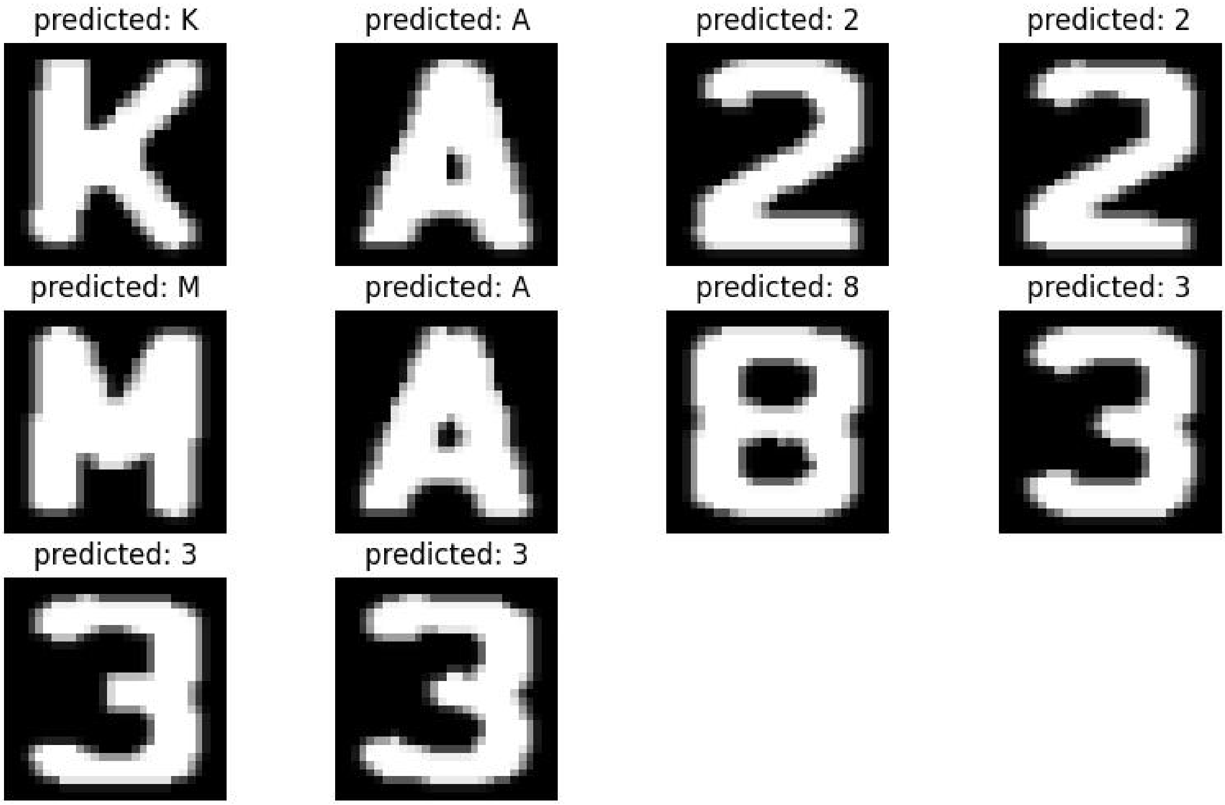
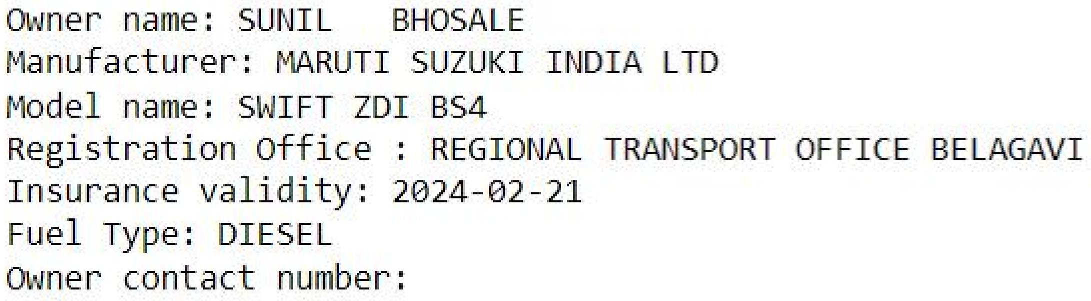
KA22MA8333



