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Co-operative Adaptive Cruise Control: A Study, Methodology, Challenges and Prospect

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ABSTRACT: Cooperative adaptive cruise control (CACC) is an extension to adaptive cruise control. CACC overcomes various is uses of conventional adaptive cruise control system (ACC). By introducing vehicle -to-vehicle (V2V) communication and also vehicle-to-infrastructure (V2-I) communication in some situation. Although the system is not completely implemented yet due to several issues which occurs during practical implementation of the system in this paper we are discussing about the various issues which occurs at the time of practical implementation of the system and the research done to solve those issues.

KEYWORDS: CACC, Platooning, String Stability, V2Vcommunication, cooperative driving.

I. INTRODUCTION

A Conventional Adaptive cruise control system (ACC) allows driver arrange desired cruise speed. ACC system accelerates and decelerates the speed according to the situations but speed doesn't goes beyond the limit which is set by driver which may affect fuel consumption [1]. ACC system fails in several situations like rough roads where if the reason preceding vehicle the vehicle which consist of ACC will run on set speed which is not comfortable.

To overcome flaws of ACC system Cooperative adaptive cruise control system comes in picture. In the modern era of automated vehicle Cooperative adaptive cruise control system (CACC) plays a key role. CACC is an extension to a conventional Adaptive Cruise Control System (ACC), by introducing vehicle-to-vehicle communication. The V2V communication provides information about surrounding vehicles [2, 3]. The vehicles having V2V facility can communicate with each other; this improves driving capacity and prevents accident. CACC system also focuses on improving traffic flow control, less fuel consumption and comfort. CACC System also uses Vehicle-to-Infrastructure Communication (V2I) [4, 5, 6].The V2I Communication provides communication between Vehicle and infrastructure through which vehicle gets idea about the current environment.

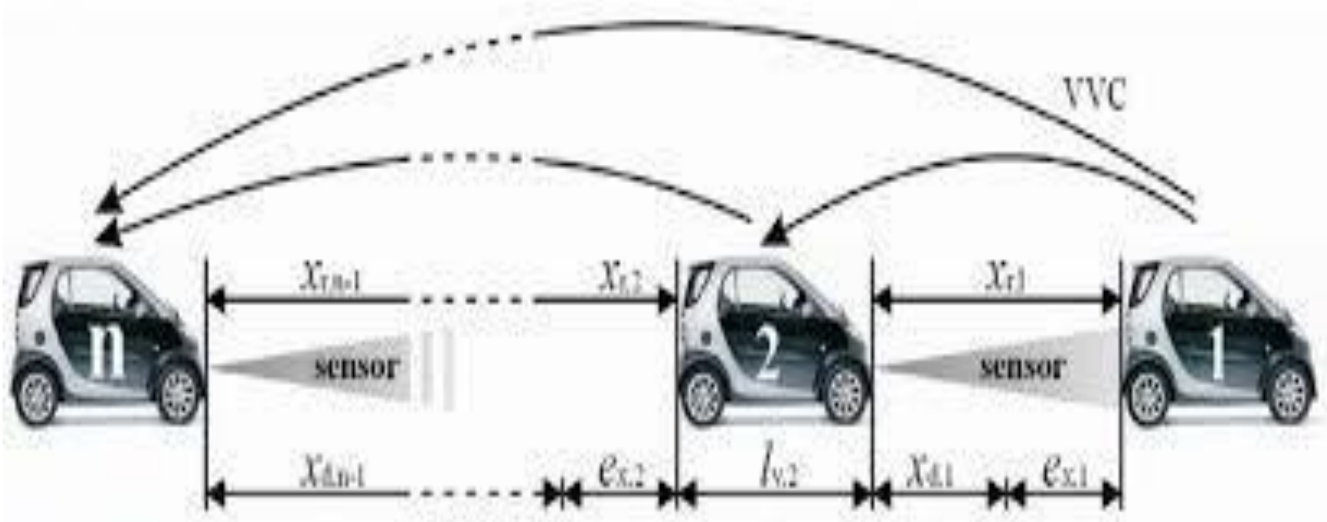

Fig. 1. Co-operative Adaptive Cruise Control.

