Smart Vehicle Number Plate Detection System

A project paper submitted in partial fulfillment of the requirements for the Degree of Master of Science (Engg.) in Information and Communication Technology

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Abstract

The implementation of number plate recognition systems has significantly improved the city's traffic conditions. These systems provide guidance for creating an efficient intelligent transportation system. With the rapid growth in vehicle numbers, Automatic Number Plate Recognition (ANPR) has become a crucial tool for traffic management. ANPR plays a vital role in traffic and security surveillance, utilizing advanced technology and image processing techniques to automatically identify characters on vehicle license plates.

In recent years, there have been notable advancements in license plate recognition technology. By employing techniques like Optical Character Recognition (OCR), traffic surveillance can effectively address issues related to criminal investigations, toll collection, traffic monitoring, speed control, and parking management. ANPR systems are indispensable for efficient traffic management and large-scale monitoring in the transportation sector.

Using image processing algorithms and vehicle image datasets, traffic can now be monitored on a massive scale. Processes such as image segmentation, feature extraction, and character recognition allow license plate characters to be identified accurately. The data collected from these systems can be used for a variety of purposes, including commercial applications, traffic management, and law enforcement. The software analyzes vehicle images as input and produces the license plate numbers as output.

Advances in image processing technology have made these systems reliable for detecting traffic and accurately recognizing license plates. Many ANPR systems are now designed with a focus on license plate character recognition, leveraging image processing techniques to enhance their functionality.

Declaration

I hereby certify that the research presented in the project labeled "**Smart Vehicle Number Plate Detection System**" is entirely original. I certify that I am the single author of the project and that it has not been submitted to any other party for any academic degree, award, diploma, or reason other than prospective publication. Any information obtained from outside sources has been duly acknowledged and cited in this project.

Signature: …… Date: ……..

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Acknowledgement

First and foremost, I would like to express our heartfelt gratitude to the Almighty Allah for guiding us on the right path throughout our journey. I extend my deepest appreciation to my supervisor whose unwavering support, patience, and guidance made this project possible. I am truly fortunate to have had her by my side from the inception of the proposal presentation. Her continuous assistance and encouragement have been invaluable. I am profoundly grateful to all the teachers in our department for their unwavering support and valuable advice throughout my Msc program. Their constant guidance, suggestions, and motivation have created a conducive and friendly environment for our studies. Their wisdom and knowledge have been instrumental in shaping this project. Finally, I would like to acknowledge the contributions of all the individuals and resources that have been referenced in this project. Their insights and research have enriched our understanding and provided a solid foundation for our work. In conclusion, I am grateful to everyone who has played a role, directly or indirectly, in the completion of this project.

Acronyms and Abbreviations

ETC	Electronic Toll Collection.
SIM	Subscriber Identity Module.
IDE	Integrated Development Environment.
GSM	Global System for Mobile.
RFID	Radio Frequency Identifier.
ANPR	Automatic Number Plate Recognition.
LAN	Local Area Network.
LPR	License Plate Recognition.
VLP	Vehicle License Plate

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Chapter 1

Introduction

In the field of data technologies, vehicles have evolved into conceptual resources through the integration of various software components, reflecting multiple perspectives of our modern world. There is a pressing need to reorganize vehicle information within information systems, as these systems rely on accurate and relevant data. This process can be achieved either manually, through external agents, or by using smart systems capable of real-time vehicle detection and identification based on license plates.One such smart system is the vehicle number plate recognition model. This system identifies and recognizes vehicle number plates by extracting text from images and using computational techniques like segmentation, character recognition, and localization. These technologies are widely applied in areas such as parking fee payments, electronic toll collection, and traffic monitoring. They are effective across different types of vehicles and environments, whether in high-traffic zones or less congested areas.

1.1 History of Vehicle Number Plate

At the start of the 20th century, as the number of motorized vehicles grew and accidents became more common, a need to classify vehicles emerged. This led to the introduction of the **Motor Car Act of 1903**, which required all motor vehicles to be registered and display more than one license plate starting January 1, 1904. This concept of vehicle registration had already been introduced five years earlier by the Dutch government.

The first license plate issued in London was the simple yet iconic **A1**, registered to Earl Russell. He was so determined to obtain this unique plate that he camped out overnight to ensure he was the first to register. Earl Russell is credited with introducing the concept of having a personalized or cherished number plate. Over time, the vehicle registration system has undergone four significant changes to keep up with the growing demand for registrations.

1.2 Architecture of Number Plate System

The Automatic Number Plate Recognition (ANPR) system captures an image of a vehicle's license plate as input and automatically extracts and identifies the license plate number as output. An overview of the ANPR system is illustrated in **Figure 1.1**. The process begins with the **preprocessing stage**, which enhances the image quality to ensure it meets the standards for computational or visual analysis. Following this, the **plate localization stage** identifies and isolates the location of the license plate within the image. Next, in the **character segmentation stage**, the individual characters on the plate are separated. Finally, the **character recognition stage** identifies and interprets the segmented characters to produce the final result.

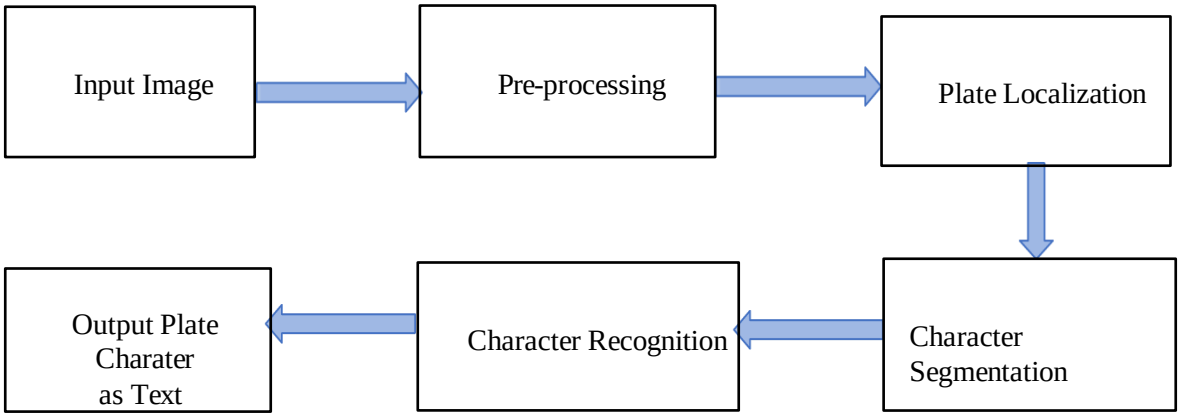

Figure 1.1: ANPR system components.

