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CRUISE CONTROL SYSTEMS AND EXAMINATION OF THESE SYSTEMS WITH TODAY'S TECHNOLOGY

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Abstract

Cruise control is a system that automatically controls the speed of an automobile. Cruise control systems have shown improvements thanks to developing technology. Cruise control is safe, economical and comfortable. This has become with the development of sensor technology and throttle, braking systems which are electronic in vehicles. Via traffic measurement systems used on highways and in city centers, vehicle can determine speed information, the best route and the most economical travel time.

In this study, safety, economy and comfort of the main cruise control systems and adaptive cruise control system, which is used today, will be focused on. Smooth acceleration, line tracking system, vehicle tracking distance protection technologies will be examined provided by the Advanced Driver Assistance Systems.

Keywords: Cruise Control, Adaptive Cruise Control, Advanced Driver Assistance Systems.

INTRODUCTION

Cruise is a system that automatically controls the speed of a motor vehicle. This system is useful for driving on the roads which are big, straight, and the destination is farther apart [3,9]. To operate the system, the driver sets the speed and the system takes over the throttle of the car to maintain the speed. The system thereby improves driver comfort in steady traffic conditions. In congested traffic conditions, where speeds vary widely, these systems are no longer effective [17, 23]. Some modern vehicles have adaptive cruise control (ACC) systems, which is a general term meaning improved cruise control. These improvements can be automatic braking or dynamic set-speed type controls [2, 24, 25].

Advanced Driver Assistance Systems (ADAS) are a whole of systems, which Adaptive Cruise Control (ACC) including and providing safety, confortable, economic trip to drivers.[12,23]

EXPOSITION

Cruise Control (CC)

The diagram below shows the inputs and outputs of a typical cruise control system. Cruise control is a small computer. According to the speed information received from the sensors which is found in the vehicle, controls the velocity of the vehicle.[14,17] The system controls the position of the throttle until you reach the top speed of the driver reaches. Here, speed information, throttle position is taken from the sensors in the vehicle. Speed of the vehicle is provided only with a throttle control. [26] This is not a safe technology.

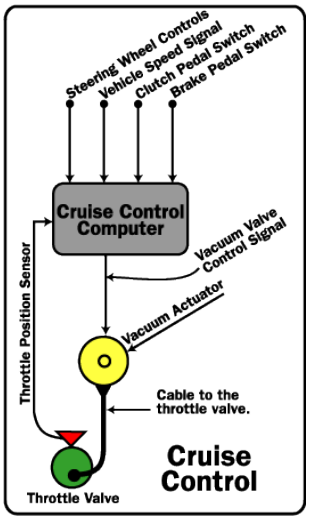

Fig. 1. *Cruise Control System*

In addition, some of the control algorithms must be used for the speed of approach. Below is a block diagram of PID control algorithm for CC controlled by a PID speed allows the continuation of a more economical and comfortable travel. The vehicle must move within certain acceleration for maintaining comfort. [4]

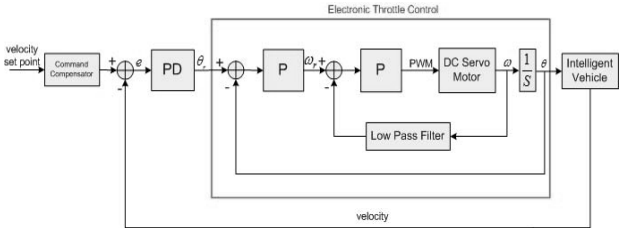

Fig. 2. *Cruise Control PID Algorithm*

Adaptive Cruise Control (ACC)

Cruise Control system includes all the features of adaptive cruise control. The sensors located on the vehicle controls the speed of the vehicle based on the traffic situation. Activate ACC by selecting a cruising speed and the distance you want to maintain from the vehicle in front of you.[2,8] When ACC detects traffic slowing down, your vehicle automatically slows to maintain the distance you've set. When traffic clears, your vehicle resumes at the pre-set speed. ACC controls the throttle for acceleration as the same as CC. In addition to this, ACC controls the brake mechanism for deceleration. [16, 19]

