Project Phase II Report On

ENHANCED OVERTAKING MANAGEMENT SYSTEM WITH INTER-VEHICULAR COMMUNICATION AND BLACK BOX

Submitted in partial fulfillment of the requirements for the award of the degree of

Bachelor of Technology

in

Computer Science and Engineering

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CERTIFICATE

This is to certify that the project report entitled ***"Enhanced Overtaking Management System with Inter-Vehicular Communication and Black Box"*** *is a bonafide record of the work done by* ***Harikrishnan R. (U2004039)****,* ***Mathew Shaji (U2004051)****,* ***Jai Mathew James (U2003099)****,* ***Hariraman M. (U2003091)****, submitted to the Rajagiri School of Engineering & Technology (RSET) (Autonomous) in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology (B. Tech.) in Computer Science and Engineering during the academic year 2023-2024.*

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Abstract

Enhanced Overtaking Management System with Inter-Vehicular Communication and Black Box addresses critical challenges associated with overtaking maneuvers, focusing on safety enhancement through the integration of Inter-Vehicular Communication (IVC) and Black Box technology. Overtaking on bridges is dangerous due to the increased risk of collisions with oncoming traffic and the limited visibility caused by large vehicles ahead further complicates the problem.

The project includes overtaking detection in bridges , a chat app that allows the driver to communicate with others drivers for requesting and granting permission to overtake and a black box . Enhanced Overtaking Management System with Inter-Vehicular Communication and Black Box helps to identify the traffic violators in bridges and reports them, it also guides the drivers for a safe overtake with minimal risk and in case of a worst case scenario if an accident occurs the black box helps to identify what really happened.

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List of Abbreviations

IoV - Internet Of Vehicle

V2V - Vehicle to Vehicle Communication

TCP - Transmission Control Protocol

EOMS- Enhanced Overtaking Management System

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Chapter 1

Introduction

1.1 Background

In modern traffic management, overtaking maneuvers pose a significant risk to road safety, especially in scenarios like bridges, where limited visibility and confined spaces increase the chances of collisions with oncoming traffic. Drivers of both cars and motorcycles encounter a heightened challenge when attempting to overtake large vehicles, leading to impaired visibility and an increased chance of accidents.

Existing traffic management systems often lack the sophistication needed to offer real-time insights and warnings to drivers attempting overtaking on bridges. This creates a need for a comprehensive solution that integrates the latest cutting edge technologies. IVC facilitates seamless communication between vehicles, enabling the exchange of crucial data to enhance situational awareness during overtaking maneuvers.

Overtaking accidents present considerable challenges for investigators, insurance firms, and regulatory bodies in identifying root causes and implementing preventive measures. A thorough understanding of the dynamics of overtaking incidents is essential for enhancing road safety standards, formulating effective traffic regulations, and mitigating the overall economic and social impact of such accidents.

Considering these factors, the Enhanced Overtaking Management System with Inter-Vehicular Communication and Black Box technology stands out as a strategic and technologically advanced solution. By addressing the specific challenges associated with overtaking on bridges and introducing a system that not only prevents accidents but also assists in thorough post-incident investigations.

1.2 Problem Definition

Overtaking on bridges poses a significant safety risk, increasing the chance of collisions with oncoming traffic due to limited visibility.This danger is compounded when driving behind large vehicles, causing a substantial lack of vision for car and motorcycle drivers.

- Overtaking in bridges is also a threat for pedestrians and cyclists.
- In the aftermath of overtaking incidents, understanding the accident's root cause is vital for investigators, insurance companies, and regulatory bodies. Current limitations in data availability hinder accurate analysis and preventive measures.

1.3 Scope and Motivation

The scope of the Enhanced Overtaking Management System is to create a comprehensive solution that addresses the specific challenges related to overtaking on bridges. This system aims to improve road safety by emphasizing real-time communication between vehicles during overtaking, particularly in situations where there are significant risks due to limited visibility and confined spaces. The scope of the project involves the incorporation of advanced technologies, specifically Inter-Vehicular Communication (IVC) and Black Box technology, to offer a holistic approach to enhancing overtaking safety. The Enhanced Overtaking Management System endeavors to establish a safer driving environment by alleviating the risks associated with overtaking, especially on bridges, and ensuring that drivers are equipped with essential information and warnings to make well-informed decisions during such maneuvers.

The motivation behind developing the Enhanced Overtaking Management System stems from a compelling need to reduce the frequency and severity of accidents resulting from overtaking maneuvers, especially on bridges. The concerning statistics and safety apprehensions linked to overtaking incidents emphasize the need for an advanced solution that surpasses traditional traffic management systems.Through the improvement of vehicle communication via IVC and the utilization of Black Box technology for post-accident analysis, EOMS strives to establish a comprehensive safety framework.The motivation is grounded in the aspiration to not only prevent accidents but also contribute valuable data for investigations, fostering a deeper understanding of the causes and facilitating the targeted implementation of preventive measures. Ultimately, the motivation aims to enhance road safety standards and markedly reduce the impact of accidents related to overtaking on the road network.

1.4 Objectives

1. Enhance Overtaking Safety: Create a system that lowers the chance of crashes with approaching traffic, hence greatly increasing safety during overtaking operations, with an emphasis on situations like bridges.

2. Real-Time Communication: Inter-Vehicular Communication (IVC) should be implemented to provide for smooth, real-time communication between cars. This will give drivers timely alerts and information when they try to overtake.

3. Vision Enhancement: Reduce the blind spots generated by large vehicles ahead of the driver by utilizing technology solutions that improve visibility, particularly in instances where passing is difficult.

4. Integrate Cutting-Edge Technologies: To guarantee a thorough and sophisticated approach to surpassing safety, incorporate cutting-edge technologies like IVC and Black Box technology. This will enable efficient post-accident analysis and preventive measures.

5. Accident Data Collection: Using Black Box technology, make it easier to gather comprehensive data on overtaking incidents. This information will help regulatory bodies, insurance providers, and investigators better understand the causes of accidents and put preventive measures in place.

6. Enhance Road Safety Standards: By tackling the unique difficulties posed by over-

taking on bridges, you may help raise the bar for road safety standards and ultimately lower the frequency and severity of accidents involving overtaking operations on the road network.

1.5 Challenges

- 1.High quality camera is required for accurately identifying the vehicle and the number plate. The camera should work in all envioumment conditions.
- 2.The output obtained should be accurate.The number plate should be correctly identified.
- 3.High performance system is to be used to avoid any delay or lag.
- 4.The payment should be secure and safe. The violators should be able to pay the fine without any issue.
- 5.Usually there is a latency or delay in communication such problems should be avoided in this V2V communication.
- 6.It is difficult to consider irrational drivers.

1.6 Assumptions

- 1.Vehicles are equipped with compatible communication systems capable of exchanging real-time data.All vehicles should have digital screen and a wifi of its own.
- 2.Number Plate of the vehicle should be clear and detectable. If the numberplate is not clear or consise it would be difficult for the camera to recognize them.
- 3.Drivers must be willing to adopt and responsibly use this technology to ensure its effectiveness.
- 4.Minimum distance between vehicles is assumed to be 10cm to 150 cm away . Detecting while to close and to far may not be accurate .
- 5.The Black Box is assumed to be Indestructible.In case of an accident or a fire the Black Box should not be affected.

- 6.Data Privacy and Security.Since the audio and video is recorded it should not be hacked or seen by a third party device or software.

1.7 Societal / Industrial Relevance

The initiative, which tackles important issues in traffic management and road safety, has enormous societal and industrial significance. By decreasing the incidence of accidents caused by overtaking movements, the Enhanced Overtaking Management System (EOMS) directly improves community well-being in a societal setting. The system's use on bridges, where there is a greater chance of collisions with incoming vehicles, is in line with larger initiatives to improve public safety and lessen the negative social and financial effects of traffic accidents.

By using state-of-the-art technologies like Black Box and Inter-Vehicular Communication (IVC), the project is positioned to lead the way in intelligent transportation system developments. This not only solves current safety issues, but it also fits with industry trends that support the use of smart technologies for a safer and more effective transportation network.

The project's significance also extends to regulatory agencies, insurance firms, and investigators who can make use of the extensive data that EOMS provides for post-accident investigation. The knowledge acquired can help establish focused preventive actions, enhance insurance risk assessments, and influence regulatory decisions—all of which can increase the transportation industry's overall resilience.

1.8 Organization of the Report

The project unfolds in several key sections. Beginning with an Introduction, it delves into the Area of Research, shedding light on the risk associated with overtaking in bridges along with the role and necessity of Inter vehicular communication and Black Box .It also outlines the limitations of current technologies. A detailed Literature Review follows, encompassing a thorough Literature Survey, Comparative Study, and a conclusive Summary. The Conclusion summarizes the research, and Future Directions suggest avenues for extended exploration. The report culminates with a comprehensive list of References..

1.9 Conclusion

In conclusion, the Enhanced Overtaking Management System (EOMS) represents a pivotal advancement in addressing the complex challenges associated with overtaking maneuvers, particularly on bridges. By prioritizing safety through real-time communication, vision enhancement, and the integration of cutting-edge technologies like Inter-Vehicular Communication (IVC) and Black Box systems, EOMS aims to redefine the landscape of road safety. The project's comprehensive approach not only mitigates the risks inherent in overtaking on bridges but also contributes to a broader societal goal of reducing road accidents and their consequential impacts.

Looking ahead, the effective deployment of EOMS has the potential to change how safety regulations and traffic management operate. The project's societal and industrial significance highlights its capacity to improve public health, transform transportation networks, and supply vital information for accident investigations and preventative actions. With its cutting-edge solutions and sophisticated technology, EOMS is proof of the ongoing efforts to make improvements that put our road networks' efficiency and safety first.

Chapter 2

Literature Survey

2.1 DSRC Versus LTE-V2X: Empirical Performance Analysis of Direct Vehicular Communication Technologies[1]

2.1.1 Introduction

The paper focuses on comparing two vehicular communication technologies, Dedicated Short-Range Communication (DSRC) and LTE Vehicle-to-Everything (V2X), in terms of their performance in real-world scenarios for road safety and traffic efficiency applications. DSRC relies on the IEEE 802.11p standard for its PHY and MAC layer, while LTE-V2X is based on 3GPP's Release 14 and operates in a distributed manner without cellular infrastructure

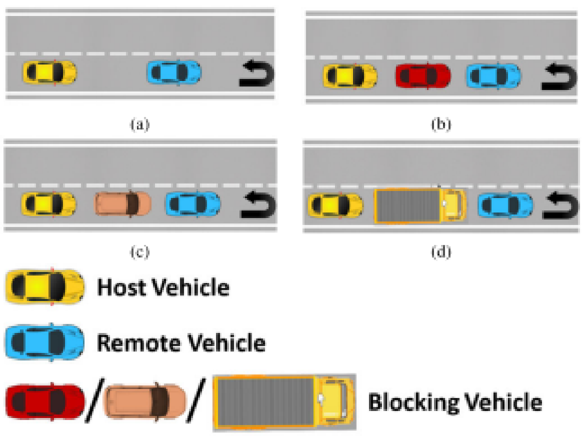

Figure 2.1: Communication Scenarios

2.1.2 Methodologies

The paper has mainly 2 methods, DSRC(Direct Short range communication) and LTE-V2X. It includes simulation-based analysis to evaluate the performance of DSRC and

LTE-V2X. Various studies are referenced that investigate the effect of MAC and PHY layer parameters, resource allocation protocols, transmission error models, resource reservation periodicity, and the impact of different road topologies and traffic models on the performance of LTE-V2X. The paper also conducts a comprehensive comparison between DSRC and LTE-V2X through a series of field tests to assess their relative performance in real-world scenarios. The goal is to select an adequate technology based on service performance requirements.

2.1.3 Advantages

- DSRC utilizes the IEEE 802.11p standard for its PHY and MAC layers, which simplifies authentication, data transmission, and enables direct broadcasting of relevant security information to neighboring units.

- DSRC operates in the 5.9 GHz band, which is dedicated to ITS applications, ensuring interference-free communication for vehicular safety applications.

- Conducts field tests and simulations to evaluate the performance of DSRC and LTE-V2X in various real-world scenarios, including Line of Sight (LOS), Non-Line of Sight (NLOS), and Obstructed-LOS (OLOS) channel scenarios.

2.1.4 Disadvantages

- DSRC's reliance on the 802.11p standard limits its scalability, as it may struggle to handle a large number of connected vehicles and high-density traffic scenarios.

- DSRC's hardware design and synchronization requirements can be more complex compared to LTE-V2X, making it potentially more challenging to deploy and maintain.

- SRC operates in the 5.9 GHz band, which provides limited bandwidth for communication compared to LTE-V2X, potentially limiting the data rate and capacity of the system.

2.1.5 Conclusion

The paper provides a thorough comparison of the PHY and MAC layer topologies of two vehicular communication systems, DSRC and LTE-V2X. Through field testing, the study assesses how well both technologies function. Under actual driving situations. It evaluates their communication range, dependability, and capacity to send data in various packet sizes. The findings demonstrate that providing geographical diversity increases the effective communication range of LTE-V2X and DSRC. LTE-V2X works better for smaller packet sizes, while DSRC offers a longer range for higher packet sizes.

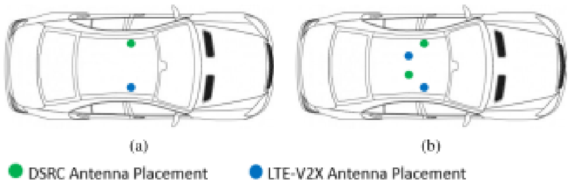

Figure 2.2: Antenna Placement.