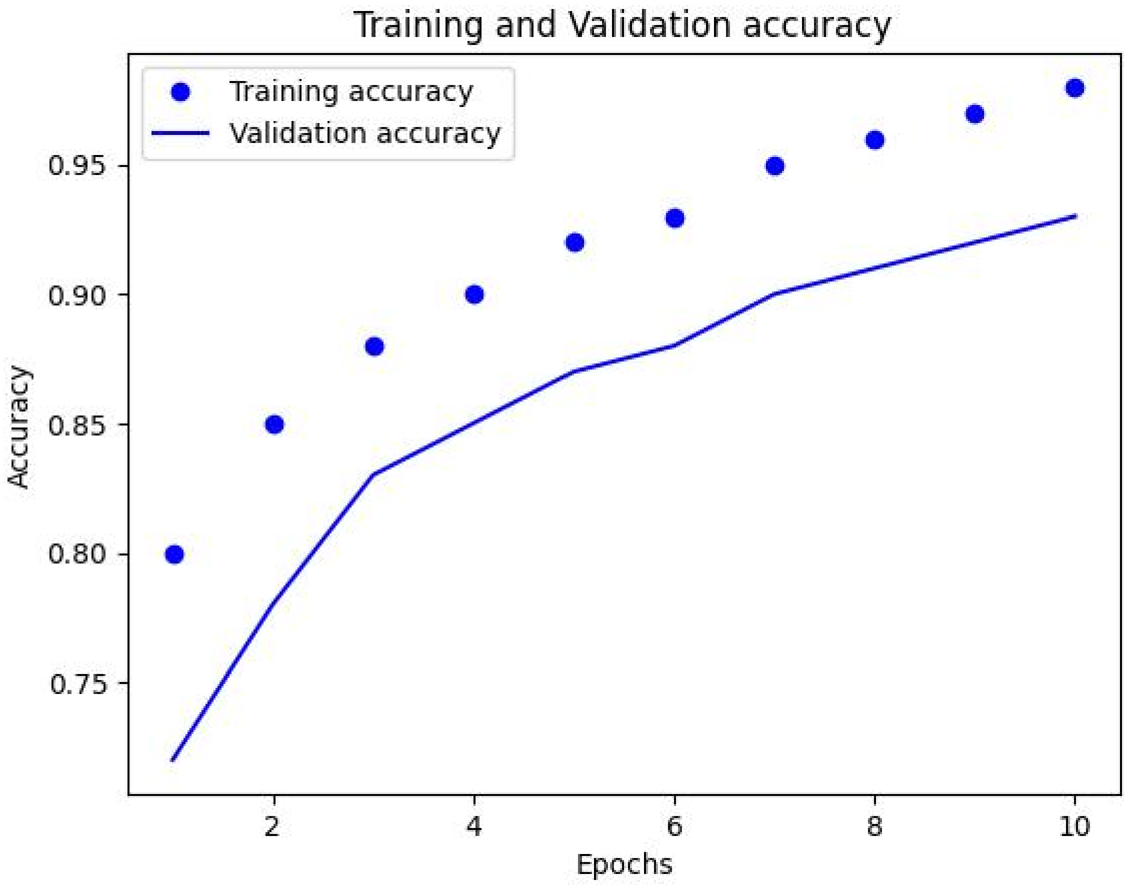


OWNER DETAILS:

