Contents lists available at www.iusrj.org
International Uni-Scientific Research Journal
Journal homepage: www.iusrj.org

Circuit and Systems

New Algorithm for Vehicle-to-Vehicle Advanced Driver-Assistance Systems (V2V-ADAS) to Prevent Collisions

Ahmed M. Mahmoud, Khaled Shaaban, Mohammed K. Salama

Article Info

Article history:

Received: 01-10-2022

Accepted:20-12-2022

doai202212201225

Available

Vol. 3 (20) 133-138

27th Dec 2022

Keywords:

AEB, V2V, FCWS, ADS, Vehicle-to-Vehicle Advanced Driver Assistance Systems

Abstract

With the rise in traffic and stress levels among drivers, driving has become increasingly dangerous. As a result, it is essential to implement systems that can prevent collisions to ensure safer and more efficient journeys on the road. This paper proposes a novel algorithm for Vehicle-to-Vehicle Advanced Driver Assistance Systems (V2V-ADAS) that uses cooperative systems with vehicular communication technologies expected to become mandatory installations in cars. The proposed algorithm specifically focuses on detecting forward collisions and calculating current breaking distances to identify potential collisions. Upon detection of hazardous road conditions, the ADAS technology immediately alerts the driver and can even take action, such as slowing or stopping the vehicle if necessary. By utilizing modern technology to enhance safety on the roads, this innovative approach to V2V-ADAS has great potential to reduce accidents significantly. In conclusion, developing advanced technology like V2V-ADAS is crucial for providing safer and more efficient driving experiences. The proposed algorithm offers a promising solution to the growing problem of collisions on our roads and has the potential to revolutionize the way we approach road safety.

Related work

New cars can be equipped with many advanced safety solutions. Airbags, seatbelts and all of the essential passive safety parts are standard equipment. Now cars are often equipped with new advanced active safety systems that can prevent accidents. The functions of the Advanced Driver Assistance Systems are still growing. A review of the most popular available technologies used in ADAS and descriptions of their application areas are discussed in this paper. [1]
the development and implementation of an integrated advanced driver assistance system (ADAS) for rural and intercity environments is proposed.

The system focuses mainly on single-carriageways roads, given the complexity of these environments compared to motorways and the high number of severe and fatal accidents on them. The proposed system is based on advanced perception techniques, vehicle automation and communications between vehicles (V2V) and with the infrastructure (V2I).
Sensor fusion architecture based on computer vision and laser scanner technologies are developed. It allows real time detection and classification of obstacles, and the identification of potential risks. The driver receives this information and some warnings generated by the system. In case, he does not

Corresponding authors
Ahmed M. Mahmoud
Khaled Shaaban
Mohammed Khalaf Salama

react in a proper way, the vehicle could perform autonomous actions (both on speed control or steering maneuvers) to improve safety and/or efficiency. Furthermore, a multimodal V2V and V2I communication system, based on Geo Networking, facilitates the flow of information between vehicles and assists in the detection and information broadcasting processes. All this, combined with vehicle positioning, detailed digital maps and advanced map-matching algorithms, establish the decision algorithms of different ADAS systems [2]

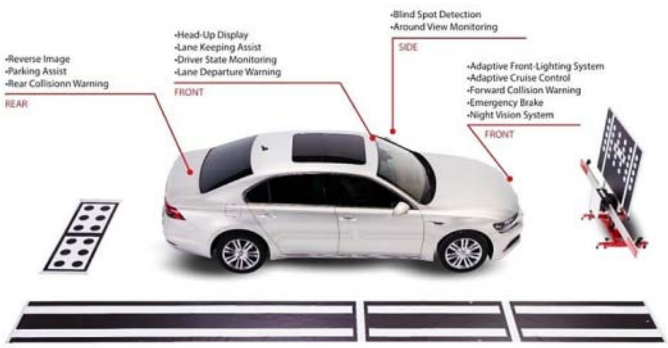
Human cognitive analysis catalyzes the innovations in Human Machine Interface (HMI) for a variety of applications. In an Automotive Advanced Driver Assistance System (ADAS), the continuous cognitive interaction of the driver with the assistance system plays a crucial role in enhancing the active safety system. Multiple ADAS functionalities uses a variety of driver alerts through visual, audio and vibrational means to provide a numerous safety alert to the driver. The effectiveness of any alert system is measured through its success rate in mitigating the actions which are against the alert commands. The actions taken by the driver for the alerts depends heavily on the driver's moods, which are responsible for driver's perception in understanding the alerts. Even though the voice alerts are considered as the most effective form of human alerts, the static nature of the voice alerts makes them less effective in making the driver to understand the criticality of the alerts when his moods are abnormal or having a reduced driving concentration level [3]

