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Review on Semi-Autonomous Vehicle for Safe Commute

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Abstract - The integration of autonomous vehicles into our transportation system has the potential to revolutionize the way we commute and address several challenges associated with traditional transportation modes. The paper presents a comprehensive literature survey on the use of a cloud-based model for controlling vehicle speed based on traffic rules. As semi-autonomous vehicles become increasingly prevalent, ensuring safe commuting experiences has become a significant focus for researchers and industry professionals. This paper explores existing literature related to the integration of cloud computing and traffic rule management systems with semi-autonomous vehicles. The primary objective is to propose a model that leverages cloud infrastructure to store and update traffic rules, enabling precise control of vehicle speed to ensure compliance with current regulations and enhance overall safety. Through a systematic review of the literature, various approaches and technologies used in similar models are analyzed. Key aspects considered include the communication framework between the cloud and vehicles, methods for real-time traffic rule updates, and the impact of cloud-based speed control on safe commuting.

Key Words: Autonomous, traffic, computing, cloud.

1. INTRODUCTION

A semi-autonomous vehicle for safe commute, specifically focusing on controlling the speed of the vehicle, refers to a type of vehicle that incorporates advanced technologies to assist drivers in maintaining a safe and appropriate speed while commuting. By integrating speed control features with autonomous driving capabilities, these vehicles aim to enhance safety and optimize the driving experience. In a semi-autonomous vehicle for speed control, various systems and sensors work together to monitor the surrounding environment, road conditions, and traffic patterns. This information is processed by the vehicle's onboard computer, which then assists the driver in maintaining a safe speed by automatically adjusting the vehicle's acceleration or deceleration. These vehicles often feature Adaptive Cruise Control (ACC) systems, which use sensors such as radar or cameras to detect the distance between the vehicle and other vehicles ahead. ACC allows the vehicle to automatically adjust its speed to maintain a safe following distance, matching the speed of the vehicle in front, and even coming to a complete stop if necessary. This technology helps mitigate the risk of rear-end collisions and promotes smoother traffic flow.

Furthermore, semi-autonomous vehicles for speed control may incorporate Intelligent Speed Adaptation (ISA) systems. ISA systems utilize GPS and mapping data to identify the speed limits of the roads being travelled. The vehicle then adjusts its speed to match the posted speed limit, providing an added layer of compliance with local traffic regulations and promoting safer driving practices. While these systems assist in maintaining speed, it's important to note that the driver remains responsible for monitoring and controlling the vehicle. The driver must be prepared to intervene and take control when necessary, such as in challenging driving conditions or when approaching road situations that require human judgment.

By combining autonomous speed control features with human oversight, semi-autonomous vehicles for safe commute aim to reduce the risk of speed-related accidents, promote smoother traffic flow, and enhance overall driving comfort. These advancements contribute to the ongoing development of safer and more efficient transportation systems, making commutes more enjoyable and stress-free for drivers while prioritizing safety on the road.

2. REVIEW ON DIFFERENT WORKING PRINCIPLES AND TECHNOLOGIES

Different types of semi-autonomous vehicles for safe commuting rely on different working principles and technologies.

Adaptive Cruise Control (ACC)

ACC is an Advanced Driver-Assistance System (ADAS) designed to enhance safety and comfort during driving. ACC uses sensors, typically radar or LiDAR, to monitor the distance and relative speed between the equipped vehicle and the vehicle ahead. The primary goal of ACC is to automatically maintain a safe following distance by adjusting the speed of the vehicle.

Adaptive Cruise Control offers several benefits, including reducing driver fatigue on long trips, improving fuel efficiency by optimizing speed control, and enhancing safety by mitigating the risk of rear-end collisions. However, it's important for drivers to remain attentive and ready to take control of the vehicle when necessary, as ACC systems do not replace the need for human intervention in all driving scenarios.

Lane Keeping Assist (LKA)

LKA is an Advanced Driver-Assistance System (ADAS) designed to enhance safety and prevent unintentional lane departures during driving. LKA utilizes sensors, typically cameras or image sensors, to monitor the vehicle's position within the lane and provide corrective steering assistance when necessary.