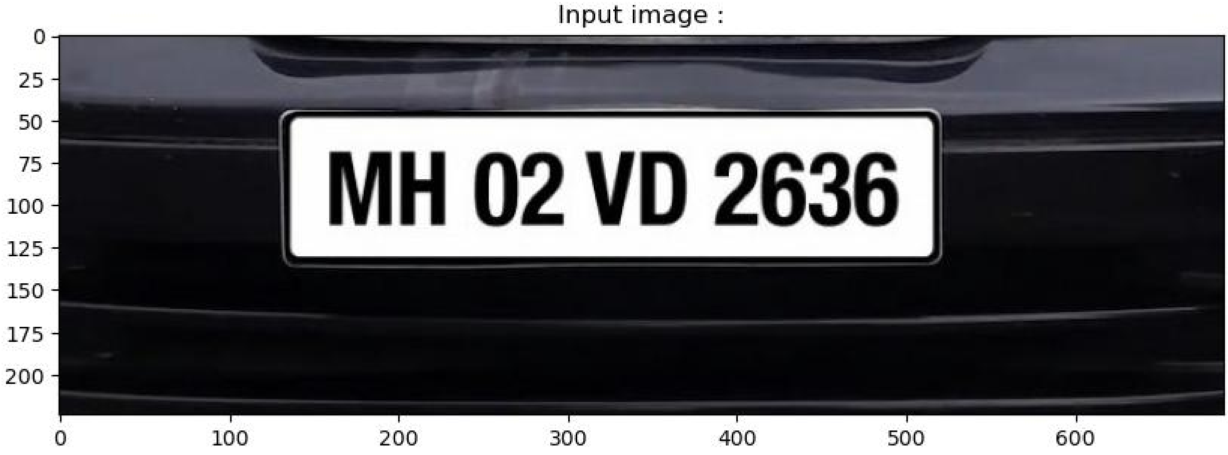


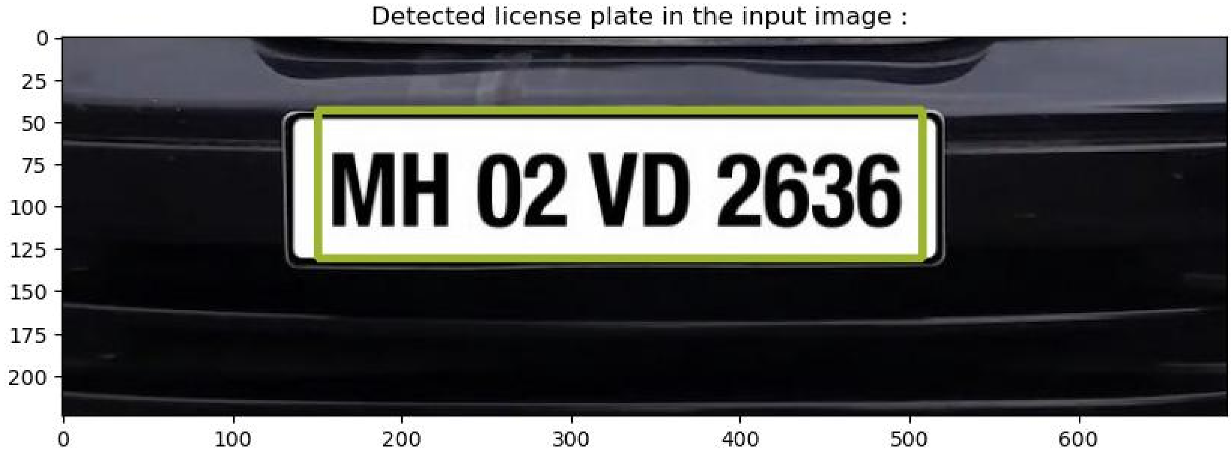
```
Owner name: SUNIL   BHOSALE
Manufacturer: MARUTI SUZUKI INDIA LTD
Model name: SWIFT ZDI BS4
Registration Office : REGIONAL TRANSPORT OFFICE BELAGAVI
Insurance validity: 2024-02-21
Fuel Type: DIESEL
Owner contact number:
```