2.2 Enhancing Reliability in 5G NR V2V Communications Through Priority-Based Groupcasting and IR-HARQ[2]

2.2.1 Introduction

The paper focuses on enhancing reliability in 5G NR V2V communications through priority-based groupcasting and IR-HARQ. The paper proposes an efficient transmission allocation system and analyzes the trade-off between delay time, reliability, and throughput when applying HARQ to broadcast, unicast, and groupcast in 5G NR V2X mode 2 environments. The paper also proposes a method to maximize reliability using HARQ while placing constraints on delay time and outage probability, and calculates and analyzes throughput based on this proposal.

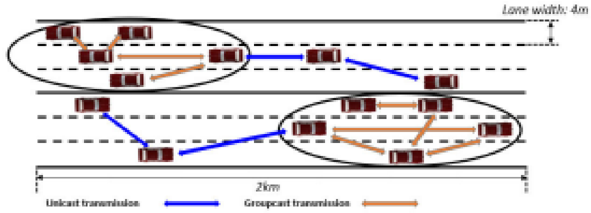

Figure 2.3: Uni/Groupcast scenario in simulation.

2.2.2 Methodologies

Priority-based groupcasting with IR-HARQ is a method proposed to enhance reliability and resource efficiency in 5G NR V2V communications. It involves assigning casting strategies to each Vehicle User Equipment (VUE) based on a combination of broadcast, unicast, and groupcast. The groupcast-based resource allocation system prioritizes groupcast transmission and applies a selection method for grouping and determining each vehicle's casting strategy. The method considers factors such as the vehicle's location, the size of the group it belongs to, etc.

2.2.3 Advantages

- Priority-based groupcasting method enhances communication reliability and efficiency in 5G NR V2V communications.
- The method achieves high reliability and throughput by adjusting the amount of retransmitted data through constraints on delay and outage probability, maximizing throughput.

2.2.4 Disadvantages

- It may face challenges in scalability as the number of vehicles increases.
- Information will be passed to a large community of vehicles even if it is not needed to be sent.

2.2.5 Conclusion

The study suggests using IR-HARQ in conjunction with a priority-based groupcasting technique to improve throughput and reliability in 5G NR V2X mode 2 scenarios. The greatest distance that satisfies the goal packet reception ratio (PRR) is increased and the reliability of V2V links is greatly enhanced when IR-HARQ is applied to each casting approach, according to the simulation results. Priority-based groupcasting preserves the maximum distance that meets the required PRR while achieving a 13% throughput increase. Moreover, compared to traditional broadcasting, increasing throughput by limiting delay and outage probability boosts it by up to 98%.

2.3 Distributed Deep Deterministic Policy Gradient for Power Allocation Control in D2D-Based V2V Communication[3]

2.3.1 Introduction

The algorithm facilitates distributed training across multiple agents or parallel environments, enhancing sample efficiency through asynchronous updates of actor and critic networks. By addressing challenges in stability and exploration, DDPG aims to achieve robust and scalable learning in complex reinforcement learning scenarios.

2.3.2 Methodologies

Here we use a deep deterministic policy gradient. We train a model to perform v2v communication. Devices are considered as Vehicles. The model is trained under a parallel environments, across multiple agents and enhances sample efficiency through asynchronous updates of actor and critic networks. This will get us precise output as it is trained only for this specific purpose.

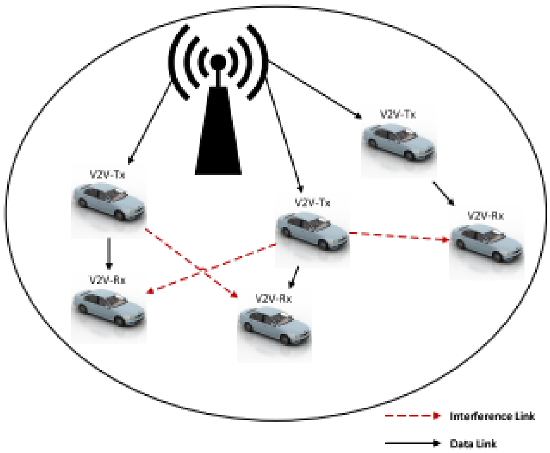

Figure 2.4: System model of D2D based V2V communication.

2.3.3 Advantages

- It is a powerful tool for enabling real-time self-organizing ability in networks, such as D2D-based V2V communications .
- It have shown improved network energy efficiency and flexibility compared to other deep reinforcement learning approaches.

2.3.4 Disadvantages

While DDPG is effective, it can be computationally expensive due to the need for training and updating the deep neural network models

2.3.5 Conclusion

For the multi-agent power allocation problem in D2D-based V2V communications, the paper suggests two unique approaches: "sharing deep deterministic policy gradient" and "distributed deep deterministic policy gradient," both of which are based on the DDPG algorithm.These methods seek to improve quality-of-service and network performance in light of the rapidly expanding number of user devices and sensors.The suggested models perform better than alternative deep reinforcement learning techniques in terms of flexibility and energy efficiency, according to numerical results.

2.4 A V2V Emergent Message Dissemination Scheme for 6G-Oriented Vehicular Networks[4]

2.4.1 Introduction

The paper discusses the need for timely and error-free dissemination of messages in vehicular networks to ensure traffic safety and efficiency in the context of sixth-generation (6G) systems. Vehicular networks use multiple types of messages for safety and efficiency applications, which should be disseminated through vehicle-to-vehicle (V2V) communication. V2V communication allows direct communication between two vehicle user equipments without involving a base station. The paper focuses on proposing a packet delivery ratio (PDR)-based message dissemination scheme (PDR-MD) for V2V in 6G-oriented vehicular networks. The scheme selects relay vehicles based on a balance between vehicle distance and PDR to reduce transmission delay while ensuring reliable PDR. Experimental results show that the PDR-MD protocol can maintain close to 95% and above PDR in transmitting emergent messages, with a transfer rate below 40%

2.4.2 Methodologies

The method used is a packet delivery ratio based message dissemination scheme (PDR-MD) for V2V communication in 6G-oriented vehicular networks .The PDR-MD scheme selects relay vehicles based on a balance between vehicle distance and PDR to reduce transmission delay while ensuring reliable PDR .

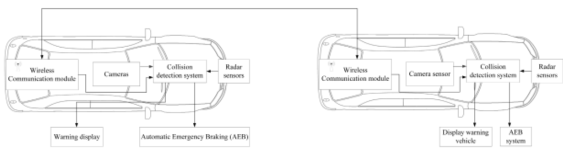

Figure 2.5: CACC SYSTEM.

2.4.3 Advantages

- It ensures timely and error-free dissemination of messages in vehicular networks.
- It reduces transmission delay while maintaining reliable PDR.

2.4.4 Disadvantages

- PDR-MD may lack adaptability to diverse and dynamic communication scenarios.
- PDR-MD is highly sensitive to channel conditions, and variations in wireless connectivity, interference etc.

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2.4.5 Conclusion

In order to broadcast emergent messages, the study suggests a PDR-based message dissemination method (PDR-MD) for 6G-oriented vehicular networks. This scheme chooses relay vehicles based on packet delivery ratio (PDR). With a transfer rate of less than 40%, the PDR-MD system keeps the transmission rate of emergent messages at or above 95%.The PDR-MD algorithm works well in an urban scenario with a focus on 6G. By choosing particular vehicles to convey messages rather than flooding them, it minimizes resource waste and packet collisions.

2.5 Vehicle Following Control via V2V SIMO Communications Using MBD Approach[5]

2.5.1 Introduction

The paper discusses the increasing complexity of autonomous vehicle systems, emphasizing the need for precise control, reliable communications, and data security. It highlights the use of Model-Based Design (MBD) as a systematic approach for developing autonomous vehicles, including modeling, test scenarios, and test coverage analysis. The paper mentions the classification of autonomous vehicles into different levels of automation, with a focus on the Adaptive Cruise Control (ACC) system. It discusses the importance of vehicle-to-vehicle (V2V) communication in improving the accuracy of analyzing the distance between vehicles and surrounding objects.

2.5.2 Methodologies

The paper presents a Model-Based Design (MBD) framework on MATLAB to integrate the vehicle model, Vehicle-to-Vehicle (V2V) communication model, and autonomous driving scenario model .The vehicle-following control model is demonstrated using locations and velocities of the leader vehicle sent via V2V.

2.5.3 Advantages

- MBD enables precise control, reliable communications, and data security in autonomous vehicle systems.
- MBD allows for the modeling of important factors such as velocities, positions, lanes, obstacles, and buildings that affect V2V communication .

2.5.4 Disadvantages

- MBD can be complex and require expertise in tools like MATLAB, Stateflow, and formal verification tools.
- MBD may require significant computational resources and time for simulation and verification.

2.5.5 Conclusion

The paper concludes that the Model-Based Design (MBD) approach is effective in developing a vehicle following control model for autonomous vehicles, integrating vehicle models, V2V communication models, and autonomous driving scenario models. The use of formal verification tools, such as Simulink Design Verifier, helps ensure the correctness and reliability of the system design.The experimental results show that the design of the Cooperative Adaptive Cruise Control (CACC) system using the MBD method reduces design time, test time, and verification time.

2.6 Summary and gaps identified

Paper	Method	Features
Paper-1	Priority-based groupcasting with IR-HARQ	Advantages: The method achieves high reliability and throughput by adjusting the amount of retransmitted data through constraints on delay and outage probability, maximizing throughput. Disadvantage: It may face challenges in scalability as the number of vehicles increases.
Paper-2	Trained model across multiple agents and environments	Advantage: It is a powerful tool for enabling real-time self-organizing ability in networks, such as D2D-based V2V communications. Disadvantage: It can be computationally expensive.
Paper-3	A packet delivery ratio based message dissemination scheme	Advantage: It reduces transmission delay while maintaining reliable PDR. Disadvantage: It is highly sensitive to channel conditions, and variations in wireless connectivity, interference.
Paper-4	Model-Based Design (MBD) framework on MATLAB.	Advantage: Enables precise control, reliable communications, and data security in autonomous vehicle systems. Disadvantage: Can be complex and require expertise in tools like MATLAB.

Table 2.1: Comparison Study of different methods

Chapter 3

Requirements

3.1 Hardware and Software Requirements

This section describes the hardware and software requirements with specifications in detail.

- Software Requirements
  - 1.For Front-end Html, CSS, and JavaScript is used .The inter vehicular communication app's gui is created with the help of java. HTML CSS and Java Script is used in violaters reporting and fine payment interface.
  - 2.For Back-end Python and java is used . Python is used for detecting the numberplate making them in numeric form and storing them in database. Java is used in the back end of inter vehicular communication.
  - 3.Algorithm used are YOLO,EasyOCR,C-V2X. YOLO is used to detect the number plate.EasyOCR is used to convert the numberplate image to text.C-V2X is used in vehicle to vehicle communication using cellular technology.
  - 4.The Database used is Firebase.
  - 5.The Libraries used is OpenCV and TensorFlow. open cv is used for vision applications.Tensor flow is used to implement best practices for data automation, model tracking, performance monitoring, and model retraining.
- Hardware Requirements
  - 1.Camera with minimum resolution of 720p and Sim Card with atleast 4G bandwidth is necessary to recognise the number plate .

- 2.Microphone is used to store the audio recording in the blackbox .The black box gets overwritten every 4 weeks .
- 3.Windows 7 or higher is required.
- 4.i5 processor system or higher is needed for faster processing.
- 5.Graphics Card is needed to be fast to avoid lag.
- 6.4 GB RAM or higher is required to avoid lag or buffering.
- 7.Storage Device with minimum storage 20GB is needed to store the black box information.

Chapter 4

System Architecture

4.1 System Overview

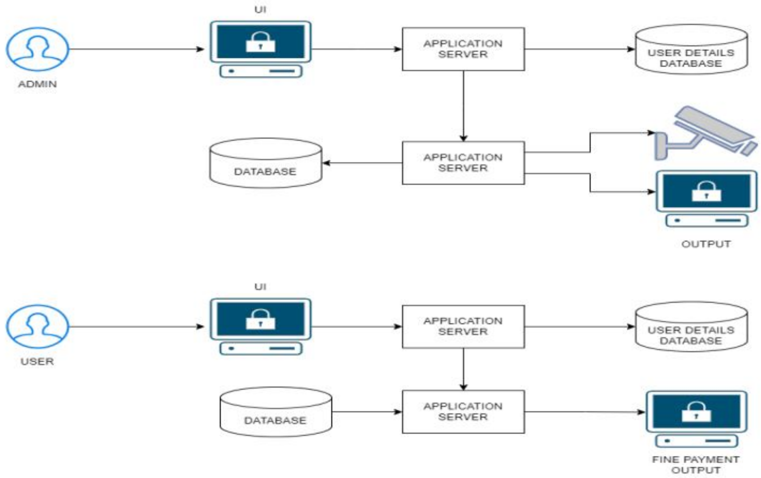

Figure 4.1: Architecture Diagram for GUI

1.Here the admin access the gui by entering the username and password . If authorized the admin enters the main page where he has 4 options - live camera feed , details of violators, fine payment and number of violations by a single user.

