# COLLISION DETECTION AND AVOIDANCE SYSTEM (CDAS) Program


## Abstract.

In the present civilized society, the number of road accidebts has skyrocketed while also becoming uncertain. Accidents cause enormous damages, serious injury and even death. Statistically speaking, most accidents are caused as a result of the failure of most drivers to apply breaks on time. Preventive measure such as improving visibility, auto headlights, windshield wipers, tire traction, etc. were deployed to reduce the probability of getting into an accident but in an attempt to actively avoid accidents as well as providing maximum protection to passengers and pedestrians, we propose a new automated vehicle Collision Detection and Avoidance System (CDAS). This project is designed to develop a new system that can solve this problem where drivers are not to brake manually but the vehicles stops automatically due to obstacles by using sensors. Therefore this papper aims at the development of a sensor based embedded system that assists drivers to detect and avoid any sort of collision on the road in order to save passenger and pedestrian lives while also preventing financial loss.



## Keywords:

Collision Detection and Avoidance Syatem(CDAS), Radio Detection and Ranging(radar), Light Amplified by Simulation of Electromagnetic Radiation(LASER), ultrasound, Light Detection and Ranging(LiDAR)

# 1 Introduction

The enterprise approach to automotive safety structures has evolved tremendously over the past few centuries. The Collision Detection and Avoidance System (CDAS)contributes to this enterprise by concentrating on advanced ideas such as pre-crash sensing, an ultrasonic or laser sensor is used to detect the obstacles in front of the vehicle and relays the signal to the microcontroller unit. Based on the signal received from the ultrasonic sensor, the microcontroller unit sends a signal to the braking unit for applying the brake automatically. A collision avoidance system, also known as a pre-crash system, collision mitigating system or forward collision warning system is an automobile safety system designed to prevent or reduce the occurrence of a collision.

The system employs the use of Radio Detection and Ranging(radar) as well as a camera (employs image recognition) and Light Detection and Ranging (LiDAR) integration to detect an imminent crash. Geographical Positioning Systems sensors may also be integrated to detect fixed dangers which include approaching road signs with the use of a location database. When an oncoming collision is detected, the above systems relay a warning to the driver. When the collision becomes imminent, they respond autonomously without any driver input (by braking or steering or both). Collision avoidance by braking is appropriate at low vehicle speeds (below 50 km/h ), while collision avoidance by steering is more appropriate while at higher vehicle speeds if lanes are clear. Vehicles with CDAS may also be equipped with adaptive cruise control, using similar forward-fixed sensors.

With reference to existing statistics, given by the global road safety partnership annual report 2014 [1], 1.24 million people die each year due to various road accidents occurring throughout the world while almost 50 million people become victims of critical life-altering injuries. The World Health Organization (WHO) has also established that road traffic injuries caused an estimated 1.35 million deaths worldwide in 2016.

The above occurring tragedies can be prevented if not avoided by the implementation of the proposed Collision Detection and Avoidance System (CDAS).

# 2 Study case

**The existing system**

---

The existing system is a predictive vehicle collision avoidance system which is a sound-based system that employs the use of an alarm to inform the driver that a collision may occur, the sound prompts the driver to take evasive action by applying brakes or steering. However, accidents are caused by the hesitation of the drivers to apply the brakes.

A CDAS system that can detect obstacles by sharp distance sensors, sends alerts in case the vehicle is in close distance of collision and attempts to stop the vehicle without the help of driver, has been proposed.

The researchers of the existing system aimed at designing a system capable of detecting any abnormal condition or accident by sensing various parameters from the seat belt sensor, driver position sensors and the eye blink sensor placed within the vehicle and can automatically inform the traffic police as well as the relatives of the driver about the location of the accident via GSM/GPRS technology in case an accident occurs. It has been established that the major cause of road accidents is the driver's lack of concentration due to fatigue and drowsiness on the road and inability to apply the brakes on time.

The researchers, therefore, reviewed various driver alert systems that assisted in the prevention or avoidance of collisions by applying technologies like Digital Image Processing, electrocardiogram screening and electroencephalogphy.