1.3 Characteristics of Number Plate Styles

An automobile registration plate is known as a license plate in American English or a license plate in Canadian English, is a metal, plastic plate that is attached to any car for legal. identification purposes. All countries require license plates for street vehicles, including cars, trucks, and motorbikes. Depending on the jurisdiction, they might also be necessary for other conveyance such as boats, bicycles, track. In the car register of the issuing region, the registration identity a numeric or alphanumeric ID uniquely identifies the vehicle or its owner. In certain countries, the identity is unique across the board, whereas in others, it is unique only inside a country or region. the identity is associated.

1.4 Application of Vehicle Number Plate

The goal of this section is to extract the license plate from a photograph. The output from this step includes a binary image with the normalized license plate (LP) and an RGB image of the cropped LP taken from the original picture. The most important guideline here is to use cautious algorithms at the beginning. These algorithms become less cautious as we move forward, allowing us to get closer to the license plate without cutting off important details, like numbers or other elements.

1.5 Advantage of Number Plate

Typically, the knowledge that their license plate is being recorded and verified is enough to discourage criminal behavior in advance. Additionally, ANPR provides the advantage of allowing law enforcement to analyze the collected data to identify suspicious vehicles or those involved in criminal activities.

1.6 Disadvantage of Our System

A dependable license plate (LP) detection and recognition system can extract license plate information from a still image or video of a stationary or moving vehicle. Identifying Bangla license plates presents a significant research challenge due to the absence of publicly available datasets and the unique characteristics of the plates, which include more than 100 distinct classes.

- Extreme weather conditions pose challenges for ANPR systems, and privacy concerns remain a significant issue as the system collects sensitive data that could potentially be misused for unintended purposes.
- Due to the blurring caused by moving vehicles, images cannot be accurately identified.
- Low-quality images often reduce the accuracy rate of ANPR technology.

1.7 Our Aim of This Project

License plate recognition is highly effective for both recording and identifying license plates. However, the traditional method of manually identifying license plates is time-consuming and inefficient for uncovering valuable information. Automatic license plate recognition offers an ideal solution for obtaining license plate details. To achieve this, various recognition techniques are required to accurately retrieve the necessary information and meet specific objectives.

To develop and implement a number plate recognition system capable of capturing images and converting them into editable numerical data.

- Developing a database to keep records of all registered vehicles passing through the toll station, including the license plate number, owner's address, and billing information.

- Designing a system that enables the gate to open upon receiving payment and close after the vehicle has passed through.

- To implement both the hardware and software components of the proposed system, ensuring the design process is accurately reflected and the integration of hardware and software is successful.

1.8 Workflow of the Project

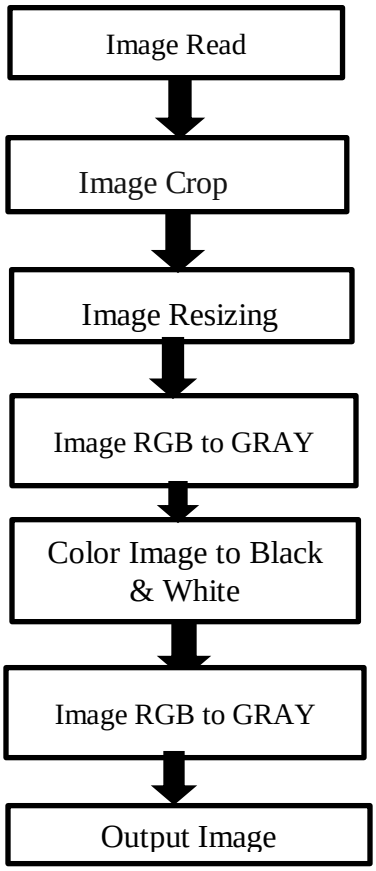

Figure 1.2: The Project Workflow.

Chapter 2

Literature Review

Reading various academic texts, both offline and online, is a crucial part of the literature review process. This helps gather essential facts and knowledge from a wide range of information sources. The reading process broadened my understanding and provided me with new approaches for executing this project. These readings offer key insights, theoretical and methodological advancements on the subject, and include consultations with project managers, professors, and other experts to gain a comprehensive understanding of the system to be implemented.

2.1 Literature Review

In their 2012 paper titled "Automated Vehicle Number Plate Detection Using Hough Lines and Template Matching," Saqib Rasheed et al. proposed a reliable number plate identification and detection system that employs Hough Transformation and a template matching model. This study uses an advanced detector along with Hough Transformation for license plate detection, and template matching techniques for identifying license plate numbers. The vehicle recognition success rates for plate extraction were found to be 90.62% and 94.11%, respectively. The proposed ANPR system utilizes a standardized numbering system, specifically designed for plates in Islamabad, accounting for 89.70% of the total findings in the study. (Volume 6, Issue 3, May-June 2020 | Int J Sci Res CSE & IT, May-June 2020; 6(3): 955-966).

In their 2017 paper titled "Automatic Car Number Plate Detection," Alice N. Cheeran et al. utilized a Modified Ant Colony Optimization (ACO) algorithm for number plate localization at the edge identification stage. The position and size of each character on the number plate are classified using the Kohonen neural network. The accuracy of this neural network is tested and compared with the Connected Component Analysis (CCA) method. Additionally, a hybrid classification system combining Support Vector Machine (SVM) and RULES-3 approach is proposed. The suggested character segmentation and extraction algorithm achieved an accuracy rate of 94% in the study. [2]

In their 2014 paper, "License Plate Identification Application Utilizing Extreme Learning Machines," Sumanta Subhadhira et al. proposed a new license plate recognition system using

Extreme Learning Machines (ELM). The system employs a smartphone app to capture a photo of a vehicle's license plate, specifically designed to recognize Thai license plates. It utilizes the Histogram of Oriented Gradients (HOG) for preprocessing and ELM as a classifier. The application can successfully process segmentation-related data, and although the province portion contains fewer data, the system achieves an accuracy of 95.05%. The overall accuracy for identifying the full plate, including the province and car registration number, is 89.05% [3].