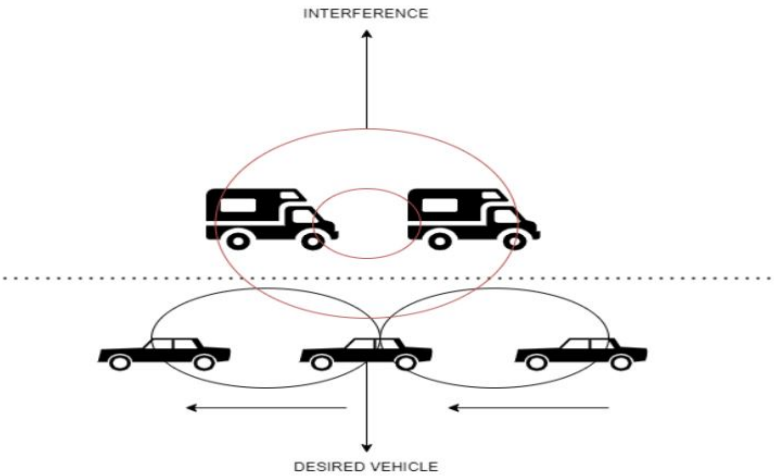

Figure 4.2: Architecture Diagram for V2V communication

2.In the context of V2V communication a vehicle should not communicate with vehicles nearby by it but rather only with the vehicle ahead or behind it .Therefore instead of using a Bluetooth mode of communication we use sim - sim or wifi enabled communication.

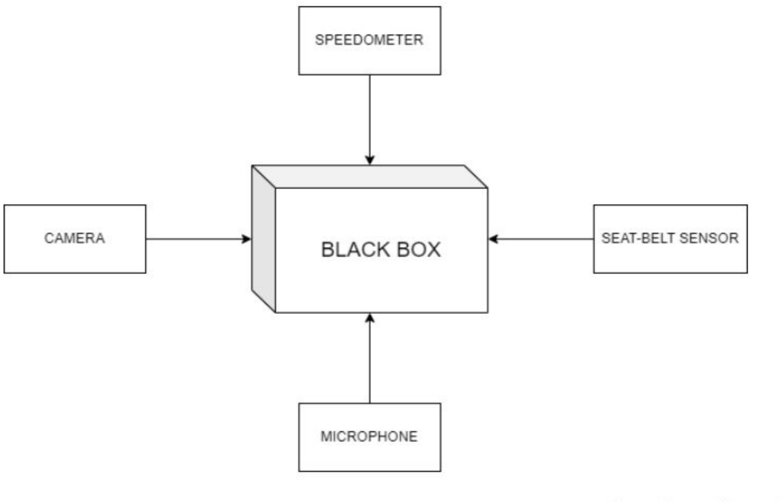

Figure 4.3: Architecture Diagram for black box

3.In the context of Black Box communication details regarding speedometer,seat belt sensor along with camera and microphone data is stored in it.The details are overwritten over a certain period of time in the black box.

4.2 Architectural Design

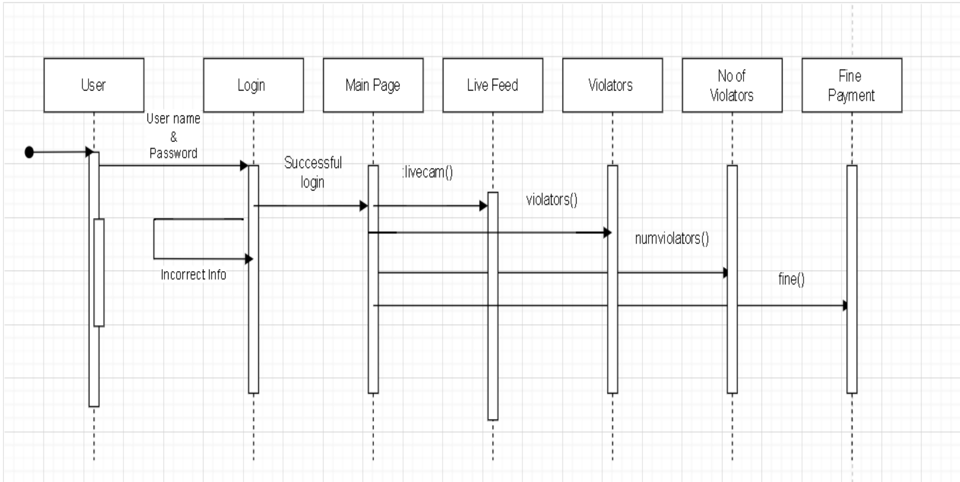

Figure 4.4: Sequence Diagram for AODS

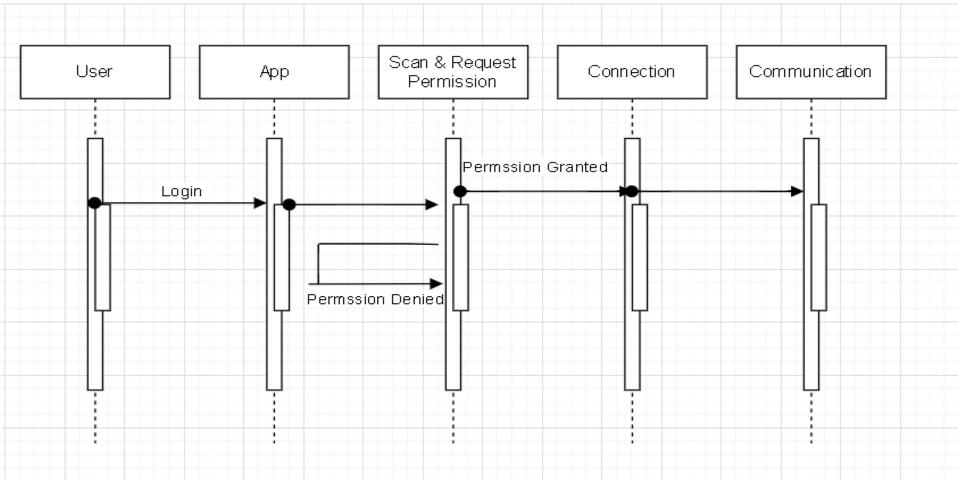

Figure 4.5: Sequence Diagram for V2V

4.3 Module Division

- 1.Vehicle Detection

  The video feed is passed into the YOLO method. The video is divided into frames. Each frame will be processed by YOLO and it will identify vehicles from each frame. Vehicles will be inside bounding boxes that will be obtained from the YOLO module. This will be done on all the frames and the output will be returned to the user.

- 2.Number Plate Recognition

The Number Plate is recognized from the image of the violator using edge detection. We pass the image of the vehicle, and then convert it into gray scale. After this we apply a filter to obtain the edges of the image. From this we identify Rectangles or squares and mask the image in order to get only that portion which will be the number plate. We use EasyOCR on the masked image to obtain the value of the number plate.

- 3.User Interface
  - User interface for vehicle detection system has a login page. Here the officials can watch the live cam, can add a new user, find the violators with their image and number plate, and can view how many times a particular vehicle have violated.
  - The fine payment phase also has a login for user, and once logged in they can view their due fines and continue to pay their dues.
  - The Inter Vehicular Communication has an interface where the driver can either ask another driver if he/she can overtake, or can report if there is any defects in the car in front, or can reply to request from a driver behind the car.

- 4.V2V Communication
  - When the driver need to overtake, they will press a button which will give access to the front camera. It will identify the number plate and will get the vehicle number from the database. After we obtain the vehicle number we send a message to that vehicles registered application. The driver can also reply to the message obtained from the driver behind.
  - The messages need not to be typed by the driver because their focus should always be on the road and driving. There will be a few options that are certain replies or questions to the driver. If they click an option it will send the message to the other driver.

- 5.Black Box Recovery
- The black box will contain multiple records, video files that are two minutes long, audio files that are also two minutes long, the speed of the vehicle will be recorded at each second and also the seat-belt status will be recorded, ie, if the driver and passenger were using the seat-belt or not.
- The files will be written after every 2 hours so that new files can be saved after a few hours and the memory wont be full.

4.4 Work Schedule - Gantt Chart

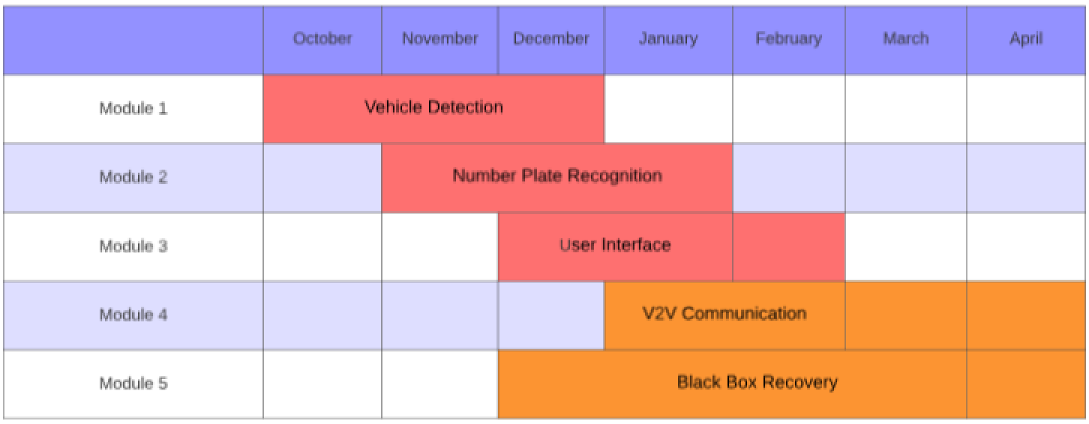

Figure 4.6: Gantt Chart

4.5 Summary

In conclusion the modules and divided into 5 parts namely vehicle detection,number plate recognition,user interface, V2V communication and Black Box recovery.Each module is created individually and the integrated. This part of the report also deals with gantt chart ie the time assosiated with completing each module. The module division and timeline including starting and ending date of each module is discussed here.The modules are divided and assigned to each team member.This chapter also includes the sequence diagram that explains the working of both gui's. The gui of the admin portal application and the gui of the vehicle to vehicle communication.

Chapter 5

Results and Discussions

Introducing an innovative system aimed at enhancing road safety and accountability. By combining cutting-edge technologies such as violator detection, fine payment portals, inter-vehicular communication, and black box implementation, this system revolutionizes how we approach traffic management. From identifying violators with precision to facilitating smoother interactions between vehicles on the road, each component serves a crucial role in fostering safer driving practices and providing valuable data for insurance companies and manufacturers in the event of accidents. Welcome to the future of road safety.

5.1 Overview

There are four major outputs they are Detecting and Reporting Violators, Fine Payment, Inter vehicular communication and Implementation of Black box.Each violator along with the image of his/her number plate and vehicle violating is detected and stored in the database.The fine payment portal allows the violators to pay their due fines.Inter vehicular communication helps the driver to ask or grant permission for overtaking thereby reducing the chance of accident. The Black Box stores the relevant data which are helpful for the insurance company, car manufacturer etc in the worst case scenario of an accident.