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II. LITERATURE SURVEY

An autonomous car is a vehicle that is capable of sensing its environment and navigating without human input. It is also called as a driverless car. Autonomous cars can detect surroundings using a variety of techniques such as radar, lidar, GPS, odometer, and computer vision [7]. The two most popular autonomous driving systems that are currently in production are the Cruise Control and the Adaptive Cruise Control systems. By using Cruise Control system, the vehicle is able to travel at a set speed. Adaptive Cruise Control (ACC) system provides an automotive feature that allows a vehicle's cruise control system to adapt the vehicle's speed to the traffic environment, hence contributing to reduced traffic accidents, thereby improving traffic flow. The ACC reduces the driving burden on the driver by controlling the acceleration and deceleration of the vehicle, maintaining a set speed to avoid crash, leading to an improvement in driving stability. California Partners for Advanced Transit and Highways (PATH) have achieved improved vehicle-following performance, using vehicle-vehicle cooperation in eight fully automated cars using wireless communication [8, 10]. The Safe Road Trains for the Environment (SARTRE) European Union project has developed virtual trains of vehicles in which a leading vehicle with a professional driver takes responsibility for each platoon [11, 12].

The extension of the commercially available adaptive cruise control (ACC) system toward the cooperative ACC (CACC) system leads to a high potential to improve traffic flow capacity and smoothness, reducing congestion on highways. The CACC system uses wireless communication as a result of which potential risk situations can be detected earlier, to help avoid crashes and in addition a more extensive and reliable information about other vehicles' motions is gathered to improve vehicle control performance.[13, 14]

Google kick-started its own self-driving car project in 2008 and it has been rumbling on ever since first with modified Toyota Prius and then with customized Lexus SUV [12, 13, 14]. In mid-October 2015, Tesla motors announced that all of its new cars would be outfitted with equipment that would allow them to drive on their own, confirming that all TESLA vehicles will have the hardware needed for full self-driving capability at a safety level substantially greater than that of a human driver [15, 17].

Advanced driver assistance systems (ADASs), are automotive systems designed to assist in all aspects of driving, including safety, drivability, and fuel economy. Examples of ADA systems are various forms of cruise control, lane-keeping systems, and collision-warning systems. The implementation of ADAS may lead to a fatality decrease of 40%. Innovative Advanced Driver Assistance Systems help drivers stay on top of things, helping them arrive safe and relaxed [18]. The CarTALK 2000 project focuses on developing cooperative driver-assistance systems, which are based upon mobile, inter vehicle communication [19]. The traffic impacts of two applications, which are basic warning function and early braking, were assessed using MIXIC model. The MIXIC model is a stochastic simulation model MIXIC which takes into account all the required considerations for assessing the impacts on traffic performance, traffic safety, exhaust-gas emission, and noise emission.

III. CACC IN REAL TRAFFIC SITUATIONS

Adaptive Cruise Control (ACC) system provides an automotive feature that enables a vehicle's controller system to adapt the vehicle's speed to the traffic Conditions, therefore helping to reduced traffic accidents, we need to do better traffic flow. The ACC Controls acceleration and deceleration of vehicle so the driving burden on the driver reduces, and it maintains a set speed to avoid crash, leading to an improvement in driving stability.
California Partners for Advanced Transit and Highways (PATH) have achieved improved vehicle-following performance, by using vehicle to vehicle cooperation in eight absolutely machine-controlled cars by making use of wireless communication. The Safe Road Trains for the environment (SARTRE) European Union project has developed virtual trains of vehicles in that a leading vehicle with a skilled driver takes responsibility for every platoon.

