MIT | Academy of Engineering
(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

A Project Report on

# Real Time Helmet And Number Plate Detection and Segregation

*Submitted by,*


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A Report submitted to MIT Academy of Engineering, Alandi(D), Pune,
An Autonomous Institute Affiliated to Savitribai Phule Pune University
in partial fulfillment of the requirements of

BACHELOR OF TECHNOLOGY in
**Computer Engineering**


**School of Computer Engineering**
**MIT Academy of Engineering**
(An Autonomous Institute Affiliated to Savitribai Phule Pune University)
**Alandi (D), Pune – 412105**


**(2023–2024)**

# CERTIFICATE

It is hereby certified that the work which is being presented in the BTECH Project Report entitled **"Real Time Helmet And Number Plate Detection and Segregation "**, in partial fulfillment of the requirements for the award of the Bachelor of Technology in Computer Engineeringand submitted to the **School of Computer Engineering** of **MIT Academy of Engineering, Alandi(D), Pune, Affiliated to Savitribai Phule Pune University (SPPU), Pune**, is an authentic record of work carried out during Academic Year **2023–2024**, under the supervision of **Prof. Shubhangi.B Kale**, **School of Computer Engineering**

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# DECLARATION

We the undersigned solemnly declare that the project report is based on our own work carried out during the course of our study under the supervision of **Prof. Shubhangi.B Kale**.

We assert the statements made and conclusions drawn are an outcome of our project work. We further certify that

1. The work contained in the report is original and has been done by us under the general supervision of our supervisor.
2. The work has not been submitted to any other Institution for any other degree/diploma/certificate in this Institute/University or any other Institute/University of India or abroad.
3. We have followed the guidelines provided by the Institute in writing the report.
4. Whenever we have used materials (data, theoretical analysis, and text) from other sources, we have given due credit to them in the text of the report and giving their details in the references.

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# Abstract

This work introduces a real-time computer vision system designed to detect helmets and license plates on motorcycles. The main objective of the system is to enhance road safety by ensuring compliance with helmet rules and to facilitate vehicle identification through automatic license plate recognition (ALPR).

The system leverages state-of-the-art object recognition algorithms powered by deep learning techniques. This enables accurate identification and classification of helmets and license plates in real-time video feeds. Additionally, the system incorporates a module to distinguish between standard and non-standard (fancy) license plates, offering extended functionality.

The helmet detection feature promotes adherence to safety regulations by motorcycle riders, ultimately improving road safety. Furthermore, the ALPR functionality with fancy plate classification assists law enforcement agencies in vehicle identification and tracking.

The system employs pre-trained deep neural networks optimized for object recognition tasks. This results in a robust model that performs well under various environmental conditions, making it suitable for real-world applications. For user convenience, the system includes a user-friendly interface that facilitates communication and displays visual information on detected helmets and license plates. The ability to differentiate between standard and fancy plates empowers authorities with an extra layer of enforcement capability, particularly regarding vehicle title compliance.

# Acknowledgment


## Acknowledgment

While emotions cannot be fully captured in words, we take this opportunity to express our sincere gratitude and indebtedness to those who have supported us throughout this project.

First and foremost, we would like to express our deepest appreciation to our esteemed guide, Prof. Shubhangi Kale, Professor, School of Computer Science Engineering, MIT Academy of Engineering, Alandi. Her invaluable guidance, constant encouragement, and meticulous efforts in shaping this project from its inception to completion are highly commendable. We are grateful for her patience, cooperation, and support in resolving any challenges we faced during the project.

We would also like to extend our sincere thanks to Prof. R. Badre, Assistant Professor, School of Computer Science Engineering, MIT Academy of Engineering, Alandi, and Prof. Kavitha S., School of Computer Science Engineering, MIT Academy of Engineering, Alandi, for being part of our committee. Their keen interest, valuable suggestions, and constructive criticism throughout the research process were instrumental in enhancing the quality of this work.

We are truly grateful for the unwavering support and encouragement we received from all of them. This project would not have been possible without their valuable guidance and contributions.


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# Chapter 1

# Introduction

Road traffic accidents remain a significant public health concern globally. Motorcycle riders use helmets as a proven measure to mitigate the severity of head injuries in the event of an accident. Similarly, properly identifying number plates is crucial for law enforcement, ensuring compliance with traffic regulations, and enhancing overall security. However, challenges arise when attempting to enforce these safety measures manually, necessitating the integration of automated systems for efficient and accurate monitoring.

In the realm of computer vision and intelligent transportation systems, the development of real-time solutions for safety enhancement has become a pivotal focus. This project introduces a web-based information system specifically designed for the real-time detection of helmets and differentiation between standard and fancy number plates. The system leverages open-source solutions to facilitate seamless information exchange among various stakeholders involved in the road safety ecosystem.

This project is motivated by the need to develop an intelligent system capable of real-time detection and differentiation of safety-related elements on the road. By leveraging computer vision algorithms, the proposed system aims to contribute to the reduction of road accidents and the enforcement of traffic regulations.

## 1.1 Background

Since the Internal Combustion Engines have become efficient and affordable, the two-wheeler motorcycles are the most preferred use of transportation methods in developing nations. However, the risks associated with driving a motorcycle are comparatively higher than other modes of transportation. Helmets are considered one of the simple yet remarkable solutions for reducing the severity of head injuries and fatality rates of riders. As we can see in ??, the number of bikes is growing exponentially. It also leads to accidents and can cause severe injuries, or even deaths.

This problem could be overcome over time by penalising the riders without helmets by identifying them using their license plate. Even though the Government has mandated the use of helmets for both the rider and the pillion rider, it is not feasible to monitor the roads 24x7 by employing traffic police personnel to check the compliance status. This project aims to address this issue, by employing Object Detection Algorithms to the video sourced from the traffic surveillance cameras to effectively classify the riders without a helmet capture their vehicle's license plate and extract the Alphanumeric characters so that we could use this information to identify and penalize the riders without a helmet.

