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International
Journal
Of Modern Engineering Research (IJMER)

Concept of Adaptive Cruise Control and Its Improved Versions

Chandra Mouli Kandi[1], R.Jayalakshmi[2], Dr. K.Umapathy[3]
(M.Tech (EDT),SCSVMV University, India)
(Asst. professor,SCSVMV University, India)
(Associate professor,SCSVMV University, India)

ABSTRACT: *-Adaptive cruise control is a growing research topic as this supports a driver in different traffic situation and reduces the work load on driver. ACC distributes itself from cruise control as this measure the distance between our vehicle and the one ahead of us. Existing the velocity of our vehicle in accordance with the one ahead of us. ACC is a collection of different actuators control devices and sensors. The motivation for this system is to increase the comfort of driving and reduction in traffic accidents.*

Keywords*: -* *sensor. Controller, space of maneuverability and stopping distance*

I. INTRODUCTION

An adaptive cruise control system (ACC)is a system developed as to assisted the drivers to keep a safe distance from the vehicle in front while travelling .This system is in developing state and also available only in luxury cars like top modelsMercedes S-class, Jaguar Audi 8 series ..etc. and Volvo uses these system in their trucks .The US department of transportation and Japan's ACAHSR have started these intelligent vehicles developing with coordinating each other with the help of a system that named as cooperative adaptive cruise control .this paper address the concept of adaptive cruise control and its improved versions.[2]

II. ADPTIVE CRUISE CONTROL (ACC)

Adaptive cruise control (ACC) is also called autonomous cruise control or radar cruise control.ACC is the advancement of cruise control system. We can atomically adjust the speed of vehicles and maintain a safe distance from vehicles in front of it based on radar sensor by using this system.

1.1 PRINCIPLE OF ACC:

ACC works by detecting the speed, distance of the vehicles ahead by using either a RADAR system or a LIDAR system [1, 2].The key of the distance measurement is the time taken by the transmission and reception while the shift in frequency of the reflected beam by Doppler Effect by this we measured to know the speed. According to this the brake, throttle controls and keep the vehicle in a safe position with respect to the other. These systems are characterized by to a certain extent low level of brake and throttle authority and are predominantly designed for highway applications with rather homogeneous traffic behavior. The second generation of ACC works as the Stop and Go Cruise Control (SACC) [2]objective is to offer the driver longitudinal support on cruise control at point lower speeds down to zero velocity [3]. The SACC can help a driver in different kind of situations where it is not possible to set a constant speed or where all lanes are occupied by vehicles or in a frequently stopped and congested traffic [2]. There is a clear contrast between similar thingsbetween ACC and SACC with respect to stationary objects (vehicles). The ACC ideology is that it will be operated in well-structured roads with a normal traffic flow with speed of vehicles around 35 or 40km/hour [3]. While SACC system should be able to work with stationary objects (vehicles) because within its area of operation the system will rendezvous such objects very frequently.

1.2. CONSTITUENTS OF AN ACC SYSTEM:

Adaptive Cruise Control (ACC) consists of a LIDAR sensor or RADAR sensor in the front grille, usually some vehicles having sensors behind the grill to obtain the information regarding the vehicle ahead. . The relevant target data may be distance, velocity, angular position and lateral acceleration. Longitudinal controller which receives the data, sense by sensor and process it to and gives the commands to the actuators of brakes a throttle or gear box using Control Area Network (CAN) of the particular vehicle.

1.2.1.SENSOR OPTIONS:

Currently four ways of object detection are technically feasible, applicable in a vehicle environment [2]. They are

1. LIDAR
2. RADAR
3. ULTRASONIC SENSOR
4. VISION SENSORS

The first ACC system used Light Detection and Ranging and abbreviated as LIDAR.

The first ACC system introduced by Toyota by using this method measuring the beat frequency difference between a FMCW (Frequency Modulated Continuous light Wave) and its reflection [3].Now a days most of the current ACC systems are based on RADAR sensors frequency having 77GHZ. The RADAR systems have the great advantage. That we can know the relative velocity directly, and the performance is not affected means less affected compare to LIDAR systems due to fog and heavy rain. LIDAR system is of low cost and provides also good angular resolution than RADAR systems. And also these weather conditions restrict its use within a 30 to 40 meters range.

II. RADAR

RADAR is an acronym derived electromagnetic system for the detection and location of reflecting objects like ships, air crafts, space crafts or vehicles. It is operated by radiating energy into space and detecting the echo signal reflected from an object and the reflected energy is not only indicative of the presence but on comparison with the transmitted signal and other information of the target can be obtained. The currently used 'Pulse Doppler RADAR' uses the principle of Doppler Effect in determining of the object velocity.

1.1. PULSE DOPPLER RADAR:

The transmitter (continuous wave oscillator) produces the signal and it to be transmitted and it is pulse modulated and power amplified. The 'duplexer' is a switching device and is fast-acting to switch the single antenna from transmitter to receiver and back. The duplexer has a gas-discharge device called T/R-switch. The high power pulse from transmitter causes breakdown the device and to protects the receiver. On reception, duplexer directs the echo signal to the receiver. The detector demodulates the received signal. The Doppler filter removes the noise and outputs the frequency shift

1.2. FUSION SENSOR:

Is the new sensor system introduced Honda and by Fujitsu Ten Ltd. through their PATH program includes millimeter wave radar linked with 640x480 pixel stereo camera with a 40 degree viewing angle. These two parts work together to track the car from the stationary (nonmoving) objects. While RADAR target is the car's rear bumper, the stereo camera is constantly captures all objects in its range of view.