**Limitations of the existing system**

The existing system possesses the following disadvantages;

- It depends on human intervention which is unreliable.
- It does not guarantee full security.
- Negligence leads to accidents.
- If the driver is unresponsive to the warning, there is a possibility of a collision.

# 3 Theoretical Framework

## 3.1 Literature Survey of the existing system

The predictive vehicle collision avoidance system uses the raspberry-pi module it is used to avoid accidents in the blind spot area using ultrasonic sensors. The ultrasonic sensor works with the radar system to detect obstacles in the blind spot region of the vehicle which may cause accidents. In addition to that the ultrasonic sensor is used to measure the distance between the vehicle and the obstacles and determines if the distance is safe before fatalities occur by alerting the driver pre-accident by applying the two-way visualization using light emitting diode (LED) and a sound buzzer while the driver alone applies the brakes or steering to control the speed. The main advantage of ultrasonic sensors is that they provide high reliability in getting proximity and possess less absorption than RF and IR frequencies used with LASER.

The system will also alert drivers of their surroundings and potentially hazardous driving situations. This system is needed to reduce the number of vehicle accidents on the road. Such a system would lead to improved efficiency of the road usage and limit human as well as economic losses. The proposed system will use ultrasonic sensors to provide blind spot coverage, while utilizing long-range radar to detect possible frontal collisions. The system will be implementable on a variety of standard cars with easy installation. While the system will not provide any autonomous action to avoid collisions, it will warn the driver through both audible and visual warnings. The system will be evaluated through rigorous testing in order to develop an algorithm that encompasses most of the countless circumstances encountered on the road. Once the system is implemented, it will accurately detect the presence of surrounding vehicles with minimal false positives and the driver will be alerted to any possible accident, giving him or her adequate time to respond.

Some examples of developed methods with interesting results which inspired this project proposal are outlined below:

## 3.2 Rear cross-traffic alert

Cross-traffic alert warns you of traffic approaching from the sides as you reverse. The warning usually consists of an audible chirp and a visual cue in either the outside mirror or the rear camera's dash display. The more advanced systems can also pick out bicycles and pedestrians.

## 3.3 Forward-collision warning (FCW) and autobrake

Also called a pre-crash warning system, these stand-alone or combined radar-, laser-, or camera-based systems warn drivers of an impending collision by using visual, auditory, or physical cues. Most vehicle systems also pre-charge the brakes and take other steps to prepare for impact. If the driver ignores the warnings, systems with autonomous braking, or autobrake, will apply partial or full braking force. They can be active at anywhere from walking to highway speeds.

## 3.4 Blind-spot monitoring (BSM) and assist

A blind-spot monitoring system uses radars or cameras to scan the areas beside and behind you, looking for vehicles entering or lurking in your blind zones. When such a vehicle is detected, an illuminated icon appears in or near the appropriate side-view mirror. If you signal a turn while a car is in your blind zone, some systems send a stronger alert, such as a blinking light or louder chirps. More advanced systems help keep you in your own lane by applying the brakes on one side of the vehicle.

## 3.5 Pedestrian detection and braking

Pioneered by Volvo and now offered by others, pedestrian detection can recognize a person straying into a vehicle's path. Some will automatically apply the brakes, if needed, sometimes partially and sometimes to a complete stop. Some newer systems can also detect bicyclists.

## 3.6 Adaptive headlights

As you turn the steering wheel adaptive headlights will swivel, which helps illuminate the road when going around curves. A 2014 IIHS study found that adaptive headlights improved drivers' reaction times by about a third of a second. That could be just enough to avoid, say, hitting a parked car on a dark road.

## 3.7 Lane departure warning (LDW) and assist LDW

These systems use a camera, along with various sensors, to identify lane markers and monitor your distance from them. If you stray over the line without signalling, you'll hear a warning tone or perhaps a physical alert like a vibration in the steering wheel or seat. More advanced "lane keeping assist" (LKA) systems selectively apply brakes or nudge the steering to guide you back if you're wandering

## 3.8 Drowsiness detection

Various methods are used to detect if a driver is tired or falling asleep. Mercedes-Benz pioneered one of the first, which uses a computer algorithm that compares a driver's steering behaviours with those recorded at the start of the trip. Other systems monitor the car's position within its lane of travel, looking for erratic manoeuvres indicative of inattention. Some also track the driver's eye movements with an in-car camera, noting rapid or prolonged eye blinks. Alerts may include a chime, a dab on the brakes, a tug on the shoulder belt, and/or an illuminated cup-of-coffee icon on the instrument panel.