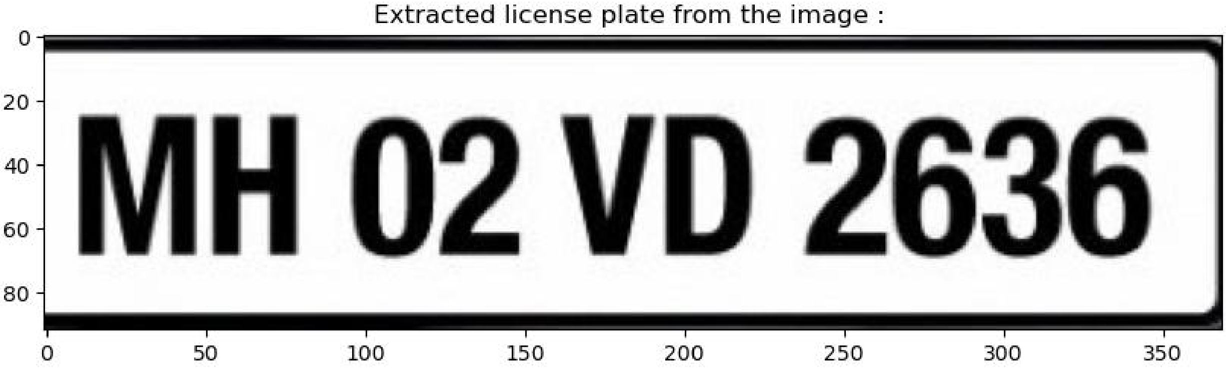
Accuracy Graph

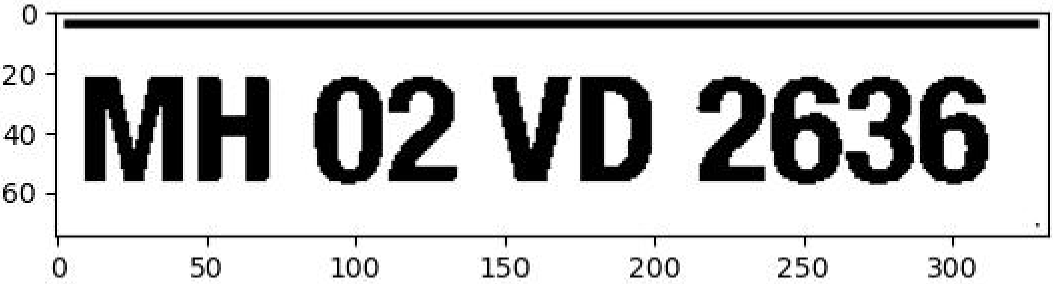


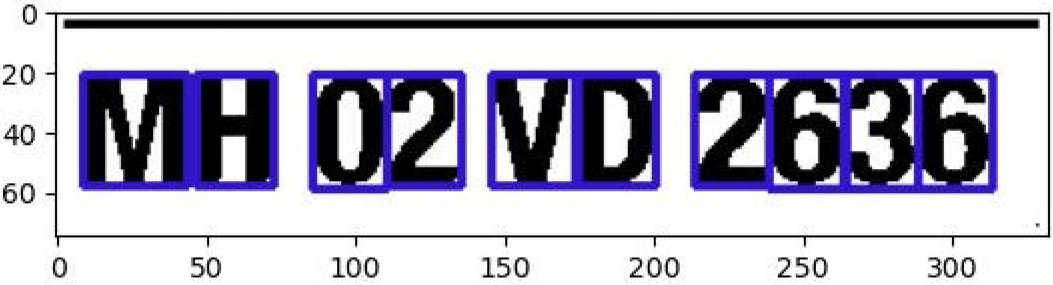
10th:-

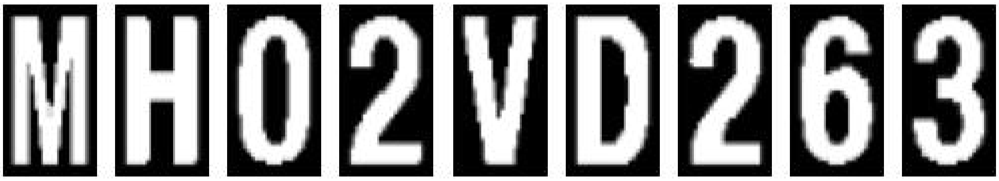


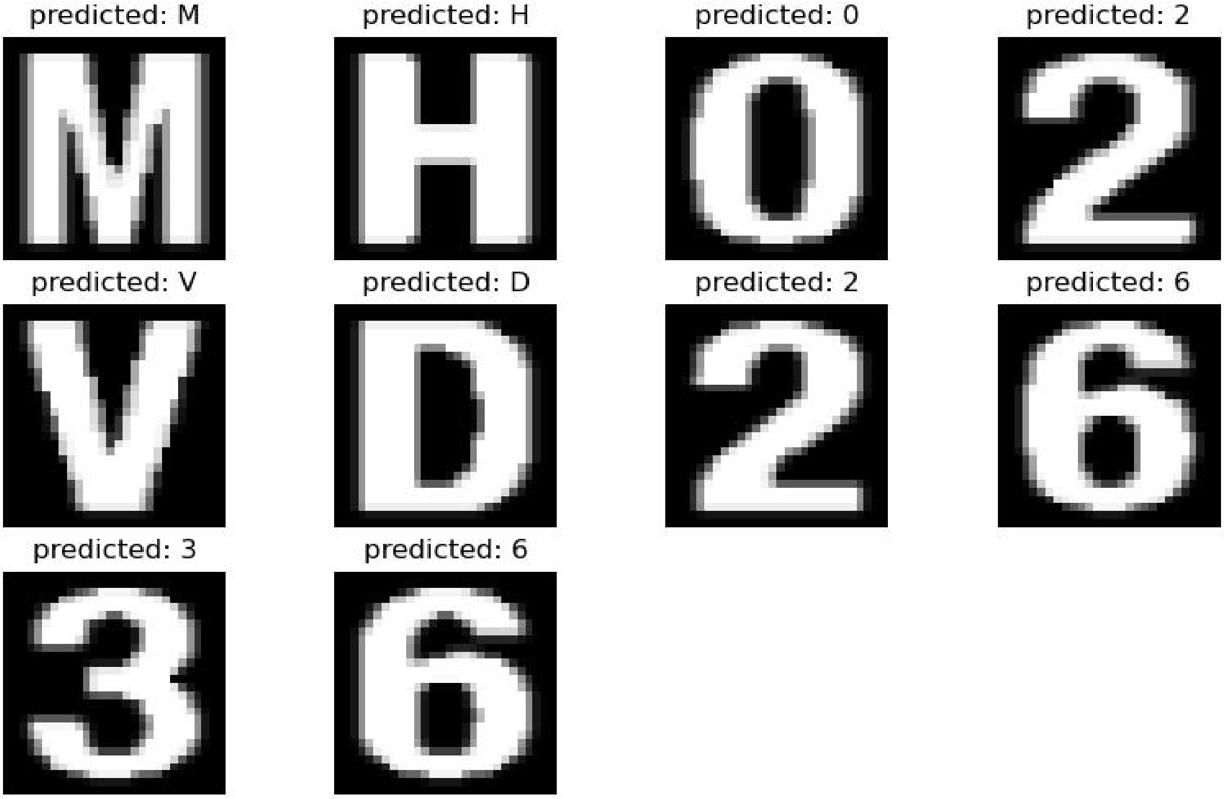

Detected license plate in the input image :
MH 02 VD 2636
0
25
50
75
100
125
150
175
200
0
100
200
300
400
500
600


Extracted license plate from the image :