Introduction

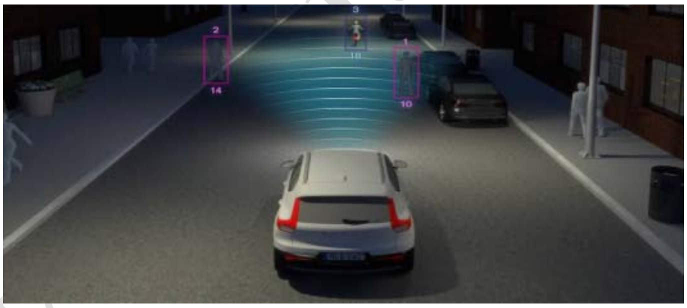
As our roads become busier, driving carries increasing risks. Luckily, technology comes to our aid with Advanced Driver Assistance Systems (ADAS). These systems help drivers with tasks like monitoring, warning, braking, and steering and they're expected to grow in popularity over the next decade. According to a recent survey conducted by the road safety charity, Brake, one in five UK drivers experience road rage at least once a week, and two million experience it every day. However, according to a recent study carried out by AXA insurance, just a 1.5 second warning can prevent 90 percent of collisions. And that's where Advanced Driver Assistance Systems (ADAS) come in. They deliver a two-second warning to drivers as obstacles approach, alerting them to hazards such as pedestrians, lane changes, and short braking distances. Currently, over 90 percent of collisions are caused by human error and as autonomous vehicles start to gain pace, ADAS will come to play an increasing role in reducing vehicle accidents. Here are some of the ways that Advanced Driver Assistance Systems currently alert drivers to hazards on the road

Vehicle safety is one of the significant areas in which automotive companies are investing heavily. Over the years, automotive companies have developed many technologies, which can be helpful in preventing road accidents. These technologies, which automate, facilitate, and improve vehicular systems to assist drivers for a safe and better driving are referred as **Advanced Driver Assistance Systems (ADAS)**. ADAS systems based on Automotive IoT Solutions, help drivers in avoiding on-road collisions by generating alerts on potential hazards while driving and allow the drivers to take timely control of the vehicle. [4]

Mechanism of ADAS



Front collision warnings



According to a report published by the Association for the Advancement of Automotive Medicine, a forward collision warning could reduce 35 percent of near-crash events under fog conditions, as a car travels, its Forward Collision Warning System (FCWS) scans the road ahead and calculates the current braking distance between the car in front. When a driver gets too close to another car, the system creates an alert, encouraging the driver to slow down and to create more distance. If the car is traveling at a high speed, the driver has enough time to perform an emergency stop and avoid colliding with the vehicle in front.

Lane departure warnings

An analysis conducted over a period of six years by the Insurance Institute for Highway Safety (IIHS) found that lane departure warning systems reduced injury crashes by 21 percent. Essentially, lane departure systems alert the driver when they're about to veer out of their lane. There are several variations of the technology and the most advanced systems enable the car to take control and steer away from the lane edge, without human interaction. These ADAS work using a camera that's mounted on the vehicle's windshield that constantly processes the lane markings on the road ahead. For an overview of how lane detection systems work, check out this video from the IIHS:

Parking Assistance Systems

Parking assistance systems are one of the most commonly used ADAS systems. Parking assistance systems generally use ultrasonic sensors, which are fixed on front and rear bumpers of the vehicle to detect the obstacles while parking and trigger alarm. The rear cam is also integrated with the system to provide visual assistance while parking. The system senses the distance between the vehicle and the obstacle**.**

Adaptive Cruise Control

The Adaptive Cruise Control (ACC) or Radar Cruise Control is an intelligent system, which allows drivers to maintain an optimum distance between vehicles while driving and allows vehicles to automatically adjust their speed while approaching towards other vehicles. ACC is based on on-board radar or laser sensor, which instructs the vehicle to slow down in case of any vehicle is detected. The adaptive cruise control system is comprised of a radar headway sensor, digital signal processor, and longitudinal controller. The system is integrated with the engine as well as breaks of the vehicles so that when the system detects any vehicle in its roadway, it automatically decelerates the vehicle and allow the vehicle to reaccelerate to the set speed when the path is clear.