Lane Keeping Assist offers several benefits, including reducing the risk of unintentional lane departures, preventing accidents caused by driver inattention or drowsiness, and enhancing overall driving safety. However, it is crucial for drivers to remember that LKA is meant to assist and support their driving efforts, and they should remain actively always engaged and maintain control of the vehicle.

Blind Spot Detection

BSD uses sensors to detect vehicles in the driver's blind spots and provides warnings, usually through visual or audible alerts, to assist in safe lane changes. This technology employs radar or ultrasonic sensors, signal processing algorithms, and driver alert systems.

Blind Spot Detection helps improve safety by addressing one of the significant challenges drivers face: limited visibility in certain areas around the vehicle. By providing timely alerts about vehicles or objects in the blind spot zones, BSD assists drivers in making safer lane changes and maneuvers, reducing the risk of accidents caused by unseen vehicles. However, it's important for drivers to continue using proper mirror usage and shoulder checks to ensure comprehensive awareness of their surroundings. BSD is a valuable tool that complements safe driving practices and enhances overall situational awareness.

Parking Assist System

Parking assist systems facilitate automated parking maneuvers by utilizing sensors and control algorithms to detect obstacles, calculate parking trajectories, and control vehicle movements. These systems employ ultrasonic or LiDAR sensors, camera systems, control algorithms, and actuators for steering and braking.

Parking Assist Systems significantly improve parking convenience and safety by reducing the risk of collisions and helping drivers navigate tight parking spaces. They provide drivers with real-time information, guidance, and assistance, making parking maneuvers more accurate and efficient. However, drivers should always remain attentive and actively monitor their surroundings while using these systems to ensure safe parking operations.

Collision Warning Systems

Collision Warning Systems are Advanced Driver-Assistance Systems (ADAS) designed to enhance safety by detecting potential collisions and providing timely warnings to the driver. These systems utilize sensors, such as radar, LiDAR, or cameras, to monitor the vehicle's surroundings and analyze the data to identify potential collision risks.

Collision Warning Systems play a crucial role in preventing or mitigating the severity of collisions by providing drivers with early warnings and allowing them to take evasive actions. They significantly contribute to overall road safety by reducing the risk of rear-end collisions, pedestrian accidents, and other collision-related incidents. However, it is important for drivers to remain vigilant, actively monitor the road, and respond appropriately to the warnings provided by the system.

Emergency Brake Assist (EBA)

Working Principle: EBA systems monitor the vehicle's surroundings and apply emergency braking if a potential collision is detected, either through driver input or automatically.

Technologies: Sensor fusion (using radar, LiDAR, and cameras), collision detection algorithms, brake actuation systems, and warning systems.

Emergency Brake Assist significantly improves braking performance in critical situations, reducing the risk of collisions and mitigating their severity. By assisting drivers in emergency braking, EBA enhances overall safety on the road and helps to prevent or minimize the impact of potential accidents. However, drivers should always remain vigilant, maintain proper following distances, and actively respond to warnings from the system to ensure optimal safety.

These semi-autonomous technologies enhance safety by assisting drivers in different aspects of driving, such as maintaining a safe distance, staying within lanes, detecting blind spots, assisting in parking, and providing collision warnings and emergency braking. Each technology relies on specific sensors, control algorithms, and actuators to accomplish its intended function and improve the overall safety of the commute.

3. LITERATURE REVIEW

To validate the effectiveness of the proposed model, the literature survey incorporates findings from various studies that have evaluated similar approaches through simulations and real-world scenarios. These evaluations provide insights into the benefits, challenges, and potential limitations of implementing a cloud-based speed control system for semi-autonomous vehicles.

The papers reviewed in this study focus on the application of advanced technologies, such as Internet of Things (IoT), cloud computing, and Global Positioning System (GPS), in the context of smart vehicle monitoring, speed control, predictive guidance, and traffic enforcement. The papers highlight the potential of these technologies to enhance road safety, improve traffic efficiency, and optimize vehicle performance.