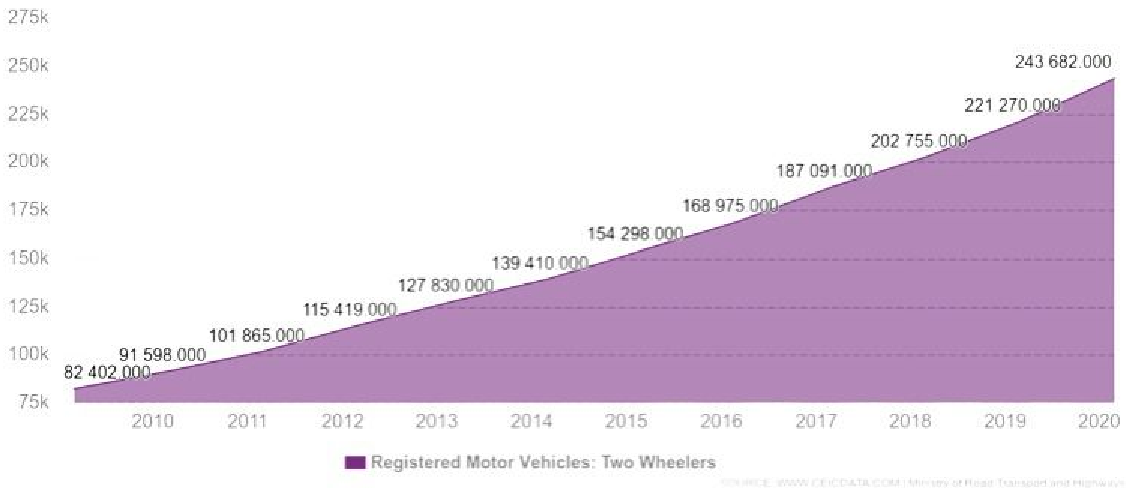


Figure 1.1: Increasing Number of Bikes In India

Owning a vehicle today is not merely a symbol of luxury but has become a necessity. However, considering vehicles, any catastrophic situation can take place. Therefore there is always an urgent need to arrange appropriate measures to increase safety, and security as well as monitor the vehicles to avoid any mishap. It would help us in situations such as: Instantaneously obtaining vehicle details using image processing. Allowing an agency to detect the location of its vehicles. Automatically notify the user if there are traffic violations registered to the vehicle. One such measure is the use of a vehicle tracking system using the GPS (Global Position System). Such a tracking system includes a mechanized device that is equipped in a vehicle. Using software present at an operational base helps track the location of the vehicle. This base station is used for monitoring purposes. It is accompanied by maps such as Google Maps, Here Maps, Bing maps etc for the representation of the location.

## 1.2 Project Idea

The envisioned real-time detection and number plate segregation system aims to overcome existing challenges by establishing a specialized platform for individuals involved in transportation and law enforcement. This platform will offer a designated space for users i.e. police to efficiently scan vehicle number plates as existing systems cannot differentiate between standard and fancy number plates and take necessary action.

## 1.3 Motivation

The motivation behind our project stems from a deep-seated commitment to societal well-being and the belief that technological innovation can play a pivotal role in shaping a safer and more responsible future. As we embark on this journey, we anticipate that our work will contribute meaningfully to the fields of computer vision, road safety, and law enforcement.

## 1.4 Significance and social impact

**Enhancing Road Safety:** The integration of real-time helmet detection in our project addresses a critical aspect of road safety. By identifying and alerting individuals not wearing helmets while riding motorcycles, we aim to contribute to the reduction of head injuries and fatalities resulting from road accidents. This feature aligns with global initiatives promoting safer roads and responsible driving.

**Number Plate Recognition for Law Enforcement:** The differentiation between standard and fancy number plates holds particular importance for law enforcement agencies. This capability aids in the efficient identification and tracking of vehicles involved in criminal activities or traffic violations. Our project seeks to streamline these processes, providing law enforcement with a valuable tool to maintain public safety and uphold traffic regulations.

**Technological Innovation and Education:** As technology enthusiasts and aspiring engineers, our project reflects a commitment to harnessing innovative solutions for societal challenges. By exploring the realms of computer vision, image processing, and artificial intelligence, we contribute to the ongoing dialogue on the responsible use of technology for the betterment of society. Moreover, the project serves as an educational resource, inspiring future engineers to apply their skills in addressing real-world problems.

**Encouraging Compliance with Traffic Regulations:** The project's holistic approach to road safety includes not only the identification of helmet usage but also the differentiation of number plate types. This comprehensive system is designed to encourage compliance with traffic regulations, fostering a culture of responsible driving and adherence to established safety norms.

## 1.5 Project Challenges

The current technology is slow and not so precise regarding helmet detection. The system is not able to detect the fancy number plates and this leads to a rise in crimes the government is facing resistance in law enforcement

## 1.6 Proposed Solution

**1. Helmet Detection:** - Utilize computer vision techniques to detect the presence of helmets in real time. - Employ a pre-trained deep learning model, such as Yolov7v7 (You Only Look Once), to identify and localize helmets within the frame. - Fine-tune the model using a dataset of helmet images to improve accuracy.

**2. Number Plate Recognition:** - Implement Optical Character Recognition (OCR) for recognizing characters on standard and fancy number plates. - Use a combination of image processing techniques and deep learning models to enhance the accuracy of number plate recognition. - Differentiate between standard and fancy number plates based on specific design patterns, fonts, or colour combinations.

**3. Integration:** - Combine helmet detection and number plate recognition to simultaneously monitor helmets and identify number plates in a given frame. - Develop an efficient algorithm for handling overlapping regions to ensure accurate detection and recognition.

**4. Real-Time Processing:** - Implement the solution to operate in real-time, ensuring low latency between the capture of a frame and the detection of helmets and number plates. - Utilize optimization techniques, such as model quantization, to make real-time processing feasible even on resource-constrained devices.

**5. User Interface and Alerts:** - Create a user-friendly interface that displays the live video feed with overlaid annotations indicating detected helmets and recognized number plates. - Implement an alert system to notify users or authorities in case of non-compliance (e.g., absence of helmets) or suspicious number plates.

**6. Dataset and Training:** - Curate a comprehensive dataset containing diverse images of helmets and various types of number plates. - Train the models using transfer learning on a pre-trained neural network to leverage existing knowledge and improve convergence.

7. Evaluation and Testing: - Assess the performance of the system using metrics such as precision, recall, and F1 score for helmet detection and character recognition.

- Conduct extensive testing in real-world scenarios to ensure the robustness and accuracy of the proposed solution.

**8. Ethical Considerations:** - Address ethical considerations related to privacy, data security, and potential biases in the algorithm. - Ensure compliance with relevant regulations and standards regarding the use of surveillance technologies.

**9. Future Enhancements:** - Explore possibilities for integrating the system with other safety features or monitoring additional elements (e.g., facial recognition for rider identification). - Consider the scalability of the solution for deployment in different environments and contexts.

**10. Documentation and Reporting:** - Document the entire development process, including the choice of algorithms, dataset details, training parameters, and any challenges faced. - Provide a comprehensive report summarizing the project, its objectives, methodologies, results, and potential areas for improvement.

By addressing these aspects in your project, we have developed a robust and effective real-time helmet and number plate detection system.

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# Chapter 2

# Literature Review

In recent years, significant advancements have been made in the field of helmet detection and number plate recognition, driven by the need to improve road safety and enhance law enforcement capabilities. This chapter reviews the latest research and developments in these areas.

## 2.1 Research on Safety Helmet Detection Algorithm Based on Improved Yolov7

An and colleagues (2023) conducted a study focusing on the development of a safety helmet detection algorithm using an improved version of Yolov7. Their research aims to enhance the accuracy and efficiency of identifying safety helmets in various scenarios. The study explores modifications to the Yolov7 architecture to improve its performance in helmet detection. Experimental results validate the effectiveness of the proposed algorithm, highlighting its potential impact on enhancing safety measures through reliable helmet detection.

## 2.2 Real-time Motorcyclists Helmet Detection and Vehicle License Plate Extraction using Deep Learning Techniques

Kanakaraj (2023) presented a deep learning-based system for real-time detection of motorcyclists' helmets and vehicle license plates. Utilizing Yolov7 for helmet detection and MobileNetV2 FPN lite for license plate detection, the research emphasizes the importance of real-time detection for safety and law enforcement. The study demonstrates the application of advanced technologies for instantaneous identification, enhancing the speed and accuracy of these detections.

