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PREDICTIVE MODEL BASED LOW-SPEED ADAPTIVE CRUISE CONTROL FOR AUTONOMOUS VEHICLES

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Abstract

In autonomous vehicles, a proposed adaptive cruise control system uses a longitudinal controller to follow a preceding vehicle. Test vehicles equipped with adaptive cruise control can keep a safe distance from the vehicle in front of them by sensing the acceleration and braking of the vehicle in front of them. By using the laser scanner positioned on the front of a subsequent vehicle, distance errors caused by previous vehicle distances can be calculated. Laser and radar technologies are used in the ACC system. This system is capable of automatically adjusting the vehicle's speed to match the speed of the vehicle in front of it. The basic throttle and braking systems of the vehicle must be modified to develop the adaptive cruise control system. Modifications are made to the original throttle valve, which is controlled by an accelerator pedal cable, so that it may be used in a drive-by-wire system. The brake pedal is directly controlled by a dc servo motor in the upgraded braking system.

Keyword: Cruise, Cruise Control, Autonomous, ACC, Controller, Throttle Valve Autonomous Vehicles.

Introduction

Vehicles are becoming safer and more pleasant as automotive technology advances. Automotive manufacturers have devised a variety of driver assistance systems in an effort to prevent an accident from occurring, either by temporarily taking control of the vehicle or by notifying the driver vocally and visually of potential danger. [1] The highway cruise control system was designed with this in mind. This approach is beneficial for travelling on long, straight roads where the goal is a long distance away. With more and more cars on the road, the standard cruise control is less and less effective. This is why the adaptive cruise control (ACC) technology was created. It is possible to control the vehicle's speed only with the use of traditional cruise control. [2] As opposed to this, ACC offers two control options: velocity and distance. ACC acts as a longitudinal control pilot to alleviate the stress of driving in heavy traffic. ACC can function like a traditional cruise control, keeping the car moving at a specified speed. If an obstacle gets too close, ACC, unlike cruise control, can automatically adjust speed to keep a safe gap between that obstacle and the vehicle equipped with ACC. Laser or radar can be used to measure the distance between the host vehicle and a vehicle ahead of it, allowing for precise positioning. [3]

It slows the car down if the car is driving a little faster, and it monitors the clearance and time between the ACC vehicle and the driver in the front of it. Longitudinal support at low or zero speed is the primary goal of the ACC system only stationary objects in the immediate vicinity of a vehicle are eligible for this ACC Stop and Go technology. [4] It is impossible to maintain a constant speed in such a system. A stationary goal can only be the focus of this specific form of ACC programme. After doing extensive investigation into the shortcomings of conventional ACC and Go and Stop ACC, a newer version of ACC was developed. [5]

It is shown in Fig 1 that the proposed research model includes the vehicle's longitudinal dynamics, hydraulic brake system, and control mechanism. The controller model is based on the following concept:

(1) The controller input is the actual distance and relative speed between the leader and following vehicles, as well as the real-time safety distance based on vehicle speed.
(2) The longitudinal dynamics model calculates the following vehicle's acceleration and distance limitations.
(3) Active brake controllers and active throttle controllers are used to convey this information to the executive agency, which includes the following vehicle's predicted acceleration.
(4) The vehicle's speed is reduced as a result of the hydraulic braking system. Additionally, the longitudinal dynamics model receives information from the brake pressure. [6]

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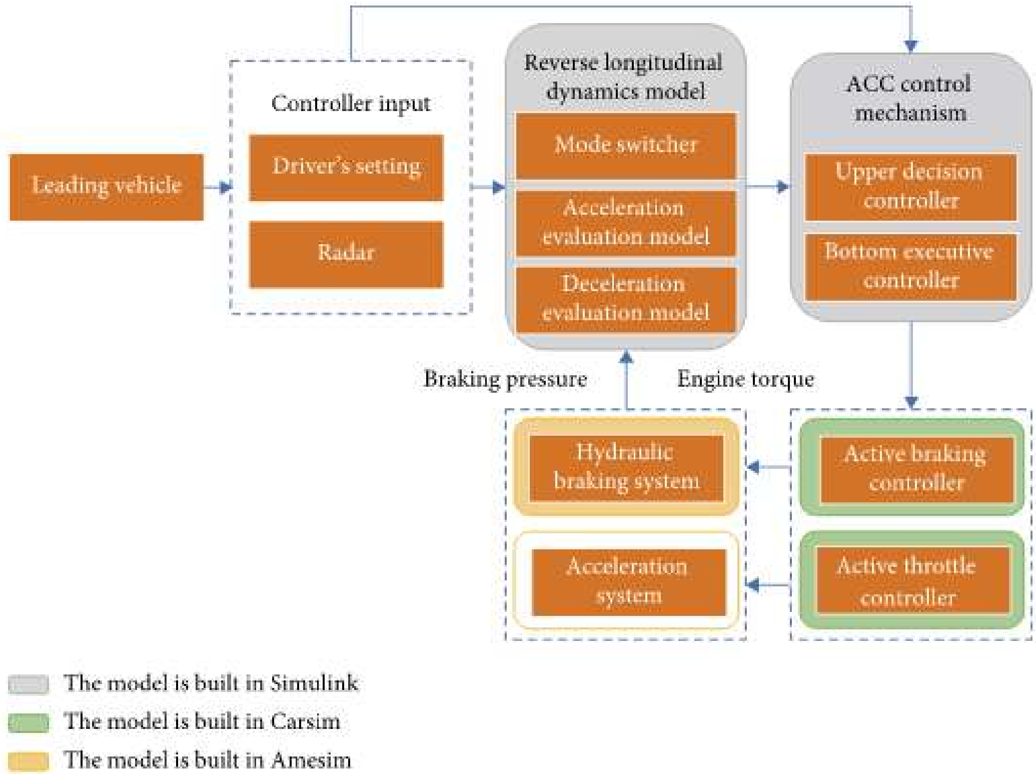