The paper [1] presents an IoT-based speed control scheme for semi-autonomous electric on-road cargo vehicles. It integrates various parameters and employs wireless sensors, IoT-based maps, and a microcontroller-based embedded system for effective speed control.

Author in [2] introduces a predictive guidance and control framework for semi-autonomous vehicles in public traffic. The framework utilizes real-time data, predictive models, and control algorithms to enhance decision-making, trajectory planning, and adaptive control strategies.

The paper [3] proposes a smart vehicle monitoring and assistance system using cloud computing in vehicular ad hoc networks (VANETs). It enables vehicles to communicate with each other and the cloud, providing intelligent assistance for navigation, congestion avoidance, and collision detection.

The paper [4] focuses on intelligent vehicle monitoring using GPS and cloud computing. It utilizes GPS technology for real-time vehicle tracking and cloud computing for data storage, processing, and analysis, enabling efficient fleet management and predictive maintenance.

Author in [5] presents a road and traffic enforcement system utilizing GPS-enabled mobile cloud computing. The system integrates GPS technology with cloud computing to enforce traffic regulations and ensure road safety.

Overall, these papers demonstrate the potential of advanced technologies in improving various aspects of the transportation system, including speed control, guidance, monitoring, and enforcement. They provide valuable insights and pave the way for further research and development in the field of smart transportation.

4. PROPOSED METHODLOGY

We are proposing a model based on the literature review to provide a comprehensive approach that integrates findings from existing studies and contributes to the existing knowledge on the subject matter.

Cloud-based vehicle speed control based on traffic rules offers several advantages over other technologies. The system can process and analyze vast amounts of real-time data, including road conditions, and traffic regulations. This enables accurate and up-to-date information for speed control, ensuring compliance with traffic rules and enhancing overall road safety.

The purpose of the design phase is to plan a solution of the problem specified by the requirement document. This phase is the first step in moving from the problem domain to the solution domain. The design of the system perhaps the most critical factors affecting the quality of the software, it has a major impact on the later phases particularly testing and maintenance. System design is a part of defining the hardware and software architecture, components, modules, interfaces, and data for a computer system to satisfy specified requirements. The design of the system is a blueprint or a plan for a solution for the system. Our system provides automatic guidelines for the user while driving a vehicle. Figure 1 shows the block diagram of proposed model where system receives data from cloud regarding traffic rules and compares to current location and sends signal to Arduino microcontroller and speed of motor is controlled.

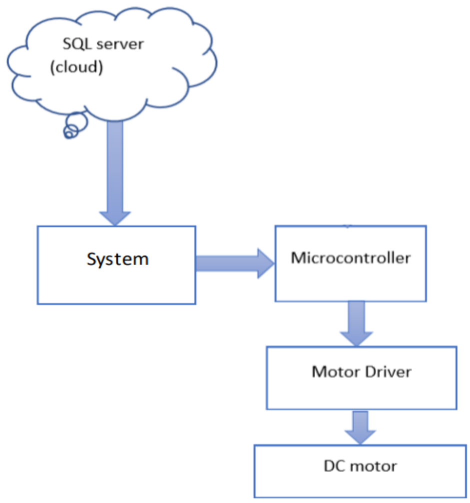

Figure 1: Block Diagram

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Use Case Diagram

The above block diagram can also be represented using use case diagram shown in Figure 2. A use case diagram is a visual representation that illustrates the interactions between actors (users or external systems) and a system under consideration. It provides a high-level view of the functionalities and relationships within a system, focusing on the different use cases or scenarios in which the system is involved.