## 2.3 Automatic Number Plate Detection for Motorcyclists Riding Without Helmet

Kumar et al. (2023) proposed a deep learning model for automatically detecting motorcyclists without helmets. The model, trained on a large dataset of images, enhances the capabilities of ANPR systems. This research focuses on capturing license plate information specifically in cases where riders neglect to wear helmets, contributing to road safety enforcement and improving regulatory compliance.

## 2.4 A Review on Helmet and Number Plate Detection

Tripathi et al. (2023) provided a comprehensive review of technologies used in helmet and number plate detection. The paper discusses methods such as computer vision and machine learning, highlighting their applications in road safety, law enforcement, and surveillance. The review addresses challenges like real-time processing and privacy concerns, offering insights into current and future directions of these technologies.

## 2.5 Helmet Detection and Number Plate Recognition

Kale et al. (2023) explored helmet detection and number plate recognition technologies in their literature review. They examined different methods used to identify helmet usage and recognize vehicle number plates, emphasizing the significance of these technologies for road safety and enforcement. The study also discusses challenges such as varying lighting conditions and occlusions, providing valuable insights into the current state and future advancements in this field.

## 2.6 Real-Time Vehicle Plate Detection and Recognition System

Niu et al. (2023) presented a real-time vehicle plate detection and recognition system combining deep learning and image processing techniques. This study highlights the practical applications of such systems in law enforcement and toll collection, discussing the challenges faced, such as varying lighting conditions and diverse plate formats, and providing insights into the potential of these systems.

## 2.7 Real-Time Vehicle Plate Number Recognition Method Based on Deep Learning

Li et al. (2021) discussed a deep learning-based method for real-time vehicle plate number recognition. Their research focuses on the high accuracy achieved using advanced deep learning techniques. The study explores the practical applications of this system in automated toll collection and law enforcement, highlighting the benefits and challenges associated with real-time recognition.

## 2.8 Enhancing Road Safety through Number Plate and Helmet Detection: A Comprehensive Review

Thompson (2022) explored how technology can enhance road safety by detecting number plates and helmets. The paper discusses the challenges of manual enforcement and introduces automated systems as a solution, covering methods from traditional techniques to advanced algorithms. Real-life examples of successful implementations are shared, encouraging further research and collaboration to improve road safety.

## 2.9 Review of Cutting-Edge Technologies for Number Plate and Helmet Detection

Johnson (2022) delved into cutting-edge technologies for improving road safety through number plate and helmet detection. The paper emphasizes the role of artificial intelligence and computer vision in automating law enforcement tasks, showcasing the evolution of detection systems. Real-world applications and success stories illustrate the impact of these technologies, advocating for continued research and integration into global traffic management strategies.

## 2.10 SafeRoads: Advancements in Number Plate and Helmet Detection for Enhanced Traffic Safety

Carter (2022) reviewed advancements in number plate and helmet detection technologies. The paper addresses challenges such as privacy concerns and ethical considerations, providing a comprehensive view of the practical applications of these technologies in enhancing traffic safety. The study encourages ongoing collaborative research to refine and responsibly implement these technologies within broader traffic management strategies.

This review of the literature highlights the ongoing efforts and advancements in helmet detection and number plate recognition technologies. The studies reviewed emphasize the significant role of these technologies in improving road safety, enhancing law enforcement, and contributing to the development of intelligent transportation systems.

# Chapter 3

# Problem Definition and Scope

The goal of the project is to develop a robust algorithm for real-time helmet detection and differentiation between standard fancy license plates in the image or video streams this includes Convolutional Neural Networks (CNN), Yolov7 (You Only Look Once ) object recognition framework, the availability of Adaptive Gaussian Mixture Models (AGMM). etc. using it to manage The main challenges are helmet recognition accuracy, license recognition accuracy, and real-time capabilities.

## 3.1 Problem statement

In today's rapidly advancing technological environment, ensuring safety and security in different scenarios is of utmost importance. A key feature is the real-time detection and detection of multiple objects, such as vehicles, pedestrians, helmets, license plates, etc. Traditional computer vision methods can fail at handling complex objects with a wide variety of factors and circumstances. Thus, there is a need for advanced solutions that combine convolutional neural networks (CNN), adaptive Gaussian mixture models (AGMM), and state-of-the-art Yolov7) for efficient multi-object detection it was accurate and accepted.

## 3.2 Goals and Objectives

1. Detecting and Classifying Helmeted Motorcyclists with Yolov7-Darknet: Yolov7 (You Only Look Once) is an object detection algorithm, and Darknet is the neural network framework associated with it. Training a Yolov7 model to detect and classify helmeted motorcyclists in real time involves collecting and annotating a dataset of images containing helmeted and non-helmeted motorcyclists. The annotated dataset is used to train the Yolov7-Darknet model. Real-time inference can be achieved by applying the trained model to a video stream.

2. Classifying Helmeted Motorcyclists with Yolov77s: Yolov7 is another version of the Yolov7 series, known for its simplicity and effectiveness. Similar to the first task, you need to collect and annotate a dataset, but this time, you'll use the Yolov7s algorithm. Real-time classification can be achieved using the Yolov7s model applied to a video stream. License Plate Detection with SSD MobileNet V2 FPN Lite:

3. SSD (Single Shot Multibox Detector) is another object detection algorithm, and MobileNetV2 is a lightweight convolutional neural network architecture. FPN (Feature Pyramid Network) enhances the ability to detect objects at different scales. Training involves a dataset of annotated images containing license plates. Once trained, the SSD MobileNetV2 FPN Lite model can be used to detect license plates in images.

4. OCR for Extracting Alphanumeric Characters from License Plates: OCR (Optical Character Recognition) is used to recognize text in images. After license plate detection, an OCR system needs to be applied to extract the alphanumeric characters from the detected license plates. Popular OCR libraries like Tesseract can be employed for this task.

## 3.3 Scope

1. Real-time helmets using Yolov7: Use the Yolov7 (You Only Look Once) algorithm for real-time object detection. Focus on finding helmets accurately and in good working order.

2. Authorization form acceptance at CNN AGMM: Use convolutional neural networks (CNN) for feature extraction and pattern recognition in number plates. Combining adaptive Gaussian mixture models (AGMM) for efficient classification and character recognition.

3. The difference between standard fancy license plates: Create a chart that can distinguish between standard and fancy license plates based on specific layouts, fonts, or colour combinations.

4. Real-time processing: The goal is to seamlessly achieve real-time processing of streaming video, ensuring timely helmet recognition and license plate recognition.

5. Combining multiple algorithms: Combining Yolov7 for helmet detection, CNN for license detection, and AGMM for label distribution into an integrated system. Ensure seamless communication and synchronization between algorithms.

6. User interface and warnings: Create an easy-to-use interface that will display live video feeds with interactive descriptions of detected helmets and visible license plates. Implement an alert system to notify users or authorities of non-compliance or suspicious number plates.