III. SPACE OF MANEUVERABILITY AND STOPPING DISTANCE

If vehicle speed is low an average driver uses larger sideways acceleration. And we here consider 'r' the curve radius of a possible trajectory for a given velocity 'v' and sideways acceleration 'a', then $r= v^2/ a$ [2].So to get the required 'r', when 'v' is low, 'a' is also to be low congruently.

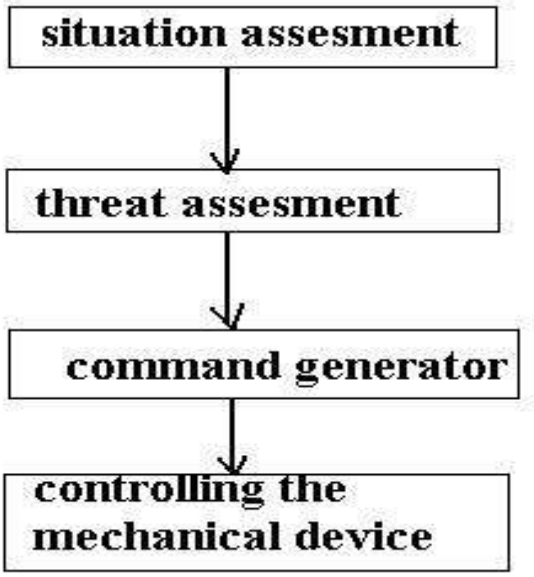
The stopping distance is given by, $Ds = 5\ u^2/ax + t\ u$, where 'u' is the initial speed 't' is the time taken by the system to receive and process the sensor data and 'ax' is the acceleration of the vehicle

IV. CONTROLLER:

The controller reacts in the situation into appropriate actions through brake and pedal and throttle control actions. Depending on the current traffic situation, there are two types of controls are possible. One is Speedcontrol and the other Headwaycontrol. If there is no vehicle presently in front, then the speed is controlled about a mentioned set point just as in conventional cruise control. But in order to keep a safe distance between the vehicle s, the headway control is required.

V. ARTIFICIAL COGNITION

The conversion of raw information (which is sense by sensors) from sensors to control actions by the two steps One analyzing the traffic conditions other Deciding on a particular situation The controllers translates the desired situation(input) into appropriate action control through brake and throttle actuation. [2]. the controller concept is simplified in the flow-diagram: Flow diagram of controlling process



VI. EXAMPLE OF ADAPTIVE CRUISE CONTROLLER IN MOTOROLA ACC

The Motorola ACC constitutes a DSP (Digital Signal Processor) module having MGT5200 which provides a multiply-accumulator. The sensor data which is from Radar and from camera and an IR sensor are processed in it, and generate the input data for the controller modules like HC12 and MPC565. [6].

6.1. MPC565:

Is a throttle controller or an engine speed controller. It having the following features

1. SRAM (1MB to10 MB)
2. EEPROM (4KB to 32 KB)
3. FLASH 1MB
4. Real time clock
5. 4 x UART interfaces
6. 64-bit floating point unit
7. 3 X CAN interfaces

The MPC 565 can be programmed as to generate the control signals according to the sensor data. 'The Phycore-MPC 565 developers' are available to program, develop the desired controller.

The throttle valve is actuated and the air intake is controlled so the requirement of fuel for the correct proportion with the air also increases. So more fuel is injected and engine speed is changed.

6.2. HC12:

HC12 is a breaking controller system and it receives data from the wheel speed sensors and from the DSP module. It generates the braking control signal. Is a breaking controller system and it receives data from the wheel speed sensors and from the DSP module. It generates the braking control signal.

VII. CAN (CONTROL AREA NETWORK) BUS

Control Area Networks BUS is the network bus established between micro-controllers. It is a 2-wire, half duplex and high speed network for high speed high speed applications with short messages. It can connect up to 2032 devices on a network theoretically. But today the practical limit is reduce to 110 devices. It offers high speed communication rate up to 1Mb/sec and allows real time control.

Each module in the ACC connected to the CAN. The connection is called a 'node'. All are acting as transceivers. The CAN bus carries data to and from all nodes and provides quicker control transfer to each module.

The actuator used for throttle control is a solenoid actuator. The signal through the coil can push or pull the plunger.

VIII. CO OPERATIVE ADAPTIVE CRUISE CONTROL [CACC]

Though ordinary (conventional) ACC and SACC are still expensive novelties, the next generation called Cooperative ACC and this already being tested. While ACC can respond to the difference between its own behavior and that of the preceding (ahead of) vehicle, the CACC system allows the vehicles to communicate and to work together to avoid collision. PATH (Partners of Advanced Transit Highways) –a program of California Department of Transportation, University of California collaborated with companies like Honda conducted an experiment. which three test vehicles used a communication protocol in the car which is leads can broadcast information about its speed, acceleration ,breaking capacity to the rest of the groups in every 20ms.[3] To develop systems PATH is dedicated that allow cars to set up platoons of vehicles communicate with each other by using protocols like Bluetooth for exchanging signals

8.1. MAIN POSTULATIONS ABOUT CACC:

1. In CACC mode, the vehicle which is preceding can communicate actively with the following vehicles so that can be coordinated with each other with their speed.
2. Because compared to autonomous in ACC communication is quicker, more reliable and responsive sensing.
3. Because other important information and braking rates, breaking capacity about the vehicles can be exchanged, safer and closer is possible in vehicle traffic.

IX. CONCLUSION

Lakhs of people are injured every year due to automobile accidents. The lack of awareness on using the basic safety features in automobiles like seat belts also paved way for development of ACC, SACC and CACC. Many researches are going on to make this perfect and cost effective. The advancement in technology now gave a group of sensors that gives a 360-degree view of surroundings. Probably by next decade ACC will be present in all the cars reducing accidents. But some road laws are to be amended for this advancement in automobile driving

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