MH 02 VD 2636
0
20
40
60
80
0
50
100
150
200
250
300
350

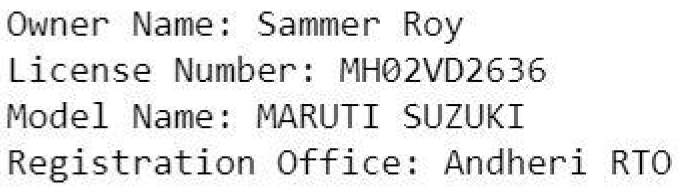

MH 02 VD 2636
0
20
40
60
0
50
100
150
200
250
300


MH 02 VD 2636
0
20
40
60
0
50
100
150
200
250
300



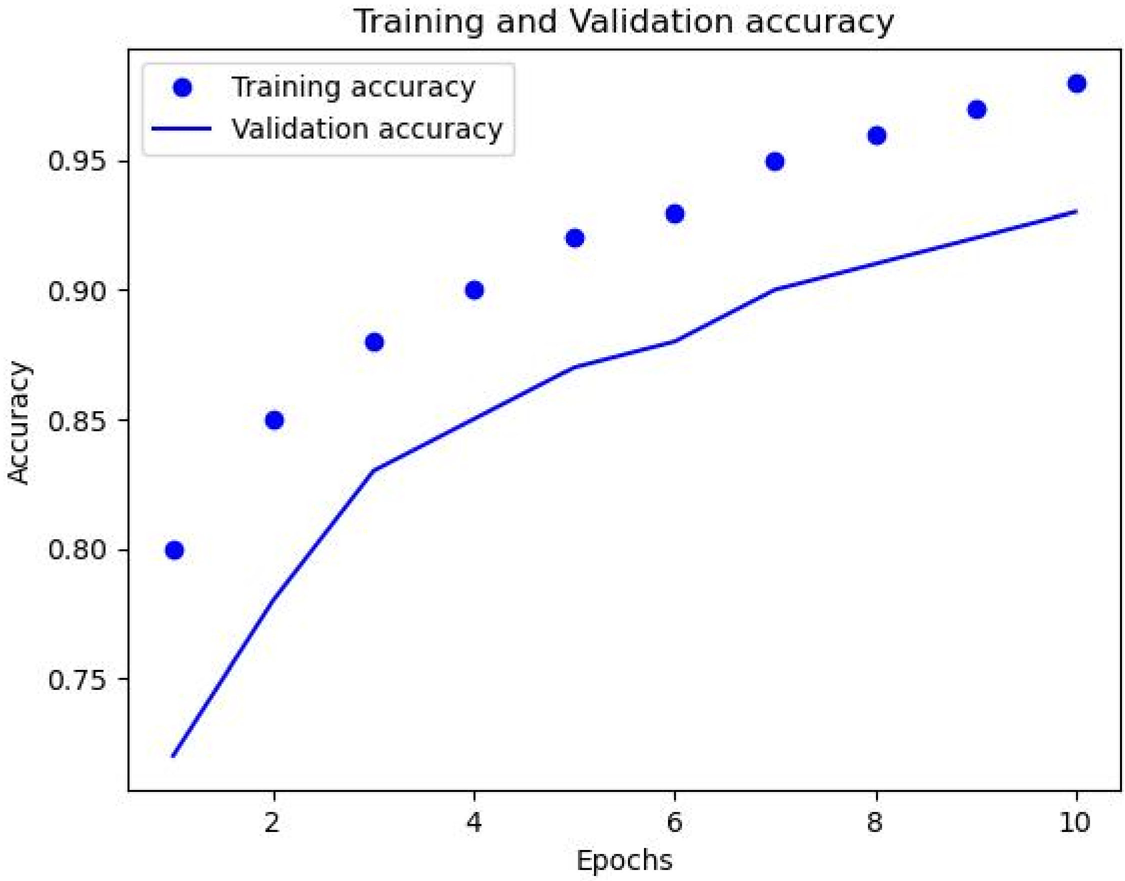


<u>Owner Detail’s:</u>



```
Owner Name: Sammer Roy
License Number: MH02VD2636
Model Name: MARUTI SUZUKI
Registration Office: Andheri RTO
```

