IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

Automotive Electronics-A Boon for Safety

Ashima Jain[*1], Karishma Jain[2]
[*1]Master of Technology (ECE) M.D. University, Rohtak, Haryana, India
[2]Bachelor of Technology (EI) M.D. University, Rohtak, Haryana, India
ashima_jain14@yahoo.co.in

Abstract

Electronics play a key role in improving vehicles safety. Use of electronics has made possible the introduction and integration of a wide range of new safety and environmental devices in cars. Nowadays, both customer demands and government legislation continue to improve traffic safety. Safety awareness for vehicles has been increasing strongly since the 1980s. It started with simple seat-belt systems continued with airbags, and has now led to the first really intelligent safety systems. With today's advances in sensor and processor technology, the possibilities are growing rapidly. Governments are also viewing these as ways to decrease traffic casualties, and legislation is starting to demand that car manufacturers make use of the technology. The paper highlights the recent technology used in the vehicles for purpose of safety. Electronics & Communication field has expanded remarkably in the last few years with the development in safety of vehicles. Carmakers are constantly seeking new ways of helping drivers to avoid accidents.

Keywords: Automotive Electronics, Automotive Night Vision, Weather Detection, Traction Control

Introduction

The present era of Information Technology is also heavily dependent on electronics.Many high-tech electronic systems that improve comfort, increase the active and passive safety and facilitate communication and navigation, are currently fitted into cars. Examples of these systems are automotive night vision, weather detection, driver alertness, blind spot detection, lane departure warning, airbags, seatbelt pre-tensioning systems, anti-lock brake systems, traction control, collision warning systems and satellite Navigation systems. Now these systems are becoming increasingly common and the demands of the driver concerning the performance and easy access to the status information of these systems is also increasing. Therefore more electronic displays will be used. These displays will offer more information than the standard information of normal dashboards. They will show the status of the safety and comfort systems mentioned, the information provided by the navigation, communication and maintenance systems. Connector systems for the auto cockpit of the future must be increasingly advanced in order to meet the requirements for faster signal transfer, reduced mass and reduced cost. In this paper, a night vision system named IVAN (Intelligent Vision for Automobiles at Night), which focuses on detecting, illuminating and recognizing road signs at night is described. Electronics already plays a key role in the connector technology for dashboards and in the development of contact systems for the cockpit of the future.

Overview of Automotive Electronics Systems

Automotive Night Vision

An automotive night vision system is a system to increase a vehicle driver's perception and can see distance in darkness or poor weather beyond the reach of the vehicle's headlights. Night Vision allows the driver to see well beyond the reach of the car's headlights. This technology helps drivers detect and avoid potentially dangerous situations. Most car headlights can light the road up to around 60 meters away. Lamps like High-Intensity Discharge (HID) types have gradually increased the range, but it is still limited. These systems typically use infrared cameras, sometimes combined with active illumination techniques, to collect information that is then displayed to the driver. Such systems are currently offered as optional equipment on certain premium vehicles. Infrared imaging systems will allow drivers to gain information about traffic up to around 150 meters away more than twice the distance of ordinary low beam headlights.

Figure 1 shows the system architecture of IVAN (Intelligent Vision for Automobiles at Night). It illustrates the interactions between the hardware and software modules. To provide a convenient, fast and simple input interface, a touch screen is used to get the driver's input and display the processed videos. The driver can also use virtual keyboard on the touch screen for data input.

Unlike normal cameras, the infrared cameras are sensitive to infrared and, therefore, it captures objects that reflect infrared.