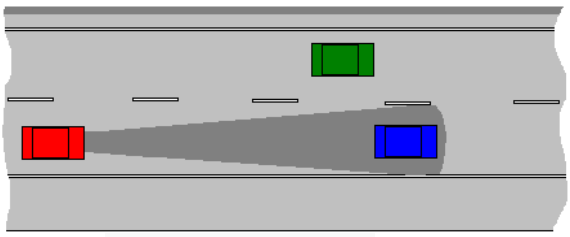

Fig. 3. *Schematic of Adaptive Cruise Control*

The system automatically maintains its distance from the follow-up with the vehicle in front. For distance measurement is used radar or lidar technologies. Generally, short-wave radar frequencies between 24-40 GHz are used. The most common form of distance measuring is lidar. Lidar is an optical remote sensing technology that can measure the distance to, or other properties of a target by illuminating the target with light, often using pulses from a laser. The reason is that it allows the use of common, 3D viewing. Lidar widely used the reason why 3D allows imaging.

Designed to switch between the vehicle speeds changes can be achieved with a control algorithm. Compile information received from sensors on the control system. The control system will output actuators. Mostly PID, Fuzzy, Neuro-Fuzzy, MPC (model predictive control) algorithm is used.[11] These algorithms can reach the best result. But sometimes it is not enough to reach a good result. This reason the behavior of the driver are also important in the ACC systems. Most of the manufacturer has been designing taking into account that.[9,20]

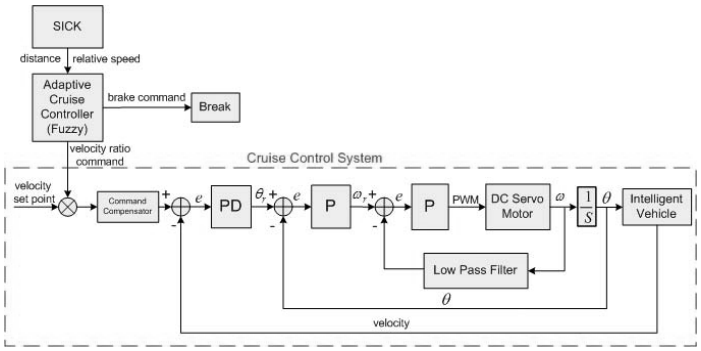

Fig. 4. *Adaptive Cruise Control PID Algorithm*

ACC PID control algorithm given above. Here, it seems that the difference is breaking system with CC. If you want to make an intelligent ACC, however, to consider the behavior of the driver. In this way, you can travel comfortably.

CC and ACC systems were given information in the previous sections, about structures, sensors, and control algorithm. After the system run regularly and comfortably, Economic nature of the system is also important. The new generation cars work with high performance and low fuel consumption with the increase in fuel prices. Engine technology is not enough just to be good for this. Systems which are used on the vehicle, need to work with low energy and high performance. In this way, we can provide energy savings. The road slope, wind information and traffic information should be added speed-distance control model to ensure the economy. [4, 18]

As shown in Model, ECU collected information from DSU and FMU units, so that

the throttle valve position is set.

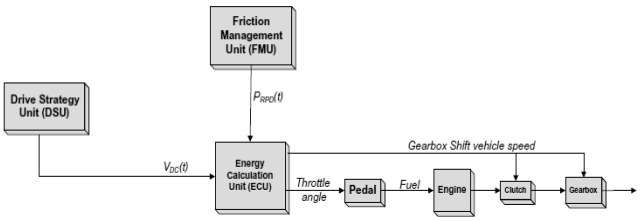

Fig. 5. *Power Flow Calculation Model*

DSU is determines the position of the throttle, braking and to protect the distance from the vehicle in front. This is a so basically ACC. In addition to system FMU added for energy management. FMU employs the following data:

- Current Road Slope,
- Road Friction,
- Combustion,
- Wind Drag,
- Vehicle Efficiencies,

The signals which collected from DSU and FMU units are combined using the appropriate algorithms. The signals are processed and moved to the engine in the Energy calculation unit. An Adaptive Neuro-Fuzzy Inference System (ANFIS) based on ACC systems is designed and observed that the average fuel consumption decreased by 3%.[4]