In his 2016 paper, "Extraction of Number Plate Images Based on Image Category Classification Using Deep Learning," Yoshihiro Shima proposed an ANPR system based on an area-gisting technique combined with morphological image processing and deep learning. The system uses edge detection and Connected Component Analysis (CCA) for image processing. A pre-trained Convolutional Neural Network (CNN) called "Alex-Net" is employed as a feature extractor, and Support Vector Machine (SVM) is used for classification. The approach is implemented in MATLAB for CNN and SVM integration, with C++ used for morphological image processing. The system was tested using 126 sample images, including 113 with correctly extracted license plates, and achieved a success rate of 89.7% [4].

In their 2014 paper, "Automated Number Plate Recognition using Machine Learning Algorithms," Dinesh Bhardwaj et al. proposed a five-step method for license plate recognition. This process involves image acquisition using a high-resolution camera, preprocessing with gray-scale transformation, noise removal using a median filter, margin detection using the Sobel technique, partitioning, and character detection with the K-Star machine learning algorithm. Their system, which used a dataset of 320 real-time images of various vehicles, focuses on Indian ANPR systems and achieved notable results in [5].

Wei-chen Liu et al. introduced a novel hierarchical character recognition method in their 2017 proposal, "A Hierarchical Plate Recognition System using Supervised K-means & Support Vector Machine." This system can recognize blurred and tilted license plates, aiming to reduce the number of SVMs and simplify their complexity by reducing the number of character classes in each subgroup. The algorithm achieved an impressive 98.89% accuracy in recognizing tilt characters and blurred license plate information, improving existing techniques by 3.6% in [6].

In 2019, Yongsheng Li et al. presented "Vehicle License Plate Recognition Combining MSER and Support Vector Machine in a Complex Environment." The system employs Maximally Stable Extremal Regions (MSER) for character zone extraction and SVM for recognition. This method outperforms traditional edge detection and color recognition techniques in complex environments, achieving a 90% accuracy rate, compared to lower accuracy rates for the other methods in [7].

Yang Guang's 2011 paper, "License Plate Character Recognition Based on Wavelet Kernel LSSVM," proposed using the Mexico hat wavelet kernel in combination with LS-SVM for character recognition. The wavelet kernel's strong generalizing potential and multi-scale exploration properties helped improve the recognition process. The proposed system achieved a 98.3% cumulative recognition rate using the RBF LS-SVM approach in [8].

In "Comparison of ML Algorithms for Identification of Automated Number Plate Identification," Dinesh Bhardwaj et al. (2014) compared various machine learning classifiers, including Random Forest, Rep Tree, IBK, and K-star, based on accuracy, precision, recall, and F-measure. The Kstar ML algorithm achieved an impressive 99% accuracy rate on the test set, demonstrating the effectiveness of the approach in [9].

Kaili Ni et al., in their 2018 paper "A Proposed License Plate Classification Method Based on Convolutional Neural Network," introduced a CNN-based method for license plate classification. The system utilizes four convolutional layers, three max-pooling layers, and fully connected layers for feature extraction and classification. The method achieved 100% classification accuracy on the training set and a 98.79% accuracy in [10].

Zied Selmi et al. discussed "Deep Learning System for Automatic License Plate Detection and Recognition" in 2017, utilizing deep learning techniques for license plate detection and recognition. The study employed a CNN model for both LP detection and classification, alongside edge detection and character segmentation using Tensor Flow architecture. Their system achieved high accuracy using datasets from Caltech and AOLP in [11].

Table 2.1: Comparative Study of Previous Works

Author	Research Work	Proposed Method	Output
Rasheed et al. (2012)	Automated number plate recognition using hough line and template matching.	Hough lines using hough transformation and template matching.	The end product can locate and identify Islamabad's license plates. It reports an overall accuracy of 89.70% and an average recognition time of 0.9 seconds for one specific image.
Sasi et al (2017)	Automatic car number plate recognition.	Modified Ant colony optimization (ACO) for plate location, hierarchical grouped structure that is based on inductive RULES - 3 and Support Vector Machine (SVM) approach	Result shows detection.
Subhadhira et al. (2014)	License plate recognition application using extreme learning machines	Extreme learning machines (ELM) for recognition and Histogram of oriented gradients (HOG) for feature extraction and pre - processing	The result provides the acknowledgement of Thai number plates. It provides an success rate of county part with 95.05% and to equalize number plate with county both results as 89.05 percent

			efficient.
Shima (2016)	Extraction of number plate images based on image	Morphological image processing, pre-trained	The proposed device is made for the extraction of license
	category classification using deep learning.	convolutional neural network (CNN) AlexNet for extracting characteristics, Support vector machine (SVM) as classifier	plate which shows the output of 126 rear sample images with 89.7 percent success rate.
Bhardwaj	Automated Number Plate Recognition System Using Machine learning algorithms (Kstar).	Kstar machine learning algorithm, sobel and vertical segmentation.	To increase the speed of number plate recognition, this method is suggested with the favor of five term based on Indian number plate detection.

Liu et al. (2017)	A hierarchical license plate recognition system using supervised Kmeans and Support Vector Machine	Hierarchical approach combining supervised Kmeans and support vector machine.	Result is shown on the base of images taken from 1530 samples of Taiwan license plate for justifying characters. The success rate of the device is marked as 98.89 percent for nonfocused & inclined images. The system was gained with high success rate and not more computations with decreases complexity.
Li et al. (2019)	Vehicle License Plate Recognition Combing MSER and Support Vector Machine in A Complex Environment.	Algorithm based on Maximum stable region extremum (MSER) and Support vector machine, Kernel method.	The combined method of MSER and SVM offers better character recognition results compared to conventional process without the use of area of license number plate and segmentation of character. The system suggested was more concise & use that gives 90 % accurate.