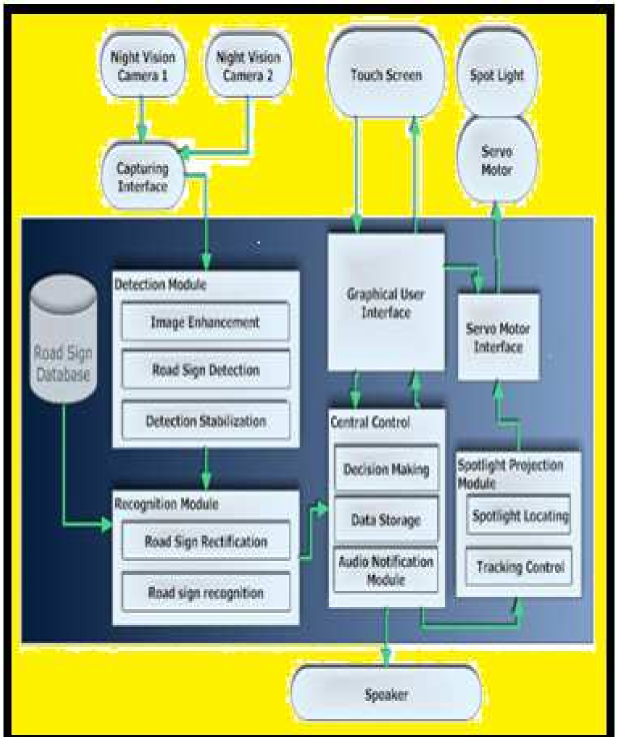

Figure 1: Architecture of IVAN

To adapt with different driving requirements, we have implemented four major functionalities in IVAN.

1. Adaptive night vision – IVAN captures the front view of the vehicle with an infrared camera and displays the video onto a touch screen. Meanwhile, the infrared camera will adaptively change direction if the vehicle is turning. The camera automatically adjusts to the best angle so that it always captures the front view.

2. Road sign detection and recognition - The detection module firstly detects road signs by processing the image captured. From these detected signs, the recognition module recognizes important ones, such as warning signs and regulatory signs. For recognized signs, a clearer picture will be displayed beside each one to increase the awareness of drivers.

3. Spotlight projection - Once a road sign has been detected and selected by the user, the system immediately finds its corresponding position and projects light onto it using a spotlight mounted on a rotating platform. Automatic tracking is also implemented in IVAN. The spotlight will illuminate on the selected road sign while the vehicle is moving.

4. Scene zooming - The user is able to view road signs at long distance using the zooming function. The user can control the degree of magnification easily by sliding on the touch screen.

Blind Spot Detection

Most blind spot detection systems use radar sensors located behind the rear bumper that can monitor both sides of a vehicle. The driver is alerted to any potential hazard when another vehicle enters the blind spot. Very often, this is done by a visible icon displayed in the side view mirror, although some vendors are now also using cameras for blind spot detection. In blind spot detection, the sensors may also provide cross-traffic alert. When we start to back out of a head-in parking spot with cars on either side, the sensors will notice traffic on either side heading in your direction and sound an alert, usually louder and more insistent that backup sonar. It sees the traffic coming almost as soon as you start backing out, while we’re still trying to peer through the window glass of cars next to us. Blind spot detection is a key technology among driver aids that provide 360 degrees of electronic coverage around your car, whether you are at speed or moving slowly. This circle of safety also includes adaptive cruise control, lane departure warning, rear and front parking sonar, the rear traffic alert, and parking cameras (ranging from rear-only through four cameras providing a birds-eye view of the car as you snake into and out of tight spaces). Some driver’s aids make you safer, especially late on a long drive, and some earn back their cost when you don’t crumple a fender, where the insurance deductible costs more than the device. Early on in Driving, we were taught to look over our shoulder before changing lanes because side view mirrors don’t see everything. What we may miss in a quick glance is what blind spot detection picks up. This driver assistance technology senses cars coming up in our blind spot behind or alongside and if we turn signal is on, it alerts you not to change lanes. We are warned by a flashing light on the side view mirror and then a beep or steering wheel vibration. If we are not planning to change lanes (there is no turn signal on), the warning light glows steadily but doesn’t flash and there’s no audible alert.