Fig. 1 Scheme of the proposed ACC control model.

Components and structures are integrated in the ACC system. ACC System Components consists of a huge number of individual components, each with a specific function to carry out. The Controller Area Network (CAN), a series of communication networks, is used to communicate between modules [7]. In the event that any processing vehicles are present, the ACC ECU Module is responsible for analysing the radar sensor data. Time gap control gives data to braking and engine control modules so that the ACC vehicle can stay within a predetermined distance from its intended target. The components of an ACC vehicle look like this [8].

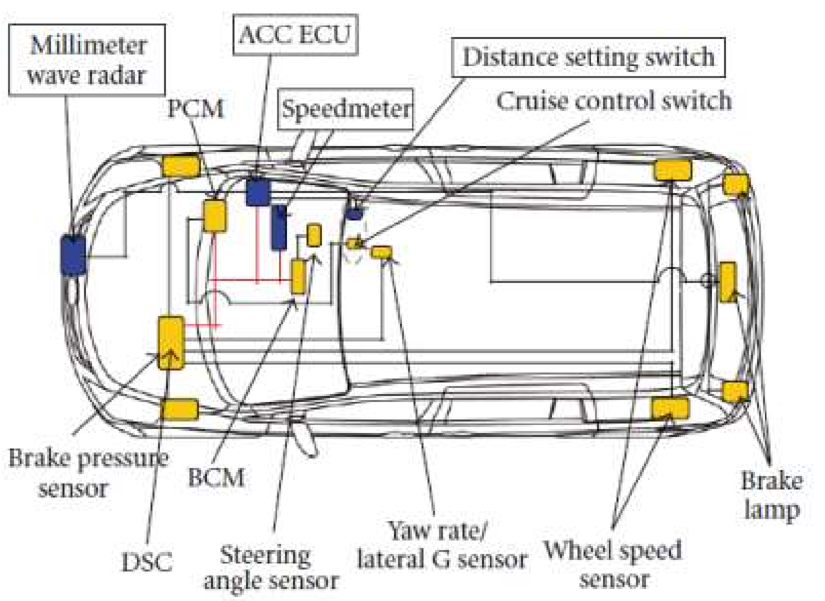

Fig. 2 ACC Vehicle Unit Components

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Review of Literature

By using a sensor, ACC calculates the distance and speed of the vehicle ahead. This sensor can be a lidar sensor or a radar sensor [Shakouri P. & Ordys A., 2012] [9]

A radar sensor installed in front of the vehicle is used to detect the presence of a vehicle [Benhard K. et al, 2012] [10] in the radar system It uses three overlapping [kHz]76-77-kHz radar beams in this arrangement. The detection range of this technology is up to 120 metres. The fundamental advantage of this technology is that it can operate even under adverse weather conditions. According to Hatipolu et al [11], in order to tackle this issue, multiple control actions defined in different areas of the phase plane, known as choice zones, are proposed. A hybrid controller for vehicle longitudinal control on highways is being developed, with many control actions being alternated between. The decision points and the phase plane's origin are spared high-frequency switching while the distance and relative velocity are smoothly pushed toward the phase plane's origin. Using an experimental and theoretical approach, a supervisory hybrid controller shifts between smooth-constant acceleration/deceleration and linear control.

Lu and Hedrick [12] created two level controllers for heavy-duty trucks where the control challenges differ from those of passenger cars due to the distinct structure of these cars: A turbocharged diesel engine's fuel injection and brake periods are controlled by a low-level controller. In addition, the higher-level controller is built on a sliding mode controller structure.

