AN REVIEW ABOUT THE DEVELOPMENT OF EMBEDDED SYSTEMS IN AUTOMOBILES

V.Bala Sai Kumar[1], K.Sri Sai Kumar[2], K.Ramana[3], O.Naveen Sai[4]

[1,2,3]Department of Automobile Engineering GIET (A) RAJAHMUNDRY, (India)

[4]Diploma in Mechanical Aditya Engineering College Surampalem , (India)

ABSTRACT

There are several tasks in which real time OSs beat their desktop counterparts hands-down. A common application of embedded systems in the real world is in automobiles because these systems are cheap, efficient and problem free.Almost every car that rolls off the production line these days makes use of embedded technology in one form or the other. An embedded systemis an electronic or computer system which is designed to control, access the data in electronics based systems. This system includes a single chip microcontroller such as cortex, ARM and also microprocessors, FPGAs, DSPs, and ASICs.

I. INTRODUCTION

An review about the usage of Embedded Systems in Automobile sector. Most of the embedded systems in automobiles are rugged in nature,as most of these systems are made up of a single chip. Other factors aiding their use are the low costs involved, ease of development, and the fact that embedded devices can be networked to act as sub modules in a large system. No driver clashes or 'system busy' condition happen in these systems. Their compact profiles enable them to fit easily under the cramped hood of a car.Embedded systems can be used to implement features ranging from adjustment of the suspension to suit road conditions and the octane content in the fuel to anti lock braking systems (ABS) and security systems. Speaking of the things nearer home the 'computerchip' that control fuel injections or the one that controls the activation of airbag nothing but an embedded system . Right from brakes to automatic traction control to air bags and fuel/air mixture controls, there may be upto 30-50 embedded systems within a present-day car.And this is just a beginning.RTOSs are performed in this area due to their fast response times and minimal system requirements.

Evolution Steps of Automobile Control Systems

Evolution of automotive control systems and networks is well understood with the following 4 stages.

Stage 1

Computer control is applied to various component (engine, brake, steering, and so on), independently.

In-vehicle network is not used.

Stage 2

Each control system (ECU) exchanges useful data for improving the quality of the control system.

Each system operates almost independently, and timing constraints on networks are loose

Stage 3 (Current)

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Integrated systems/services Each system still operates autonomously, and some services are provided with multiple ECUs connected with in-vehicle networks.

Mechanical backup system still exists, thus the basic functions of a car are preserved even if an electronic system fails.

Stage 4 (Future)

Networks with outside of the car (communication with another car and the road) are intensively used.

By-wire systems

Mechanical systems (incl. backups) are replaced with ECUs and networks.

A failure of electronic systems is life-critical

General Features of Automobile Embedded Systems

Many (as many as 100) ECUs are used for the following purposes: energy saving & low emission safety (active & passive) comfortableness, convenience, entertainment cost & weight reduction ECUs are connected with several in-vehicle networks. High reliability and safety requirements Strict real-time property required

Severe environmental conditions (temperature, EMC)

Severe production cost restriction ! ECUs for different systems/services have different requirements and require different technologies

Classification of Automobile Embedded Systems

Powertrain and Chassis Control

engine, automatic transmission, hybrid control, ... steering, brake, suspension, ...

Body Electronics

instrument panel, key, door, window, lighting, …

air bag, seat belt, ...

Multimedia (Infortainment) Applications

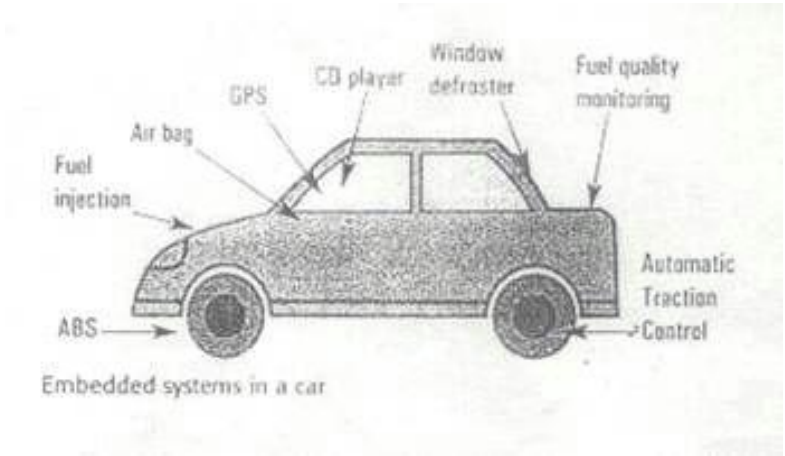
car audio, car navigation, traffic information, ...

electronic toll collection (ETC), backguide monitor, ...

