Advanced Driver Assistance Systems (ADAS) in Modern Vehicles

Seminar- III

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Introduction to ADAS

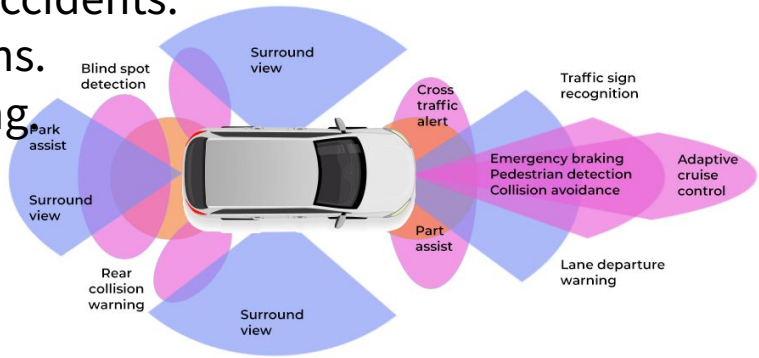
- Advanced Driver Assistance Systems (ADAS) are electronic systems that assist the driver in driving and parking functions.

- These systems use sensor data, real-time processing, and control mechanisms to enhance driver safety and vehicle control..

- Rising vehicle population has led to an increase in road accidents and driver fatigue

- ADAS aims to:

1. Reduce human error, which accounts for ~90% of accidents.
2. Provide real-time alerts or automatic control actions.
3. Enable safer, smarter, and more comfortable driving.



Classification of ADAS

Based on Functionality

Passive ADAS	Active ADAS
Warns the driver but doesn't take control.	Takes action along with or instead of the driver.
Monitor the environment and alert the driver.	Capable of taking control actions to avoid impact
Lane Departure Warning (LDW)	Autonomous Emergency Braking (AEB)
Blind Spot Detection (BSD)	Adaptive Cruise Control (ACC)
Forward Collision Warning (FCW)	Lane Keeping Assist (LKA)

Based on Level of Automation

Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
No Automation	Driver Assistance	Partial Automation	Conditional Automation	High Automation	Full Automation

Key Technologies Behind ADAS

1. **Sensor Technologies** :

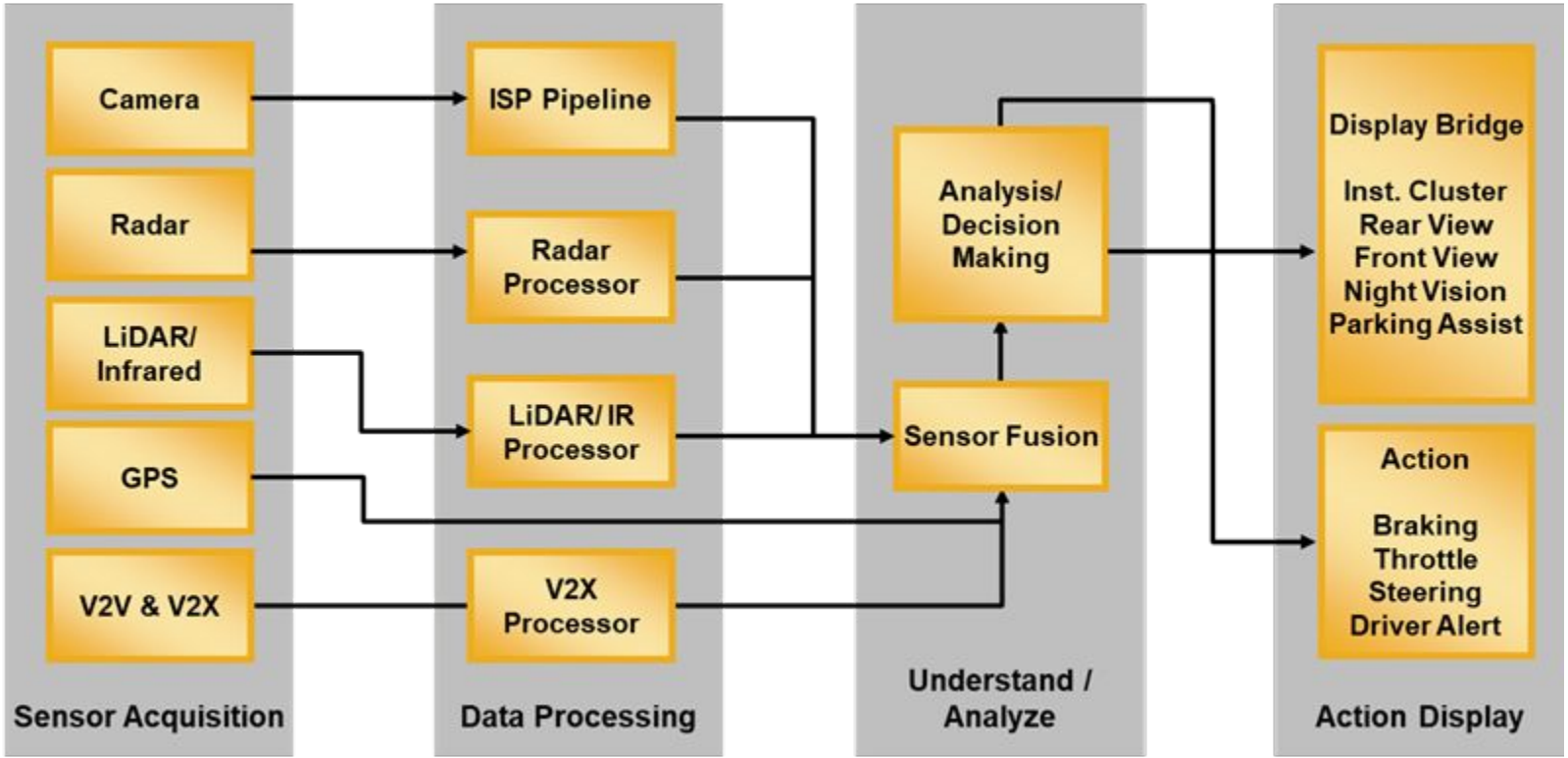
- Camera Systems
- Radar (Radio Detection and Ranging)
- LiDAR (Light Detection and Ranging)
- Ultrasonic Sensors
- GPS and IMU

2. **Electronic Control Units (ECUs)**: High-performance microcontrollers or SoCs process sensor data.

