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Automatic Vehicle Speed Control System

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Abstract: The advancement of automotive technology has led to significant developments in vehicle safety and control systems. Among these innovations is the *Automatic Vehicle Speed Control System*, which aims to assist drivers in maintaining optimal speed based on real-time road conditions, traffic patterns, and safety regulations. This paper explores the design, functionality, and implications of automatic vehicle speed control systems, focusing on their role in reducing road accidents, improving fuel efficiency, and complying with traffic regulations. The system's architecture, components, and algorithms will be reviewed, alongside a discussion on challenges and future advancements.

Keywords:

Automatic Vehicle Speed Control System (AVSCS) Road Safety

Traffic Flow Fuel Efficiency Cruise Control

Intelligent Speed Adaptation (ISA) Sensors

Global Positioning System (GPS) LIDAR

Electronic Control Units (ECUs)

Vehicle-to-Vehicle (V2V) Communication Vehicle-to-Infrastructure (V2I) Communication Real-Time Adjustments Control Algorithm

Data Collection & Processing Predictive Models

Actuators

Safety Regulations

Compliance with Speed Limits Sensor Reliability

System Latency Ethical Concerns

Autonomous Vehicles

Machine Learning Integration Autonomous Speed Control Challenges and Limitations Future Directions

Smart Cities

Traffic Management

Environmental Impact (CO2 Emissions)

I. INTRODUCTION

A. Background

As the number of vehicles on the road increases, maintaining safe speeds is critical for minimizing accidents, enhancing road safety, and improving traffic flow. Manual speed control often leads to variability in response times, speeding violations, and human errors, which contribute to road accidents. With the integration of electronics, sensors, and intelligent control algorithms, the *Automatic Vehicle Speed Control System* (AVSCS) offers a solution by automating the speed regulation process.

B. Objectives of the Study

This research aims to:

- 1) Understand the structure and components of automatic vehicle speed control systems.
- 2) Explore the methodologies employed in these systems to regulate vehicle speed.
- 3) Assess the advantages and limitations of implementing AVSCS.
- 4) Investigate the impact of these systems on road safety, traffic management, and fuel efficiency.

II. LITERATURE REVIEW

A. Overview of Speed Control Systems

Vehicle speed control has evolved from manual systems to advanced driver assistance systems (ADAS). Earlier approaches, such as cruise control, allowed drivers to set a constant speed, while newer systems use sophisticated sensors and algorithms to dynamically adjust speed.

Thesystemsare key in maintaining a safe distance between vehicles, adhering to speed limits, and avoiding collisions.

B. Technologies In Use

AVSCSintegratesmultipletechnologies:

1) Sensors:

- Measure the distance and speed of objects in front of the vehicle, enabling dynamic speed adjustment.

2) GlobalPositioningSystem (GPS):

- Assists in identifying speed zones and determining optimal speeds based on location data.

3) CamerasandLIDAR Systems:

- Detect roadsigns, pedestrians,and vehicles,feeding real- time data to the control system for safe navigation.

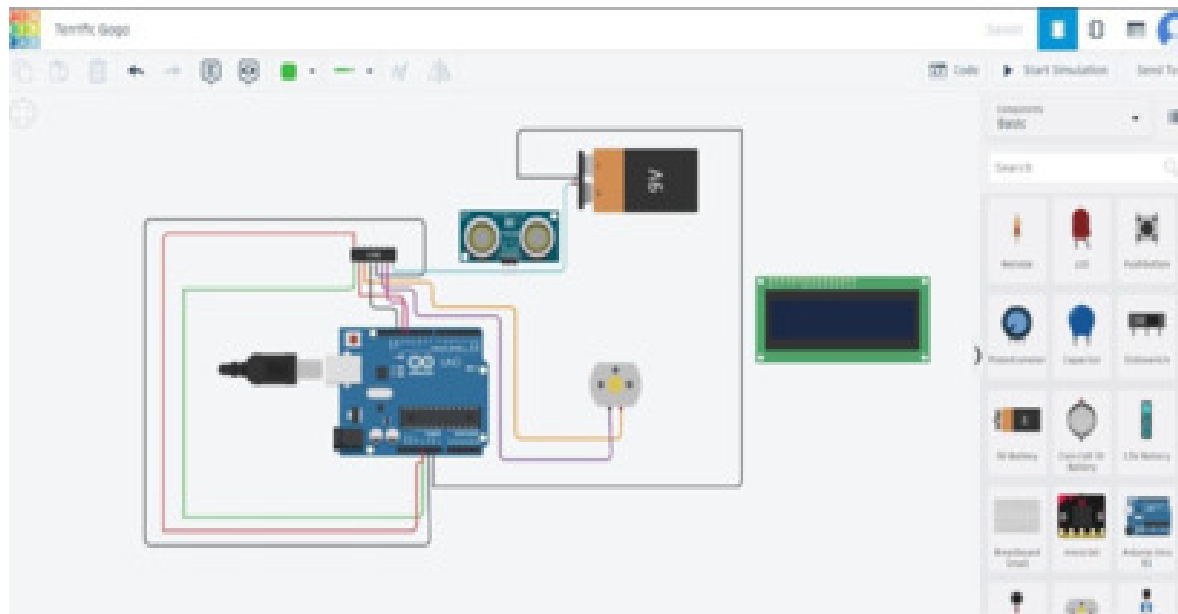
4) ElectronicControlUnits(ECUs):

- Actasthebrainofthesystem,analyzingsensorinputsand adjusting throttle and braking to control speed.