Integrated Systems/Services

electronic stability control, pre-crash safety, …

parking assistance, lane keeping assistance, ...



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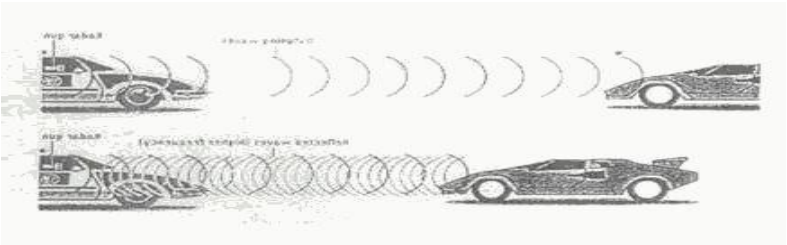


Recent Automobile Application's

1) Adaptive Cruise Control

Embedded systems can also make driverless vehicle control a reality. Major automobile manufacturers are already engaged in work on these concepts. One such technology is Adaptive Cruise Control (ACC).ACC allows cars to keep safe distances from other vehicles on busy highways. The driver can set the speed of his car and the distance between his car and others. When traffic slows down, ACC alters vehicle speed using moderate braking. This ensures that a constant distance is maintained between cars. As soon as traffic becomes less, ACC moves up to the desired cruise speed that has been set by the driver. The driver can over ride the system any time he wants to be breaking. Each car with ACC has a micro wave radar unit or laser transceiver fixed in front of it to determine the distance and relative speed of any vehicle in the path. The ACC computer (What else but an embedded system or a grouped system of embedded system) constantly controls the throttle and brakes of the car. This helps to make sure that the set cruise speed or adapted speed of traffic at that time is not exceeded.

Working Principle Of Adaptive Cruise Control

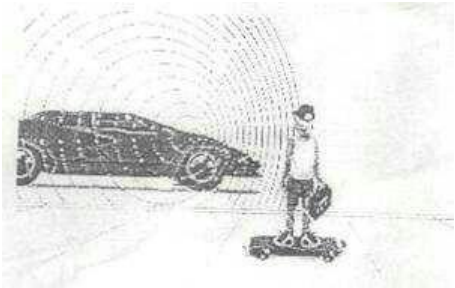
As already mentioned each car with ACC have a micro wave radar unit fixed in front of it to determine the distance and relative speed of any vehicle in it's path. The principle behind the working of this type of radar is- the Doppler Effect.

Doppler Effect

Doppler Effect is the change in frequency of the waves when there is a relative motion between the transmitting and receiving units. The two figures below clearly show the Doppler Effect.

Higher Pitch Sound

In this case the vehicle is speeding towards the stationary listener. The distance between the listener and the car is decreasing. Then the listener will hear a higher pitch sound from the car, which means the frequency of sound, is increased.



Lower pitch sound

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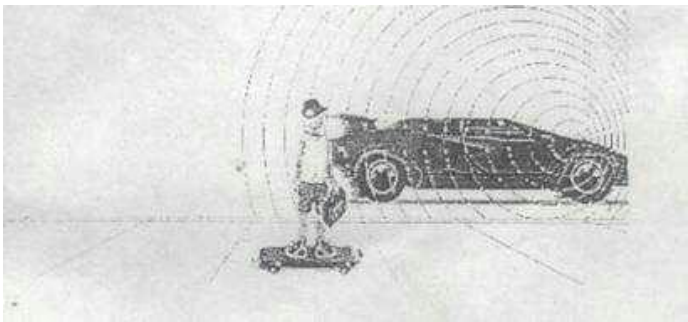
In this case the vehicle is moving away from the listener. The distance between and the car is increasing. Then the listener will hear a lower pitch sound from the car, which means the frequency of sound, is decreased. So that is the Doppler Effect in case of sound waves.Similarly the radar unit in ACC will be continuously transmitting radio waves. They will be reflected and echo singles (reflected waves) will be having the same frequency or different frequency depending on speed/position of the object due to which the echo singles originate. If the echoes singles have the same frequency it is clear that there is no relative motion between the transmitting and receiving ends. If the frequency is increased it is clear that the distance between the two is decreasing and if the frequency is decreased it means that the distance is increasing.