## 3.9 Automatic Park assist.

The system will identify a parallel or perpendicular parking space your car can fit into. Once found, the system steers the car into the space; some can also exit from parallel parking spaces. The driver still does the braking and has to follow commands from the system.

### 3.10 Rear cameras and parking assist.

Rear-view cameras will be mandatory with the 2018 model year. They can help prevent a back-over accident, such as hitting a child who wanders behind your car. Parking assist sensor systems notify you with progressively louder and quicker beeps as you close in on an obstacle.

## 4 Theoretical design categories

Vehicle collision and detection avoidance system performs calculations to determine if there are any potential obstructions present. If the speed variance between the vehicle and any object in front of it is too great, then the system may perform different tasks. The simplest collision avoidance systems will issue a warning beep sound at this point, which will provide the driver with enough advanced warning to either hit the brakes or steer away from the obstruction. In some cases, the collision avoidance system may also pre-charge the brakes in conjunction with an automatic braking or emergency brake assistance system. That can provide the driver with a substantial amount of braking power the moment he depresses the pedal, which may effectively reduce the severity of an accident.

If the forthcoming car is too close the system prompts the driver to take preventative action with audio and visual warnings.

If the distance between the two vehicles further diminishes, the system provides a tactile warning beep and applies light braking.

If an accident appears to be unavoidable, the system applies brakes and avoids collision.

### 4.1 Design

These systems require front-facing sensors. Depending on the particular system, these sensors may use radar, lasers, or other techniques to capture the physical space in front of a vehicle.

## Modules

### 4.2 Power supply system

Theoretically, the power supply system should be a 9v LiPO rechargeable battery that will supply energy to the collision detection system (RADAR and ultra-sonic system). These systems have been proven to consume less amount of energy as compared to laser system which was earlier proposed. The battery should be positioned in a car in such a way that it is away from any heat source such as the radiator or the engine to increase its life span and also to work effectively.

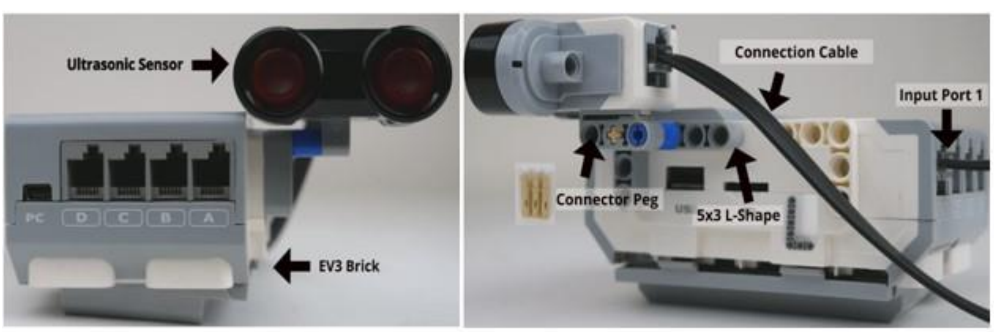
### 4.3 Radar system

The main purpose of the radar system is to detect any obstacles that might exist along the path of an automotive.Radar sensor data and camera image combined with brigade's Radar sensors minimize both vehicle damage and collisions by informing the driver of the distance between vehicle and obstacles, whether moving or stationary. This is ideal for vehicles moving at low speeds.

### 4.4 Ultrasonic sensor module

This is a low-cost, high-performance sensor used to provide stable and high ranging accuracy of 2cm to 350cm with 3mm accuracy. Within the module are the ultrasonic transmitter, receiver and control circuit. The module is preferable because its relatively inexpensive, accurate, and easy to interface with a micro-controller. The HC-SR04 range makes it ideally suited for developing object detection and avoidance schemes.