Guang (2011)	License plate character recognition based on wavelet kernel LS-SVM.	Mexico hat wavelet LSSVM (least square SVM).	The outcome demonstrates the precise and speedy identification of a vehicle license plate. 500 image samples were used in the experiment as training and testing data. The results of the suggested study were also contrasted with those of the neural network BP and the LSSVM RBF. Mexico Hat Wavelet LS-SVM, among them, was found to have a high success rate of 98.3%.
Bhardwaj and Kaur (2014)	Comparison of ML algorithms for identification of Automated Number Plate Recognition	Kstar ML algorithm, WEKA tool, IBK, Random Forest, REP Tree, MLP	The outcome of comparing various machine learning methods for license plate recognition is obtained. Kstar exhibits the highest accuracy on the data sample photos (99%) of all the algorithms that were compared.
Satsangi et al. (2018)	License Plate Recognition: A Comparative Study on Thresholding, OCR and Machine Learning Approaches	Viola Jones ML algorithm	510 photos are used to identify characters using Viola Jones' ML system. The output comparison with other conventional methods, such as threshold and OCR technology, was done as a result. The viola jones technology, which yields an 80 percent recognition rate, is the most effective of the three.

Ni et al. (2018)	A Proposed License Plate Classification Method Based on Convolutional Neural Network	Convolutional Neural Network, Faster-CNN	The outcome is attained by classifying license plates using the CNN model. This upgraded classifi cation technique is included to prevent the poor picture quality from impairing the effective identification of characters from data sample. The created program was

			deemed to be more accurate because it had a 98.79 percent accuracy rate.
Selmi et al. (2017)	Deep learning system for automatic license plate detection and recognition	Second CNN model, Canny Edge Detection Technique, Tenser flow framework	The outcome exhibits the use of deep learning architecture for vehicle number plate identification. The Tenser flow framework was chosen. CNN is used for classification and recognition. On 2400 dataset photos, the caltech and AOLP dataset was used. The performance was further evaluated in comparison to prior work, and it was discovered that the suggested work provides the highest success rate of detection.

2.2 Issues and Challenges in using ANPR System

In recent years, Automatic Number Plate Recognition (ANPR) systems have gained significant attention within the field of intelligent transportation systems (ITS). These systems have reduced the need for human intervention by enabling the automatic identification of license plates. This automatic detection and recognition of license plates have become crucial for monitoring traffic, which is especially important in large urban areas where managing traffic and identifying vehicle owners is critical. With population growth and an increase in vehicles, the need for efficient license plate reading systems has escalated to assist in traffic management and collect relevant vehicle data.

ANPR systems play an essential role in various applications such as traffic control, automated toll collection, law enforcement, recovering stolen vehicles, parking management, and criminal investigations. However, challenges persist, particularly in detecting license plates accurately. Factors such as unique vehicle plate designs, unfavorable weather conditions, poor lighting, low camera resolution, and inclined or obscured views make license plate recognition difficult. deemed to be more accurate because it had a 98.79 percent accuracy rate. Selmi et al. (2017) Deep learning system for automatic license plate detection and recognition Second CNN model, Canny Edge Detection Technique, Tenser flow framework The outcome exhibits the use of deep learning architecture for vehicle number plate identification. The Tenser flow framework was chosen. CNN is used for classification and recognition. On 2400 dataset photos, the caltech and AOLP dataset was used. The performance was further evaluated in comparison to prior work, and it was discovered that the suggested work provides the highest success rate of detection. 12 Additionally, vehicles within a single image, tilted plates, and moving vehicles often complicate the detection process. To enhance vehicle recognition, it is crucial to implement advanced image processing techniques. Developing accurate segmentation and recognition technologies is vital for effective traffic surveillance. Precision in recognition and lower computational complexity are key considerations for widespread deployment in urban traffic monitoring. Moreover, issues such as noise sensitivity in images, dirt on plates, and missing or damaged plates hinder proper vehicle identification, further complicating the use of ANPR for traffic management. Despite these challenges, ANPR systems continue to play an important role in the advancement of intelligent transportation networks. The incorporation of image processing techniques, along

with neural networks, can significantly improve recognition accuracy. These systems can be further enhanced to handle inclined or side-view images, moving vehicles, and varied plate designs, making them an indispensable tool for traffic management. However, to overcome the current limitations, improvements in object detection and recognition methods are required to ensure robust and reliable vehicle identification through ANPR systems.

2.3 Proposed Model

This project aims to identify a vehicle's license plate from images stored in a database. Essentially, the objective is to recognize the license plate of a vehicle and extract relevant information using the MATLAB program, as illustrated in Fig. 2.1

Figure 2.1: A Vehicle Number Plate Recognition In Matlab Software.

This project aims to create a connection between the vehicle and its owner or user through the government agency's motor vehicle registration program. The registration number, typically alphanumeric, uniquely identifies the vehicle in the database of the issuing body. The appearance of number plates, including colors, fonts, and sizes, may vary based on the country and its regulations.

The following applications are possible for this project:

1. Peak-hour city traffic analysis
2. Improved vehicle theft prevention
3. Effective traffic rule enforcement
4. Flexible and automatic vehicle entry and exit from parking spaces
5. Parking lot management software
6. Enhanced security for parking lot managers

In addition to these uses, the system can be applied for detecting vehicle license plates at ports, airports, and borders. 17 Key factors considered in the project include:

- **Number plate recognition**: The system is designed to detect both the front and back number plates of a vehicle.
- **Text extraction**: Only one vehicle's number plate is processed at a time to extract the text.
- **Training data**: The system is trained on non-random images, specifically focusing on vehicles, and does not use irrelevant images like animals (e.g., cats, dogs)

Chapter 3

Methodology

Methodology refers to the systematic and theoretical study of the methods and processes used in a particular field of study. It involves the exploration and analysis of the body of rules, principles, and procedures that guide how knowledge is acquired, studied, and applied in that field. In simpler terms, methodology is the structured approach or set of steps followed to conduct research or carry out a process in a logical and organized manner. In essence, a methodology provides a framework for how tasks or research are to be conducted, ensuring that processes are carried out efficiently and in a way that aligns with established guidelines and principles.

3.1 Image Reading:

The imread function is commonly used to read image files into MATLAB. When dealing with GIF files that contain multiple frames, the idx parameter allows you to specify which frame to read. Here's how it works:

- If you provide idx as an integer scalar, it will return the corresponding frame from a multi-frame image file (e.g., a GIF).
- For example, if idx is set to 3, imread will return the third frame of the GIF file.
- If idx is a vector of integers (e.g., 1:5), it will return the first five frames from the GIF file.
- For example, if idx = 1:5, the function will return the first five frames in the GIF file.
- The idx option is supported for GIF files (which often contain multiple frames), as well as other file types like CUR (cursor files), ICO (icon files), and HDF4 files.
- Note that if you try to read more frames than exist in the GIF, MATLAB will return an error or only process the frames that are available.