The extension of the commercially offered adaptive cruise control (ACC) system toward the cooperative adaptive cruise control (CACC) system ends up in a high potential to boost traffic flow capability and smoothness, reducing congestion on highways [8]. The CACC system uses wireless communication as a result of that potential risk conditions could be detected earlier, to assist a void crashes and additionally a additional in-depth and reliable data regarding alternative vehicles' motions is gathered to improve vehicle management performance. In addition, there are numerous challenges in an ACC system that should be self-addressed within the close to future. One of the most vital problem s discovered among drivers in ACC system is the irritability to adapt to dynamical driving habit among drivers.

IV. STRING STABILITY

String Stability of Interconnected Vehicles implies a study of Cooperative adaptive cruise control (CACC) system that regulates inter-vehicle distances during a vehicle string by utilizing the info exchange between vehicles through wireless

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communication [17] and native sensing element measurements. String stability allows vehicle strobe interconnected by another vehicle following management law and a constant time head way spacing policy.

This analysis technique will be used to investigate tradeoffs between CACC performance and network specific at ions like delays that are a unit essential within the multidisciplinary style of CACC controllers. The propagation of disturbances through the interconnected vehicle string is inspected by exploitation string stability. String stability ensures that automatic vehicles movement in platoons exhibit stability each singly and as a bunch [4].

String in stability could manufacture a tiny low disturbance at the starting of the string that grows without certain where as propagating through the string worrying the entire structure of the conveyance platoon. Some analysis has targeted on creating use of underlying inter connection structures to derive climb able system supposititious properties for this sort of platoon systems. Additional recently, proof-of-concept demonstrations with CACC vehicles are performed with unvaried vehicle strings and additionally with heterogeneous vehicle strings during a multi vendor setting [6]. Networked system (NCS) primarily based CACC model was developed and by experimentation verified. The analysis framework for string stability was with success performed in a Leyster check with two CACC-equipped model vehicles. Daintily tread the throttle and the brake pedals alternatively to ensure a smooth driving execution.

V. MERGING IN PLATOON

A demand of any CACC system is that it should be ready to support the merging of vehicles within an existing platoon .At any instance vehicle may wish to join a platoon or they are forced to do so at a merging junction. The geo-casting concept targets the vehicles based on predicting where the vehicle will be in the direct future, instead of their current position. This concept is referred as constrained recast [3, 4]. This might be helpful in things wherever vehicles have interdependencies supported man oeuvres once a vehicle within a platoon receives a request from another vehicle to join the platoon it can produce a alleged merging gap by step by step decreasing its speed, thereby increasing the head way to its preceding vehicle [6].
Once the merging gap is massive enough the merging vehicle aligns with it and joins the platoon. Later traditional CACC operation is resumed. We need a communication system that is in a position to warn any vehicle with in a platoon in advance, by using indirect multi-hop communication that it has to produce a merging gap for a merging vehicle at a junction. Geocast is a type of routing during which messages are routed through a network based mostly on spatiotemporal constraints. We tend to believe that this might prove a valid geocast approach for sorts of intelligent traffic systems that want to focus on approaching vehicles, e.g., warning applications or traffic info applications [2].
Leading European projects on field of transport networking includes SAFESPOT3, COMeSafety2, CVIS5 and GeoNET4. We tend to use COMeSafety's European ITSVANET Protocol (EIVP) as network level protocol, and based mostly our geocast protocol on SAFESPOT's positioning interface. geocast supports the dissemination of data in a larger geographical area. The sender of the message defines the geographic area wherever the information message ought to be disseminated and attaches it to the message. Data is distributed once [5].
In distinction, lasting geocast could be a dissemination approach wherever the data is geocasted to all nodes that are within a destination region within a specific interval of time. Our forced geocast protocol is so conjointly forced to the use of these beacons, though their temporal order could be altered. The goal of our CACC system is to have vehicles drive in platoon-wise fashion, with very little area in between individual vehicles, such AN approach could cause things wherever merging vehicles won't be ready to notice a spot to merge in. a lot of vital even, since we have a tendency to assume that our system should add AN setting wherever vehicles area combination of automatic and non-automated vehicles, our system must be ready to cope with non-automated vehicles. Later on we have a tendency to could add practicality, therefore that once the merging vehicle is similarly automatic its speed could conjointly be controlled [6].

