Automotive Embedded Systems

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Introduction

- The Automotive industry is one of the major application domains of embedded systems.
- The presence of automotive embedded system in a vehicle varies from simple mirror and wiper controls to complex air bag controller and antilock brake systems (ABS).
- Automotive embedded systems are normally built around microcontrollers or DSPs or a hybrid of the two and are generally known as Electronic Control Units (ECUs).
- The number of embedded controllers in a normal vehicle varies somewhere between 20 to 40 and can easily be between 75 to 100 for more sophisticated vehicles.

Some of the other uses of embedded controllers in a vehicle are listed below and a few are depicted in Figure 1:

a. Air Conditioner
b. Engine Control
c. Fan Control
d. Headlamp Control
e. Automatic break system control
f. Wiper control
g. Air bag control
h. Power Windows

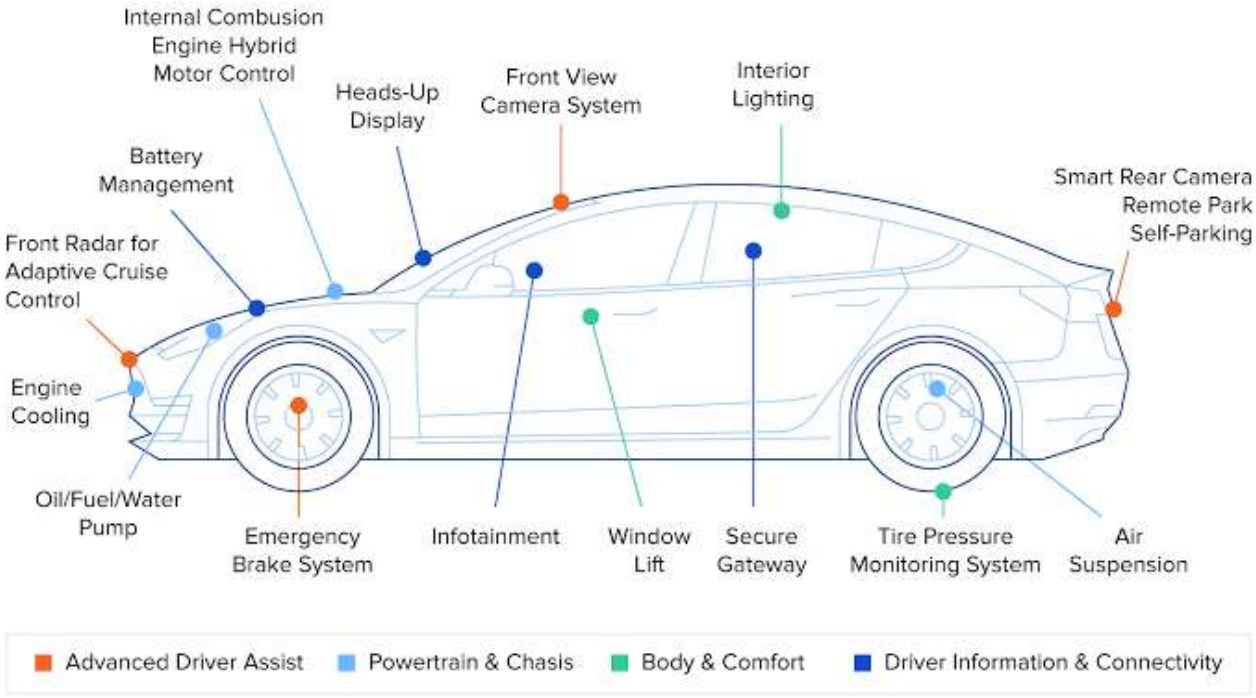

Figure 1: Automotive Embedded Systems

Electronic control units (ECUs)

The various types of electronic control units (ECUs) used in the automotive embedded industry can be broadly classified into two-High-speed embedded control units and Low-speed embedded control units. A few controls under each category are listed here and a few more in Figure 2.

1) **High-speed Electronic Control Units (HECUs)**:
   - High-speed electronic control units (HECUs) are deployed in critical control units requiring fast response.
   - They include :
     - fuel injection systems
     - antilock brake systems
     - engine control
     - electronic throttle
     - steering controls
     - transmission control unit
     - central control unit.

2) **Low-speed Electronic Control Units (LECUs)**:
   - Low-Speed Electronic Control Units (LECUs) are deployed in applications where response time is not so critical.
   - They generally are built around low cost microprocessors/microcontrollers and digital signal processors.

- They include:
  - Audio controllers
  - passenger and driver door locks
  - door glass controls (power windows)
  - wiper control
  - mirror control
  - seat control systems
  - head lamp and tail lamp controls
  - sun roof control unit etc

