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ADVANCING ROAD SAFETY: DSRC-ENABLED COLLISION AVOIDANCE SYSTEM FOR SAFER URBAN TRANSPORTATION

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Abstract:
This research introduces a sophisticated collision avoidance system that harnesses Dedicated Short-Range Communication (DSRC) technology to significantly enhance road safety, particularly in complex driving scenarios such as blind turns and intersections. Through the establishment of real-time communication links between vehicles, our system proactively warns drivers about potential collision risks and provides assistance in navigating to avoid accidents. We conduct extensive simulations to assess the system's efficacy under diverse environmental conditions, illustrating its capability to mitigate crashes and optimize traffic flow. Furthermore, we delve into the broader implications of DSRC-enabled collision avoidance systems for urban planning and transportation infrastructure, underscoring their pivotal role in fostering safer, more intelligent, and sustainable urban environments.
Keywords: DSRC, collision avoidance system, road safety, urban transportation, real-time communication, vehicle-to-vehicle communication, traffic flow optimization, simulations, intersection safety, smart cities.

1 Introduction

Urban transportation systems face numerous challenges, including traffic congestion, pedestrian safety, and environmental concerns. Among these challenges, the risk of collisions remains a critical issue that jeopardizes the safety of road users and undermines the efficiency of urban mobility. In response to this pressing need, collision avoidance systems have emerged as a pivotal technology aimed at enhancing safety and efficiency in urban transportation. A collision avoidance system is a sophisticated technological framework designed to detect and mitigate potential collisions between vehicles, pedestrians, cyclists, and other objects in urban environments. Leveraging a combination of sensors, cameras, radar, lidar, and advanced algorithms, these systems continuously monitor the surrounding environment and proactively intervene to prevent or minimize the severity of accidents.

Key Components and Functionality:

At the core of a collision avoidance system are its sensing and detection capabilities, which enable it to perceive the environment in real-time and identify potential collision hazards. These systems employ a variety of sensors, including radar, lidar (light detection and ranging), cameras, and ultrasonic sensors, to gather comprehensive data about the vehicle's surroundings. Once the system detects a potential collision threat, it utilizes advanced algorithms to analyze the data and assess the severity of the situation. Depending on the nature of the threat and the available response options, the collision avoidance system may take immediate action to mitigate the risk of a collision.

Common intervention strategies employed by collision avoidance systems include:

1. Warning Alerts: The system provides visual, auditory, or haptic warnings to alert the driver of an impending collision, giving them an opportunity to react and take corrective action.
2. Automatic Emergency Braking (AEB): In situations where a collision is imminent and the driver fails to respond in time, the system can autonomously apply the brakes to reduce the vehicle's speed or bring it to a complete stop, thereby minimizing the impact of the collision.
3. Lane Departure Warning (LDW): To prevent collisions caused by unintentional lane departures, collision avoidance systems may include LDW functionality, which alerts the driver when the vehicle drifts out of its lane without signaling.
4. Pedestrian and Cyclist Detection: Recognizing the vulnerability of pedestrians and cyclists in urban environments, collision avoidance systems are often equipped with specialized sensors and algorithms to detect and track these vulnerable road users, enabling timely intervention to avoid accidents.

Benefits and Impact:

The integration of collision avoidance systems into urban transportation infrastructure holds the potential to revolutionize road safety and mobility. By proactively identifying and mitigating collision risks, these systems can significantly reduce the incidence of accidents, injuries, and fatalities on urban roads. Furthermore, collision avoidance systems have the potential to enhance the efficiency of urban transportation networks by reducing traffic congestion, improving traffic flow, and minimizing the disruptions caused by accidents and delays. In conclusion, collision avoidance systems represent a critical advancement in the quest for safer and more efficient urban transportation. By leveraging cutting-edge technology and proactive intervention strategies, these systems have the power to transform urban mobility, making cities safer and more livable for all residents and road users.