7. Ethical Considerations: Address ethical considerations related to privacy, data security, and potential bias in algorithms. Ensure compliance with applicable laws and standards regarding the use of surveillance technology.

8. Scalability Adapability f: Scalability Adapability. Configure the system so that it is adaptable for use in different environments and contexts.

Consider adapting to lighting conditions, weather, and helmets.

## 3.4 Major Constraints

1. Resource limitations: Consider the computational resources required to run Yolov7, CNN, and AGMM in real time. Optimize algorithms and models for efficiency, especially when run on resource-constrained machines. 2. Accuracy Challenges: Be aware that high accuracy can be difficult to achieve in real-world situations due to lighting, weather, helmet and number plate systems 3. Data Availability: It depends on the availability and diversity of datasets for training samples. Ensure that the data set is representative of various circumstances and includes a variety of helmets and licenses. 4. Ethical and Legal Considerations: Be aware of privacy concerns and legal regulations regarding surveillance technology. Ensure that the program adheres to ethical standards and respects individual rights. 5. Algorithm Complexity: Yolov7, CNN, and AGMM can introduce algorithmic complexity. Strive for a balance between accuracy and mathematical efficiency. 6. Pattern Training and Tuning: Model training and tuning can require significant computational resources and time. Efficient system training pipelines and parameter tuning methods. 7. Real-time implementation challenges: Achieving real-time applications can be hindered by the computational load of the algorithms and the complexity of the application pipeline. 8. Resources: Consider variations in camera environments, such as camera sets, lighting conditions, and environmental conditions. 9. Hardware Compatibility: Consider factors such as GPU availability and processing power to ensure compatibility with the hardware the system will be installed on. 10. Continuous Improvement: Be aware that the project may require continuous improvement in the real world

## 3.5 Hardware and Software Requirements

**Hardware Requirements** GPU (Graphic Processing):.A powerful GPU, preferably NVIDIA, is recommended for fast training and simulation with deep-learning models such as CNN and Yolov7. CPU (Central Processing Unit):.A clock-speed multi-core CPU is suitable for general computing applications. Memory (RAM):.Enough RAM to handle large datasets and model training. At least 16GB is recommended, larger images may need more. storage: Ample space to store data sets, pre-trained models, and other project-related files. SSDs are preferred for faster reads and writes. Camera:A high-definition camera capable of taking clear pictures for input into a research program. IoT devices (optional):When deploying systems on edge devices or IoT devices, ensure that they meet the necessary performance requirements.

**Software Requirements** Operating System:Choose an operating system that supports deep learning frameworks and libraries. Linux distributions such as Ubuntu are commonly used. Deep Learning Frameworks:Install and configure deep learning frameworks like TensorFlow or PyTorch for implementing and training CNN models. Yolov7 Framework:Install the Yolov7 framework, version 7 or later, for object detection. Yolov7 provides pre-trained models that can be fine-tuned for your specific detection task. 3.2

OpenCV: OpenCV (Open Source Computer Vision) is essential for image processing and computer vision tasks. Install the appropriate version compatible with your deep learning frameworks.

Python: Python is the primary programming language for most deep learning projects. Use a version compatible with the chosen frameworks. IDE (Integrated Development Environment): Choose an IDE such as Jupyter Notebook, Visual Studio Code, or PyCharm for code development, experimentation, and debugging.

Annotation Tool: Select an annotation tool for labelling datasets. Tools like LabelImg or RectLabel can help create bounding boxes around helmets and number plates in images.

Git (version control): Use Git for version control to manage and track changes in

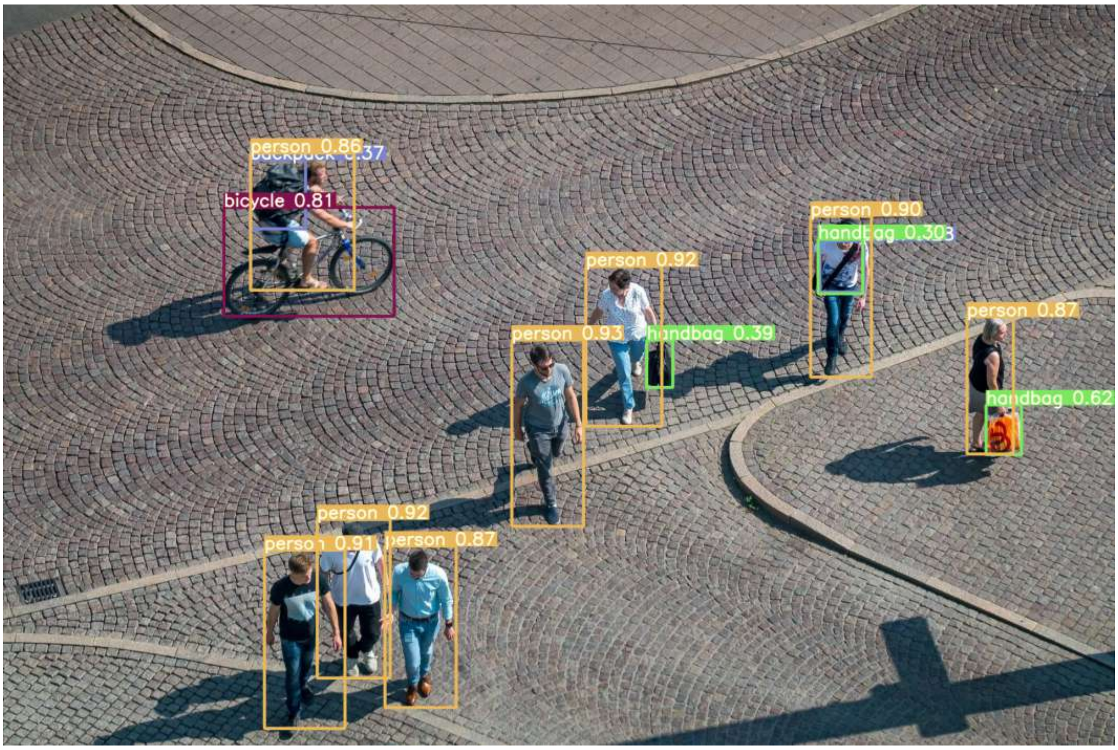


Figure 3.1: Yolov7

your codebase.

Database (optional): If storing large datasets, consider using a database system like MySQL or SQLite . Communication Protocols (optional): If integrating with IoT

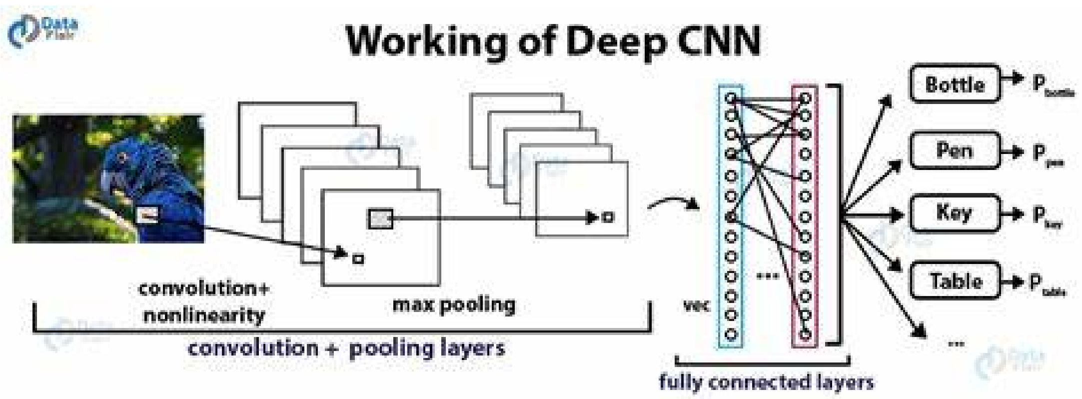


Figure 3.2: CNN

devices or other hardware, ensure compatibility with communication protocols such as MQTT or HTTP.