5.2 Testing

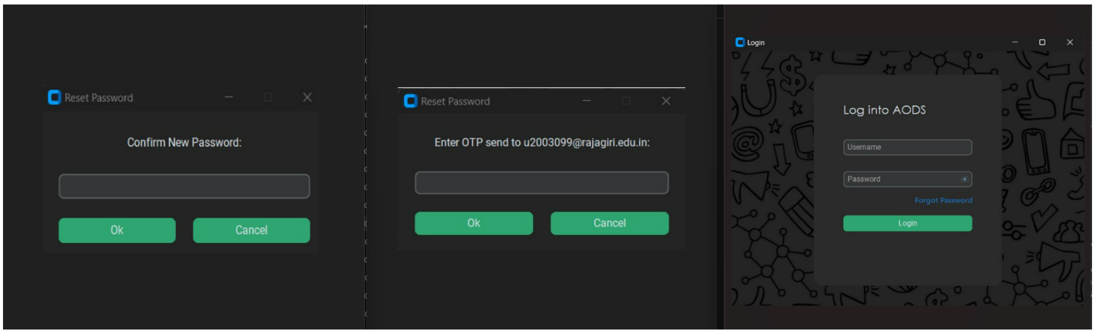

Figure 5.1: Login page for overtaking detection

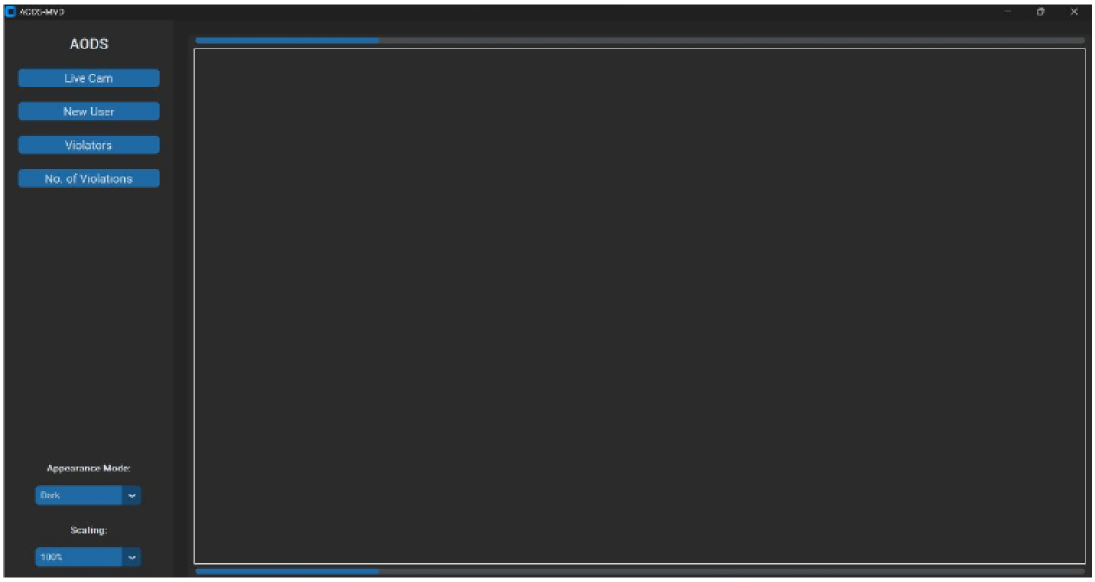

Figure 5.2: Main Page

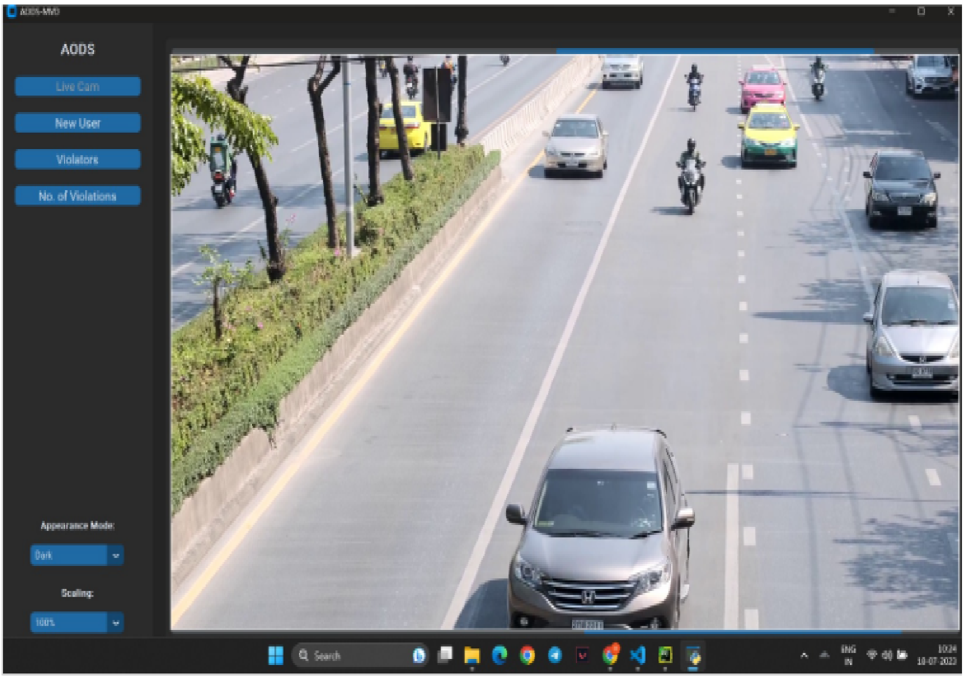

Figure 5.3: Live Camera

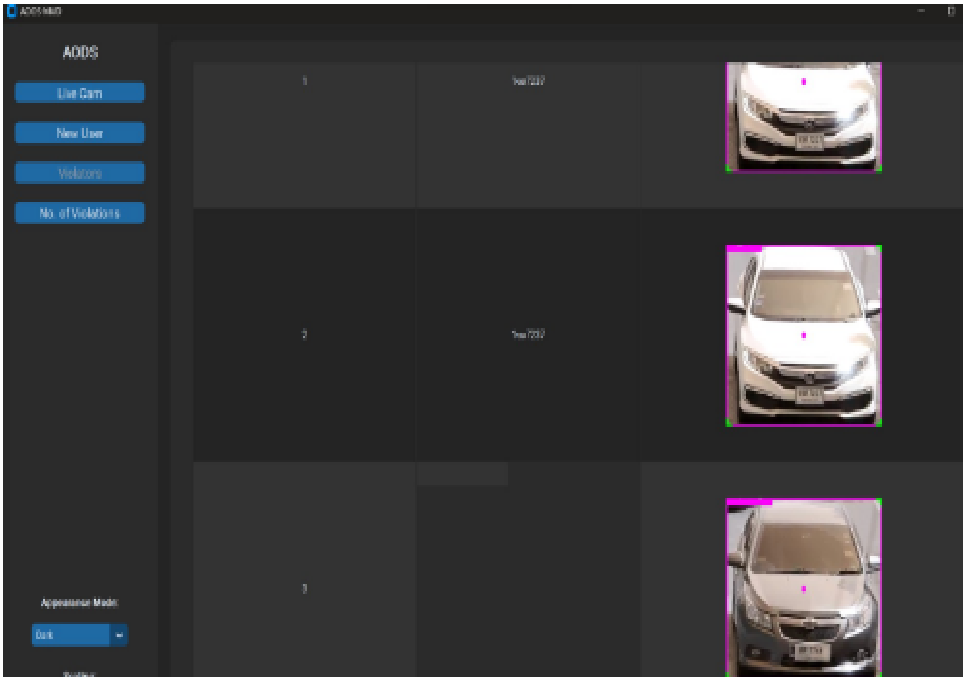

Figure 5.4: List of Violators

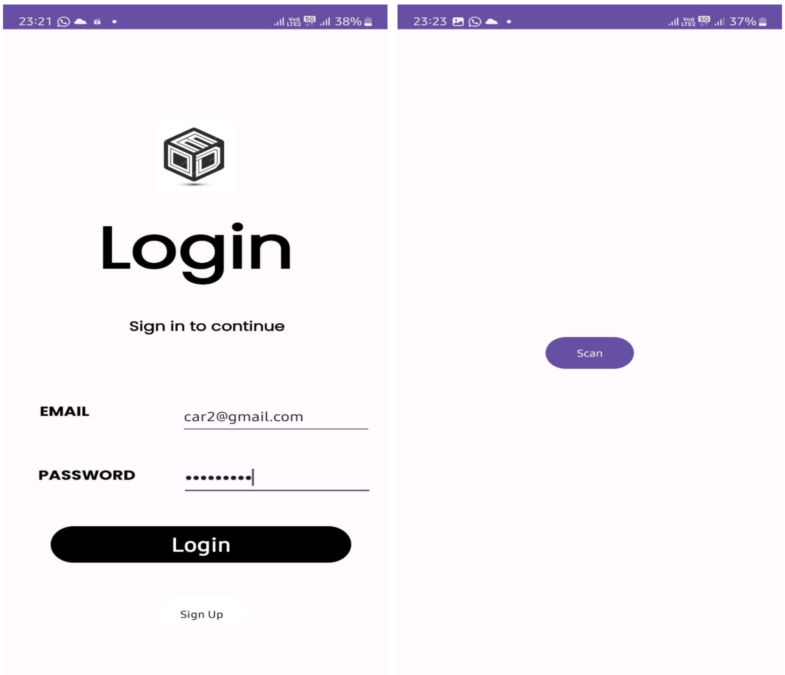

Figure 5.5: Login page for v2v and scanner page

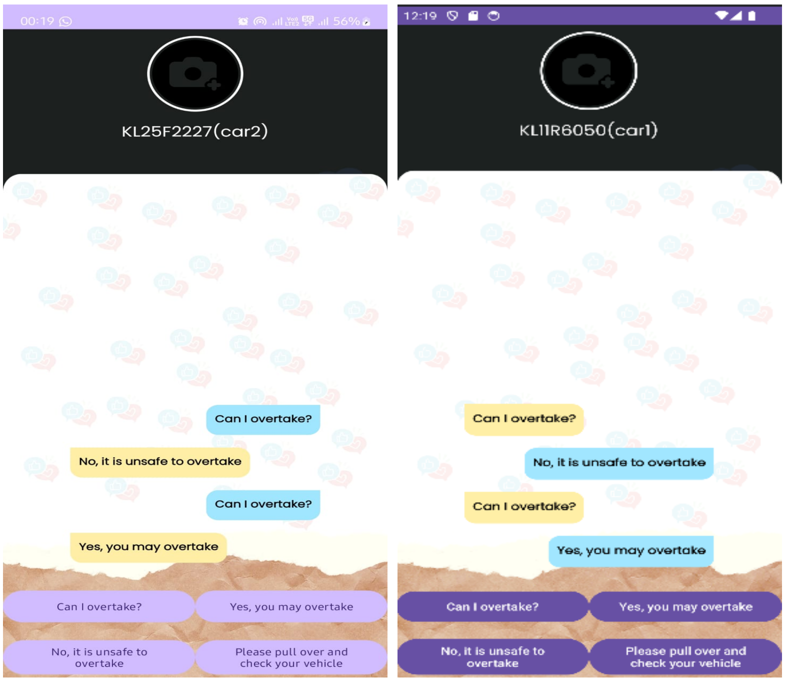

Figure 5.6: Chat page window

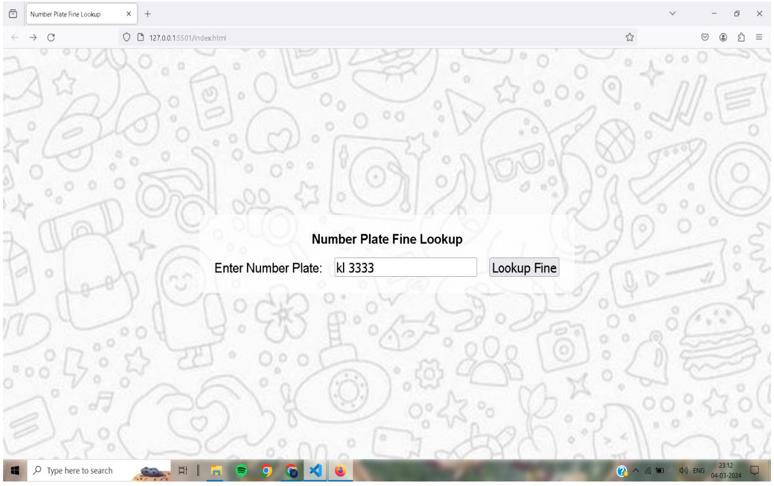

Figure 5.7: Fine Payment Login

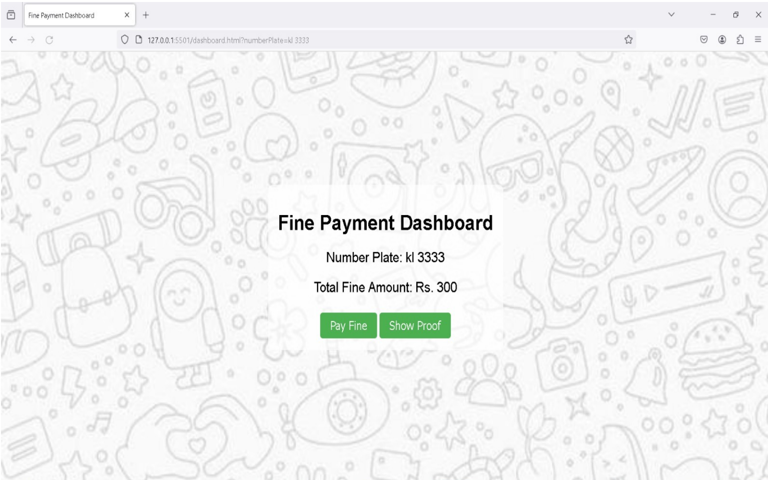

Figure 5.8: Payment dashboard

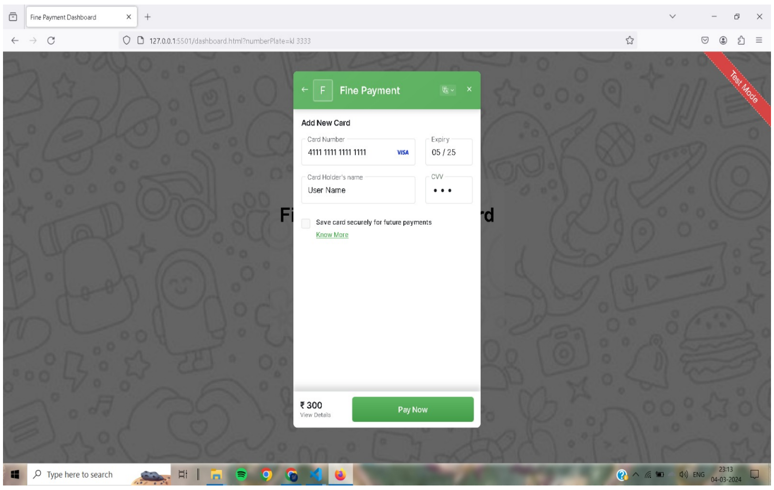

Figure 5.9: Payment interface

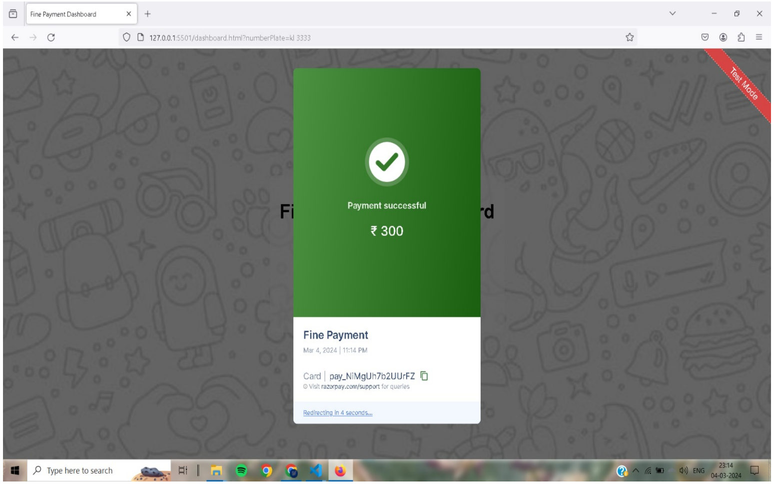

Figure 5.10: Payment successful

5.3 Discussion

In contemporary traffic management, four pivotal components emerge as key players: Detecting and Reporting Violators, Fine Payment, Inter-Vehicular Communication, and Black Box Implementation. Each facet serves a distinct purpose, from identifying and cataloging violators with their vehicle details to facilitating fine payments via online portals. Inter-vehicular communication enables safer driving practices by allowing drivers to request or grant overtaking permissions, thus mitigating accident risks. The Black Box, akin to an automotive flight recorder, stores critical data essential for insurance claims and post-accident analysis. These innovations collectively mark a significant stride towards safer roads. In evaluating the outcomes, we delve into the effectiveness of each system, identifying areas of success and potential challenges. Through this comprehensive discussion, we underscore the importance of modern traffic control mechanisms and outline avenues for future research and development, emphasizing their role in the ongoing evolution of traffic management strategies.

