Role of Embedded Systems in Automobile Technology

Bhavik Sharma¹
¹B.Tech Scholar
¹Department of EIC
¹Global College of Technology, Jaipur, India

Abstract — Automobiles are one of the most widely used machines and are now being used all across the globe, which in turn is leading to rapid development and enhancement of the automotive sector. Manufacturers are working hard to introduce new technologies in their vehicles, for which they are using Embedded Systems. Embedded Systems are being used in automobiles to achieve energy saving and lower emissions, safety (active and passive), comfort, convenience, entertainment and cost & weight reduction. While this has led to many breakthrough technologies being introduced in cars, it has also resulted in decreasing the complexity of the mechanical and electrical structure.

I. INTRODUCTION

An Embedded System is a combination of hardware and software which creates a dedicated computer system that performs specific, predefined tasks and which is generally encapsulated within the device it controls. Every year, automobile manufacturers worldwide pack new embedded systems into their vehicles. Tiny processors under the hood and in the deep recesses of the car gather and exchange information to control, optimize, and monitor many of the functions that just a few years ago were purely mechanical. A typical vehicle today contains an average of 25-35 microcontrollers with some luxury vehicles containing up to 70 microcontrollers per vehicle. Flash-based microcontrollers are continuing to replace relays, switches, and traditional mechanical functions with higher-reliability components while eliminating the cost and weight of copper wire. [1]

II. ANTI-LOCK BRAKING SYSTEM (ABS)

As consumers spend more time on the road nowadays, the requirement of safety equipment is increasing. There are two types of safety systems – Active and Passive. While Active safety aims at preventing accidents happening in the first place, Passive safety describes the safety systems which are built into cars to protect the driver, the occupants and other vulnerable road users after the accident has happened.

One of the most important active safety systems is the Anti-lock Braking System, often referred to as by its abbreviation-ABS. This system prevents the wheels from getting locked, even under panic braking. In cars without ABS, panic braking can lead to locking of wheels and can cause the car to skid without any control of the driver. Hence ABS has two main purposes: to allow the driver to maintain steering control and to shorten braking distances by allowing the driver to fully hit the brake without the fear of skidding or the loss of control. [2]

Wheel-speed sensors detect whether a wheel is showing a tendency to lock up. In case of a lock up tendency, the Electronic Control Unit (ECU) reduces the braking pressure individually at the wheel concerned. This helps in high speed correction of the braking pressure, shortly before the lock up threshold.

III. TRACTION CONTROL

The traction control system is required to prevent driver error from overloading any of the four wheels and causing slip, through either throttle or brake application. It is typically (but not necessarily) a secondary function of...
the Anti-lock Braking System (ABS) designed to prevent loss of traction of driven wheels with the road. When the traction control computer (often incorporated into another control unit, like the ABS module) detects one or more wheels spinning significantly faster than another, it invokes the ABS electronic control unit to apply brake friction to wheels spinning with lessened traction. Braking action on slipping wheels will cause power transfer to wheel axles with traction due to the mechanical action within a differential. [3]

Intervention consists of one or more of the following:
- Reduces or suppress spark sequence to one or more cylinders
- Reduce fuel supply to one or more cylinders
- Brake force applied at one or more wheels
- Close the throttle, if the vehicle is fitted with drive by wire throttle
- In turbo-charged vehicles, a boost control solenoid can be actuated to reduce boost and therefore engine power.

Fig 3: Importance of Traction Control

IV. AIRBAGS

Airbag is an occupant restraint system that consists of a flexible cushion or envelope designed to inflate rapidly during a collision. The goal of an airbag is to slow the passenger’s forward motion as evenly as possible in a fraction of a second. It cushions the occupants during a crash and provides protection to their bodies when they strike interior objects such as the steering wheel or a window. They are also referred to as Supplemental Restraint System (SRS).

A central Airbag Control Unit (ACU), which is basically a specific type of ECU, monitors a number of related sensors within the vehicle, including accelerometers, impact sensors, gyroscopes, brake pressure sensors and seat occupancy sensors. The bag and its inflation mechanism is concealed within the steering wheel (for the driver), or the dashboard (for the front passenger), behind plastic flaps or doors which are designed to “tear open” under the force of bag inflation. In case of a collision, once the required threshold has been reached or exceeded, the airbag control unit triggers the ignition of a gas generator to rapidly inflate a fabric bag. When the vehicle occupant collides with the bag, it squeezes it and the gas starts escaping in a controlled manner through tiny vent holes. Hence the motion of the car’s occupants is slowly decelerated.

The airbag sensor is a MEMS accelerometer, which is a small integrated circuit with integrated micro mechanical elements. The microscopic mechanical element moves in response to rapid deceleration, and this motion causes a change in capacitance, which is detected by the electronics on the chip that then sends a signal to fire the airbag. [4]

![Fig 4: Basic Airbag System](image)

V. CRUISE CONTROL

Cruise control (sometimes known as speed control or auto cruise) is a system that automatically controls the speed of a motor vehicle. The system takes over the throttle of the car to maintain a steady speed as set by the driver. Modern Cruise Control systems also allow the driver to instruct his car to follow the car in front while maintaining a specific predefined distance.