The BSD side sensors also help find parallel parking spaces and then park the car. Ford has been aggressive in marketing both automated parking (active park assist) and cross-traffic alert and bringing it down from full-size cars to the low-cost Ford Focus. The sensors at the back and side of the car may also be used for safe backing, called variously parking sonar, backup assist, reverse parking sensor. Not all rear sensors for parking are used for blind spot detection. If your car has rear parking assist, it may not have blind spot detection. Blind spot detection is one of the technologies that car purists detest. Blind spot monitoring, like lane departure warning, is more of a highway than urban safety aid. It benefits drivers on long trips, especially once they are several hours in. It's also a benefit to older drives whose head-turning ability is limited. . In our system, images are analyzed using optical flow techniques to detect pixels that move in the same direction as the ego-vehicle [1].

Weather Detection

Radar has the advantage of operating in all weather conditions, and accurately measures the distance to moving objects. Cameras can identify moving and stationary objects, though, and can therefore improve the accuracy of radar obstacle detection systems. Vehicle detection is easily influenced by weather conditions such as rainy day, foggy day, night, and shadow. The information of surrounding scenario in these weather conditions is quite different with normal day. To detect preceding vehicle robustly under variant weather conditions, the features have to adapt to the weather. The proposed procedure uses horizontal and vertical edge to detect vehicles. At first, the proposed scheme detects lane to obtain the information of lane mark which helps us to generate a searching region and delete the redundant horizontal edges. Cameras have the advantages of cheap and versatile functions over radar devices to detect vehicles; however, the vision detection is easily influenced by variant weather conditions. In this multiple edges are used which are the most robust features to detect vehicles.

Driver Alertness

Drivers not being alert, whether from fatigue or distraction, is one of the main causes of vehicle crashes. For some high-end cars, buses and trucks offer an option that monitors the driver's face using a camera located in the vehicle instrument panel. The camera monitors a driver's head and eye position, and the frequency at which the driver blinks his or her eyes. When needed, it sounds an alert to keep the driver awake, and can apply additional braking force when other sensors predict an imminent collision. Drowsy driver alert system is used to monitors the driver's gaze and head position to assess visual distraction. The drowsy driver warning system uses low level infrared signals (which are not visible) to monitor eye closure. Driver distraction alert assesses the driver's drowsiness level and can apply stimuli to help alert the driver of the situation.

Figure 2 Drowsy Alert Systems

Lane Departure Warning

In US alone, around 4,500 deaths occur each year from head-on collisions or sideswipes when vehicles cross the center line and collide with oncoming traffic. Lane departure warning systems can indicate when it's possible to cross the centerline using a green symbol on the dashboard display. They can provide an auditory alert if a driver crosses a lane marking without first having indicated. Most recent systems use CMOS cameras to "follow" the centerlines. Besides lane departure warning systems, these cameras will in the near future also be used for traffic sign recognition.

Automotive Navigation System

Satellite navigation is a leading-edge technology which allows anyone with a receiver to determine their position very accurately at any time by picking up signals from a constellation of several satellites. The key element offered by satellite technology of observation, telecommunication and navigation are highly suited to the needs of future transport systems of all kinds. An automotive navigation system is a satellite navigation system designed for use in automobiles. The first system was the global positioning system developed for use by the US military [2].It typically uses a GPS navigation device to acquire position data to locate the user on a road in the unit's map database. Using the road database, the unit can give directions to other locations along roads also in its database. Dead reckoning using distance data from sensors attached to the drive train, a gyroscope and an accelerometer can be used for greater reliability, as GPS signal loss or multipath can occur due to urban canyons or tunnels. At the present time the only fully functional Global Satellite Navigation System (GPS) has a horizontal accuracy of about 10–15 meters [3]. In the recent decade the use of satellite navigation has become common for consumer vehicle navigation purposes. Related works in the area of the satellite navigation correction are dead reckoning systems and map-matching algorithms [4]. The first consists of an odometer to measure the vehicle travel distance and a gyro or compass to provide moving direction [4]. Based on these the current vehicle position can be determined given an initial known starting position. The map-matching

ISSN: 2277-9655
Impact Factor: 1.852

algorithms correct the vehicle position based on vehicle trajectory and the constraint that the vehicles will be on roads for the majority of the time [4].