5.4 Conclusion

In conclusion, the integration of Detecting and Reporting Violators, Fine Payment, Inter-Vehicular Communication, and Black Box Implementation signifies a significant advancement in modern traffic management. These systems synergistically contribute to enhancing road safety and accountability. Through our evaluation of their effectiveness, we have identified areas of success and potential challenges. Moving forward, continued research and development in this field are crucial for further refining these technologies and ensuring their continued efficacy in safeguarding our roads.

Chapter 6

Conclusions & Future Scope

Enhanced Overtaking Management System with Inter Vehicular Communication and black box helps in detecting and reporting violators disobeying traffic rules.It also allows vehicle to vehicle communication in terms of requesting and granting permission to overtake.It allows the user to login and pay the due fines of the violations they committed. It also includes a black box with all the relevant data.

The Enhanced Overtaking Management System endeavors to establish a safer driving environment by alleviating the risks associated with overtaking, especially on bridges, and ensuring that drivers are equipped with essential information and warnings to make well- informed decisions during such maneuver.It could be used with future advancements where if the vehicle encounters an accident it automatically triggers and SOS message

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Appendix A: Presentation

ENHANCED OVERTAKING MANAGEMENT SYSTEM WITH INTER VEHICULAR COMMUNICATION AND BLACK BOX

Harikrishnan R(U2004039) , Jai Mathew James(U2003099)
Mathew Shaji(U2004051) , HariRaman M (U2003091)

Rajagiri School of Engineering and Technology, Kakkanad
Department of CSE

April 27, 2024

Guided by: Ms. Anu Maria Joykutty
Asst. Professor Department of CSE

Contents

Problem Definition

- Overtaking on bridges can be extremely dangerous, as it increases the risk of collision with on going traffic.
- A challenge while driving a car or a bike is that a huge vehicle in front it, creates lack of vision.
- Knowing the cause of an accident is needful for investigators, insurance companies etc to know exactly what happened.

ENHANCED OVERTAKING MANAGEMENT SYSTEM WITH INTER VEHICULAR COMMUNICATION AND BLACK BOX

Project Objective

- Detecting violators in bridges
- Inter Vehicular Communication using V2V communication
- Implementation of a Black Box.

Scope of implementation

- Detection of Overtaking vehicles
- Inter Vehicular Communication
- Fine payment module
- Black box

Gantt Chart

	October	November	December	January	February	March	April
Module 1	Vehicle Detection						
Module 2		Number Plate Recognition					
Module 3			User Interface				
Module 4				V2V Communication			
Module 5			Black Box Recovery				

Work in 30% Evaluation

- Detecting violators in bridges.
- Gui for V2V communication

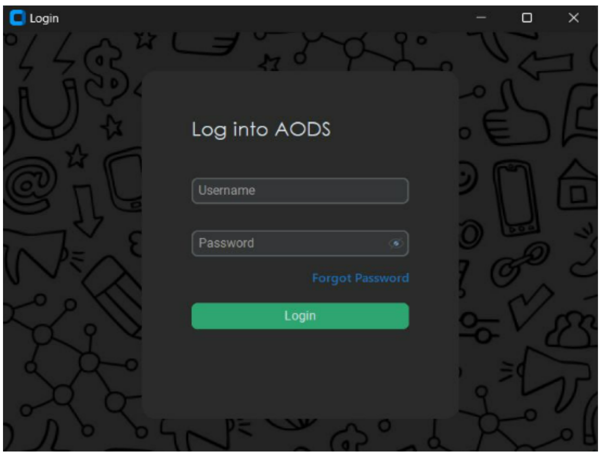
Work in 60% Evaluation

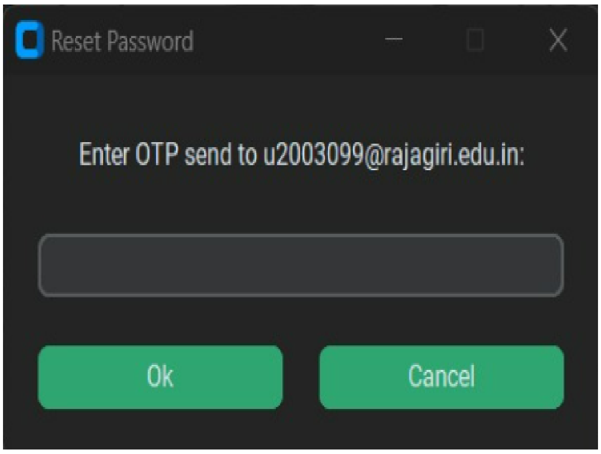
- Completed Part of Detecting violators in Bridges
- Completed Part of V2V communication
- Gui and Database connection for Fine Payment Module

Work in 100% Evaluation

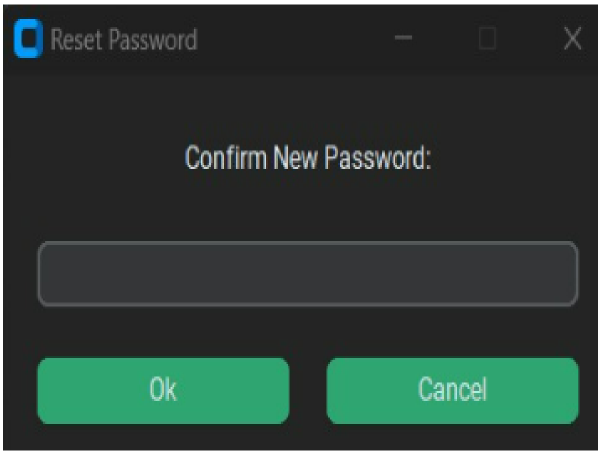
- Detecting and Reporting Violators in Bridges
- Website for Fine Payment
- V2V communication for safe Overtaking
- Implementation of Black Box

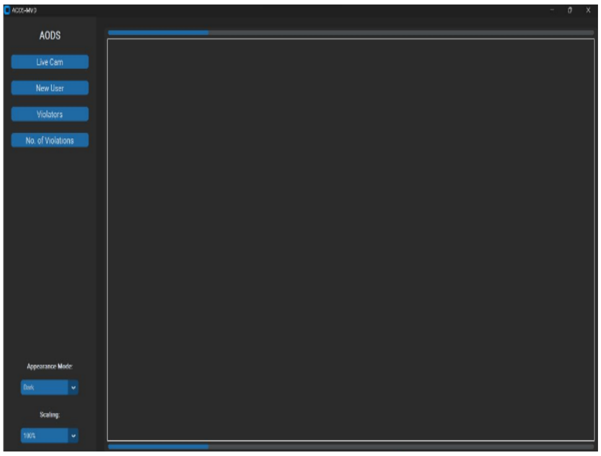
Interim Results(AODS)





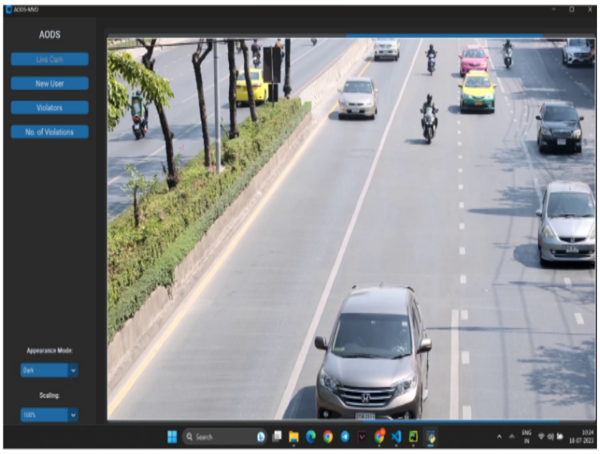
Interim Results(AODS)

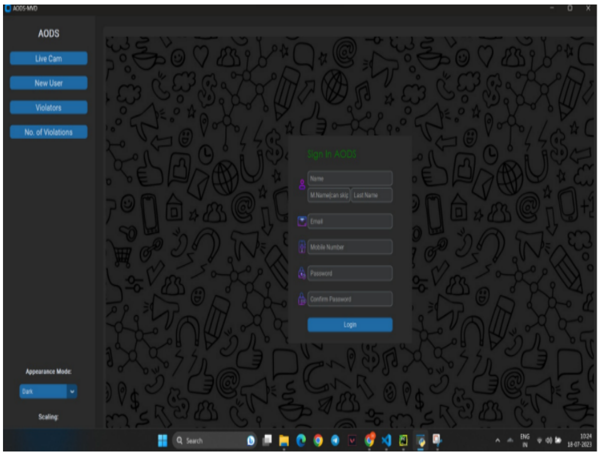




ENHANCED OVERTAKING MANAGEMENT SYSTEM WITH INTER VEHICULAR COMMUNICATION AND BLACK BOX

Interim Results(AODS)





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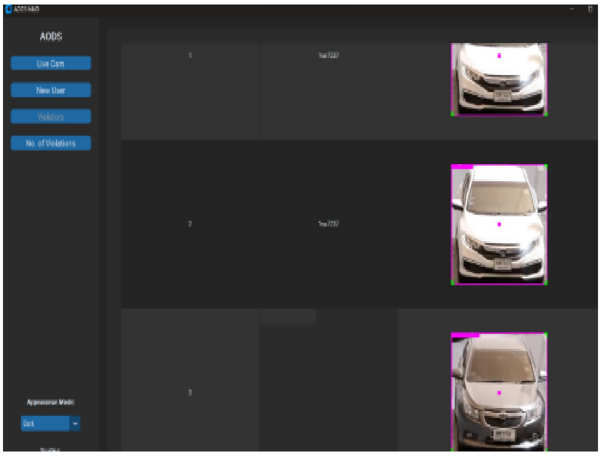