VI. COLLISION WARNING IN CACC

Vehicle-to-Vehicle wireless communication protocols points out the necessity for conveyance Collision Warning Communication (VCWC) protocol to enhance route traffic safety. Rising wireless technologies for vehicle-to-vehicle (V2V) and vehicle-to-roadside (V2R) communications like DSRC square measure promising to dramatically scale back the amount of fatal road accidents by providing early warnings [8].
A Joint V2V/V2R (R2V) communication protocol for handing love collision avoiding, improves the communication responsible ness. Previous analysis work with relation to V2V communication has centered on three aspects: Medium access management, Message forwarding, and cluster management.
Briefly, water proof protocols coordinate channel access among completely different vehicles; multi-hop forwarding mechanisms extend the approachable region for warning messages; and cluster management protocols outline the cluster of vehicles that share a typical interest [10, 17]. A vehicle will become associate degree abnormal vehicle (AV) attributable to its

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own mechanical failure or attributable to surprising road hazards. In general, the abnormal behavior of a vehicle will be detected by using numerous sensors inside the vehicle.
A vehicle controller will mechanically monitor the vehicle dynamics associate degreed activate the collision warning communication module once it enters an abnormal state. Command primarily based intelligent systems with on-board perception/detection devices have contributed greatly to up road safety [19]. Such forms of vital developments have conjointly been achieved in Advanced Driver help System (ADAS).

VII. PROBLEMS IN WIRELESS COMMUNICATION IN CACC

Cooperative adaptive Cruise control (CACC) is basically vehicle-following management systems that mechanically accelerates and decelerates thus on keeps a desired distance to the preceding vehicle. CACC is prone to unreliable wireless communication as a result of high latency or packet loss. CACC is prone to communication impairments like packet loss, during which case it might effectively degrade to traditional adaptive Cruise control (ACC), which needs considerably larger time head way, thereby increasing the minimal inter-vehicle distance required for string-stable behavior [15, 17].
The minimum string-stable time headway will increase from 0.25s to over 3s.It is, therefore, vital to have an different management technique that exhibits string-stable behavior for a less dramatic increase in time head way, that comes in to action once a failure in the wireless communication is detected. Therefore, an impression strategy for swish degradation of one vehicle look-ahead CACC is needed to partially maintain the string stability properties of CACC.
A pullout strategy has been known to graciously degrade practicality of a one-vehicle look ahead CACC, based mostly on estimating the preceding vehicle's acceleration by using the obtainable information from an on board sensor. This calculable acceleration will be used as another to the required acceleration transmitted through wireless communication for this sort of CACC. It's shown through simulations and experiments that the planned strategy results in a noticeable improvement of string stability characteristics, compared to the case during which ACC is employed as a fallback scenario.

A. Advantages

- The driver is relieved from the task of Careful Acceleration, Deceleration and Braking in congested traffics.
- A highly responsive traffic system that adjusts itself to avoid accidents can be developed.
- Since the breaking and acceleration are done in a systematic way, the Fuel Efficiency of the vehicle is increased.

B. Applications

- Lane Departure
- Vehicle to Infrastructure (V2I) Environment
- Location Tracker
- Smoke / Alcohol Detector
- Accident detection and send info automatically to nearest Hospital.

VIII. CONCLUSION

In this paper we have collectively studied the Co-operative adaptive cruise control (CACC) concept. We have gone through CACC methodology, all the issues and challenges might occur while implementing CACC system and different research done to solve those issues. We have gone through various prospects related with CACC. Hence we can conclude that for automatic vehicle its good technique.

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