Automotive Collision Warning

A collision avoidance system is an automobile safety system designed to reduce the severity of an accident. Also known as precrash system, forward collision warning system or collision mitigating system, use radar and sometimes laser and camera sensors to detect an imminent crash. In 2009 the U.S. National Highway Traffic Safety Administration (NHTSA) began studying whether to make frontal collision warning systems and lane departure warning systems mandatory.

Forward Collision Warning (FCW) systems are based on camera or radar sensors monitoring the road ahead. They provide object recognition and detect relative speeds between a vehicle and objects in the road. If the closing speed represents a risk of an impending collision, drivers can be alerted through a number of warning methods. We also used wireless communication based collision warning systems, Cooperative Collision Warning (CCW), and we have shown that indeed wireless communications can support vehicle safety services when all cars have radios (i.e., 100% market penetration) andwhen there is sufficient wireless spectrum [5].

CAMERA-BASED FORWARD COLLISION WARNING

The camera-based FCW system uses a forward-looking monocular camera with object recognition, mounted on the windscreen behind the rear view mirror. This is linked to a warning device. The camera-based system can also support Lane Departure Warning functionality.

RADAR-BASED FORWARD COLLISION WARNING

The radar-based FCW system consists of a 24GHz medium-range radar sensor. The radar sensor is mounted at the vehicle front and linked to a warning device. Radar technology provides high performance with direct measurement of distance and relative speed, operating under all weather conditions.

Traction Control System

A traction control system (TCS) is used to improve the acceleration performance on slippery roads by preventing excessive wheel slip [6]. Traction control helps limit tire slip in acceleration on slippery surfaces. In the past, drivers had to feather the gas pedal to prevent the drive wheels from spinning wildly on slippery pavement. Many of today's vehicles employ electronic controls to limit power delivery for the driver, eliminating wheel slip and helping the driver accelerate under control. In modern vehicles, traction control systems utilize the same wheel speed sensors employed by the antilock braking system. These sensors measure differences in rotational speed to determine if the wheels that are receiving power have lost traction. When the traction control system determines that one wheel is spinning more quickly than the others, it automatically "pumps" the brake to that wheel to reduce its speed and lessen wheel slip. In most cases, individual wheel braking is enough to control wheel slip. However, some traction ontrol systems also reduce engine power to the slipping wheels. On a few of these vehicles, drivers may sense pulsations of the gas pedal when the system is reducing engine power much like a brake pedal pulsates when the antilock braking system is working.

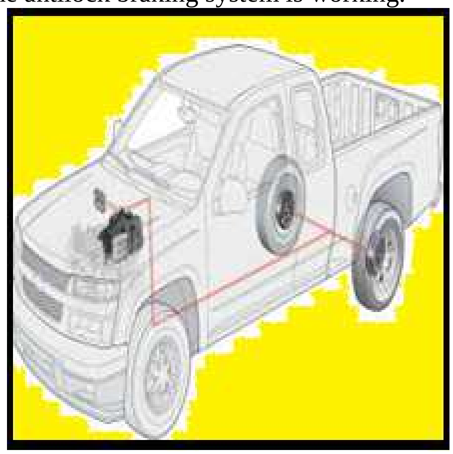

Figure: 3 Traction Control

Automotive Occupant Detection

Automotive Occupant Detection system detects loading force on the front passenger seat and classifies the seat as empty or the occupant as an adult or infant/child. The ECU processes the sensor data and provides a deployment-allowed output to the vehicle’s sensing and diagnostic module when a defined threshold is met. It helps to reduce the potential for airbag-induced injury and allows airbag suppression when seat is empty, occupant is below defined threshold and for children .Allows airbag deployment when 5th percentile female and larger adults are present.