The figure below shows a car having ACC transmitting and receiving radio waves.



In the above case, the gun transmits the waves at a given frequency toward an oncoming car. Reflecting waves return to the gun at a different frequency,depending on how fast the car being tracked is moving. A device in the gun compares the transmission frequency to the received frequency to determine the speed of the car. Here, the high frequency or the reflected waves indicate the motorist in theleft car is speeding.The embedded system is connected to the radar unit and its output will be sent to breaking and accelerating unit as early mentioned the embedded system isa device controlled by instructionsstored in a chip. So we can design the chip or ACC having an algorithm such that it will give output only when the input signalsare less than the corresponding safe distance value. So only when the between the car and the object in front of it is less then the same distance value the embedded system will give output to the breaking and the accelerating units. Thus the safe distance will be kept always. That's how the ACC works.

2)Engine Management System Components

control computer (ECU)

many sensors

crank position sensor

air flow meter

intake temperature sensor

throttle sensor

some actuators Basic Functions of the Control System to calculate fuel injection volume and ignition timing, and to control the actuators in every rotation cycle Automotive Embedded Systems

a)Timing Behavior of Engine Management System

When rotation speed is 6000rpm, one cycle is 20msec.

Timing precision of the ignition is 10μsec. order

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b)Required Real-Time Property (Example)

The calculation of the fuel injection volume must be finished before the injection timing.

The calculation of the ignition timing must be finished before the ignition timing. ▸ Calculating too early has no additional value.

c)Safety Requirement (Example)

Missing an ignition must not happen, because inflammable gas is emitted outside of the engine and can lead to a fire (because catalyst burns).

If the ignition plug of a cylinder is broken, fuel must not be injected to the cylinder.

The engine management system monitors the ignition plug and stops the injection if the plug is broken

Specific Requirements on Example Systems Engine Management

very short response time (10 or 100μsec. order)

large software and high computing power required

high reliability

3) ABS

ABS = Anti-lock Breaking System

Functions of ABS system are :-

▸The speed of the car and the rotational speed of the wheel are monitored, and a skid is detected.

When a skid is detected, hydraulic pressure to the brake is reduced to stop the skid.

The system is relatively simple, but is becoming more complex, recently. Safety Requirement (Example) and Fail-Safe Design

Continuous reduction of hydraulic pressure causes non-braking.

If some fault is detected, ABS stops functioning. Then, the brake works though a skid cannot be avoided.

4) Airbag Control

Function of Airbag Control :-

▸ Airbag control system monitors various sensors including accelerometers and detects a collision.

Real-Time Constraint :-

If a collision is detected, the ignition of a gas generator propellant is triggered to inflate a bag.

The trigger must be within 10-20msec. after the collision.

Safety Requirements :-

Fail-safe design cannot be applied. ! even harder than ABS

Specific requirements

a kind of signal processing application

short response time (10msec. order)

very high reliability

5) Car Navigation System

The current position of the car obtained from GPS, gyroscope, and others is displayed with the map

Route navigation service

Traffic information is also displayed

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Specific requirements

largest and most complicated software in a car

large computing power required

moderate reliability, real-time property still required

Conclusion

In this paper, we have said about Adaptive Cruise Control, Engine Management System Components, ABS, Airbag Control, Car Navigation systems. But inspite of these applications, it can also be used in Automatic Rain Sensing Technology, embedded based Automatic Parking System, Satellite Radio, Drive by Drive Systems and so on. By introducing this type of technology, an greater revolution had taken in Automobile sector and in no time we have an eco free vehicles which are controlled completely by an Embedded system .