3. **Communication Protocols**: CAN, FlexRay,Automotive Ethernet, V2X (Vehicle-to-Everything)

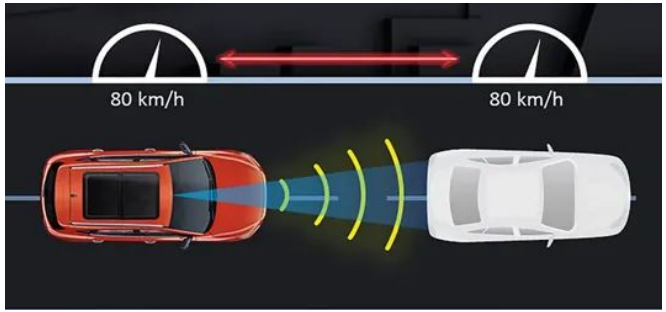
4. **AI & Algorithms**: AI/ML models process sensor data for pattern recognition and decision making

ADAS Architecture

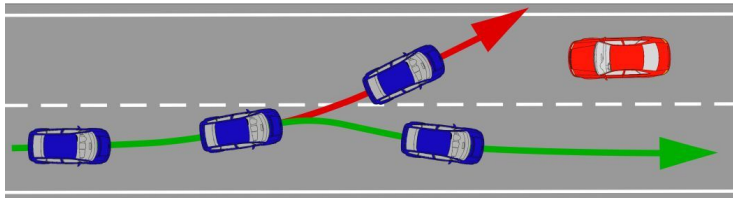


Important ADAS Feature

1. **Adaptive Cruise Control (ACC)**
   Maintains a safe distance from the vehicle ahead by automatically adjusting the car's speed.
   - Uses radar and camera sensors
   - Ideal for highway driving



2. **Lane Departure Warning (LDW) & Lane Keeping Assist (LKA)**
   Alerts the driver or corrects the vehicle if it unintentionally drifts out of its lane.
   - LDW: Gives audio/visual warning
   - LKA: Actively steers the vehicle back into lane



Important ADAS Feature

3. Automatic Emergency Braking (AEB)

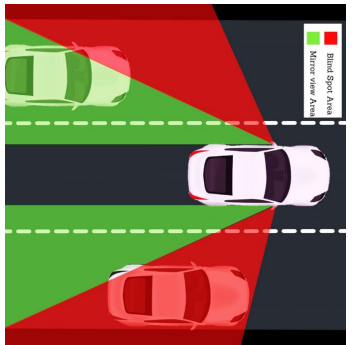
Detects collision with another vehicle, pedestrian, or object and automatically applies brakes to prevent or mitigate impact.

- Works at low and high speeds
- Critical for urban safety

4. Blind Spot Detection (BSD)

Monitors areas not visible to the driver and alerts if another vehicle is present in the blind spot.

- Typically uses side-mounted radar sensors
- Helps in lane changing and merging



Important ADAS Feature

5. Traffic Sign Recognition (TSR)

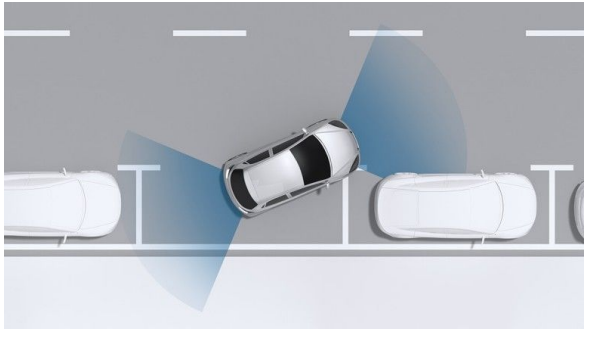
Reads traffic signs using cameras and displays them on the dashboard or HUD.

- Detects speed limits, no-entry signs, etc.
- Enhances driver awareness

6. Parking Assistance

Helps in parallel or perpendicular parking using sensors or even automating the parking process.

- Includes rear-view cameras, ultrasonic sensors and auto-park features
- Reduces parking stress



Challenges in ADAS

1. **Sensor Fusion Complexity**
   Integrating data from cameras, radar, LiDAR, and ultrasonic sensors

2. **Environmental Limitation**
   Performance affected by weather (fog, rain, snow)

3. **Real-Time Processing**
   Need for ultra-fast decision-making to ensure safety.

4. **Cost and Power Constraints**
   High-end sensors and ECUs are expensive.

5. **Cybersecurity Threats**
   ADAS is vulnerable to hacking and spoofing.

Application of ADAS

1. **Continental AG**
   Continental has adjustable cruise control, collision protection, and blind-spot detection.

2. **Delphi Technologies (Aptiv)**
   Delphi has LiDAR technology has a high-resolution 3D mapping of the vehicle's environment.

3. **Robert Bosch GmbH**
   Bosch has expertise in sensor fusion technology. This technology gathers data from multiple sensors

4. **Mobileye**
   The company uses high-resolution camera systems to gather detailed visual data for accurate environment perception