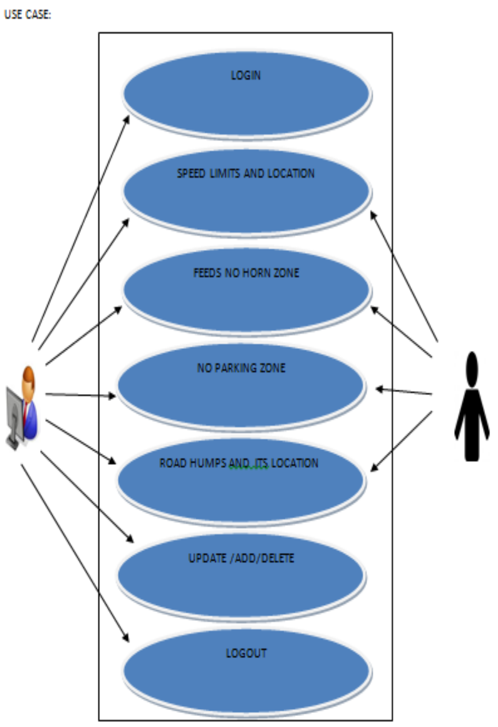

Figure 2: Use Case Diagram

- The actor or admin login to the webpage where he can enter the details of the rules, values to the cloud.
- These entered values are stored in the cloud and fetched whenever it is needed.
- The stored values are speed limited values, parking mode, humps areas, no horn zones at a particular location.
- The user has control over speed limitation location, no horn zones, parking zones and humps but not on the data entry of the location.
- Only the admin can feed the values to the cloud.

Sequence diagram

The proposed model can also be represented using use case diagram shown in Figure 3. A sequence diagram is a type of behavioral diagram used in software engineering and systems analysis to visualize the interactions and order of messages exchanged between objects or components within a system. It represents the dynamic behavior of a system by illustrating the sequence of events and the flow of communication between different entities.

In a sequence diagram, objects or participants (also known as lifelines) are represented as vertical lines, and the messages exchanged between them are shown as horizontal arrows or lines. The vertical axis represents time, with the top being the beginning and the bottom being the end of the sequence.

The sequence diagram showcases the chronological order in which messages are exchanged between objects, depicting the exact timing and dependencies of these interactions. It helps to understand the interactions between different components, objects, or actors in a system and the specific order in which these interactions occur.

Each interaction or message in the sequence diagram is labeled with the corresponding method or operation being invoked, along with any parameters or return values. It also captures the conditions or constraints under which the message is sent or received.

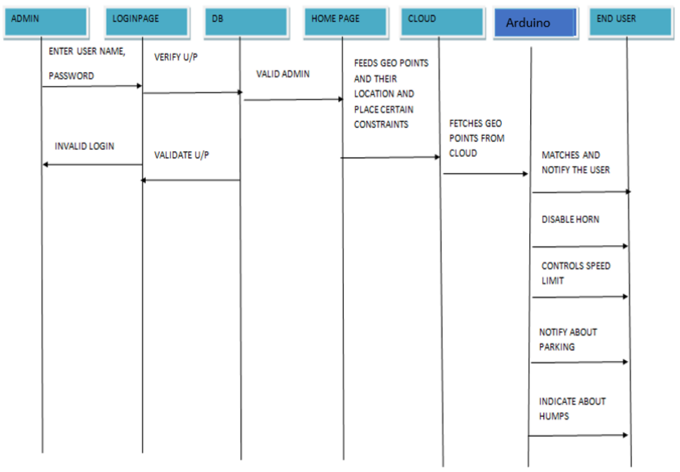

Figure 3: Sequence Diagram

5. CONCLUSION AND FUTURE DIRECTIONS

To validate the effectiveness of the proposed model, the literature survey incorporates findings from various studies that have evaluated similar approaches through simulations and real-world scenarios. These evaluations provide insights into the benefits, challenges, and potential limitations of implementing a cloud-based speed control system for semi-autonomous vehicles.

In conclusion, this paper introduces a novel model that integrates cloud-based traffic rule management with semi-autonomous vehicles. By leveraging cloud computing, the model enhances the safety and efficiency of commuting by enabling real-time control of vehicle speed based on traffic rules stored in the cloud. The proposed model presents a significant step towards achieving safe and reliable semi-autonomous vehicle systems for future transportation networks.

The findings have provided valuable insights into the advantages and capabilities of the system. Moving forward, we are committed to implementing and refining the proposed model to ensure its successful integration into real-world applications. Additionally, we recognize the importance of continuous improvement and future research in order to enhance the model's performance, scalability, and adaptability. With a focus on practical implementation and ongoing refinement, we are optimistic about the positive impact that this proposed model can have on the field and its potential to contribute to the advancement of the subject area.

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