Stop & GO Adaptive Cruise Control (S&G-ACC)

Stop & Go Adaptive Cruise Control (S&G-ACC) is a system that maintains cruise speed in the same way as a conventional cruise control system, but also maintains the gap to the vehicle ahead by operating the throttle and brake systems. The S&G-ACC control module is mounted at the front of the vehicle, which uses radar to measure the gap and closing speed to the vehicle ahead. A few radar sensors with a range of up to 150 meters permanently monitor the road ahead. As you approach a slower vehicle in your lane, the system directs the engine control unit to reduce power output and if necessary apply the brakes to ensure you remain a predefined distance away. If the vehicle ahead stops, ACC with Stop & Go will bring your car to a complete stand still too. When the vehicle ahead moves off again or changes lanes, ACC with Stop & Go increases engine power; if possible, your car accelerates to your preferred cruising speed. Fig. 6 shows a functional block model of the system. [7, 22]

The S&G-ACC functions at all speeds and is capable of slowing the vehicle to a complete stop. Once the vehicle has become stationary, the driver must intervene. This can be achieved by pressing the resume button, which will reactivate S&G-ACC providing a sufficient distance to the vehicle ahead has been attained, or by depressing the throttle, which will always override the system. The system is immediately cancelled by either the cancel button or driver braking.

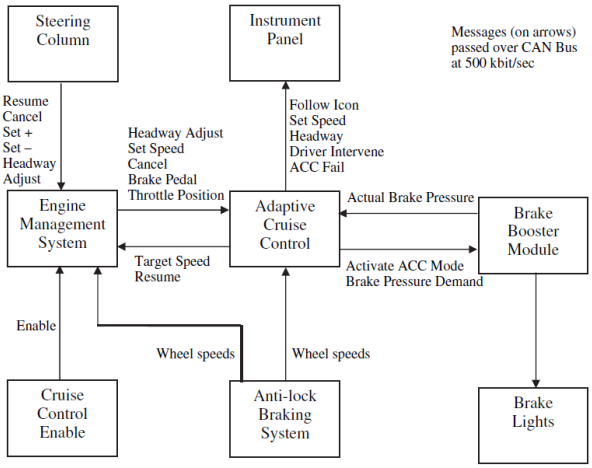

Fig. 6. *S&G-ACC Block Model*

Stop & Go Adaptive Cruise Control is an extension of Adaptive Cruise Control, as it is able to bring the vehicle to a complete stop. Previous versions of Adaptive Cruise Control have only operated above 26 kph. The distance to the vehicle ahead is measured in seconds rather than metres. This ensures that you have adequate reaction time in relation to the speed you are travelling at. ACC with Stop & Go makes driving both more relaxing and safer.

Cooperative Adaptive Cruise Control (CACC)

Cooperative Adaptive Cruise Control (CACC) is an extension of Adaptive Cruise Control (ACC) functionality. CACC is a system based on wireless communication between vehicles. Vehicles driving on a road communicating with each other, is based on the adjustment of speeds and distances. In Figure 7, a schematic representation of a string

of vehicles, a so-called platoon, equipped with CACC functionality is shown. [1,3]

The speed, distance and traffic management can easily be achieved with provided communication between vehicles.[8]

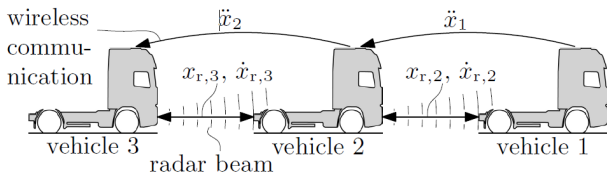

Fig. 7. *Schematic representation of a platoon of vehicles equipped with CACC functionality.*

CACC functionality, however, is not commercially available, despite the promising advantages. One of the reasons is that research commonly focuses on platoons in which all vehicles are equipped with CACC functionality, whereas this will not be the case when implementing CACC in practice. Furthermore, the wireless networking needs to be fail-safe, secure and ad-hoc, which is still a major difficulty. Moreover, often, communication networks requiring significant adjustments to the existing infrastructure are considered. Finally, the influence of the application of CACC on the traffic flow is difficult to analyse. Especially so-called string stability of a platoon, i.e., attenuation of disturbances upstream a platoon, is a major concern.[3]