The speed control application of cruise control is the most common in today’s passenger cars. The driver has to bring the vehicle up to a specific speed manually and use a button to set the cruise control to the current speed. The cruise control takes its speed signal from a rotating driveshaft, speedometer cable, wheel speed sensor, engine’s RPM, or from electronically produced internal speed pulses. Most systems do not allow the use of the cruise control below a certain speed (normally around 40 km/h). The vehicle maintains the desired speed by pulling the throttle with a solenoid, a vacuum driven servo mechanism, or by using the electronic systems built into the vehicle (fully electronic) if it uses a ‘drive-by-wire’ system.

![Fig 5: The Cruise Control System](image)

This technology is still in its development stage and hence has a couple of shortcomings too. While cruising on an open stretch of road with the cruise control engaged, the driver has very little to do. Hence the probability of highway hypnosis, loss of concentration or sleepiness increases. This can lead to accidents as the driver is unable to react quickly.
in emergency conditions. Moreover, in wet conditions or on ice-covered roads the vehicle can go into a skid while the cruise control is engaged, though this can be avoided by the use of traction control systems as discussed above. This is chiefly the reason that most of the cars having cruise control come equipped with traction control and ABS.[5]

VI. DRIVE-BY-WIRE

Drive-by-wire technology in the automotive industry refers to the use of electrical or electro-mechanical systems for performing vehicle functions which were traditionally achieved by mechanical linkages/actuators. This technology replaces the traditional mechanical control systems with electronic control systems using electromechanical actuators and human machine interfaces such as pedal and steering feel emulators. Hence, the traditional components such as the steering column, intermediate shafts, pumps, and master cylinders are eliminated from the vehicle.

A car with this type of system would rely mainly on electronics to control a wide range of vehicle operations, including acceleration, braking and steering. By the use of Drive-By-Wire technology response times are improved through elimination of mechanical linkages. Safety can be improved by providing computer controlled intervention of vehicle controls with systems such as Electronic Stability Control (ESC), adaptive cruise control and Lane Assist Systems. Ergonomics can be improved by the amount of force and range of movement required by the driver and by greater flexibility in the location of controls. This flexibility also significantly expands the number of options for the vehicle's design. Moreover, eliminating mechanical linkages can provide savings in weight. Though the cost of these systems is still quite high as compared to its conventional counterparts.

There are several different types of Drive-By-Wire systems, some of which are briefly described below:

- **Throttle-By-Wire:** This system helps accomplish vehicle propulsion by means of an electronic throttle without any cables from the accelerator pedal to the throttle valve of the engine. It controls the electric motors by sensing the accelerator pedal input and sending commands to the power inverter modules.

- **Brake-By-Wire:** A pure brake by wire system eliminates the need for hydraulics completely by using motors to actuate calipers and lock the wheels in comparison to the currently existing technology where the system provides braking by building hydraulic pressure in the brake lines.

- **Steer-By-Wire:** Sensors detect the movements of the steering wheel and send information to a microprocessor. The computer then sends commands to actuators on the axles, which turn according to the driver's directions.

- **Shift-By-Wire:** The direction of motion of the vehicle (Forward, Reverse) is set by commanding the actuators inside the transmission through electronic commands based on the current input from the driver (Park, Reverse, Neutral or Drive). [6]

VII. CONCLUSION

The continuously expanding automobile sector needs some major breakthrough technologies in order to cope with the demands and expectations of its customers. Modern cars need to be best in all sectors (like performance, handling, ride & comfort, entertainment and safety) in order to appeal to the masses. And the only available option to achieve this is the use of embedded systems.

Embedded systems were introduced to the world of automobiles in the year 1968 when the Volkswagen 1600 used a microprocessor in its fuel injection system. In 1978, Cadillac Seville used a microprocessor chip, a modified 6802, that drove the car's "Trip Computer," a flashy dashboard bauble that displayed mileage and other real time information. As time went by, the role of embedded system increased immensely and started expanding its applications in every area of the automotive universe.

New cars now frequently carry 200 pounds of electronics and more than a mile of wiring. Processors and their peripherals have squeezed into the side- and rear-view mirrors, wheel rims, headliner, gas tank, seat cushions, headrests, bumpers, and every other crevice of a modern car. Amongst current examples, the present BMW 7 series and Mercedes S-class boast about 100 processors each. A relatively low-profile hatchback also has 50 to 60 baby processors on board.

Looking further in the future, these trends seem to continue. Google has already produced a fully automatic driver-less car which can drive without any interference from the driver. Cybercars or driverless cars need to know the state of the whole vehicle to control the vehicle in an optimal way. This can only happen when there is central software. In the far future, there might be a trend towards communication between cars and between cars and road infrastructure. This will help in manipulating stop lights in order to overcome the problem of traffic. Experiments in this area are currently conducted by Mercedes-Benz. Their engineers are working on a system called "Interactive Vehicle Communication" which allows cars to communicate with one another. The current status of their research is shown in their concept car "ESF". The exchange of data between different cars is via ‘ad hoc’ networks that are formed between vehicles over short distances. These WLAN require no extra external infrastructure. Transmission occurs at a frequency of 5.9GHz over a distance of up to 500 meters. Of course this distance is expanded if different cars are communicating with each other and messages are passed on.

Therefore, in the coming decade, embedded systems will further spread its footprints in the automotive sector to provide comfort, convenience, performance and safety to the customers.

REFERENCES