Raza et al [13] Attempted to build an all-encompassing solution for a variety of driving conditions. Autonomous cars, co-operative vehicle following, and platooning are all modes of the Vehicle Longitudinal Control System (VLCS). Supervisory control and throttle/brake control form the foundation of the vehicle's control system.

In Yanakiev and Kanellakopoulos [14], there was a comparison of two methods of controlling the system (PID with quadratic derivative and adaptive PID). Lu and Hedrick [15] the structural differences between large trucks and cars necessitated the development of two separate level controllers. A turbocharged diesel engine's fuel injection and brake periods are both controlled by a low-level controller. Sliding mode control is used in the higher-level controller.

Objectives

- To study ACC cotrol model
- To study working of ACC model
- To study components of ACC vehicle
- To study of structure of breaking controller in ACC

Research Methodology

A research methodology is a universal way to addressing a study subject through data collection, data evaluation, and results based on the findings of the study. A research technique is a plan for carrying out a research study. The methodical gathering and analysis of facts and information for the advancement of knowledge in any area may be loosely defined as research. The goal of the study is to use systematic techniques to find solutions to intellectual and practical problems. The data used for preparing this paper are secondary in nature which are collected from the various published resources. The data derived for preparing this paper are from various relevant websites.

Result and Discussion

Several cutting-edge computer boundaries have been attempted to be broken in our system. Ultrasonic can be used to prevent fatal mishaps in our proposed equipment. The primary goal of this exercise is to figure out how far the car is from a potential obstacle. This can be seen in Figure 3. [16]

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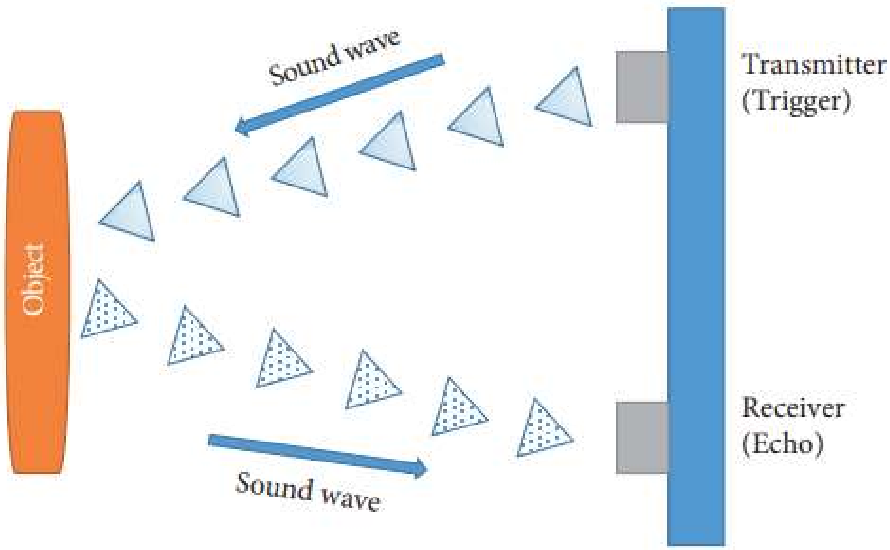

Fig. 3 Ultrasonic sensor working

Autonomous car aspirations can't be met without sensors and sensor technologies. Ultrasonic sensors, infrared sensors, radar, and other technologies help us meet these obstacles and keep the vehicle running smoothly. Figure 4 shows a block diagram. [17]