3.2 Image Croping

Image cropping is a crucial step in license plate recognition systems as it helps focus the computational resources on the relevant portion of the image — in this case, the number plate. By removing extraneous parts of the image, the system can work more efficiently, speeding up processing times.

Here’s a breakdown of how this process works in MATLAB:

1. **Cropping the Image**:

    - The goal is to create a bounding box around the license plate, which removes unnecessary parts of the image and focuses on the region containing the plate.
    - The MATLAB regionprops function can be used to find the bounding box of the number plate (i.e., the smallest rectangle that contains all the plate's characters).

2. **Binary Conversion**:
    - After cropping, converting the image to binary (black-and-white) helps simplify the recognition process by removing color complexity. Binary images have only two pixel values (0 or 1, black or white), making it easier to perform subsequent image processing steps such as edge detection or character segmentation.
    - You can use imbinarize in MATLAB to convert the image to binary form.

Explanation of Steps:

1. **Grayscale Conversion**: rgb2gray is used to convert the image to grayscale if it's in color. This simplifies further processing.
2. **Edge Detection**: edge uses the Canny method to detect edges in the image. These edges can help identify the boundary of the license plate.
3. **Regionprops**: This function analyzes the regions in the image and calculates bounding boxes around areas with significant content (like the license plate).
4. **Cropping**: The imcrop function crops the image based on the identified bounding box, zooming in on the plate.
5. **Binary Conversion**: imbinarize simplifies the image to black-and-white, which makes it easier for the system to perform the next steps in recognition, such as character extraction.

By following this process, you can significantly reduce the computational load and improve the efficiency of your license plate recognition system.

Figure 3.1: Croping Of An Image By Using Matlab

3.3 Binary Images

A binary image is one where the pixel values are quantized into two levels: 0 and 1, representing black and white (0 and 255). The process of creating a binary image starts by converting the original image into grayscale, followed by applying a threshold to the grayscale image. Any pixel with a value greater than the threshold is assigned a value of 1 (white, or 255), while all other pixels are set to 0 (black). This results in an image with either white objects on a black background or the reverse.

3.4 Image Enhancement

Image enhancement involves improving the clarity and visibility of an image. Techniques used in this process include sharpening edges, increasing contrast, reducing noise, processing color images, and segmenting the image into distinct regions for better analysis and interpretation.

3.5 Histogram Processing

The previous transformation will produce an image with an equalized histogram intensity level, a method known as histogram image equalization. This technique enhances the image by increasing its contrast and creating a more defined range of intensity compared to the original. Due to its discrete nature, the histogram of the processed image may not be uniform. The adaptive transformation function developed through histogram equalization ensures that the histogram remains stable unless the image itself undergoes a change.

3.6 Thresholding

Thresholding is one of the earliest techniques used for image segmentation. In gray-level thresholding, a threshold (T) value is selected and compared with each pixel of the image. This process segments the input binary image (K) into an output binary image (F). If a pixel's value exceeds the threshold, it is classified as one part of the image, and if it is below the threshold, it is classified as another part.

F (x,y) = 1 if K (x,y)>=T; = 0 if K (x,y) 3.1

3.6.1 Global thresholding

In global thresholding, a single threshold value is applied to segment the image's histogram. This threshold defines the boundary between the foreground and the background pixels, determining which shades of gray are assigned to the foreground and which to the background. The threshold serves as a baseline for classifying pixel intensities into two distinct groups.

3.6.2 Local thresholding

In local thresholding, the image is divided into smaller regions or blocks, and a separate threshold value is calculated for each section. This approach allows for more adaptive segmentation, as different areas of the image can have different threshold values based on local variations in lighting or contrast, improving the accuracy of segmentation in varying conditions.

3.7 Adaptive thresholding

Adaptive thresholding involves calculating a threshold value for each pixel based on its local neighborhood. If the histogram is bimodal, the threshold is typically set at the midpoint between the two modes. In cases where the histogram's modes overlap, the threshold aims to minimize errors in classifying background pixels as foreground (object) pixels, and vice versa. This technique improves segmentation by accounting for local variations in lighting or intensity across the image.

3.8 Edge detection

The initial step in vehicle number plate recognition is detecting the size of the number plate. One challenge is developing an algorithm that can accurately identify the rectangular shape of the plate in an image. The focus is on the horizontal and vertical edges of the plate, as the contrast between the license plate and the background typically results in high-density margins, which can lead to the detection of incorrect areas. To address this, edge detection is applied, utilizing the intensity discontinuities to locate the boundary between different regions. By examining the relationship between each pixel and its neighbors, edge information is obtained, which serves as the foundation for further detection.

3.9 Processing and Recognition Phase

The steps involved in the overall image processing is represented by the flow diagram bellow:

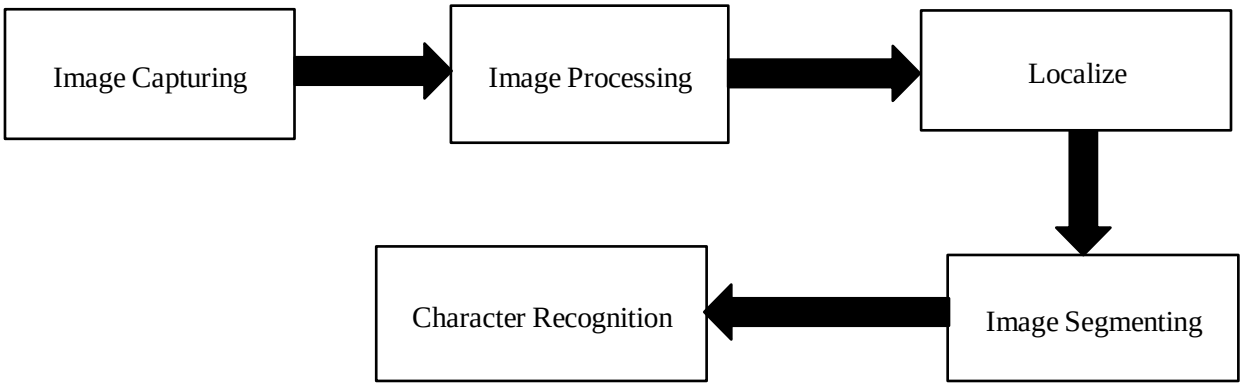

Figure 3.3 Flow chart for Image Processing and Recognition phase

3.9.1 Image Capturing

The USB Sensing camera is responsible for capturing images when triggered, facilitating image acquisition. Its placement will be strategically designed to capture a clear image of the front half of an approaching vehicle as it nears the toll booth. This ensures that the license plate is visible and can be accurately detected for processing.