.




*The front and back side of LEGO base ultrasonic system with sensor*

*Source: www.techengineering.com*

### 4.5 Micro-controller Module

The micro-controller module plays a role of deciding, based on the collision risk whether or not to intervene (e.g. it can warn the driver of an impeding collision or by applying the brakes autonomously). The decision is then forwarded to the actuators or human-machine interfaces which perform the required actions. The board is embedded with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.

### 4.6 Hazardous warning module

Includes an LED and a buzzer. The LED connected to the microcontroller which is the central control module is a distance warning indicator warning. Hazard warning module bleeps if it finds the minimum distance between the vehicles but the speed is still above the critical and alerts the driver to either brake or steers to the other

Raspberry-pi

Source: Raspberrypi.com

lane. When the vehicle is at a very close proximity and the driver hasn't yet responded, it gives signal to the micro-controller to perform autonomous breaking.

.

Since our software system involves programming of the raspberry-pi board, it is designed in such a way that it is able to acquire data from the collision detection system, analyze and synthesize the data and send the data to the collision alert system which is our peripheral device. The algorithm fed in the board needs to have a data flow as shown below:

1. System booting upon the start of the engine.

2. Collection of the collision detection system data.

3. A conditional if statement follows, e.g., if distanceBetween¡ 5m and ¿1.5m go to stage 4, else go to step 5.

4. Warn the driver through the console by LED or buzzerto slow down.

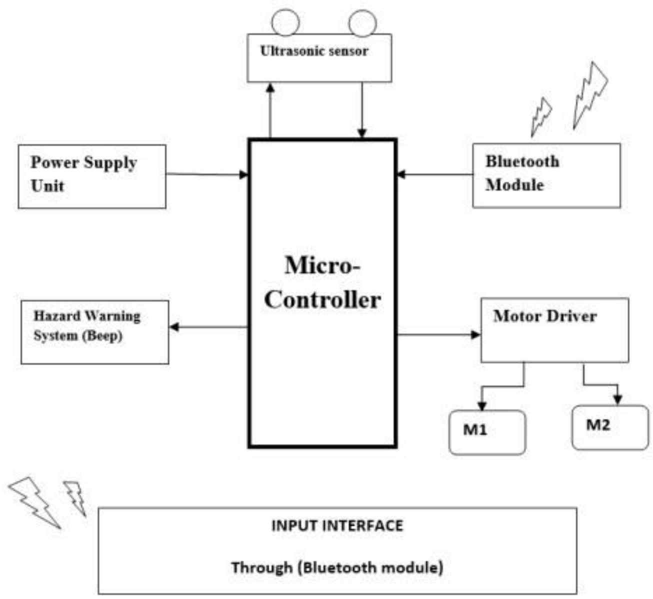
5. Give the driver a time stamp of 3 seconds and if noaction is taken due to neglect, let the CDAS override the braking system and take control of the vehicle hence slowing it.

6. Continue with the second step.

The above algorithm runs continuously as long as the vehicle engine is running. To integrate the software into the board, a C++ program written in visual studio code is installed in the board. Loading a C++ program into a raspberry-pi is simple through a USB 2.0 or USB C cable connected to a computer with the source code which is not complex as compare to other programmers such as the AVRISPmkII.

The CDAS is such that it provides the driver with adequate time to take action and effectively minimize the severity of the accident.