Traffic Sign Recognition System

Missing out any traffic sign can be a cause of a serious road accident. The real-time traffic sign recognition (TSR) systems not only help drivers to follow the traffic signals, but help them follow the traffic rules. Traffic sign recognition systems in a vehicle are equipped with forward-facing cameras to detect the on-road signs. Real-time feeds from the front cameras with image processing, computer vision and image recognition algorithms help this system to recognize the traffic signs and display on the infotainment system to be addressed by the driver in addition to The V2V and V2R communication algorithm utilizes advanced technology to prevent collisions at intersections by facilitating real-time communication between vehicles and road infrastructure.[4]

Tire Pressure Monitoring Systems (TMPS)

Tire pressure is a critical parameter in ensuring vehicle suspension and safety on the road. Uneven tire pressure can create mileage issues, more emissions, reduced tire tread life and can cause a tire failure, which may result in serious road accidents. Tire Pressure monitoring systems are critical ADAS systems as it warns the driver if any tire is under-inflated. Tire pressure monitoring systems are of two types, indirect and direct systems. Indirect TPMS systems measure rpm (revolutions per minute) of the tires and if any unprecedented rpm is measured in wheels, the driver is indicated by the system. On the other hand, direct TMPS systems are pressure sensors attached to each tire, which provide readings of actual pressure inside each tire.

Night Vision and Pedestrian Detection

Pedestrian detection systems are the ADAS functions, which requires high accuracy and reliability. As a majority of the pedestrian-related accidents occur in the nighttime, they are paired with night vision systems to function precisely even in low visibility. Efficient pedestrian detection systems with night vision are equipped with thermal cameras and far-infrared sensors. Infrared sensors capture thermal radiations from the front of the vehicle and clearly distinguish living beings from objects, trees and traffic signs on pedestrian and roadways. The automotive companies are researching on artificial intelligence (AI) based pedestrian detection technologies, which are expected to be more precise than the existing ones. [4]

AEB System Design

AEB system analysis model. for analyzing the usability of V2V communication in comparison with that of vehicle-mounted sensors, a detailed model including various sensors and modules, the driving and communication environment, and vehicle dynamic characteristics was required AEB is an active safety system that measures the degree of risk between a user vehicle and a forward vehicle using vehicle-installed environment recognition sensors such as radars or cameras. It helps in preventing accidents through automatic brake control in risky situations

AEB is an active safety system that measures the degree of risk between a user vehicle and a forward vehicle using vehicle-installed environment recognition sensors such as radars or cameras. It helps in preventing accidents through automatic brake control in risky situations. In Europe, the enforcement of rules concerning AEB systems from 2014 has been initiated. In Europe, the rules concerning AEB systems have come into effect since the beginning of 2014. In 2009, it was proposed that an informal group, called the autonomous emergency braking system (AEBS)/lane departure warning system (LDWS) informal group, will be formed under the Working Party on Brakes and Running Gear (GRRF), a subsidiary body of a World Forum for Harmonization of Vehicle (WP.29), in order to formulate AEBS/LDWS standards. Economic Commission for Europe (ECE) regulations concerning AEBS are being enacted under the United Nations Economic Commission for Europe [5]

Preventing driver fatigue

Fatigue detection systems use an infrared camera that points directly to the driver's face. The camera is mounted on the dashboard to give a full view of the driver's face without impairing their vision. The camera processes the driver's facial movements and looks for signs of fatigue like a yawn, closed eyes, or a dropping head. When detected, the system then alerts the driver with a loud audible alert.

Overview on ADAS

Four control point in ADAS are key for autonomous driving and product differentiation

Processor

Software algorithms

Sensor

Mapping stores and update geological and infrastructure information

Processors: Electronic control units (ECUs) and microcontroller units (MCUs) are essential for most ADAS applications, including autonomous driving. For ADAS to advance, processors need better performance, which could be enabled by multicore architectures and higher frequencies, as well as lower power-consumption requirements.

Sensors: These devices gather information on their immediate environment, such as pedestrians and oncoming cars. Most have a limited measurement range and signal bandwidth, which makes it difficult to distinguish between "signal" (for example, obstacles in the road) and system "noise" It is especially difficult for sensors to track moving objects during less-than-ideal environmental conditions, such as rain and fog.

Many industry players are trying to improve individual sensors. They are also attempting to optimize system performance through better sensor fusion—the coherent combination of data from multiple sensors. On the hardware side, inter sensor communication is a major challenge because it requires high bandwidth and solutions for preventing network overloads[7]

Problem Statement

Aim of ADAS technology is to improve the safety and convenience considering the future of car society and various technologies developed. In addition to improving functions, widely penetrating is also a major key. Therefore, it can be said that it is necessary to establish various requirements such as sensor selection, price of processing chip, selection of mounting position.

ADAS realize the safety and comfort of the driver, accurately displays and warns the driver, replaces the driver .It is a collective term for functions that support driving such as controlling a car

Problem Solving

ADAS technology alert the driver of hazardous road conditions and, in some cases, slow or stop the vehicle and ADAS detect forward collision and current breaking distance to prevent collision

To solve collision, we must find a way to make communication stable between vehicles.

The system was modified to prevent sudden collision. When the velocity exceeds 40 km/h, AEB would never work. If the velocity less than 40 km/h, AEB will work at collision.