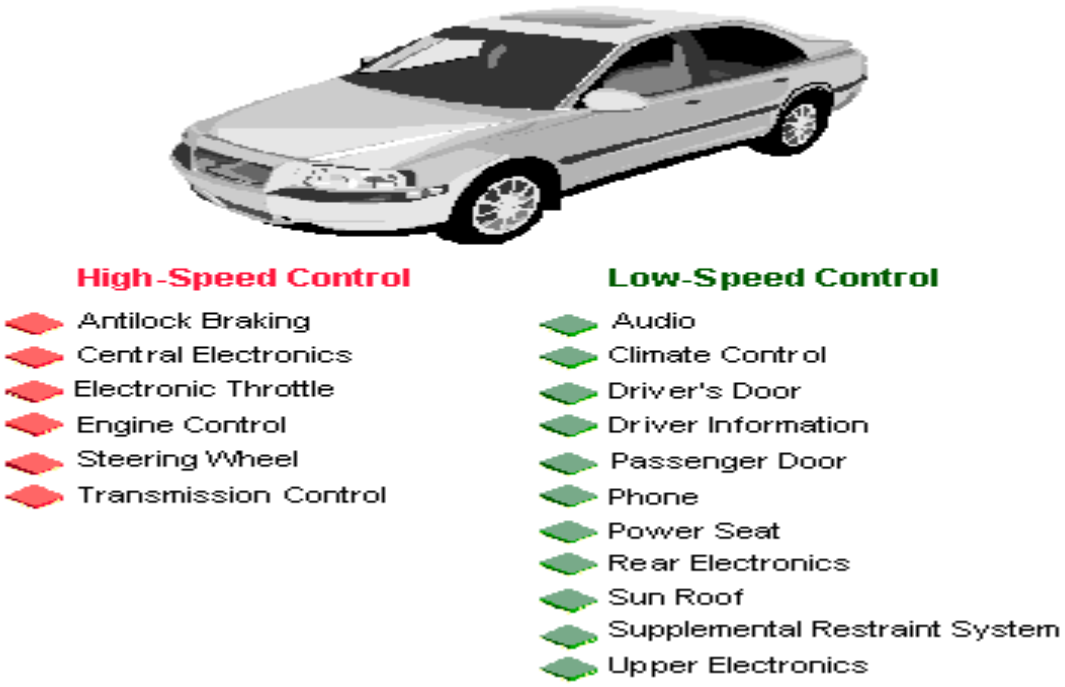

Figure 2: High Speed and Low Speed Controls

Automotive Communication Buses

Automotive applications make use of serial buses for communication, which greatly reduces the amount of wiring required inside a vehicle.

The different types of serial interface buses deployed in automotive embedded applications are:

1) **Controller Area Network (CAN)**:
   - The CAN bus was originally proposed by Robert Bosch,pioneer in the Automotive embedded solution providers.
   - It supports medium speed and high speed data transfer.
   - CAN is an event-driven protocol interface with, support for error handling in data transmission.

- It is generally employed in safety system like airbag control; power train systems like engine control and Antilock Brake System (ABS); and navigation systems like GPS.

2) Local Interconnect Network (LIN):

- LIN bus is a single master multiple slave communication interface.
- LIN is a low speed, single wire communication interface with support for data rates up to 20 Kbps and is used for sensor/actuator interfacing.
- LIN bus follows the master communication triggering technique to eliminate the possible bus arbitration problem that can occur by the simultaneous talking of different slave nodes connected to a single interface bus.
- LIN bus is employed in applications like mirror controls, fan controls, seat positioning controls, window controls, and position controls where response time is not a critical issue.

3) Media-Oriented System Transport (MOST) Bus:

- The Media-oriented system transport (MOST) is targeted for automotive audio/video equipment interfacing
- A MOST bus is a multimedia fibre-optic point-to-point network implemented in a star, ring or daisy chained topology over optical fibre cables.
- The MOST bus-specifications define the physical (electrical and optical parameters) layer as well as the application layer, network layer, and media access control.

Each of these embedded systems has their own controllers. Given below is an example of an automatic windshield wiper which operates automatically when it senses rain (Figure 3). You can explain any other embedded system as an example as well.

Automatic Windshield Wiper

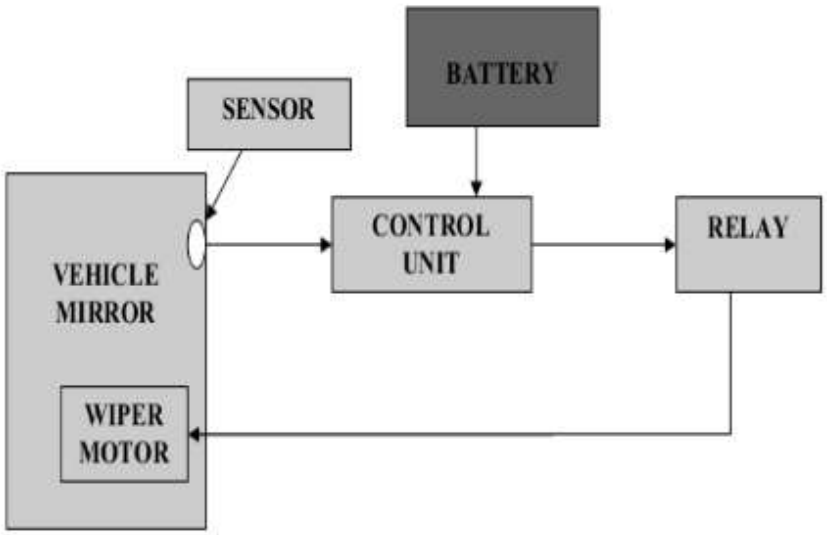

Figure 3: Block diagram of automatic windshield wiper

The battery supplies the power to the sensor as well as rain operated motor. Wiper motor is automatically ON during the time of rainfall. The sensor is fixed in the vehicle glass. The touch or conductive sensor is used here. It senses the rainfall and gives a control signal to the control unit. The control unit activates the wiper motor automatically.

References:

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