Automotive Pre-Crash Detection

Before a crash, some near-zone radar sensors are capable of identifying the relative speed towards an object and the estimated time of impact. The regular crash sensor is then put in alert mode and activates the appropriate safety device. The safety devices may include modules for vehicle control, adaptable interior or exterior structures, restraint systems or any combinations of these. The severity of a collision can be measured by the advanced crash detection system, which is provided by sensors mounted on the front and sides of the vehicle. Crash sensing systems use radar, laser and/or ultrasonic sensors to detect potential impact situations. The sensing system is typically a single ECU to measure the severity of the impact, and provide deployment signals to the

ISSN: 2277-9655
Impact Factor: 1.852

appropriate squibs. Accident Avoidance and Detection on Highways is designed by S.P. Bhumkar, V.V. Deotare, R.V.Babar [7]. Thompson has designed Pre-crash detection system using ultrasonic, laser range finder and radar sensors [8].

Conclusion

Electronics systems are being deployed increasingly to monitor vital control and safety function in modern motor vehicle. Most innovation in cars is now being driven by developments in electronics. In fact, automotive electronics currently account for over 20% of vehicle costs and this is projected to double to 40%. To reduce the risk of causing fatal traffic accidents, many companies integrate research and hardware equipments to develop a certain mechanism for adding more safety to vehicle. Auto safety has evolved from seatbelts and airbags that cradle and cushion the body in an accident to telematics systems that provide automatic crash notification and send help right away. But while many auto safety features help during and after an accident, more carmakers are now offering safety technology that intervenes *before* a crash to help minimize occupant injury and damage to a vehicle or even avoid an accident altogether. Through the use of sensors, cameras and onboard computers, these crash prevention systems warn the driver of a potential accident, better prepare the car and occupants for a collision and, in some cases, automatically apply the brakes if the driver doesn't act in time to avoid a crash. While these systems are not a substitute for attentive and careful driving, they can make a substantial difference in the degree of injury to everyone and every vehicle involved in a car accident. They can also help you avoid a crash altogether, ushering in the next evolution in auto safety.

References

[1] Miguel Ángel SOTELO, José BARRIGA, “Blind spot detection using vision for automotive applications” ,Journal of Zhejiang University SCIENCE A ,ISSN 1673-565X (Print); ISSN 1862-1775 (Online) 2008 9(10):1369-1372.
[2] Dr. Paul E. Firmin, “Satellite navigation Technology Appliation for Intelligent Transport System:A European Perspective”,European Navigation Conference-Manchester,8th-10thMay 2006.
[3] C. H. Yao,“Global Positioning System (GPS) Technology and Cars”, (2002).
[4] Y. Meng, et al., “A Simplified Map-Matching Algorithm for In-Vehicle Navigation Unit”, Journal of Geographic Information. Sciences, Vol. 8, No. 1, pp. 24-30, (2002).
[5] James A. Misener, Raja Sengupta, “Cooperative Collision Warning:Enabling Crash Avoidance with Wireless Technology” ,12th World Congress on ITS, 6 – 10 November 2005, San Francisco
[6] J. Shi, X. Li, T. Lu, J. Zhang ,“Development of a new traction control system for vehicles with automatic transmissions” ,International Journal of Automotive Technology, Volume 13, Issue 5, pp 743-750, August 2012.
[7] S.P. Bhumkar , V.V. Deotare, R.V.Babar, “Accident Avoidance and Detection on Highways”, International Journal of Engineering Trends and Technology Volume3, Issue2- 2012.
[8] Charles Birdsong, Ph.D., Peter Schuster, Ph.D., John Carlin, Daniel Kawano, William Thompson,“Test Methods and Results for Sensors in a Pre-Crash Detection System”, California Polytechnic State University, San Luis Obispo, California, Paper Number 06AE-19.