Advanced Driver Assistance System (ADAS)

Advanced Driver Assistance Systems, or ADAS, are systems to help the driver in the driving process. When designed with a safe Human-Machine Interface it should increase car safety and more generally road safety. Some of these; In-vehicle navigation system with typically GPS (Global Positioning System) and TMC (Traffic Message Channel) for providing up-to-date traffic information, Adaptive cruise control (ACC), Lane departure warning system, Lane change assistance, Collision avoidance system (Precrash system), Intelligent speed adaptation or intelligent speed advice (ISA), Night Vision, Adaptive light control, Pedestrian protection system, Automatic parking, Traffic sign recognition, Blind spot detection, Driver drowsiness detection, Vehicular communication systems, Hill descent control.[21]

These systems, new ones are added every day. In this study, only with the relevant parts driving of the system will be examined. [12]

563806 vehicles in Turkey over the last year have been to traffic. [27] Drivers spent a lot of time in increasingly dense traffic. This also led to economic losses. This system is used in vehicles in order to eliminate losses. Cars can find the shortest possible route to go with GPS-based in-car navigation systems. Real-time traffic congestion is detected with sensors located in the town and on highways. This information is detected by the navigation system can be made more efficient route calculation. Provided by Istanbul Metropolitan Municipality (IMM) Trafic Control Center, traffic density map is shown below. This information can be reached at any time via the Internet. The information obtained from the best route and speed information collected by vehicles can be calculated.[6]

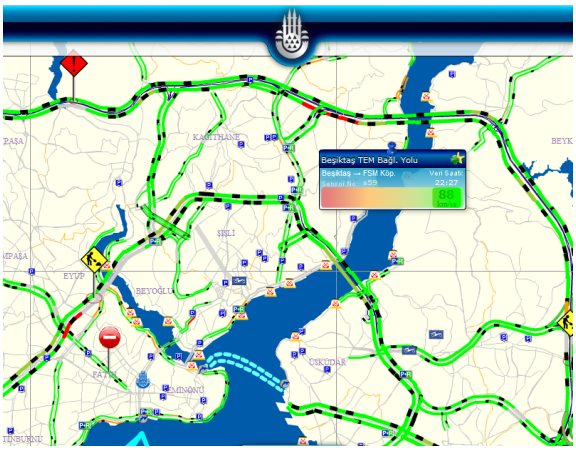

Fig. 8. *Traffic Density Map for İSTANBUL*

As well as benefits such as comfort and economy, the system is also generated important systems for security. While maintain distance with the vehicle in front, the system should follow the line.[10] If there is a violation of the line, the system should alert the driver. In this line the road-transport terminology, a lane departure warning system is a mechanism designed to warn a driver when the vehicle begins to move out of its lane (unless a turn signal is on in that direction) on freeways and arterial roads. These systems are designed to minimize accidents. Usually lines is perceived by using image processing technology. LIDAR, video cameras are used for detectin lines.[9,10]

The output signal is produced, by signals which collected all of these system processed as soon as possible. Analysis of the collected signals and to transmit the output response time is an important parameter. Time delays in the system should be avoided. In this way, safe and stable operation of the system can be achieved.[13,15]

CONCLUSION

With developments in the Cruise Control system, Adaptive Cruise Control System which is more comfortable, safe, and economic has been produced. With improvements in sensor technology and electronics, systems produced integrated with each other and made available for the users. This systems which come into use under Advanced Driver Assistance Systems, communicate with each other and eases the driver's use. The shortest route, and the least traffic areas, is calculated with the in-vehicle navigation systems. Driving safety is provided whereby lane departure warning system and other driver warning systems. Stop&Go ACC technology provides speed control in heavy traffic. In the future with the development of these systems, the vehicle can make automatic movement. This means that the auto-pilot. Of course, Equipment of vehicles is not enough for a good auto-pilot. Therefore roads and other traffic equipment must be regular.

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