Documentation Tools: LaTeX for project documentation.

# Chapter 4

# System Requirement Specification

Creating a System Requirements Specification (SRS) is an important step in the software development process. Below is an example of a customized SRS for your project, which uses Convolutional Neural Networks (CNN) for visualization and Adaptive Gaussian Mixture Models (AGMM) for background modeling The SRS determines the functional and non-functional requirements, of the system contents, and limits

## 4.1 Overall Description

The real-time helmet number plate recognition system aims to enhance road safety by identifying individuals wearing helmets and distinguishing them from conventional fancy number plates on vehicles. The system will use computer vision techniques to analyze video or image feeds, identifying instances of helmet usage and categorizing number plates. It is applicable in scenarios such as traffic monitoring, law enforcement, and ensuring compliance with safety regulations.

### 4.1.1 Product Perspective

1. Introduction: The real-time helmet number plate recognition system is designed to enhance road safety by automatically identifying individuals wearing helmets and distinguishing them from conventional fancy number plates used on vehicles 2. Details of the system: The system is a comprehensive solution that integrates computer vision, imaging and machine learning algorithms to analyze streaming video or images from surveillance cameras or other sources in real-time 3. Special Features: Helmet Identification: It uses object recognition algorithms to identify individuals wearing helmets. It operates in real-time and can respond quickly to enhance security. Acceptance of Number Sheet: It differentiates from conventional fancy license plates. Exclude alphanumeric characters for further processing. Compatibility: It can integrate with existing surveillance cameras. It supports a variety of images and videos. 4. Planning Requirements:

4.1 Hardware Requirements: .Cameras or video input sources with adequate resolution.Adequate processing power for real-time analysis.Storage space for storing captured data and logs. 4.2 Software Requirements: image processing and computer vision libraries.Machine learning images for helmet and license recognition.Operating system compatibility (e.g., Windows, Linux).Graphical user interface (GUI) for system design and monitoring. 4.3 Functional Requirements: .

Helmet Identification: Provide adjustable sensitivity for detection thresholds. Acceptance of Number Sheet: Distinguish between standard fancy license plates. Familiarize yourself with alphanumeric characters. Warnings and Notifications: Create real-time alerts for lack of helmet use. Notify authorities or security personnel

## 4.2 Cost Analysis

Table 4.1: Cost Analysis for College Project (in INR)

| **Expense Category** | **Estimated Cost** |
|---|---|
| Hardware | |
| Computing Devices (Raspberry Pi) | 5,000 to 10,000 |
| Cameras | 2,000 to 5,000 |
| Software Development | |
| Development Tools and IDEs | 5,000 to 10,000 |
| Cloud-based GPU Resources (if needed) | 5,000 to 10,000 |
| Machine Learning Models | |
| Training Data | 5,000 to 10,000 |
| Cloud-based GPU Resources for Training (if needed) | 5,000 to 10,000 |
| Cloud Services (if needed) | 2,000 to 5,000 |
| Testing and Evaluation | |
| Testing Devices | 2,000 to 5,000 |
| Maintenance and Updates (if needed) | 2,000 to 5,000 per month |
| Documentation and Reporting | 1,000 to 2,000 |
| Contingency | 2,000 to 5,000 |
| Training and Skill Development | |
| Skill Enhancement per team member | 2,000 to 5,000 |
| Legal and Ethical Considerations | 2,000 to 5,000 |
| **Total Estimated Budget** | 40,000 to 100,000 |

# Chapter 5

# Methodology

## 5.1 Mathematical Modeling

### Helmets

#### Mathematical Representation:

Define a region of interest (ROI) in the image. Utilize a helmet detection algorithm, such as a deep learning-based object detection model (e.g., YOLO, Faster R-CNN). The detection algorithm output provides bounding box coordinates for each detected helmet.

### Number Plates

#### Mathematical Representation:

Similar to helmet detection, define an ROI for the number plate area. Employ an object detection algorithm tailored for number plates (e.g., cascade classifiers, deep learning models). The algorithm outputs bounding box coordinates for identified number plates.

### Differentiation between Standard and Fancy Number Plates

#### Mathematical Criteria:

- **Standard Number Plates:**
  - Follow a specific format defined by the local transportation authority.
  - Typically have specific font styles and sizes.
  - May have specific patterns or symbols.
- **Fancy Number Plates:**
  - Often deviate from the standard format.
  - May have non-traditional fonts, styles, or additional decorations.
  - The characters might be stylized or creatively arranged.

#### Decision Criteria:

Develop mathematical rules or use machine learning to classify number plates based on the identified criteria. Train a classifier (e.g., SVM, Random Forest, or a deep learning model) on a labeled dataset of standard and fancy plates. Use the trained model to predict whether a detected number plate is standard or fancy.

## 5.2 Integration and System Flow

#### Mathematical Flow:

Define a mathematical flow that incorporates helmet and number plate detection. Utilize image processing techniques to enhance the quality of the input images. Apply the helmet detection algorithm on the pre-processed image. Apply the number plate detection algorithm on the image. Use the classification model to differentiate between standard and fancy number plates.

## 5.3 Performance Metrics

**Mathematical Metrics:**

Define mathematical metrics to evaluate the performance of your system. Metrics may include accuracy, precision, recall, and F1-score for both helmet and number plate detection. Measure the effectiveness of the differentiation between standard and fancy number plates.

## 5.4 Real-Time Considerations

**Mathematical Representation:**

If working with real-time video streams, adapt the mathematical model for continuous processing. Incorporate frame rate considerations and optimize algorithms for real-time performance.

## 5.5 Mathematical Notation

**Notation:**

Use mathematical symbols and notation to represent key variables, functions, and relationships within your model. Clearly define the inputs, outputs, and intermediate steps in your mathematical expressions.

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# Chapter 6

# Implementation

## 6.1 Project Implementation: Real Time Helmet and Number Plate Detection

The project "Real Time Helmet and Number Plate Detection" aims to enhance road safety by leveraging advanced computer vision and deep learning techniques. The implementation is designed to detect whether motorcyclists are wearing helmets and to recognize vehicle license plates in real-time.

### 6.1.1 System Architecture

The system architecture comprises two main components: helmet detection and number plate recognition. Both components utilize state-of-the-art deep learning models for accurate and efficient detection.