Modern society, where the reliance on vehicular transportation is ubiquitous, ensuring the safety of road users remains an ever-pressing concern. Despite remarkable advancements in automotive engineering and safety technology, blind spots persist as a significant and potentially perilous aspect of the driving experience. These blind spots, areas around a vehicle that are not directly visible to the driver, pose a considerable risk by hindering the ability to perceive nearby vehicles, cyclists, or pedestrians, thus increasing the likelihood of accidents and collisions. Traditional safety measures such as side-view and rear-view mirrors, along with sensors and cameras, have undoubtedly improved driver awareness and reduced the frequency of accidents. However, these technologies are not infallible and still have inherent limitations, particularly in addressing blind spots comprehensively. Drivers often find themselves relying on quick glances and peripheral vision, which may not always suffice, especially in dynamic and fast-paced traffic environments. In response to these ongoing challenges, emerging technologies in the realm of vehicle-to-vehicle (V2V) communication present a promising avenue for enhancing road safety. By establishing direct communication channels between neighboring vehicles, V2V systems have the potential to revolutionize how information is shared on the road, significantly improving situational awareness and facilitating proactive hazard avoidance. Central to our endeavor is the utilization of Dedicated Short-Range Communication (DSRC) technology, a wireless communication protocol specifically designed for vehicular communication systems. DSRC operates on a reserved portion of the 5.9 GHz band and enables vehicles to exchange vital safety information, such as speed, position, and trajectory, in real-time. Our project focuses on leveraging DSRC technology to develop a robust and adaptive model within the NS2 simulator framework. This model aims to replicate real-world driving scenarios and simulate the interactions between vehicles as they navigate through various traffic conditions. A key aspect of our model is its ability to detect instances where vehicles approach each other closely or encroach upon each other's blind spots. Upon detecting such situations, our model initiates a proactive response by transmitting blind spot warning messages to the relevant vehicles involved. These messages serve as timely alerts, prompting the vehicles to adjust their speed, direction, or lane position to mitigate the risk of potential collisions effectively. By integrating DSRC-based V2V communication into our simulation model, we aim to demonstrate the efficacy and potential impact of this technology in addressing blind spot-related challenges on the road. Through extensive testing and evaluation, we seek to showcase how V2V communication can enhance overall road safety by fostering greater awareness and cooperation among vehicles, ultimately paving the way towards safer and more efficient transportation systems.

2 Literature survey

Kim et.al [1] presents a mathematical model for evaluating the performance and reliability of the IEEE 802.11p Enhanced Distributed Channel Access (EDCA) broadcast scheme in Dedicated Short-Range Communication (DSRC) networks, considering hidden terminals. The model combines a semi-Markov process (SMP) to depict channel contention with M/G/1/K queues for safety message generation and service. It accounts for various network parameters such as packet delay, delivery rate, and reception rate, as well as factors like backoff counter process, packet arrivals, queue length, fading channels, and transmission ranges. Simulation results validate the model's accuracy and demonstrate its advantage in analyzing hidden terminal impacts on network performance.

Hu et.al [2] presents a mathematical model to evaluate the performance and reliability of the IEEE 802.11p EDCA broadcast scheme in DSRC-based VANETs with hidden terminals. It introduces a semi-Markov process (SMP) model for channel contention and M/G/1/K queues for safety message generation. The model considers various factors such as backoff counter process, packet arrivals, queue length, fading channels, and transmission ranges. Simulation results validate the model's accuracy and demonstrate its advantage in analyzing hidden terminal impacts on network performance.

Lian et.al [3] focusing on evaluating the reliability of the Dedicated Short Range Communication (DSRC) control channel in Vehicular Ad-Hoc Networks (VANETs) for safety applications. The researchers introduce an analytical model along with a new mobility model to accurately represent vehicle speed-density relationships, considering safety-related rules. This model incorporates factors such as vehicle mobility, transmitter and receiver speeds, channel fading, hidden terminal problems, and transmission collisions. The analysis indicates potential performance degradation of current DSRC specifications, particularly in dense and high-mobility conditions. To mitigate this, the researchers propose an adaptive algorithm aimed at enhancing system reliability. Simulations conducted with realistic vehicular traces validate the effectiveness of the proposed model and algorithm in assessing system reliability and improving VANET performance.

Byungjun et.al [4] presents a solution called "Nearest-first" to enhance communication reliability in environments where vehicles use different technologies such as LTE-V2V and DSRC. This system employs hybrid devices equipped with both technologies to relay messages received through one technology using the other. Simulations demonstrate that Nearest-first outperforms other schemes, improving effective communication distances by up to 91%. By managing relaying operations efficiently, Nearest-first ensures longer communication distances and reduces the number of relaying events. This approach effectively addresses communication issues between vehicles using different technologies, contributing significantly to improving communication reliability in mixed-technology environments crucial for the efficiency of vehicular communication systems.

