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

Anu Maria Joykutty
Dept. of Computer Science and Engineering
Rajagiri School of Engineering & Technology
Rajagiri Valley P O, Kochi, Kerala, India
anumj@rajagiritech.edu.in

Harikrishnan R
Dept. of Computer Science and Engineering
Rajagiri School of Engineering & Technology
Rajagiri Valley P O, Kochi, Kerala, India
harykrish998@gmail.com

Mathew Shaji
Dept. of Computer Science and Engineering
Rajagiri School of Engineering & Technology
Rajagiri Valley P O, Kochi, Kerala, India
mathewspeediackal@gmail.com

Jai Mathew James
Dept. of Computer Science and Engineering
Rajagiri School of Engineering & Technology
Rajagiri Valley P O, Kochi, Kerala, India
jaimathewjames2002@gmail.com

Hariraman M
Dept. of Computer Science and Engineering
Rajagiri School of Engineering & Technology
Rajagiri Valley P O, Kochi, Kerala, India
hariramamlekha467@gmail.bom

***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.

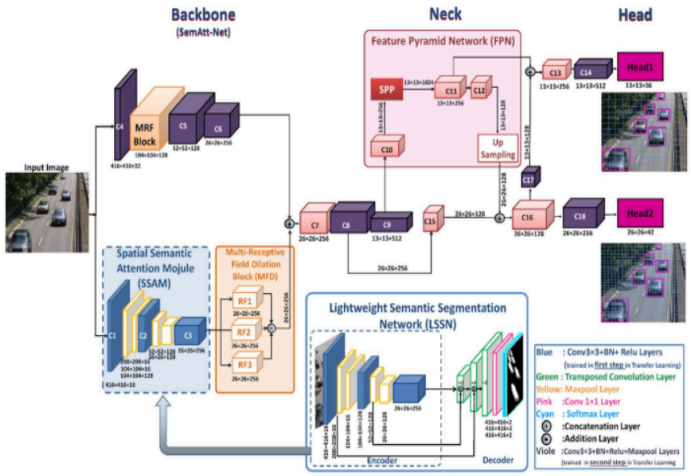

Fig. 2.1 Algorithm for Fast YOLO Recognition

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.

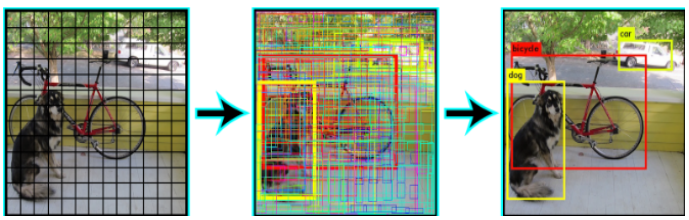

Fig.2.2 Image is divided into several grids

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.

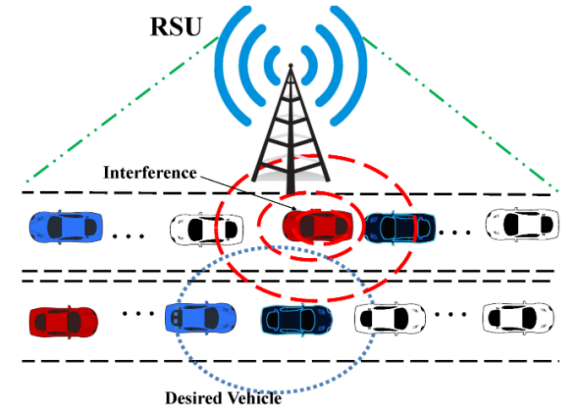

Fig.2.3 DSRC Communication architecture

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.

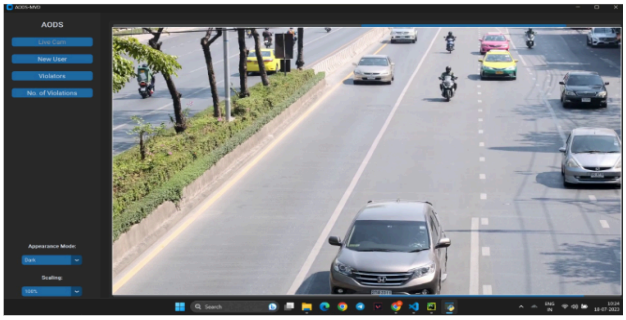

Fig.3.1 Live Camera With Tracking Facilities

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.

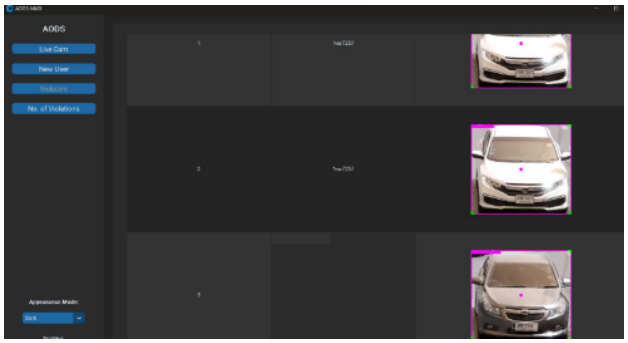

Fig.3.2 List of Violators taken from the DataBase

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.

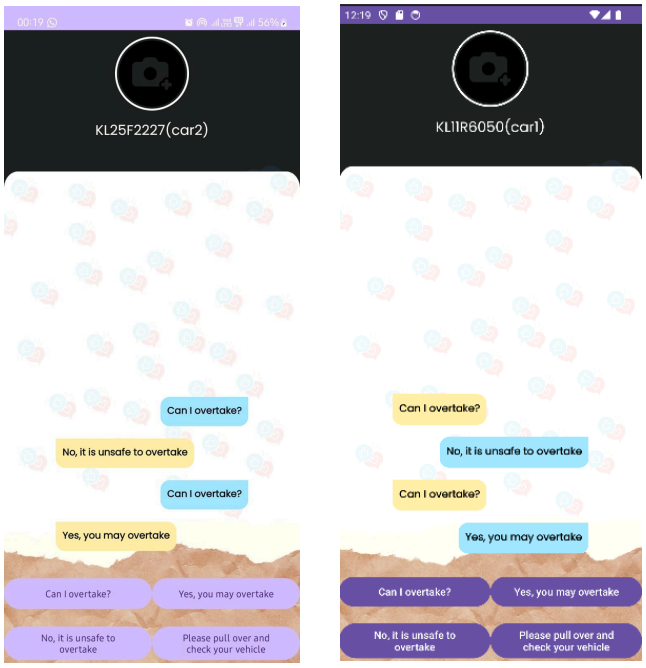

Fig.3.3 V2V Communication interface

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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