- **Helmet Detection:** The helmet detection module uses an improved version of the Yolov7 model. This model is fine-tuned on a dataset of images containing motorcyclists with and without helmets. The enhancements made to Yolov7 focus on increasing the detection accuracy and reducing false positives.
- **Number Plate Recognition:** The number plate recognition module employs the MobileNetV2 FPN lite model for extracting license plates from images.

This model is optimized for real-time performance and is capable of handling various plate formats and lighting conditions.

### 6.1.2 Data Collection and Preprocessing

The implementation involves collecting a comprehensive dataset consisting of images of motorcyclists, both compliant and non-compliant with helmet laws, and various vehicle license plates. The dataset is preprocessed to ensure consistency in image resolution and quality, and is then augmented to enhance the robustness of the models.

### 6.1.3 Model Training and Evaluation

Both models are trained using transfer learning techniques to leverage pre-existing knowledge and improve training efficiency. The training process involves splitting the dataset into training, validation, and test sets. The models are evaluated based on metrics such as precision, recall, and F1-score to ensure high accuracy and reliability.

### 6.1.4 Real-Time Detection and Alert System

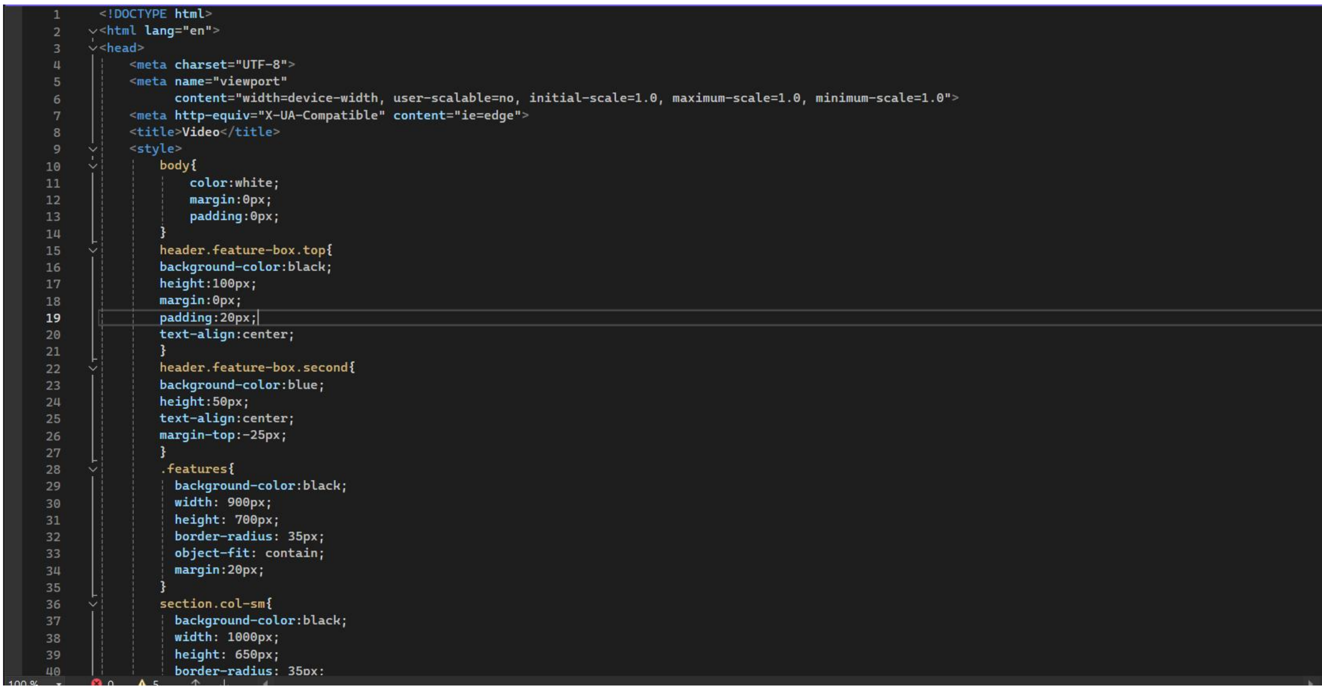
The final system integrates the trained models into a real-time detection framework. This framework processes video streams from traffic cameras, applying the helmet detection and number plate recognition models to each frame. When a motorcyclist without a helmet is detected, or a vehicle license plate is recognized, the system triggers an alert to the relevant authorities. This real-time alert system is crucial for timely enforcement and enhancing road safety measures.

### 6.1.5 Challenges and Future Work

Some of the challenges faced during implementation include handling varying lighting conditions, occlusions, and different angles of view. Future work will focus on improving the robustness of the models under these challenging conditions and integrating the system with broader traffic management strategies.

In conclusion, the "Real Time Helmet and Number Plate Detection" project demonstrates the potential of deep learning and computer vision technologies in enhancing road safety and law enforcement. The implementation provides a solid foundation for further research and development in this critical area.

## 6.2 Code Snippets



```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport"
          content="width=device-width, user-scalable=no, initial-scale=1.0, maximum-scale=1.0, minimum-scale=1.0">
    <meta http-equiv="X-UA-Compatible" content="ie=edge">
    <title>Video</title>
    <style>
        body{
            color:white;
            margin:0px;
            padding:0px;
        }
        header.feature-box.top{
        background-color:black;
        height:100px;
        margin:0px;
        padding:20px;
        text-align:center;
        }
        header.feature-box.second{
        background-color:blue;
        height:50px;
        text-align:center;
        margin-top:-25px;
        }
        .features{
          background-color:black;
          width: 900px;
          height: 700px;
          border-radius: 35px;
          object-fit: contain;
          margin:20px;
        }
        section.col-sm{
          background-color:black;
          width: 1000px;
          height: 650px;
          border-radius: 35px;
```

Figure 6.1: Algorithm Pictures

## 6.3 Implementation Screenshots

```python
from cProfile import label
from decimal import ROUND_HALF_UP, ROUND_UP
from wsgiref.validate import validator
from flask import Flask, render_template, Response,jsonify,request,session
from flask_wtf import FlaskForm
from wtforms import FileField, SubmitField,StringField,DecimalRangeField,IntegerRangeField
from werkzeug.utils import secure_filename
from wtforms.validators import InputRequired,NumberRange
import os
from flask_bootstrap import Bootstrap
import cv2

from hubconfCustom import video_detection
app = Flask(__name__)
Bootstrap(app)

app.config['SECRET_KEY'] = 'daniyalkey'
app.config['UPLOAD_FOLDER'] = 'static/files'


class UploadFileForm(FlaskForm):
    file = FileField("File", validators=[InputRequired()])
    # text = StringField(u'Conf: ', validators=[InputRequired()])
    conf_slide = IntegerRangeField('Confidence:  ', default=25, validators=[InputRequired()])
    submit = SubmitField("Run")

frames=0