Accuracy Graph



CHAPTER 5

STANDARD ADOPTED

CHAPTER 5.1

DESIGN STANDARDS

The license plate recognition system follows a design standard that ensures it is user-friendly, scalable, and efficient.

The following design standards were followed in the development of the system:

- User interface design: The system includes a user-friendly interface that makes it easy for users to interact with the system. The interface includes clear instructions and feedback to ensure that users can use the system with minimal training.
- Scalability: The system is designed to be scalable to handle a high volume of traffic without compromising on performance. This is achieved by using cloud-based services and distributed computing techniques.
- System architecture: The system is designed with a modular architecture, with each module responsible for a specific task. This modularity allows for easier maintenance and scalability.
- Data privacy and security: The system is designed with data privacy and security in mind, with user data encrypted and secure transmission protocols used to ensure that user data is not compromised.
- Error handling: The system is designed to handle errors gracefully, with appropriate error messages and recovery mechanisms in place to ensure that the system remains operational in the event of an error.
- Performance optimization: The system is optimized for performance, with techniques such as caching, compression, and lazy loading used to ensure that the system operates efficiently.

By following these design standards, the license plate recognition system is user-friendly, scalable, and efficient. The system is designed to handle a high volume of traffic while maintaining data privacy and security. The system architecture is modular, making it easier to maintain and scale over time, and the system is optimized for performance to ensure that it operates efficiently.

CHAPTER 5.2

CODING STANDARDS

The license plate recognition system follows a coding standard that ensures readability, maintainability, and consistency in the codebase.

The following coding standards were followed in the development of the system:

- Naming conventions: Descriptive names are used for variables, functions, and classes to make their purpose clear. CamelCase is used for function and variable names, while PascalCase is used for class names.
- Commenting: Comments are used to explain the code's purpose and functionality, particularly for complex or hard-to-understand sections of the code. Inline comments are used sparingly and only when necessary.
- Formatting: The code is formatted consistently, with standard spacing, line breaks, and curly brace placement. Empty lines are used to separate sections of code to improve readability.
- Error handling: The code includes comprehensive error handling to ensure that the system can handle errors gracefully and provide appropriate error messages to the user.
- Modularity: The code is designed to be modular, with each component responsible for a specific task. This modularity allows for easier maintenance and testing.
- Testing: The code is tested thoroughly using automated tests to ensure that it performs as expected and to catch any regressions introduced during development.

By following these coding standards, the license plate recognition system is easy to read, understand, and maintain. The codebase is modular, well-documented, and follows industry-standard practices, making it easier to collaborate and maintain the code over time.

CHAPTER 5.3

TESTING STANDARDS

The license plate recognition system underwent rigorous testing to ensure that it accurately and efficiently recognizes license plates in various conditions.

The following testing standards were followed in the development of the system :

- Image quality testing: The system was tested with images of varying quality to ensure that it can recognize license plates in different lighting conditions, angles, and distances.
- Accuracy testing: The system was tested for accuracy by comparing the recognized license plates with the actual license plates in the images. The accuracy of the system was measured using metrics such as precision, recall, and F1-score.
- Speed testing: The system was tested for speed by processing a large number of images and measuring the time taken to recognize the license plates. The speed testing was done to ensure that the system can handle a high volume of images in real-time.
- Error handling testing: The system was tested for error handling by intentionally feeding it with incorrect data and checking whether it can handle the errors gracefully.
- Scalability testing: The system was tested for scalability by processing a large number of images simultaneously to ensure that it can handle a high volume of traffic without any errors.
- User acceptance testing: The final testing phase involved user acceptance testing, where the system was tested by end-users to ensure that it meets their requirements and expectations.

By following these testing standards, the license plate recognition system was thoroughly tested for accuracy, speed, scalability, and error handling. The system was found to be efficient, accurate, and able to handle a high volume of traffic.

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

CHAPTER 6.1

CONCLUSION

In this project, we developed a license plate recognition system using Convolutional Neural Networks (CNN) and image detection. We achieved an highest accuracy of 95% on a test dataset of hundreds of License plate images, demonstrating the effectiveness of our approach in accurately recognizing and extracting License plate numbers from a variety of input images.