Wang et.al [5] presents the development of an analytical model to assess the performance of vehicular safety communication using the IEEE 802.11p protocol. Specifically, it focuses on the MAC layer's Distributed Coordination Function (DCF) or single-class Enhanced Distributed Channel Access (EDCA) without certain mechanisms like RTS/CTS, ACK, and retransmissions. The model integrates factors such as traffic loads, packet lengths, hidden terminals, node mobility, queuing systems, and faulty channels. This comprehensive model addresses a gap in existing research, offering precise predictions of vehicular network performance regarding packet delay, delivery rate, and reception rate under varying traffic and channel conditions. The conclusion emphasizes the model's novelty in collectively considering practical factors, which was previously lacking in analytical models. Experimental validation confirms the model's accuracy across diverse scenarios, making a significant contribution to optimizing safety communication in vehicular networks.

3 Methodology

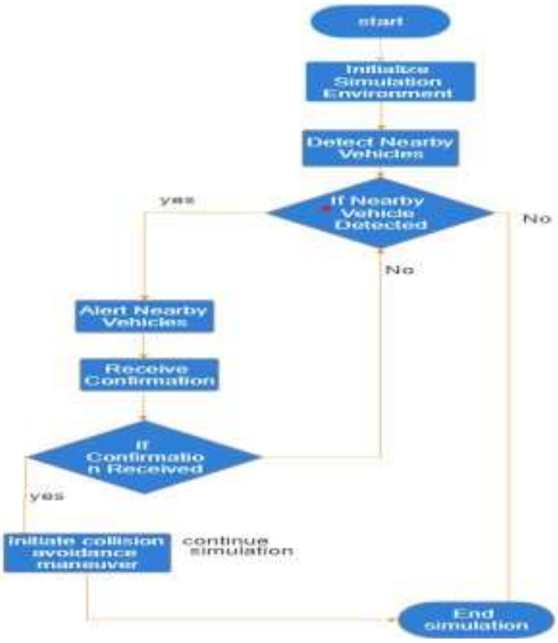


Fig 1 Flow chart

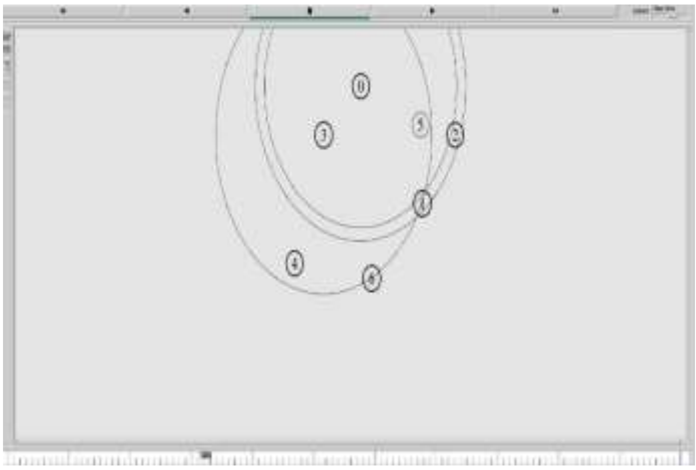
The steps involved in a simulation process, possibly related to autonomous vehicles. Let's break down the flowchart:

1. **Start:** The simulation begins.
2. **Initialize Simulation Environment:** The simulated environment is set up, which likely includes the creation of the virtual world where the simulation will take place.
3. **Detect Nearby Vehicles:** The simulated vehicle being controlled by the simulation software looks for other vehicles around it.
4. **If Nearby Vehicle Detected:** There is a decision point here. If a nearby vehicle is detected, the process moves to step 5. If no nearby vehicle is detected, the process moves to step 8.
5. **Alert Nearby Vehicles:** The simulated vehicle being controlled by the simulation software communicates with the other vehicles it detected in step 3, possibly to inform them of its presence.
6. **Receive Confirmation:** The simulation waits to receive a confirmation message from the nearby vehicles it alerted in step 5.
7. **If Confirmation Received:** There is another decision point here. If a confirmation message is received, it likely means the nearby vehicles are aware of the simulated vehicle and will avoid a collision. If this is the case, the process moves to step 10. If no confirmation is received, it may mean the nearby vehicles are not aware of the simulated vehicle and there is a risk of a collision. The process then moves to step 9.
8. **No Nearby Vehicles Detected:** This likely means there is no risk of a collision and the simulated vehicle can continue on its way without taking any evasive actions. The process moves to step 10.
9. **Initiate Collision Avoidance Maneuver:** Since a nearby vehicle was detected in step 3 but there was no confirmation of awareness from that vehicle in step 7, the simulated vehicle takes evasive actions to avoid a collision.
10. **Continue Simulation:** The simulation continues, likely moving the simulated vehicle and any other simulated objects according to the programmed parameters.
11. **End Simulation:** The simulation ends.

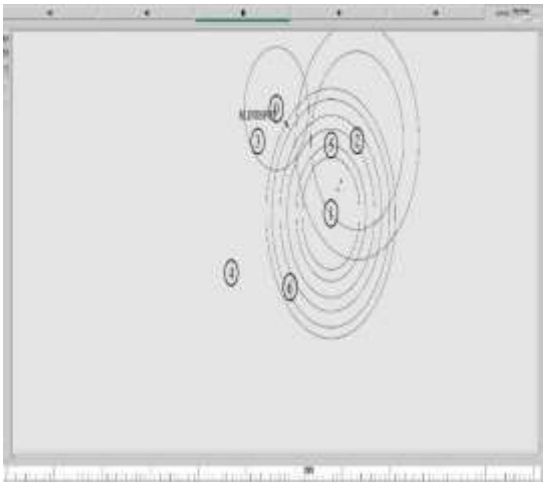
This flowchart provides a basic overview of the steps involved in a simulation process, likely focused on collision avoidance between simulated autonomous vehicles.

Results

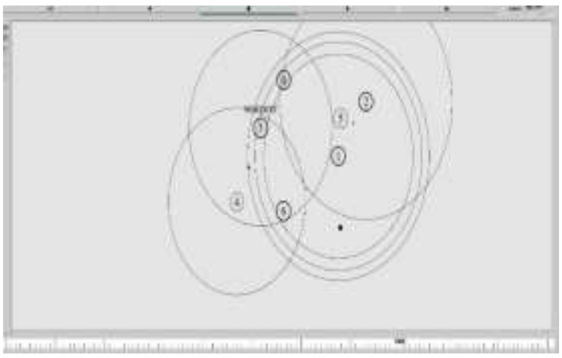
Vehicle movement is achieved as a set of mobility models which are used to track and maintain the current cartesian position and speed of an object. This can be achieved by giving different destinations of x,y and z cartesian coordination's. While vehicles movement in dsrc range of communication we can generate packets as data transmission and receiving from one another vehicle in overall dsrc range. If excess packets has transmitted with the nearer vehicle then there is packet loss. If the vehicles are far away to one another then there is packet delay.



Labelling Blindspot when the vehicles is moving with high speed to another nearer vehicle. As the vehicles are nearer then there is less packet generation is required so remaining data as packets is dropped as Black dots towards down in NAM.



After identifying Blindspot message either one of the vehicles set new destination in different direction to avoid accidents at blind spots



MODEL GRAPHS:

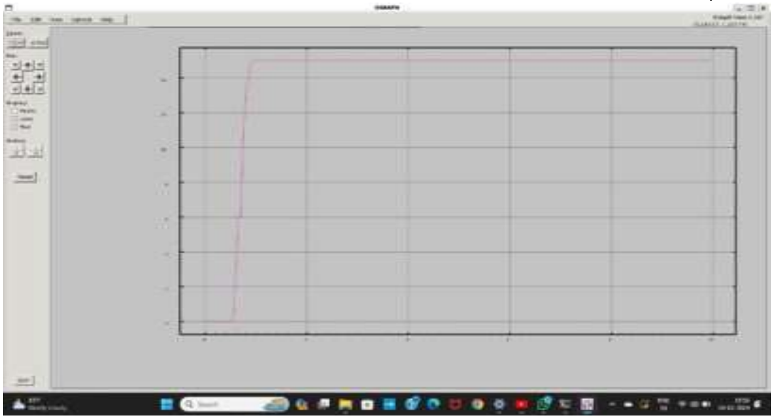


Fig 2 Packet Received

Packet has been received in dsrc communication of vehicles to communicate one another vehicle using packets as data. At initial there less no of packets because of less movement shown in x graph.