C. IntelligentSpeedAdaptation (ISA)

AsubsetofAVSCS,*IntelligentSpeedAdaptation*(ISA),uses GPS data and onboard cameras to ensure that vehicles comply with speed limits. ISA systems can be either advisory, providingwarnings,orinterveningdirectlytopreventspeeding violations by reducing the throttle or applying brakes.

D. System Design and Architecture



Components of Automatic Vehicle Speed Control Systems

The core components of AVSCS include:

- 1) *Sensors*: Radar,LIDAR,andcamerastogatherdataaboutthe vehicle's environment.
- 2) *Controller*: AnECUthatprocessessensordataandcalculatestherequired actions.
- 3) *Actuators*: Mechanisms that control the throttle and braking systems to adjust speed.
- 4) *CommunicationModules*: Enable data exchange between the vehicle, external infrastructure, and other vehicles for collaborative decision-making(e.g., Vehicle-to-Infrastructure(V2I)and Vehicle-to-Vehicle (V2V) communication).

E. Algorithmic Approach

The control algorithm in AVSCS typically follows a feedback loop, where sensor data is continuously monitored, and vehicle speed is adjusted in real time. Key stages in the control process include:

- 1) *Data Collection*: Sensors gather information about the environment, speed limits, and surrounding vehicles.
- 2) *Data Processing*: The ECU processes sensor data using predictive models and machine learning algorithms to anticipate road and traffic conditions.
- 3) *Control Decision*: Based on the processed data, the system decides whether to accelerate, decelerate, or maintain current speed.
- 4) *Actuation*: The vehicle's throttle or braking system is adjusted accordingly.

F. Advantages of Automatic Vehicle Speed Control Systems

1) Enhanced Road Safety

By maintaining a safe speed and distance from other vehicles, AVSCS significantly reduces the risk of accidents caused by human error, speeding, and delayed reactions.

2) Improved Traffic Management

Through real-time adjustments, AVSCS helps maintain smoother traffic flow, reduce congestion, and prevent bottlenecks. V2V communication allows vehicles to coordinate movements, improving overall road efficiency.

3) Fuel Efficiency

Optimal speed control minimizes unnecessary acceleration and braking, leading to more efficient fuel consumption. This reduces CO₂ emissions and contributes to more environmentally friendly driving.

4) Compliance with Speed Regulations

AVSCS ensures that vehicles comply with speed limits, reducing the likelihood of fines and legal violations. Intelligent systems also adapt to changing speed limits in work zones or other dynamic environments.

III. CHALLENGES AND LIMITATIONS

A. Technical Challenges

Sensor Reliability: Sensors may malfunction in adverse weather conditions such as rain, fog, or snow, leading to inaccurate data.

System Latency: Real-time decision-making requires high processing power, and delays in response can lead to unsafe driving situations.

Integration with Legacy Systems: Retrofitting older vehicles with AVSCS technology can be expensive and complex.

B. Ethical and Legal Concerns

The automated nature of AVSCS raises concerns about liability in the event of accidents. The division of responsibility between drivers and automated systems must be clearly defined. There are also concerns regarding privacy, as these systems often collect and transmit data about the vehicle and its surroundings.

C. Future Directions Autonomous Vehicles

The development of fully autonomous vehicles (self-driving cars) is the next frontier for AVSCS. Integrating speed control systems with complete automation can remove the need for human drivers, reducing the likelihood of human error and increasing overall safety.

D. Enhanced Communication Systems

Improvements in V2V and V2I communication can enhance the responsiveness and adaptability of AVSCS, enabling more accurate real-time decisions. With the growth of smart cities, infrastructure that communicates directly with vehicles will make speed regulation more efficient and precise.

E. Machine Learning Integration

Machine learning algorithms can make AVSCS more adaptive by learning from past driving patterns and conditions. Predictive modelling can anticipate road conditions more accurately and allow for more intelligent decision-making processes.

IV. CONCLUSION

The *Automatic Vehicle Speed Control System* represents a significant leap forward in automotive safety and efficiency. By automating the process of speed control, AVSCS minimizes human error, enhances road safety, and contributes to better traffic management. While there are challenges in implementation, particularly regarding sensor reliability and ethical concerns, advancements in technology will continue to refine these systems. As the automotive industry moves toward fully autonomous vehicles, the role of AVSCS will be integral in shaping the future of transportation.

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This paper outlines the essentials of automatic vehicle speed control systems, delving into its components, advantages, and challenges while offering insight into its future potential within the automotive industry.



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