If the car ahead is too close, the CDAS alerts the



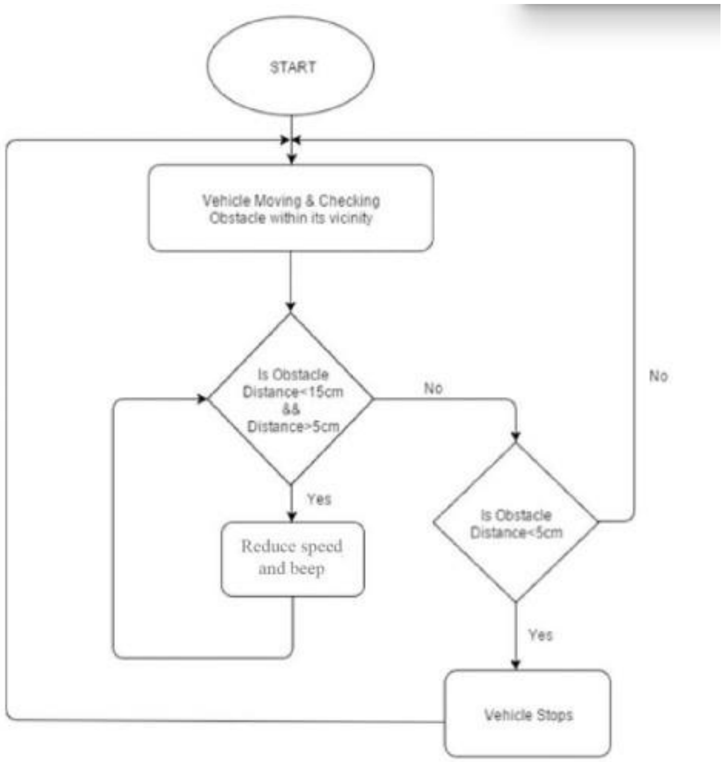

driver through the console to take appropriate measures via audiovisual warnings on the dashboard of the car.

Continued decrease in the distance between the two cars will cause the CDAS to apply slight brakes to the car.

If the collision appears to be unavoidable due to drivers neglect, the CDAS applies brakes instantly to avoid it.

.

.




## 5 Methodological design

### 5.1 Types of data collected

SICK ultrasonic technology data.

Ultrasonic radar sensors data.

Optical scanners (inclusive of cameras) data.

Number of accidents occurring worldwide annually.

### 5.2 Research type and general goal

We applied both experimental and descriptive methodological designs to obtain the research results.

The method used quantitative approach which involved analyzing the available statistics on collisions caused on roads over the previous periods to coming up with the design to curb the undesired occurrence of such collisions.

### 5.3 Population and samples

The statistics on the previous accidents and their causes were analyzed. The causes of accidents which involved sharp bends and non-detection of impending obstacles were the main causes. Over speeding and carelessness of drivers were also got from the statistics obtained.

A sample of the available techniques to prevent accidents including; traffic lights, police controls and the available existing designs discussed above were also obtained and analyzed. This was to get an attempt to get good measures or techniques to prevent the collisions using other means not shouldered on drivers' technical know-how but from scientific designs to enhance appropriate control and prevention of collisions unexpected.

### 5.4 Methods and techniques

The methodology used involved the following steps;

Investigate through literature the safety and accident problems and the kind of its applications and technologies currently deployed or still under research, with a special emphasis on the different warning and collision avoidance systems.

Better understand the specific problem under study by collecting data and information about the various elements contributing to accident occurrence namely about roadway characteristics, traffic conditions and driver performance.

Evaluate the system in terms of predefined measures of effectiveness (MOEs), especially the measure of reducing the number of accidents and eventually the number of human and property losses.

Develop a conceptual design of the proposed system in terms of functions and sub-functions, then followed by a detailed design of the various system components.

## 6 Conclusion

The Collision Detection and Avoidance System is designed and mounted on a very simple and easily understandable model. The sensors can read distances that are at shorter range accurately. The system takes action automatically without any driver input. Hence this automatic braking system can stop the car to prevent an accident.

## 7 References

[1.3]. Md. Maminul Islam, Md. Rabiul Hasan, Imran Chowdhury and Md. Towhid Chowdhury,"Internet of Car: Accident Sensing, Indication and Safety with Alert system” in American Journal of Engineering Research (AJER).

[1.4]. Nesreen Alsbou,Nicholas Martinek, Brian Beckrest and Nathan Pax, “Vehicle Collision Avoidance System” ASEE North Central Section Conference, 2012.

[5]. G. GURURAJ (2008), Road traffic deaths, injuries and disabilities in India: Current scenario, The National Medical Journal of India, volume 21, no 1, page 116 www.porpular science.com

www.universal laser tec.com

www.IEEE.com