Algorithm of ADAS mechanism

ADAS system collect data and data from V2V system are received.

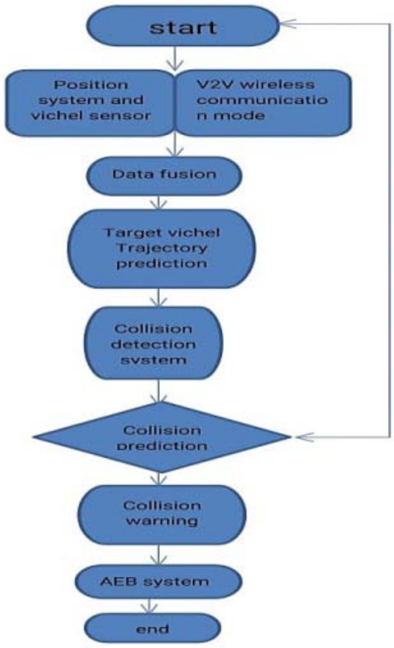
Data fusion would be done to all data collected.

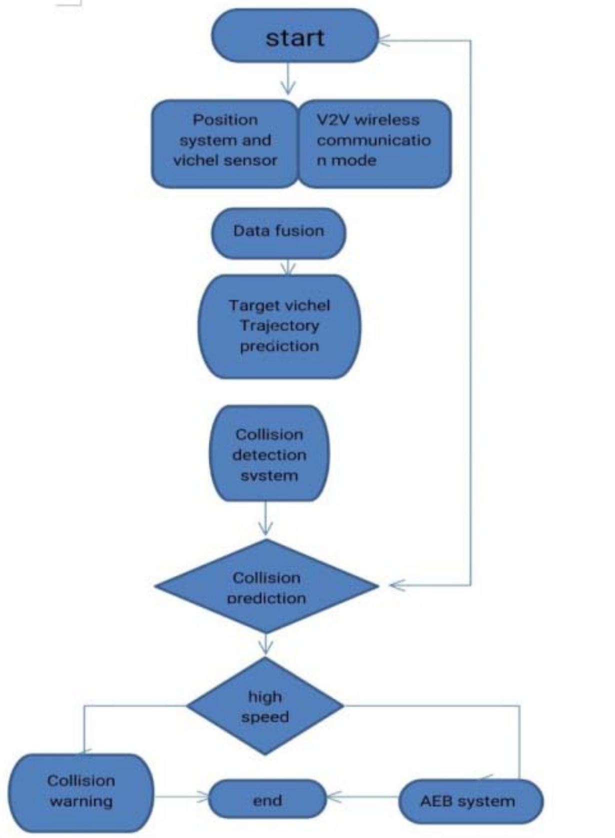
Vehicle position can be detected by Target vehicle trajectory prediction.

System is working to find collision.

When system predict collision, it will fire warning.

Then AEB system will stop the car to prevent collision





Conclusion:

In short, Advanced Driver Assistance Systems make our roads safer. They can reduce collisions and ultimately save lives.

In the short-term, they can also make us better drivers. Rather than resigning our safety to technology in its entirety, ADAS are more likely to increase our awareness and encourage us to be safer drivers through behavior change.

As autonomous vehicles take to our roads, ADAS will play a key role in ensuring their safety. According to manufacturing services company, Jabil, 36 percent of automotive companies say ADAS are a key element of their automotive visions.

References

[1] Adam Ziebinski, "Review of advanced driver assistance systems (ADAS)," 2017. DOI:10.1063/1.5012394

[2] MA. Felipe Jiménez, "Advanced Driver Assistance System for Road Environments to Improve Safety and Efficiency," 2016. 10.1016/j.trpro.2016.05.240

[3] SM. Sarala, "Emotionally Adaptive Driver Voice Alert System for Advanced Driver Assistance System (ADAS) Applications," 2019. DOI:10.1109/ICSSIT.2018.8748541

[4] HE. Mahmoud ,MA. Elsaid ,MK. Salama(2021),V2V and V2R Communication Algorithm to avoid collisions at intersections. IUSRJ International Uni-Scientific Research Journal (2)(32),197-204. https://doi.org/10.59271/s44413.021.1335.32

[5] A. SAXENA, "Top 7 ADAS Technologies that Improve Vehicle Safety," 2020.

[6] G.-E. K. B.-W. K. Hong Cho, "Usability Analysis of Collision Avoidance System in Vehicle-to-Vehicle Communication Environment," 2014. Journal of Applied Mathematics Volume 2014 (2014), Article ID 951214, 10 pages http://dx.doi.org/10.1155/2014/951214

[7] F. T. D. W. a. F. W. Seung Yuk Choi, "Advanced driver-assistance systems: Challenges and opportunities ahead," 2016.