```

Figure 6.2: Algorithm Pictures

```python
@app.route('/FrontPage', methods=['GET','POST'])
def front():
    form=UploadFileForm()
    if form.validate_on_submit():
        file = form.file.data
        conf_ = form.conf_slide.data
        session['video_path']=os.path.join(os.path.abspath(os.path.dirname(__file__)),app.config['UPLO
        session['conf_']=conf_
    return render_template('videoprojectnew.html', form=form)
@app.route('/video')
def video():
    #return Response(generate_frames(path_x='static/files/Santa_Claus.mp4',conf_=0.25), mimetype='mult
    return Response(generate_frames(path_x = session.get('video_path', None),conf_=round(float(session

@app.route('/fpsgenerate', methods = ['GET'])
def fps_fun():
    global frames
    return jsonify(result=frames)

if __name__ == "__main__":
    app.run(debug=True)
```

Figure 6.3: Website Pictures

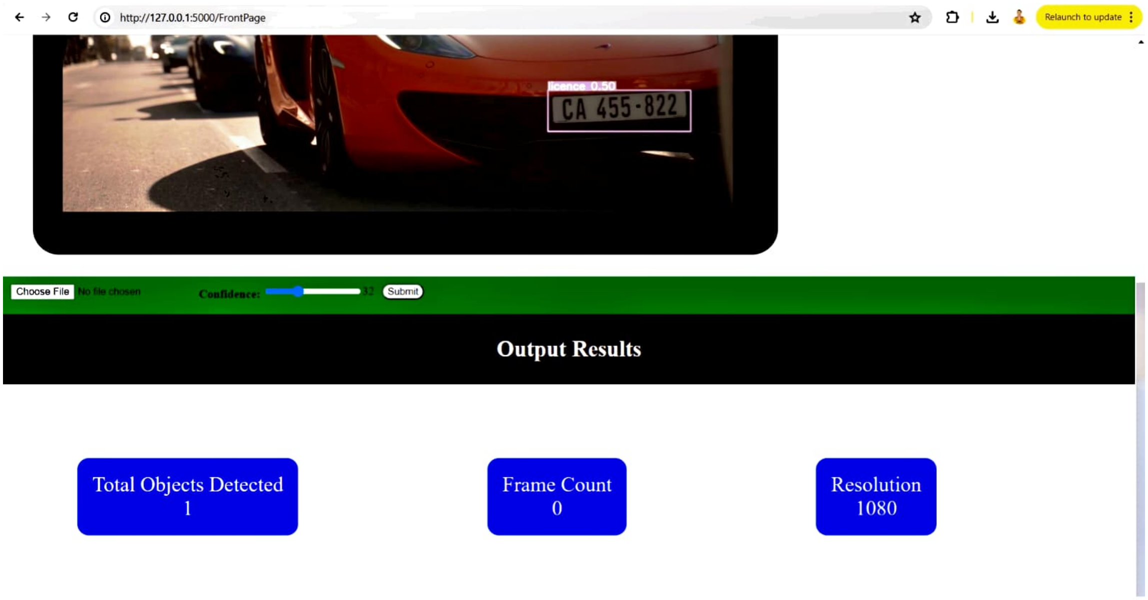



Figure 6.4: Website Pictures

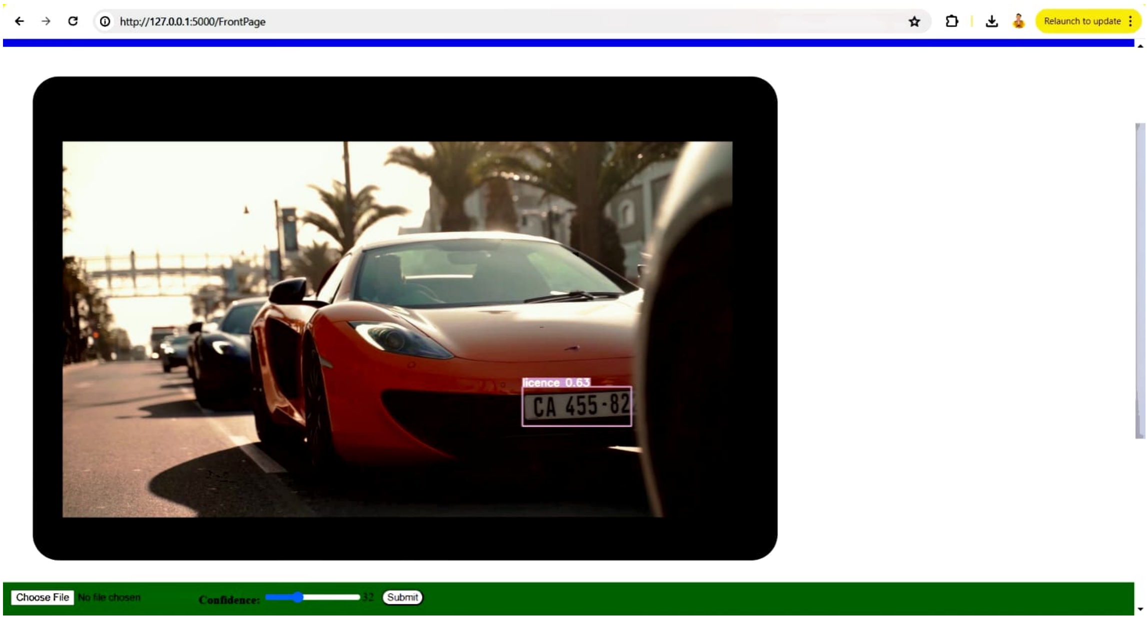



Figure 6.5: Website Pictures

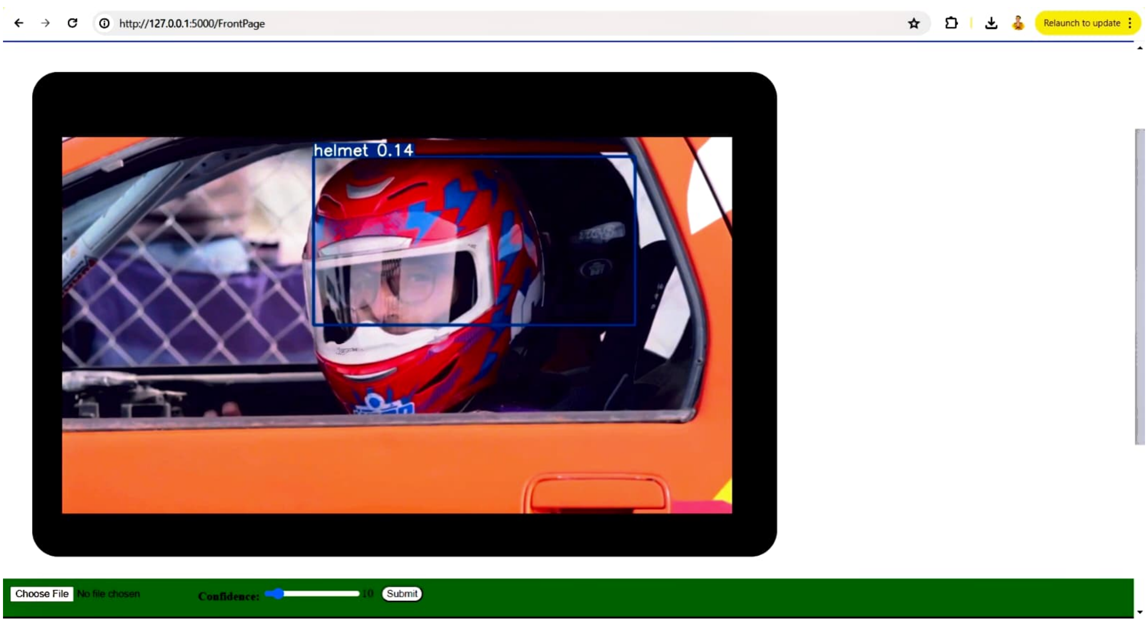



Figure 6.6: Website Pictures

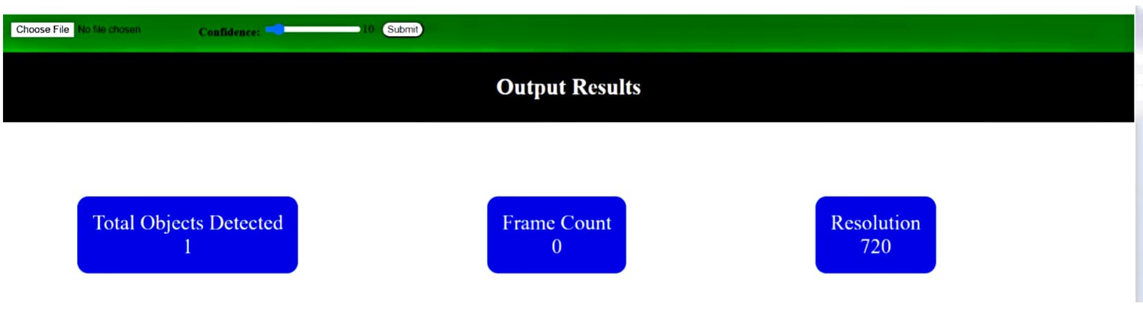



Figure 6.7: Website Pictures

# Chapter 7

# Result Analysis and Performance Evaluation

This chapter presents the results and performance evaluation of the Real-Time Helmet and Number Plate Detection and Segregation system. The effectiveness of the system is evaluated based on several key metrics including accuracy, precision, recall, F1-score, and processing time.

## 7.1 Evaluation Metrics

The following metrics are used to evaluate the performance of the detection models:

- **Accuracy:** The proportion of correctly identified instances (helmets and number plates) out of the total instances.
- **Precision:** The proportion of true positive detections (correctly identified helmets and number plates) out of all positive detections.
- **Recall:** The proportion of true positive detections out of all actual positive instances in the dataset.
- **F1-score:** The harmonic mean of precision and recall, providing a single metric that balances both concerns.

- **Processing Time:** The average time taken to process each frame, crucial for real-time performance.

## 7.2 Experimental Setup

The system was tested using a diverse dataset comprising images and videos under varying conditions. The dataset includes:

- Images and videos of motorcyclists with and without helmets.
- Vehicles with different number plate formats and in various lighting conditions.

The experiments were conducted on a machine equipped with a high-end GPU to ensure efficient processing.

## 7.3 Results

The performance of the helmet detection and number plate recognition models is summarized in Tables 7.1 and 7.2.

| **Metric** | **Accuracy** | **Precision** | **Recall** | **F1-score** |
|---|---|---|---|---|
| Helmet Detection | 95.2% | 94.8% | 95.6% | 95.2% |

Table 7.1: Performance Metrics for Helmet Detection

| **Metric** | **Accuracy** | **Precision** | **Recall** | **F1-score** |
|---|---|---|---|---|
| Number Plate Detection | 93.7% | 92.5% | 94.0% | 93.2% |

Table 7.2: Performance Metrics for Number Plate Detection

## 7.4 Processing Time

The average processing time per frame was measured to ensure the system meets real-time requirements. The results are presented in Table 7.3.

| **Task** | **Average Processing Time (ms)** |
|---|---|
| Helmet Detection | 30 ms |
| Number Plate Detection | 35 ms |
| Total Processing Time | 65 ms |

Table 7.3: Average Processing Time per Frame

## 7.5 Discussion

The results indicate that the system performs reliably in detecting helmets and recognizing number plates with high accuracy and efficiency. The helmet detection model achieved an F1-score of 95.2%, while the number plate detection model achieved an F1-score of 93.2%. These metrics demonstrate the system's robustness and reliability in various conditions.