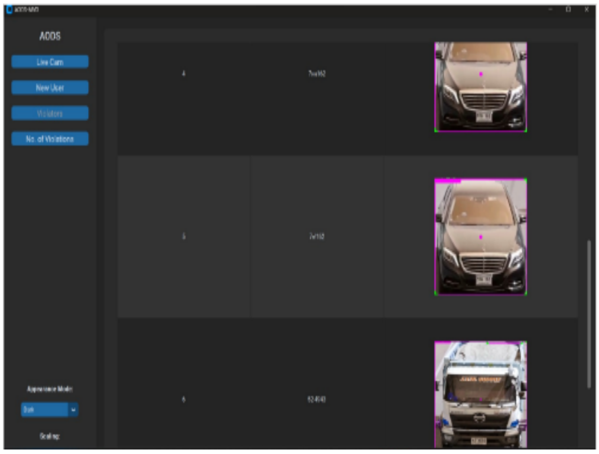

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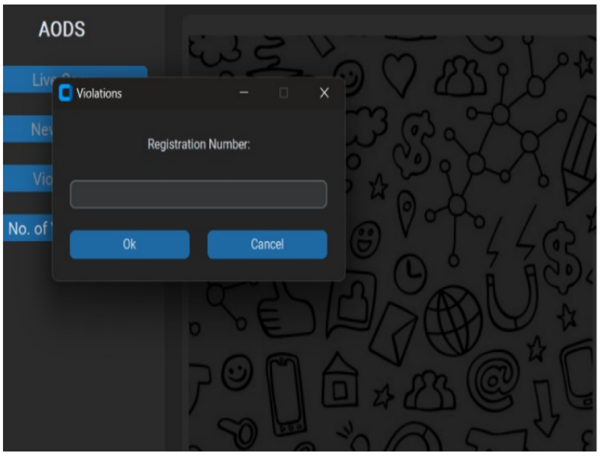
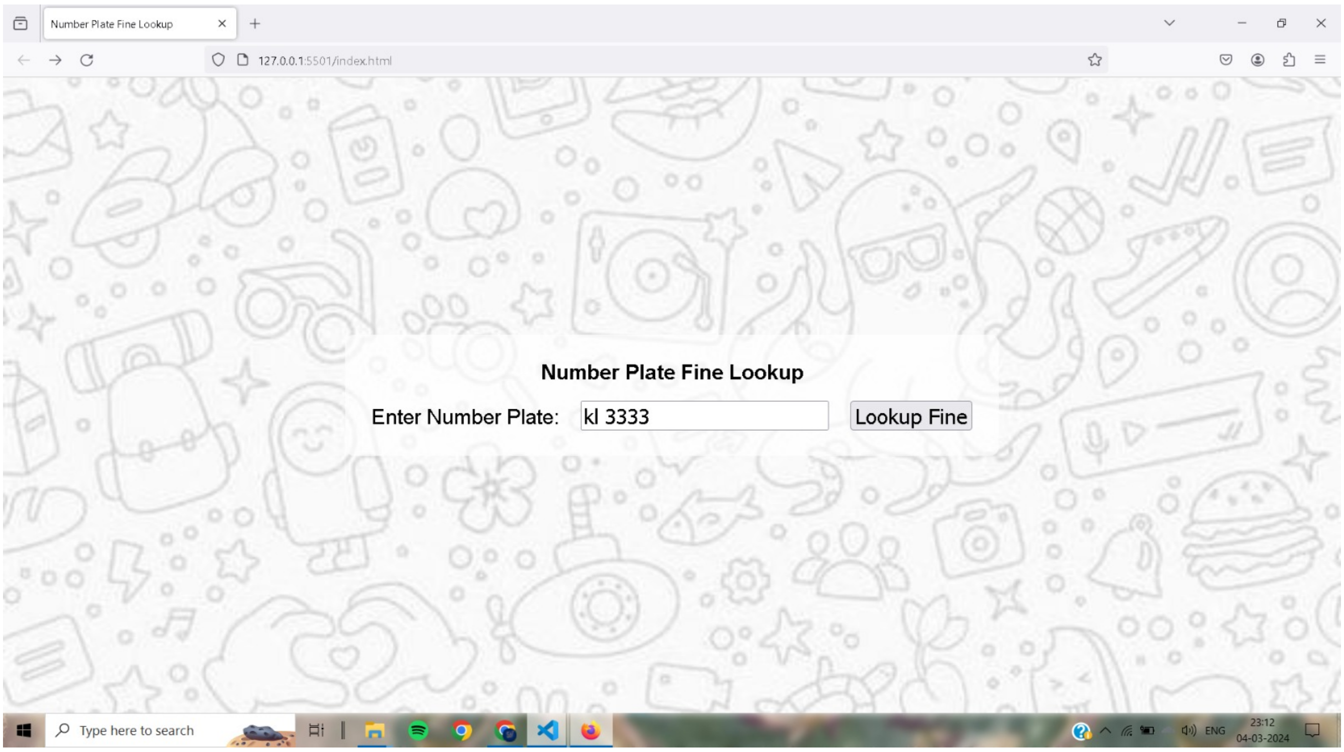
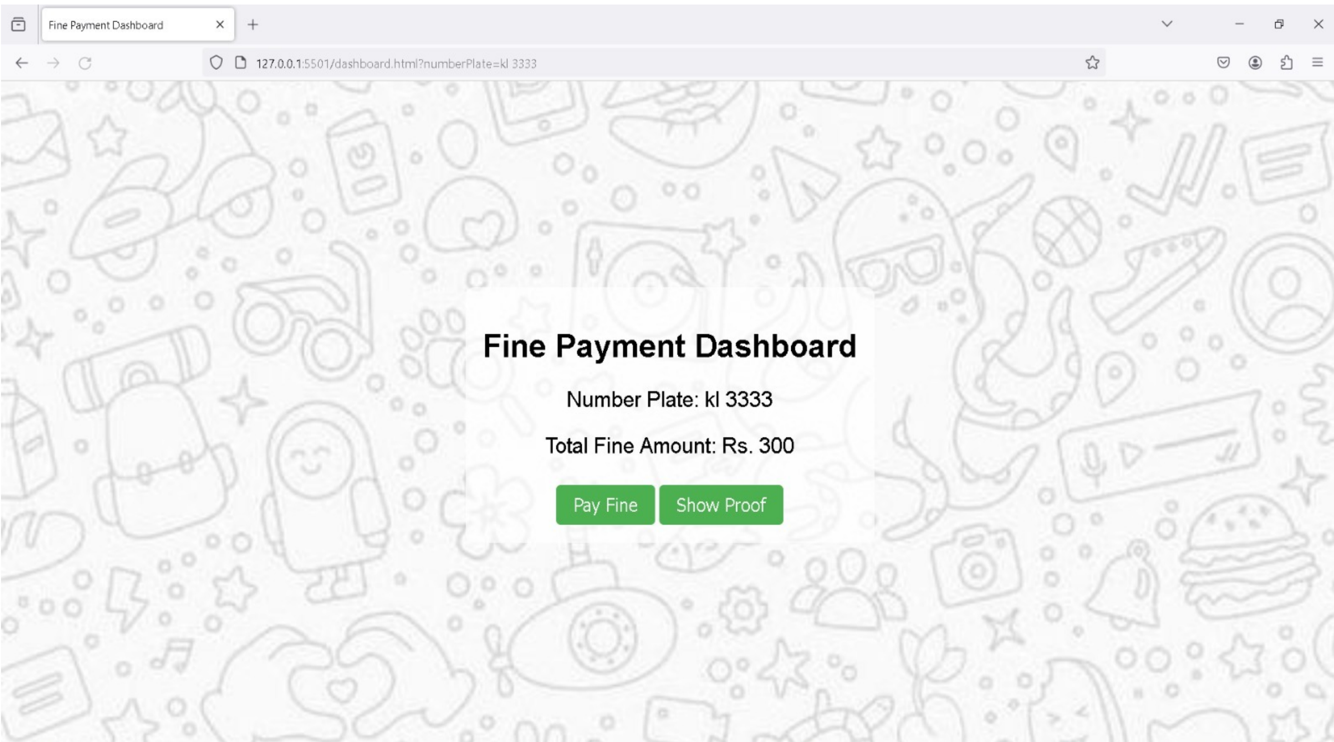


Interim Results(Fine Payment)

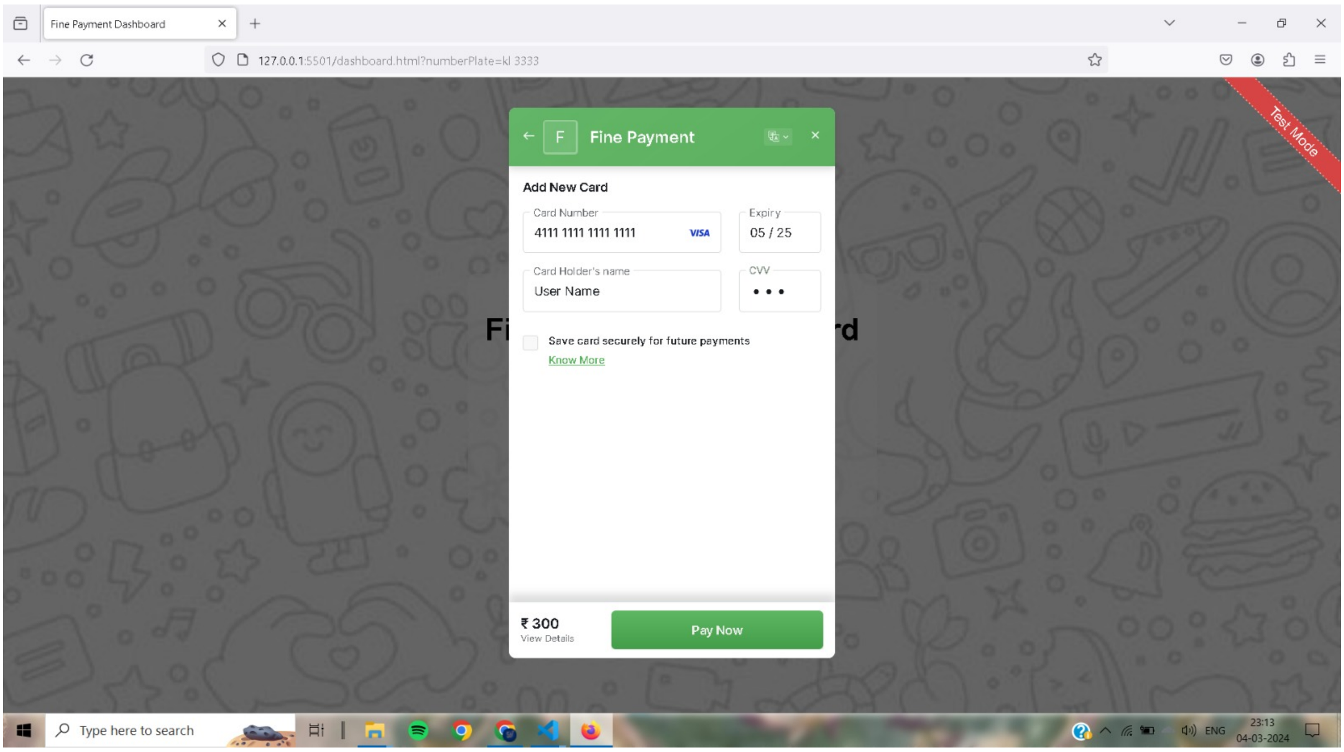


ENHANCED OVERTAKING MANAGEMENT SYSTEM WITH INTER VEHICULAR COMMUNICATION AND BLACK BOX

Interim Results(Fine Payment)

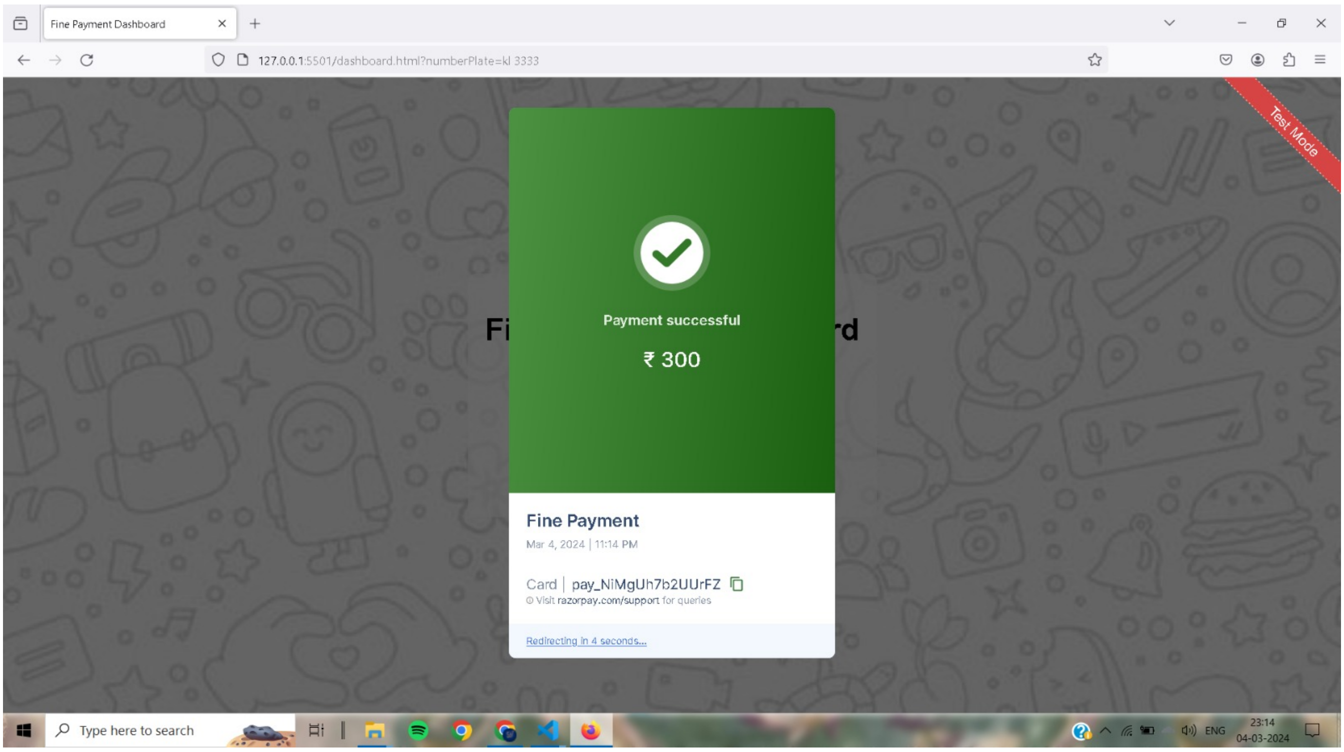


Interim Results(Fine Payment)

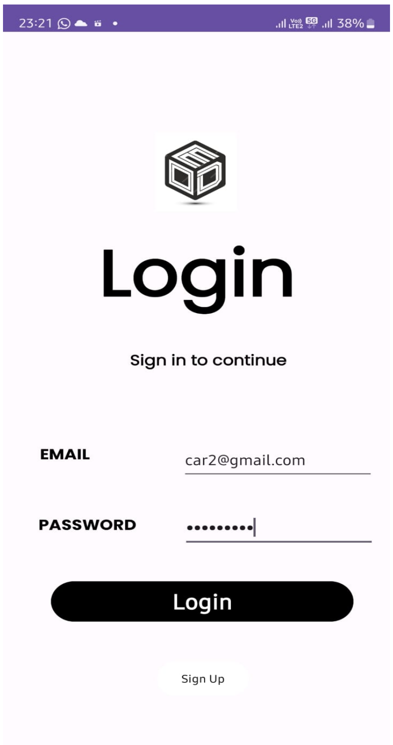


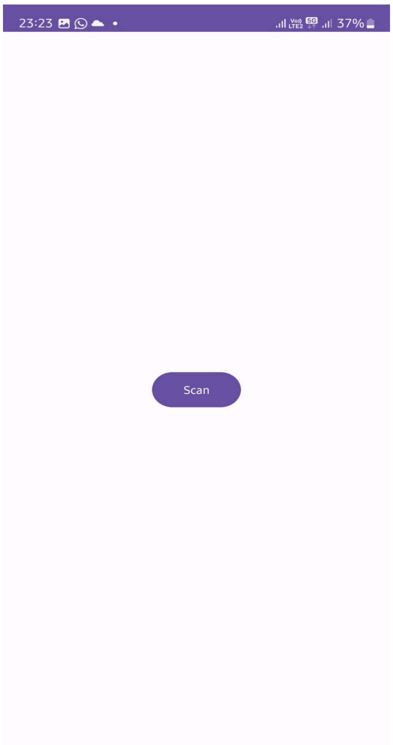
ENHANCED OVERTAKING MANAGEMENT SYSTEM WITH INTER VEHICULAR COMMUNICATION AND BLACK BOX

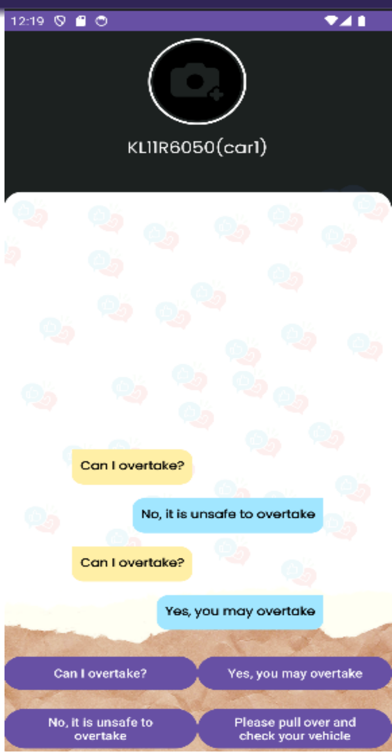
Interim Results(Fine Payment)



Interim Results(V2V)







Future Scope

- EODS can be useful for the motor department as no AI camera's have the capability to capture violators in Bridges.
- Inter-Vehicular communication could be integrated and used in vehicles for a safer and more clear overtaking.
- The implementation of black box would be a major breakthrough for investigators and insurance companies.It could also be enhanced in the future to detect the presence of alcohol, not wearing seat belt, etc.