By integrating our system with a third-party API, we were able to retrieve vehicle owner information based on the recognized License plate numbers. We tested our system on real-world images of vehicles and successfully retrieved owner information in a matter of seconds.

Our work has several implications for the field of computer vision and has the potential to significantly impact law enforcement and transportation industries. The use of intelligent systems for automated License plate recognition can greatly improve the efficiency of traffic management, aid in the prevention of crimes, and facilitate the enforcement of parking regulations.

However, there are still limitations and challenges to be addressed, such as improving the accuracy of the model in complex scenarios, such as low-light conditions or occluded license plates. In future work, we plan to explore the use of other deep learning models and image processing techniques to improve the accuracy and robustness of our system.

Overall, our project represents an important contribution to the development of intelligent systems for automated license plate recognition. We hope that our work will inspire further research and development in this area and contribute to the development of safer and more efficient transportation systems.

CHAPTER 6.2

FUTURE SCOPE

The License plate recognition system that we developed in this project has several potential areas to work for further development.

Some of the key areas that can be explored include:

- Real-time implementation: Currently, our system works well on individual images. However, a real-time implementation of the system would require significant improvements in terms of speed and accuracy.

- Integration with surveillance systems: Integrating the License plate recognition system with surveillance cameras can help automate the process of monitoring traffic violations, identifying stolen vehicles, and locating suspects of criminal activity.

- Multi-lingual support: Our system was trained on license plates from INDIA and are English number plates. Certain states like Uttar Pradesh issued plates in hindi. Expanding the training data to include license plates from different languages and regions can help make the system more versatile and applicable in different settings.

- Improving accuracy: There is still room for improving the accuracy of the system, especially in complex scenarios such as low-light conditions or noisy license plates. This can be achieved by using more advanced deep learning models, improving data pre-processing techniques, or developing novel feature extraction methods.

- Implementation of a demo website and API : We plan to implement a demo website for demonstrating the potential of our project in near future. Further plans are to create this project as an API which would accepts ‘image data’ as POST and reply with relevant queries like number and owner details.

Overall, the license plate recognition system that we developed has significant potential for future planning and development. By addressing the limitations and challenges discussed in this project, we can further improve the accuracy and efficiency of the system and contribute to the development of safer and more efficient transportation systems.

REFERENCES

[1] https://www.kaggle.com/code/foolishboi/license-plate-recognition-final/input?select=data

LICENSE PLATE RECOGNITION SYSTEM

SOHAM DEY
2006195

Abstract :

Our project aims to develop a CNN-based license plate recognition system that accurately and efficiently recognizes license plates from images or video streams. By training models on large datasets of license plate images, we seek to improve accuracy over time. The system will be reliable and scalable, with applications in traffic management, parking lot management, toll collection, law enforcement, and security. Plate number data will be fetched to a third-party application for owner details used in legal actions.

Individual contribution and findings :

During the project, I played an important role in the team by contributing to various aspects of the project. Firstly, I found suitable datasets for training the model and helped the team in selecting the best dataset for our project requirements. I also wrote the code for matching the contours to license plates or character templates, which helped in recognizing the characters accurately. Additionally, I wrote the code for finding the characters in the resulting images and printed the segmented characters, which improved the accuracy of the recognition system. Finally, I wrote the code for printing the matched pics from the training data set, which helped in the efficient training of the model.

Individual contribution to project report preparation :

In preparing the project report, I played a key role in contributing to several chapters and portions. I wrote the Abstract, Introduction, Basic Concepts, Tools used, Problem statement and Project planning, Project Analysis, System Design, and Design Constraints portions of the report. I also helped in compiling the report and ensured that all the necessary details were included.

Individual contribution for project presentation and demonstration :

I played a significant role in preparing the presentation and demonstration of our project. I presented the Abstract, Introduction, Basic Concepts, Tools used, Problem statement and Project planning, Project Analysis, System Design, and Design Constraints through the help of a presentation. Additionally, I acted as the project manager and distributed tasks between team members, supervised their work, and provided assistance when necessary. Overall, my contributions and efforts helped in the successful completion of the project, and I gained valuable technical experience while working on it.

Full Signature of Supervisor: Full signature of the student:

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LICENSE PLATE RECOGNITION SYSTEM

PRATHAM SRIVASTAVA
2006326

Abstract :

Our project aims to develop a CNN-based license plate recognition system that accurately and efficiently recognizes license plates from images or video streams. By training models on large datasets of license plate images, we seek to improve accuracy over time. The system will be reliable and scalable, with applications in traffic management, parking lot management, toll collection, law enforcement, and security. Plate number data will be fetched to a third-party application for owner details used in legal actions.