3.9.2 Preprocessing

After the image is captured digitally and transmitted to the server system, pre-processing is the next essential step. The main goal of pre-processing is to enhance character recognition by applying a series of algorithms that improve the image quality, ensuring the necessary characters are clearly identifiable. This stage plays a crucial role in optimizing the accuracy and efficiency of the entire recognition process.

3.3 Binary Images

A binary image is one where the pixel values are quantized into two levels: 0 and 1, representing black and white (0 and 255). The process of creating a binary image starts by converting the original image into grayscale, followed by applying a threshold to the grayscale image. Any pixel with a value greater than the threshold is assigned a value of 1 (white, or 255), while all other pixels are set to 0 (black). This results in an image with either white objects on a black background or the reverse.

3.9.3 Character Recognition

In this phase, the extracted characters undergo scaling to fit into a designated window size. This step ensures that all characters are of a consistent size, making them suitable for the next processing step. Before the dataset is fed into the neural network for training, each character is normalized to a fixed binary image size of 50x30 pixels. This standardization ensures that the neural network can effectively process and learn from the input data, as the characters are now uniform in size and format.

3.1 The Proposed Recognition System Simulation's development

The document will begin by outlining the goals set at the start of the project. Following this, the specification simulation will be thoroughly examined. To facilitate testing and troubleshooting, modular software for the simulation will be developed. The development process is divided into three key modules:

1. **Extracting individual digits from the car plate** - This module focuses on isolating the characters on the number plate.
2. **Identifying individual digits** - This module handles the recognition of the isolated characters and determines their corresponding digits or letters.
3. **Cross-referencing with a database** - The final module compares the identified digits with a predefined database to verify the vehicle's number plate and provide the necessary results.

Each of these modules will be designed to work independently for ease of testing and debugging, ultimately contributing to a smooth overall system operation.

Chapter 4
Proposed Model

This project is designed to identify a vehicle's license plate from images stored in a database. In essence, it aims to recognize a vehicle's license plate and extract relevant data about the vehicle using the MATLAB program. The goal of a government agency's motor vehicle registration system is to establish a connection between the vehicle's owner or user and the vehicle itself. The vehicle's registration number, which is typically alphanumeric, serves as a unique identifier within the issuing body's database. The format of these number plates may vary depending on the country and its specific regulations, including differences in color, font, and size.

4.1 Architecture of Our Model

The architecture of our model given below:

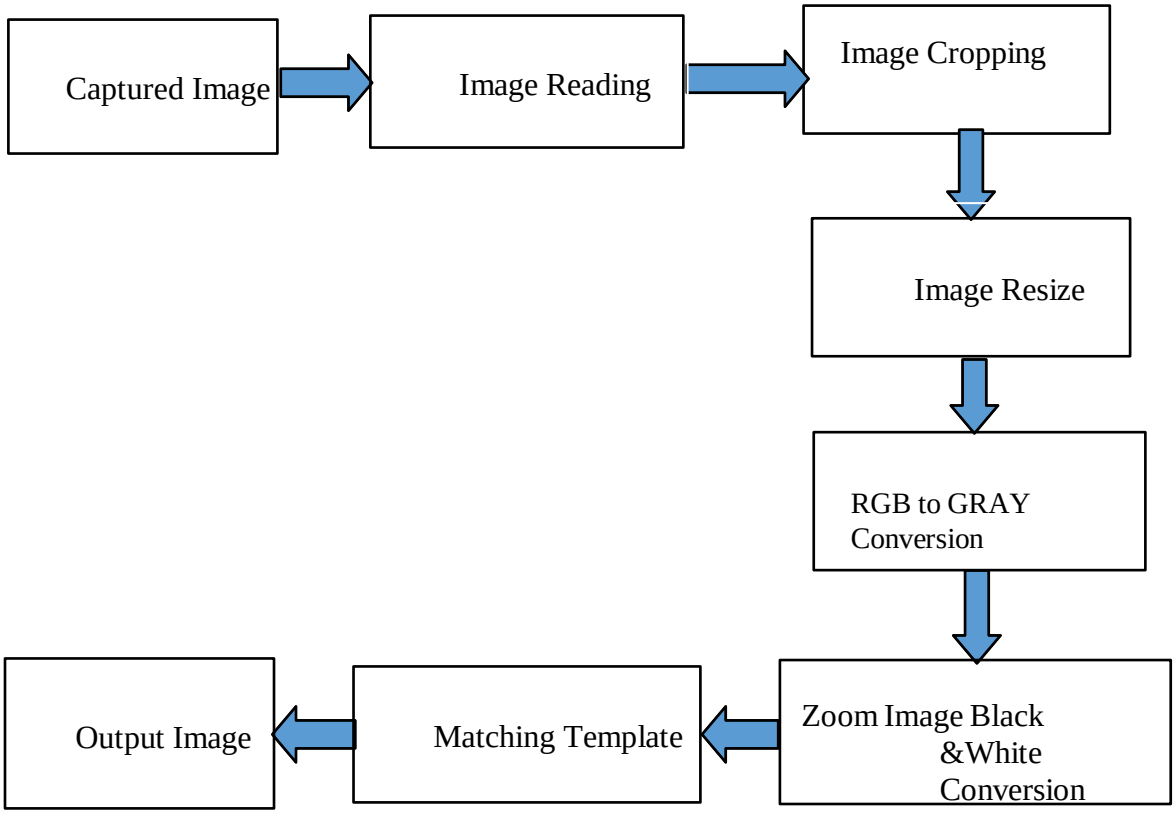

Figure 4.1: The Architecture Model Our Project.