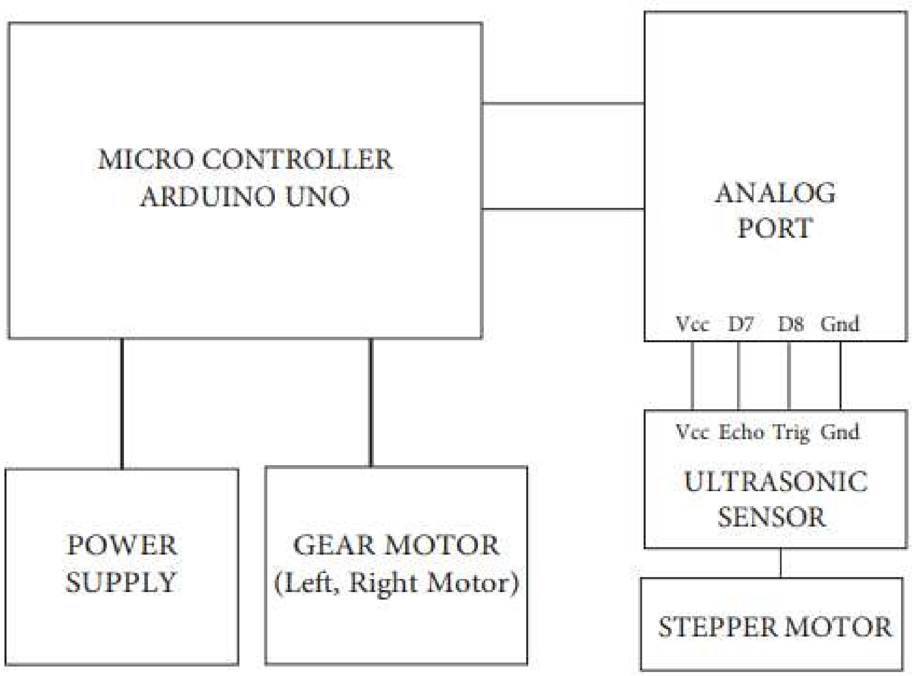

Fig. 4 Block diagram for an accident-avoidance system

ACC uses a sensor to determine the distance and speed of the vehicle in front of it. This sensor can be used for either lidar or radar. Alternatively, it can be used for both. Distance measurement in the ACC system is based on the time it takes to send and receive data. [18] Using the Doppler Effect, speed can be determined by the shift in the reflected beam frequency. To keep the vehicle in a safe position, the brake and throttle can be controlled based on speed and distance calculations. Distance and speed can be measured using the time and frequency graph illustrated in Figure 5[19].

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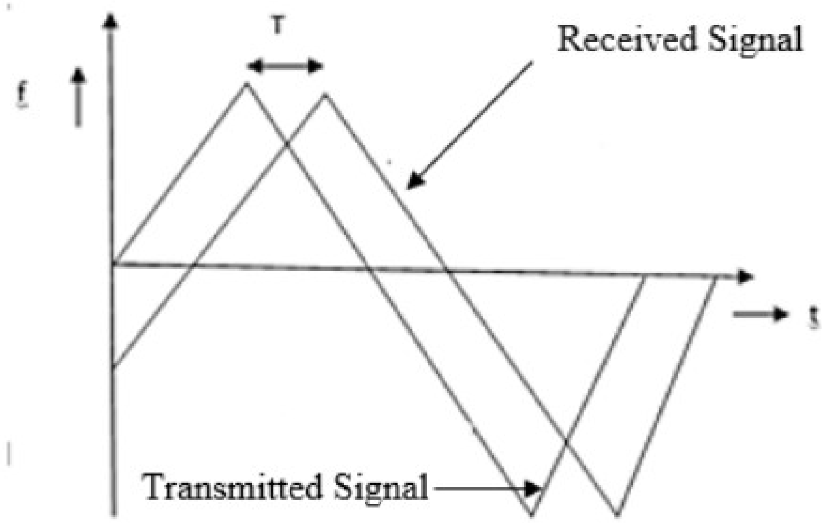

Fig. 5 Working Principle of ACC system

Static error is eliminated, and acceleration control accuracy is improved, thanks to the feedback and feed forward controller working together. As can be seen in Fig. 6, the brake controller's overall design is illustrated. [20]

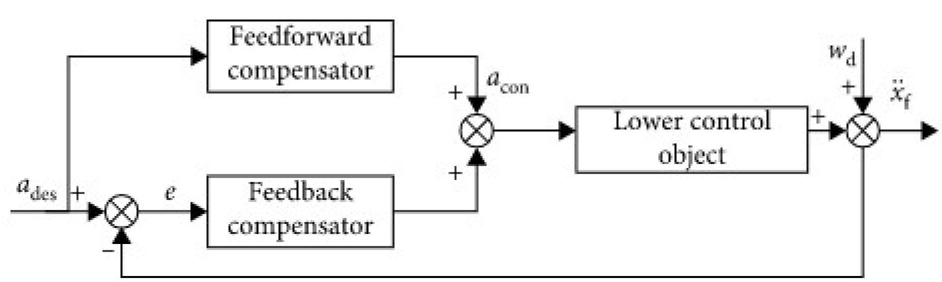

Fig. 6 Structure of the braking controller.

Conclusion

Safe and easy driving is the goal of Adaptive Cruise Control. Using this feature decreases the driver's requirement for brake and turn movements. As a result, the driver benefits from a more restful driving experience thanks to this technology. With the ACC programme, you can get the most out of your fuel. The acceleration and deceleration of an automatic vehicle improves the driving experience by reducing fatigue and increasing safety. It is possible to conclude that ACC is a means of improving driving and preventing collisions or accidents from occurring. When driving in foggy or terrible weather, the driver is unable to determine the distance between the preceding vehicles, but the ACC system gives a safer method of driving. The A.CC system has the potential to reduce accidents. As a result, there are fewer braking and switching procedures required by the driver to do. As a result, the driver no longer has to bear as much of the load thanks to this technology. Driving using ACC saves fuel. Driving is more secure and more predictable when the car accelerates and decelerates automatically.

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