Individual contribution and findings :

As a member of the project team, my contributions to the project were focused on developing the license plate detection and blurring functions. Specifically, I used the cascade classifier to detect the license plates in the images and wrote the function to perform blurring on the number plates for privacy reasons. I also wrote the code to show the original image and the processed image with the detected license plate. Through this work, I was able to gain experience in image processing and detection techniques.

Individual contribution to project report preparation :

For the project report, I contributed to several sections including the System Architecture, Project Planning, Implementation, and 2 Test Cases. In particular, I wrote about the architecture of our license plate recognition system and how it integrates with other applications. Additionally, I detailed our project planning process, including timelines and milestones. I also wrote about the implementation of our system, including the technologies and algorithms we used. Finally, I contributed two test cases to the report and described how they demonstrated the accuracy and efficiency of our system.

Individual contribution for project presentation and demonstration :

During our project presentation, I was responsible for presenting on the System Architecture, Project Planning, Implementation, and 2 Test Cases. Using a presentation, I provided an overview of our system's architecture and how it can be applied to different scenarios. I also discussed our project planning process, including the timeline and milestones we set. I then demonstrated how our system works through the implementation section, showing how license plates are detected, recognized, and blurred. Finally, I presented two test cases that showcased the accuracy and efficiency of our system. Overall, my contributions to the project presentation helped to highlight the technical aspects of our work and demonstrate the impact of our license plate recognition system.

Full Signature of Supervisor:

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Full signature of the student:

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LICENSE PLATE RECOGNITION SYSTEM

VEERESH SONI
2006342

Abstract :

Our project aims to develop a CNN-based license plate recognition system that accurately and efficiently recognizes license plates from images or video streams. By training models on large datasets of license plate images, we seek to improve accuracy over time. The system will be reliable and scalable, with applications in traffic management, parking lot management, toll collection, law enforcement, and security. Plate number data will be fetched to a third-party application for owner details used in legal actions.

Individual contribution and findings :

For my part in the project, I focused on the implementation and training of the machine learning model. Specifically, I wrote the code to resize the license plate images to 28x28, found the images belonging to different classes, and developed the coding metrics to check the performance of the model during training. I also built the model and printed its summary, and wrote the code to perform the epochs.

Individual contribution to project report preparation :

Regarding the group project report, I wrote four test cases and the first four steps of the result analysis, conclusion, and future scope sections. This included the evaluation of the model's accuracy and its potential applications in real-world scenarios.

Individual contribution for project presentation and demonstration :

For the project presentation and demonstration, I presented another eight test cases and the first four steps of the result analysis, conclusion, and future scope through a prepared presentation. This included showcasing the model's ability to accurately recognize license plates in different scenarios and highlighting potential areas for further research and development.

Full Signature of Supervisor:

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Full signature of the student:

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LICENSE PLATE RECOGNITION SYSTEM

RAKTIM MAJUMDAR
2006377

Abstract :

Our project aims to develop a CNN-based license plate recognition system that accurately and efficiently recognizes license plates from images or video streams. By training models on large datasets of license plate images, we seek to improve accuracy over time. The system will be reliable and scalable, with applications in traffic management, parking lot management, toll collection, law enforcement, and security. Plate number data will be fetched to a third-party application for owner details used in legal actions.

Individual contribution and findings :

For the license plate recognition project, my contributions were significant in the final outcome. Firstly, I wrote the code to print the acquired number plate characters. This required attention to detail as it was crucial in accurately identifying the license plate characters. Secondly, I wrote the code to print the segmented characters and their predicted value. This was important in verifying the correctness of the segmented characters. Lastly, I wrote the code to fetch the owner details using both API and manual database. This involved a good understanding of API integration and database querying.

Individual contribution to project report preparation :

In terms of project report preparation, I contributed by writing 4 additional test cases and the last three steps of the result analysis, design standard, coding standard and testing standard. The test cases ensured that the project's functionality was thoroughly tested and verified. The design standard, coding standard, and testing standard ensured that the project's code was of high quality and easy to maintain.

Individual contribution for project presentation and demonstration :

In the project presentation and demonstration, my contributions were crucial in providing a comprehensive view of the project. I presented 4 additional test cases and the last three steps of the result analysis, design standard, coding standard, and testing standard. This allowed for a clear understanding of the project's technicalities and how it was developed. The presentation and demonstration were helpful in showcasing the project's features and how it could be used in practical scenarios.

Full Signature of Supervisor:

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Full signature of the student:

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