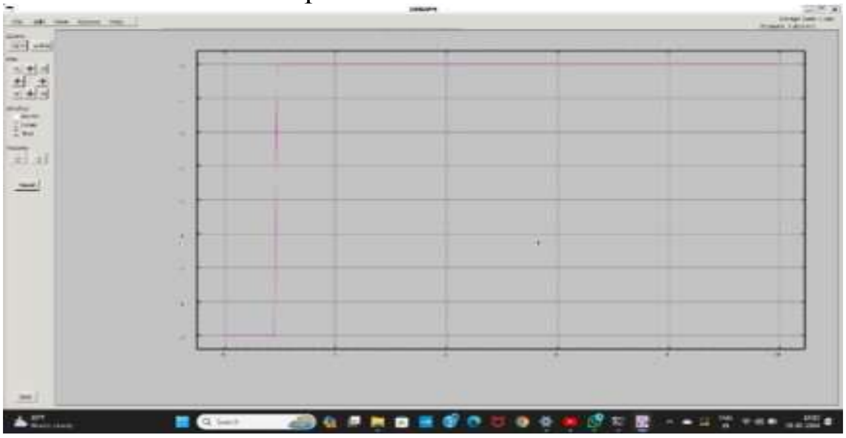


Fig 3 Packet Delay

Packet delay is seen in the vehicles which are far apart from one another. As no packets at initial is less so there is no packet delay by increasing packets as data for far away vehicles there is packet delay shown in x graph.

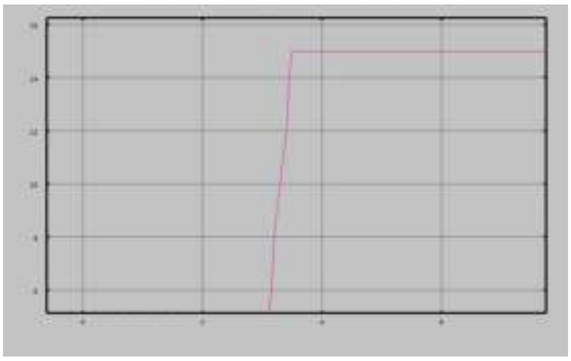


Fig 4 Packet Dropped

Packet dropped is seen in when the vehicles is nearere then less packets as data needed to communicate one another is shown in xgraph.

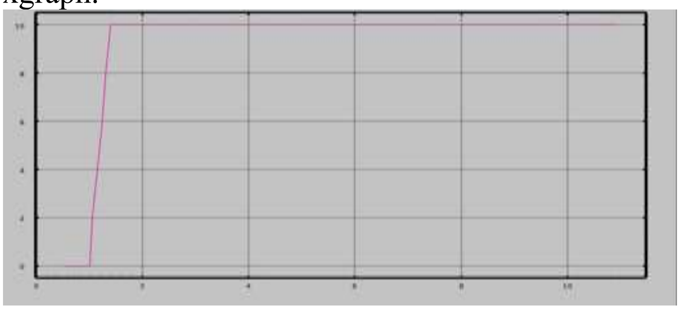


fig 5 Delivery Ratio

Delivery ratio the performance is measured by the average end-to-end delay. The model quantifies the PDR (Packet Delivery Ratio) as a function of the distance between transmitter and receiver.

Conclusion

The project's implementation of DSRC-based V2V communication has shown promising results in enhancing safety measures in vehicular environments, particularly in addressing blind spot-related accidents. By utilizing DSRC technology and the ns2 simulator, the project has effectively enabled vehicles to communicate with each other, thus improving situational awareness and reducing the risks associated with blind spots. Through the transmission of messages between vehicles, prompt actions can be taken to avoid collisions, thereby preventing accidents and potentially saving lives. Overall, the successful implementation of this project highlights the potential of V2V communication systems in enhancing road safety and paving the way for more intelligent and interconnected transportation systems in the future.

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