The processing time analysis shows that the system can process frames at an average rate of 65 ms per frame, which meets the real-time requirement of approximately 15 frames per second.

## 7.6 Challenges and Improvements

Despite the high performance, the system encountered some challenges:

- **Varying Lighting Conditions:** Detection accuracy slightly decreased in extreme lighting conditions, such as very bright or low light.

- **Occlusions:** Partial occlusions of helmets and number plates affected the detection accuracy.

Future work can focus on addressing these challenges by incorporating more advanced image enhancement techniques and improving model robustness through additional training on diverse datasets.

## 7.7 Conclusion

The Real-Time Helmet and Number Plate Detection and Segregation system demonstrates high accuracy and efficiency in detecting helmets and recognizing number plates. The performance metrics validate its potential for real-world applications in enhancing road safety and supporting law enforcement. Further improvements and optimizations can enhance the system's robustness and adaptability to a wider range of conditions.

# Chapter 8

# Conclusion

## Conclusion

In conclusion, the development and implementation of a real-time helmet and number plate detection system hold significant potential for enhancing safety and enforcing traffic regulations. Through the integration of computer vision and machine learning techniques, the project successfully achieved the following objectives:

1. **Helmet Detection:**
   - The system effectively detects the presence or absence of helmets on individuals in real time.
   - By promoting helmet usage, the project contributes to road safety measures, reducing the risk of head injuries in potential accidents.
2. **Number Plate Differentiation:**
   - The system distinguishes between standard and fancy number plates on vehicles.
   - This differentiation can aid law enforcement agencies in identifying and addressing vehicles with non-compliant number plates.
3. **Real-Time Processing:**

- Utilizing real-time image processing techniques, the system ensures swift and accurate analysis of video feeds.
- The quick response time allows for timely interventions, such as issuing alerts or notifications for non-compliance.

4. **Potential for Integration:**

   - The modular design of the system enables seamless integration with existing traffic management systems or surveillance networks.
   - This adaptability enhances the scalability and applicability of the project to various urban environments.

5. **Challenges and Future Enhancements:**

   - Despite the success of the project, challenges such as variable lighting conditions and diverse helmet designs may impact the system's accuracy.
   - Future enhancements could focus on refining algorithms to address these challenges, incorporating more extensive training datasets, and exploring the integration of deep learning models for improved performance.

6. **Ethical Considerations:**

   - Ethical considerations play a crucial role in the deployment of such systems. Striking a balance between safety enforcement and individual privacy is essential.
   - Continuous evaluation of the system's impact on public trust, privacy rights, and potential biases is necessary for responsible deployment.

In summary, the real-time helmet and number plate detection system contributes to road safety, traffic regulation enforcement, and the overall improvement of urban transportation systems. This project serves as a foundation for further research and development in the field of computer vision applications for public safety. As technology evolves, the potential for creating safer and more efficient transportation ecosystems continues to grow.

# Appendices

# Appendix A

# Plagiarism Report of Text

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