4.2 Flowchart of This Project

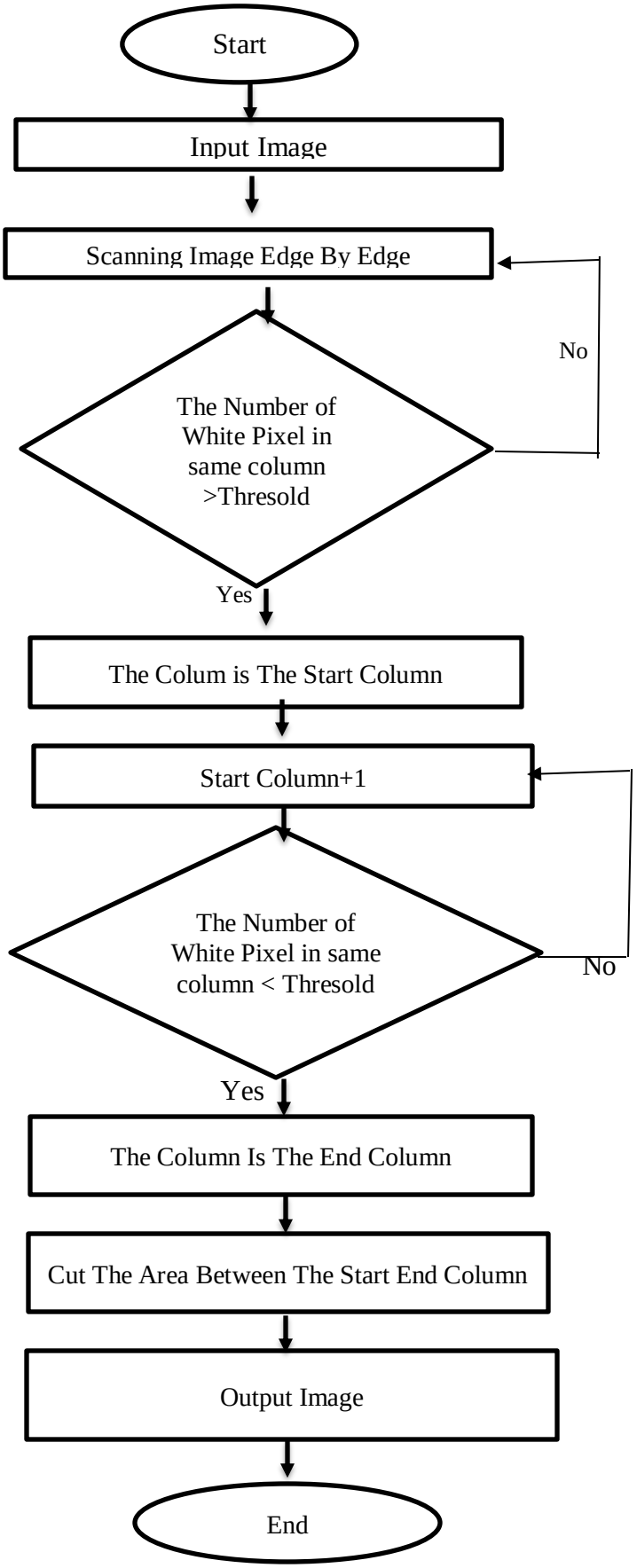

Figure 4.2: Flowchart of This Project

Chapter 5

Implementation & Result Analysis

5.1 Output Result

At first MATLAM read the image by the imread function,then it croped the enter image as the following figure 5.1

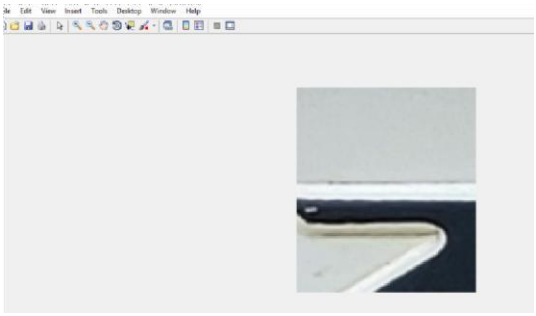

Figure 5.1: Cropped the Enter Image

In the second step we have to resize the cropped image as the following figure 5.2

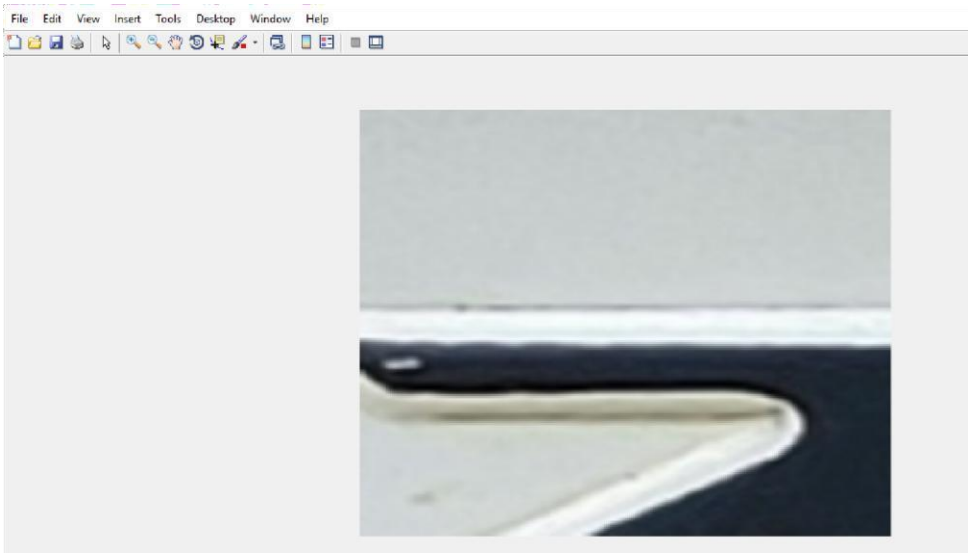

Figure 5.2: Resize the Cropped Image

Then it need to convert resize image RGB to GRAY conversion as the following figure 5.3