Task Distribution

- Harikrishnan R: Inter Vehicluar Communication
- Mathew Shaji : Fine Payment, Database
- Hariraman M : Black Box
- Jai Mathew James: QR Recogntion , Black Box

Conclusion

Enhanced Overtaking Management System with Inter Vehicular Communication and black box helps in detecting and reporting violators disobeying traffic rules. It also allows vehicle to vehicle communication in terms of requesting and granting permission to overtake. It allows the user to login and pay the due fines of the violations they committed. It also includes a black box with all the relevant data.

ENHANCED OVERTAKING MANAGEMENT SYSTEM WITH INTER VEHICULAR COMMUNICATION AND BLACK BOX

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ENHANCED OVERTAKING MANAGEMENT SYSTEM WITH INTER VEHICULAR COMMUNICATION AND BLACK BOX

THANK YOU

Appendix B: Research Paper

Enhanced Overtaking Management System With Inter-Vehicular Communication And Black Box

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***Abstract*—The Enhanced Overtaking Management System addresses critical challenges associated with overtaking maneuvers, focusing on safety enhancement through the integration of Inter-Vehicular Communication (IVC) and Black Box technology. Overtaking on bridges is dangerous due to the increased risk of collisions with oncoming traffic and the limited visibility caused by large vehicles ahead further complicates the problem.The Enhanced Overtaking Management System addresses critical challenges associated with overtaking maneuvers, focusing on safety enhancement through the integration of Inter-Vehicular Communication (IVC) and Black Box technology. Overtaking on bridges is dangerous due to the increased risk of collisions with oncoming traffic and the limited visibility caused by large vehicles ahead further complicates the problem.The project includes overtaking detection in bridges , a chat app that allows the driver to communicate with others drivers for requesting and granting permission to overtake and a black box . The Enhanced Overtaking Management System helps to identify the traffic violators in bridges and reports them, it also guides the drivers for a safe overtake with minimal risk and in case of a worst case scenario if an accident occurs it helps to identify what really happened.**

Keywords—Overtaking, V2V, YOLO, Black Box

Introduction

In modern traffic management, overtaking maneuvers pose a significant risk to road safety, especially in scenarios like bridges, where limited visibility and confined spaces increase the chances of collisions with oncoming traffic. Drivers of both cars and motorcycles encounter a heightened challenge when attempting to overtake large vehicles, leading to impaired visibility and an increased chance of accidents. Existing traffic management systems often lack the sophistication needed to offer real-time insights and warnings to drivers attempting overtaking on bridges. This creates a need for a comprehensive solution that integrates the latest cutting edge technologies. IVC facilitates seamless communication between vehicles, enabling the exchange of crucial data to enhance situational awareness during overtaking maneuvers.

Overtaking accidents present considerable challenges for investigators, insurance firms, and regulatory bodies in identifying root causes and implementing preventive measures. A thorough understanding of the dynamics of overtaking incidents is essential for enhancing road safety standards, formulating effective traffic regulations, and mitigating the overall economic and social impact of such accidents.

Overtaking on bridges poses a significant safety risk, increasing the chance of collisions with oncoming traffic due to limited visibility.This danger is compounded when driving behind large vehicles, causing a substantial lack of vision for car and motorcycle drivers.Considering these factors, the Enhanced Overtaking Management System with Inter-Vehicular Communication and Black Box technology stands out as a strategic and technologically advanced solution. By addressing the specific challenges associated with overtaking on bridges and introducing a system that not only prevents accidents but also assists in thorough post-incident investigations.

I. Related Research

The comparative study [1] delves into the performance evaluation of Dedicated Short-Range Communication (DSRC) and LTE Vehicle-to-Everything (V2X) technologies, crucial for enhancing road safety and traffic efficiency in real-world scenarios. DSRC, relying on the IEEE 802.11p standard, ensures simplified authentication and direct broadcasting of security information in the 5.9 GHz band, dedicated to Intelligent Transportation System (ITS) applications. However, its scalability is limited by the standard's constraints, potentially struggling with high-density traffic scenarios and complex hardware requirements. On the other hand, LTE-V2X, operating without cellular infrastructure in a distributed manner, offers a promising alternative with simpler hardware design and potentially higher bandwidth capacity, although it operates in shared spectrum bands.

The methodologies employed encompass simulation-based analyses and field tests to comprehensively evaluate both DSRC and LTE-V2X. Various parameters such as MAC and PHY layer configurations, resource allocation protocols, and transmission error models are scrutinized to gauge performance under different road topologies and traffic conditions. While DSRC exhibits advantages in terms of longer communication range for larger packet sizes, LTE-V2X showcases superiority for smaller packet sizes and possibly higher data rates due to its potential bandwidth advantage. The findings underscore the importance of considering geographical diversity to enhance the effective communication range of both technologies, thus aiding in the selection of an appropriate technology based on specific service performance requirements.

In conclusion, the research illuminates the nuanced performance attributes of DSRC and LTE-V2X in real-world scenarios, shedding light on their strengths and limitations. By elucidating the implications of different MAC and PHY layer configurations and conducting thorough field tests, the study offers valuable insights for stakeholders involved in deploying vehicular communication systems. Ultimately, the findings contribute to informed decision-making processes regarding the adoption of DSRC or LTE-V2X technologies, tailored to meet the evolving needs of road safety and traffic management applications.

The research presented in the paper [2] aims to enhance the reliability of 5G New Radio (NR) Vehicle-to-Vehicle (V2V) communications by introducing priority-based groupcasting and Incremental Redundancy Hybrid Automatic Repeat reQuest (IR-HARQ). This innovative approach involves assigning casting strategies to Vehicle User Equipment (VUE) based on broadcast, unicast, and groupcast methods, prioritizing groupcast transmission. By carefully adjusting the amount of retransmitted data through constraints on delay and outage probability, the proposed method achieves high reliability and throughput. However, challenges in scalability may arise with an increasing number of vehicles, and unnecessary information dissemination to a large vehicle community might occur.

The study concludes that integrating IR-HARQ with priority-based groupcasting significantly enhances throughput and reliability in 5G NR V2X mode 2 scenarios. Simulation results demonstrate an increase in the maximum distance satisfying the desired packet reception ratio (PRR) and substantial improvements in V2V link reliability. Moreover, priority-based group casting effectively preserves the required PRR distance while achieving a notable throughput increase. Compared to traditional broadcasting, limiting delay and outage probability leads to remarkable throughput enhancements, potentially boosting it by up to 98%. These findings underscore the promising potential of the proposed approach in advancing the reliability and efficiency of 5G NR V2V communications.

II. Proposed Method

Within the realm of Vehicle-to-Vehicle (V2V) communication, the integration of You Only Look Once (YOLO) technology presents a promising avenue for advancing automotive safety and efficiency. YOLO is a state-of-the-art object detection algorithm renowned for its real-time performance and accuracy in identifying objects within images and video streams. By leveraging deep neural networks, YOLO is capable of detecting and classifying objects of interest, such as vehicles, pedestrians, cyclists, and traffic signs, with remarkable speed and precision.

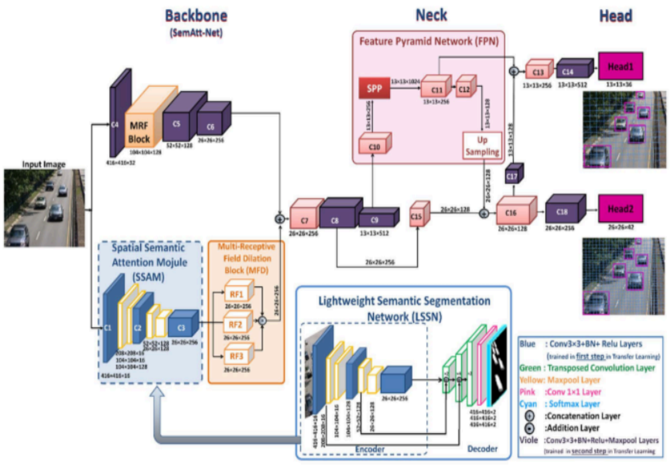

Fig. 2.1 Algorithm for Fast YOLO Recognition

In the context of V2V communication, YOLO can be employed to enhance situational awareness among vehicles by enabling them to perceive and respond to their surrounding environment in real-time. By equipping vehicles with YOLO-based detection systems, they can autonomously identify nearby objects and anticipate potential hazards on the road, thus facilitating proactive collision avoidance and adaptive driving strategies. Furthermore, YOLO's efficient architecture enables it to run on resource-constrained automotive hardware, making it a viable solution for deployment in mass-produced vehicles. As automotive technology continues to evolve, the integration of YOLO into V2V communication systems holds the promise of revolutionizing road safety and ushering in a new era of intelligent transportation.

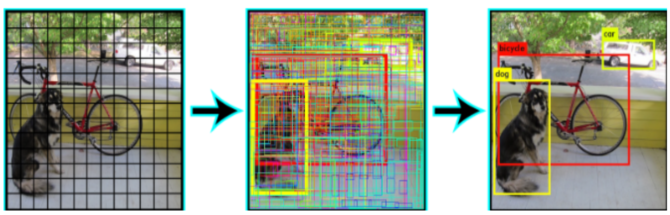

Fig.2.2 Image is divided into several grids

Dedicated Short Range Communication (DSRC) is a fundamental technology within the realm of Vehicle-to-Vehicle (V2V) communication, playing a pivotal role in modern transportation systems. DSRC operates within the 5.9 GHz band and enables vehicles to communicate with each other over short distances, typically up to 300 meters. This technology facilitates the exchange of critical information such as vehicle speed, position, acceleration, and direction, allowing vehicles to anticipate and react to potential hazards on the road in real-time. DSRC's low-latency and high-reliability characteristics make it well-suited for safety-critical applications, including collision avoidance, emergency braking, and cooperative adaptive cruise control.

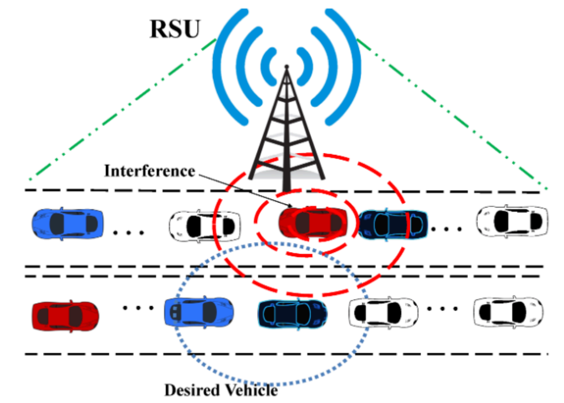

Fig.2.3 DSRC Communication architecture

Moreover, DSRC serves as the backbone for the development of intelligent transportation systems (ITS), paving the way for enhanced vehicle safety, traffic efficiency, and overall mobility. By fostering seamless communication between vehicles, DSRC enables the creation of cooperative driving scenarios, wherein vehicles can collaborate to optimize traffic flow, reduce congestion, and minimize the likelihood of accidents. Additionally, DSRC can integrate with infrastructure-based systems, allowing vehicles to exchange information with roadside units and traffic management centers, further enhancing the effectiveness of transportation networks. As automotive technology continues to advance, DSRC remains a cornerstone technology for enabling safer, smarter, and more connected transportation ecosystems.

III. Results and Discussions

The Enhanced Overtaking Management System (EOMS) represents a comprehensive solution aimed at enhancing road safety through innovative technologies and proactive measures. By integrating Inter-Vehicular Communication (IVC) capabilities and a black box system, the EOMS addresses the inherent risks associated with overtaking maneuvers, particularly in challenging environments such as bridges. Through real-time communication between vehicles, the system facilitates a collaborative approach to overtaking, allowing drivers to request and receive permission from surrounding vehicles, thereby minimizing the likelihood of collisions and ensuring smoother traffic flow.