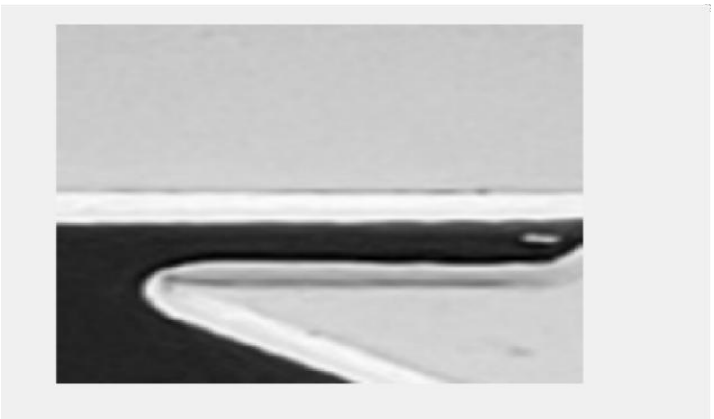

Figure 5.3: Convert the image from RGB to GRAY

In the figure 5.4 we make the image double size convert to black &white image

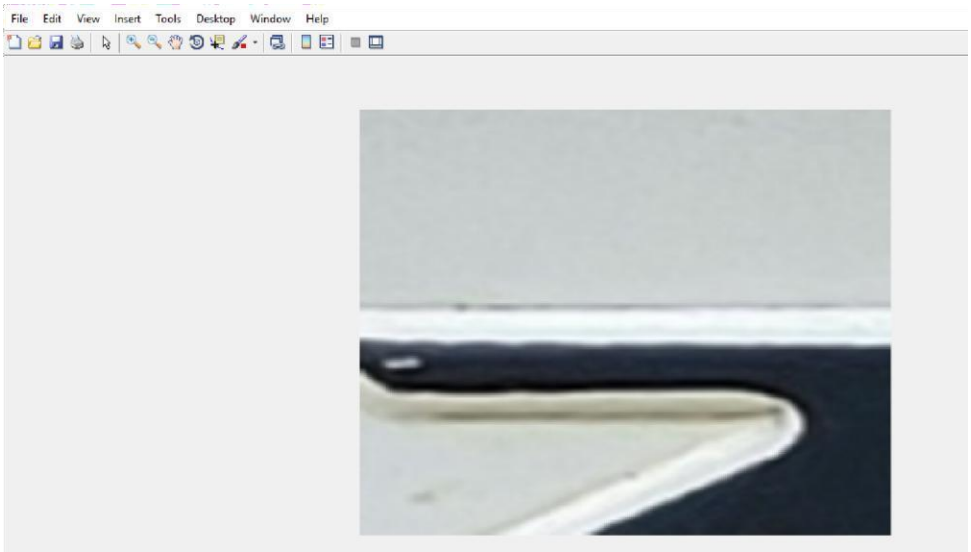

Figure 5.4: Black & white image of cropped image

In the figure 5.5 we get the original image

Figure 5.5: The original image

Here the template matching to the original image as the following figure 5.6

Figure 5.6: Template matching Image

The cross-correlation of the image as surface in the following figure 5.7

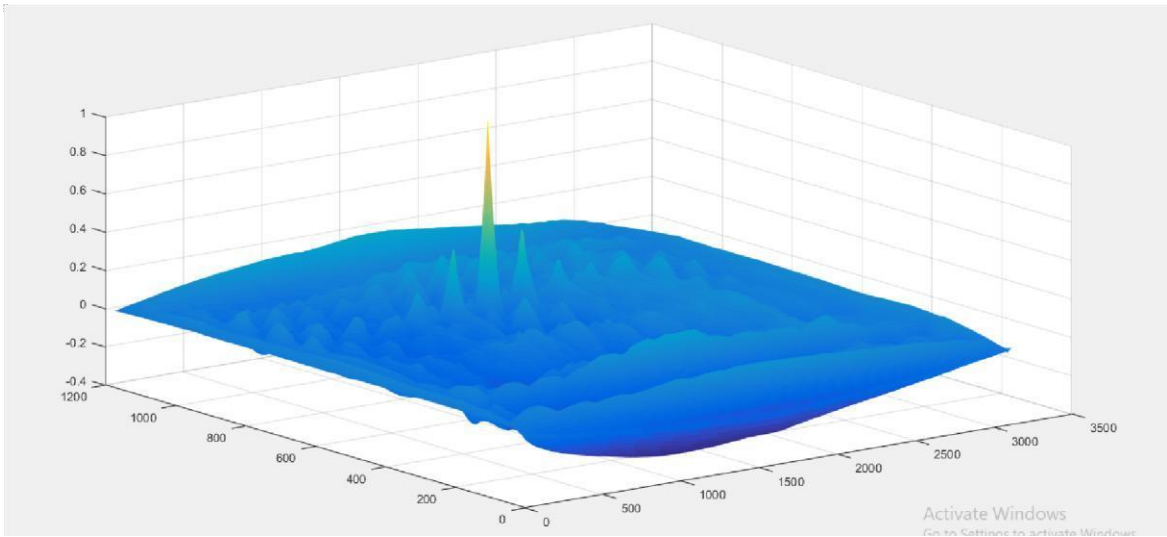

Figure 5.7: Cross-correlation of the template matched image as surface

This is the final image where the matching area of lience plate number as the following figure 5.8

Figure 5.8: Marked the matched are of the number plate

And finally it show name of the driver Name, Address, NID number and the mobile number as the following figure 5.9

Figure 5.9: Details about the vehicle

Chapter 6

Conclusion

6.1 Analysis of Our System

In our system, we showcase the detection of a vehicle's number plate by comparing it to a given pattern. If the template matches the pattern, the corresponding area of the vehicle's number plate is marked. However, if there is no match, the area is left unmarked. This system enables us to easily determine whether a number plate is valid or not. If the number plate is valid, the system displays the driver's details, including their name, address, National ID number, and cell phone number. Essentially, our system is capable of detecting any vehicle number plate and retrieving the associated vehicle owner's information.

6.2 Limitation of Our System

The limitation of our system is that it currently cannot handle larger datasets. It is designed to work with only a limited number of datasets, meaning it can detect only a specific set of number plates. This constraint affects the scalability of the system for broader applications.

6.3 Future Plan of Our System

Currently, our system is unable to handle larger datasets. However, we aim to enhance its capability so that it can detect a wider range of number plates. In the future, we plan to implement this system in toll stations, which will help alleviate traffic congestion on bridges like the Padma, and the Jamuna bridge.

Reference

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