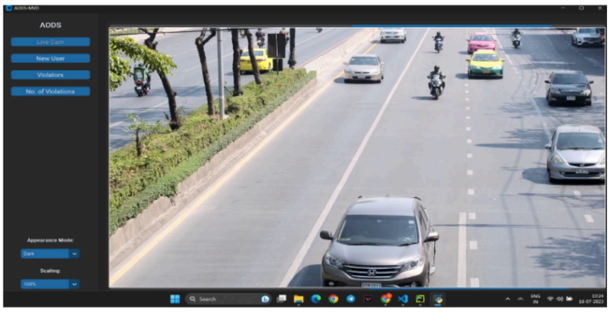

Fig.3.1 Live Camera With Tracking Facilities

One of the key features of the EOMS is its ability to detect and report violations of traffic rules, such as reckless overtaking, through the utilization of the black box. By continuously monitoring vehicle behavior and recording relevant data, including speed, acceleration, and proximity to other vehicles, the black box serves as a critical tool for identifying and penalizing drivers who endanger themselves and others on the road. Moreover, the system provides users with the convenience of accessing their violation history and paying fines online, streamlining the enforcement process and promoting greater compliance with traffic regulations.

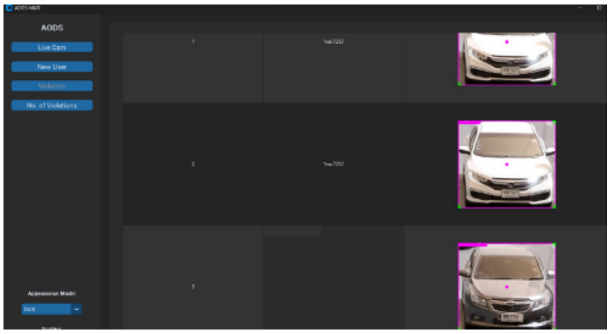

Fig.3.2 List of Violators taken from the DataBase

Furthermore, the EOMS is designed to evolve in tandem with future advancements in automotive technology, with provisions for automatic SOS messaging in the event of accidents. By leveraging the data collected by the black box, the system can rapidly assess the severity of incidents and dispatch emergency services, potentially reducing response times and minimizing the impact of collisions. This proactive approach to safety underscores the EOMS's commitment to fostering a safer driving environment and underscores its potential to serve as a cornerstone technology in the ongoing quest for road safety and efficiency.

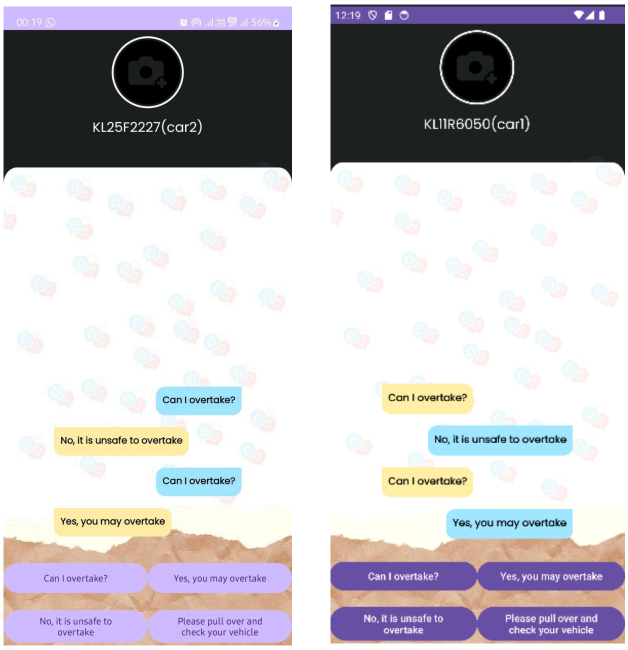

Fig.3.3 V2V Communication interface

IV. Conclusion

The Enhanced Overtaking Management System stands at the forefront of technological innovation in the realm of road safety, offering a robust framework to tackle the complexities inherent in overtaking maneuvers. Through its integration of cutting-edge features like Inter-Vehicular Communication and a sophisticated black box system, the system not only facilitates seamless communication between vehicles but also provides a comprehensive data recording and analysis mechanism to enhance safety measures.By fostering real-time communication among vehicles, the Enhanced Overtaking Management System promotes responsible driving behavior and mitigates the risks associated with reckless overtaking. This proactive approach not only aims to reduce the frequency of traffic violations but also instills a culture of compliance with traffic regulations, thereby contributing to overall road safety.

Moreover, the system's user-friendly interface, including functionalities like online fine payment and violation history access, serves to reinforce accountability among drivers. By offering convenient avenues for drivers to rectify their violations and stay informed about their driving records, the system encourages a sense of responsibility and adherence to road rules.Furthermore, the Enhanced Overtaking Management System's forward-thinking design, with provisions for future integration of automatic SOS messaging, positions it as a pivotal tool in ongoing efforts to create safer driving environments. The system's ability to leverage emerging technologies ensures its relevance and effectiveness in addressing evolving road safety challenges.In conclusion, the Enhanced Overtaking Management System represents a comprehensive and adaptable solution to improving road safety and traffic management. With its multifaceted approach and commitment to continuous innovation, the system holds the potential to revolutionize the way we navigate our roads, ultimately leading to safer and more efficient transportation systems for all road users.

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Appendix C: Vision, Mission, Programme Outcomes and Course Outcomes

Vision, Mission, Programme Outcomes and Course Outcomes

Institute Vision

To evolve into a premier technological institution, moulding eminent professionals with creative minds, innovative ideas and sound practical skill, and to shape a future where technology works for the enrichment of mankind.

Institute Mission

To impart state-of-the-art knowledge to individuals in various technological disciplines and to inculcate in them a high degree of social consciousness and human values, thereby enabling them to face the challenges of life with courage and conviction.

Department Vision

To become a centre of excellence in Computer Science and Engineering, moulding professionals catering to the research and professional needs of national and international organizations.

Department Mission

To inspire and nurture students, with up-to-date knowledge in Computer Science and Engineering, ethics, team spirit, leadership abilities, innovation and creativity to come out with solutions meeting societal needs.

Programme Outcomes (PO)

Engineering Graduates will be able to:

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and Team work: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

10. Communication: Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Programme Specific Outcomes (PSO)

A graduate of the Computer Science and Engineering Program will demonstrate:

PSO1: Computer Science Specific Skills
The ability to identify, analyze and design solutions for complex engineering problems in multidisciplinary areas by understanding the core principles and concepts of computer science and thereby engage in national grand challenges.

PSO2: Programming and Software Development Skills
The ability to acquire programming efficiency by designing algorithms and applying standard practices in software project development to deliver quality software products meeting the demands of the industry.

PSO3: Professional Skills
The ability to apply the fundamentals of computer science in competitive research and to develop innovative products to meet the societal needs thereby evolving as an eminent researcher and entrepreneur.

Course Outcomes (CO)

Course Outcome 1: Model and solve real world problems by applying knowledge across domains (Cognitive knowledge level: Apply).

Course Outcome 2: Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: Apply).

Course Outcome 3: Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks (Cognitive knowledge level: Apply).

Course Outcome 4: Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: Apply).

Course Outcome 5: Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: Analyze).

Course Outcome 6: Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: Apply).

Appendix C: CO-PO-PSO Mapping

CO-PO AND CO-PSO MAPPING

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO1 1	PO1 2	PSO1	PSO2	PSO3
CO 1	2	2	2	1	2	2	2	1	1	1	1	2	3		
CO 2	2	2	2		1	3	3	1	1		1	1		2	
CO 3									3	2	2	1			3
CO 4					2			3	2	2	3	2			3
CO 5	2	3	3	1	2							1	3		
CO 6					2			2	2	3	1	1			3

3/2/1: high/medium/low

JUSTIFICATIONS FOR CO-PO MAPPING & CO-PSO MAPPING

MAPPING	LOW/MEDIUM/HIGH	JUSTIFICATION
100003/ CS722U.1-PO1	M	Knowledge in the area of technology for project development using various tools results in better modeling.
100003/ CS722U.1-PO2	M	Knowledge acquired in the selected area of project development can be used to identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions.
100003/ CS722U.1-PO3	M	Can use the acquired knowledge in designing solutions to complex problems.
100003/ CS722U.1-PO4	M	Can use the acquired knowledge in designing solutions to complex problems.
100003/ CS722U.1-PO5	H	Students are able to interpret, improve and redefine technical aspects for design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
100003/ CS722U.1-PO6	M	Students are able to interpret, improve and redefine technical aspects by applying contextual knowledge to assess societal, health and consequential responsibilities relevant to professional engineering practices.
100003/ CS722U.1-PO7	M	Project development based on societal and environmental context solution identification is the need for sustainable development.

100003/ CS722U.1-PO8	L	Project development should be based on professional ethics and responsibilities.
100003/ CS722U.1-PO9	L	Project development using a systematic approach based on well defined principles will result in teamwork.
100003/ CS722U.1-PO10	M	Project brings technological changes in society.
100003/ CS722U.1-PO11	H	Acquiring knowledge for project development gathers skills in design, analysis, development and implementation of algorithms.
100003/ CS722U.1-PO12	H	Knowledge for project development contributes engineering skills in computing & information gatherings.
100003/ CS722U.2-PO1	H	Knowledge acquired for project development will also include systematic planning, developing, testing and implementation in computer science solutions in various domains.
100003/ CS722U.2-PO2	H	Project design and development using a systematic approach brings knowledge in mathematics and engineering fundamentals.
100003/ CS722U.2-PO3	H	Identifying, formulating and analyzing the project results in a systematic approach.
100003/ CS722U.2-PO5	H	Systematic approach is the tip for solving complex problems in various domains.
100003/ CS722U.2-PO6	H	Systematic approach in the technical and design aspects provide valid conclusions.
100003/ CS722U.2-PO7	H	Systematic approach in the technical and design aspects demonstrate the knowledge of sustainable development.
100003/ CS722U.2-PO8	M	Identification and justification of technical aspects of project development demonstrates the need for sustainable development.

100003/ CS722U.2-PO9	H	Apply professional ethics and responsibilities in engineering practice of development.
100003/ CS722U.2-PO11	H	Systematic approach also includes effective reporting and documentation which gives clear instructions.
100003/ CS722U.2-PO12	M	Project development using a systematic approach based on well defined principles will result in better teamwork.
100003/ CS722U.3-PO9	H	Project development as a team brings the ability to engage in independent and lifelong learning.
100003/ CS722U.3-PO10	H	Identification, formulation and justification in technical aspects will be based on acquiring skills in design and development of algorithms.
100003/ CS722U.3-PO11	H	Identification, formulation and justification in technical aspects provides the betterment of life in various domains.
100003/ CS722U.3-PO12	H	Students are able to interpret, improve and redefine technical aspects with mathematics, science and engineering fundamentals for the solutions of complex problems.
100003/ CS722U.4-PO5	H	Students are able to interpret, improve and redefine technical aspects with identification formulation and analysis of complex problems.
100003/ CS722U.4-PO8	H	Students are able to interpret, improve and redefine technical aspects to meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
100003/ CS722U.4-PO9	H	Students are able to interpret, improve and redefine technical aspects for design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
100003/ CS722U.4-PO10	H	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools for better products.

100003/ CS722U.4-PO11	M	Students are able to interpret, improve and redefine technical aspects by applying contextual knowledge to assess societal, health and consequential responsibilities relevant to professional engineering practices.
100003/ CS722U.4-PO12	H	Students are able to interpret, improve and redefine technical aspects for demonstrating the knowledge of, and need for sustainable development.
100003/ CS722U.5-PO1	H	Students are able to interpret, improve and redefine technical aspects, apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
100003/ CS722U.5-PO2	M	Students are able to interpret, improve and redefine technical aspects, communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
100003/ CS722U.5-PO3	H	Students are able to interpret, improve and redefine technical aspects to demonstrate knowledge and understanding of the engineering and management principle in multidisciplinary environments.
100003/ CS722U.5-PO4	H	Students are able to interpret, improve and redefine technical aspects, recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
100003/ CS722U.5-PO5	M	Students are able to interpret, improve and redefine technical aspects in acquiring skills to design, analyze and develop algorithms and implement those using high-level programming languages.
100003/ CS722U.5-PO12	M	Students are able to interpret, improve and redefine technical aspects and contribute their engineering skills in computing and information engineering domains like network design and administration, database design and knowledge engineering.
100003/ CS722U.6-PO5	M	Students are able to interpret, improve and redefine technical aspects and develop strong skills in systematic planning, developing, testing, implementing and providing IT solutions for different domains which helps in the betterment of life.
100003/ CS722U.6-PO8	H	Students will be able to associate with a team as an effective team player for the development of technical projects by applying the knowledge of

		mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
100003/ CS722U.6-PO9	H	Students will be able to associate with a team as an effective team player to Identify, formulate, review research literature, and analyze complex engineering problems
100003/ CS722U.6-PO10	M	Students will be able to associate with a team as an effective team player for designing solutions to complex engineering problems and design system components.
100003/ CS722U.6-PO11	M	Students will be able to associate with a team as an effective team player, use research-based knowledge and research methods including design of experiments, analysis and interpretation of data.
100003/ CS722U.6-PO12	H	Students will be able to associate with a team as an effective team player, applying ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
100003/ CS722U.1-PSO1	H	Students are able to develop Computer Science Specific Skills by modeling and solving problems.
100003/ CS722U.2-PSO2	M	Developing products, processes or technologies for sustainable and socially relevant applications can promote Programming and Software Development Skills.
100003/ CS722U.3-PSO3	H	Working in a team can result in the effective development of Professional Skills.
100003/ CS722U.4-PSO3	H	Planning and scheduling can result in the effective development of Professional Skills.
100003/ CS722U.5-PSO1	H	Students are able to develop Computer Science Specific Skills by creating innovative solutions to problems.
100003/ CS722U.6-PSO3	H	Organizing and communicating technical and scientific findings can help in the effective development of Professional Skills.