	Marwadi University
Marwadi University NAAC A+ (logo)	**Faculty of Technology**
	Department of Information and Communication Technology
Subject: Microcontroller and Interfacing (01CT0403)	**Aim:** ADAS (Advanced Driving Assistance System)
Case Study :- 01	**Date:-** 09-03-2024 **Enrollment No:-** 92200133030

Objective: Case Study: Advanced Driver Assistance System (ADAS)

Introduction:- Almost all vehicle accidents are caused by human error, which can be avoided with Advanced Driver Assistance Systems (ADAS). The role of ADAS is to prevent deaths and injuries by reducing the number of car accidents and the serious impact of those that cannot be avoided. An advanced driver-assistance system (ADAS) includes technologies that assist drivers with the safe operation of a vehicle. Through a human-machine interface, ADAS increases car and road safety. ADAS uses automated technology, such as sensors and cameras, to detect nearby obstacles or driver errors, and respond accordingly. ADAS can enable various levels of ADAS. According to a 2021 research report from Canalys, approximately 33 percent of new vehicles sold in the United States, Europe, Japan, and China had ADAS features. The firm also predicted that fifty percent of all automobiles on the road by the year 2030 would be ADAS-enabled.

Levels of ADAS:-

ADAS (Advanced Driver Assistance Systems) typically consist of various levels of automation, often categorized under the SAE International (formerly known as the Society of Automotive Engineers) standard J3016. These levels describe the degree of automation and the level of human involvement in driving tasks. Here are the commonly recognized levels:

1) Level 0: No Automation. The driver is responsible for all aspects of driving, with no automated assistance.

2) Level 1: Driver Assistance ,Automation is limited to specific tasks, such as steering or acceleration/deceleration, but not both simultaneously.Examples include systems like adaptive cruise control or lane-keeping assistance.

3) Level 2: Partial Automation ,Automation involves both steering and acceleration/deceleration simultaneously under certain conditions.The driver must remain engaged and supervise the driving environment at all times.Systems like Tesla's Autopilot and GM's Super Cruise fall into this category.

4) Level 3: Conditional Automation ,The vehicle can manage most aspects of driving under certain conditions or environments.The driver must still be ready to take control when prompted by the system.However, the vehicle can handle some driving tasks independently.No production vehicles have reached this level as of my last update in January 2022 due to regulatory and technical challenges.

5) Level 4: High Automation ,The vehicle can perform all driving functions under specific conditions or within certain environments.Human intervention might be required in exceptional circumstances or when the system requests it.Outside of these conditions, the vehicle can manage the driving tasks independently.

6) Level 5: Full Automation,The vehicle is fully autonomous and capable of performing all driving functions under all conditions without any human intervention.There's no need for a human driver; occupants are passengers.As of my last update, no vehicles have reached this level for widespread consumer use, and it poses significant regulatory and technological challenges.

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Applications of ADAS :-

- **Adaptive Cruise Control :-** Advanced cruise control can automatically accelerate, slow down, and at times stop the vehicle, depending on the action's other objects in the immediate area.
- **Glare-Free High Beam and Pixel Light :-** Glare-free high beam and pixel light uses sensors to adjust to darkness and the vehicle's surroundings without disturbing oncoming traffic.
- **Adaptive Light Control :-** Adaptive light control adapts the vehicle's headlights to external lighting conditions.
- **Automatic Parking :-** Automatic parking helps inform drivers of unseen areas so they know when to turn the steering wheel and stop.
- **Autonomous Valet Parking :-** Autonomous valet parking is a new technology that works via vehicle sensor meshing, 5G network communication, and cloud services that manage autonomous vehicles in parking areas.
- **Navigation System :-** Car navigation systems provide on-screen instructions and voice prompts to help drivers follow a route while concentrating on the road.
- **Night Vision :-** Night vision systems enable drivers to see things that would otherwise be difficult or impossible to see at night.
- **Unseen Area Monitoring :-** Unseen area detection systems use sensors to provide drivers with important information that is otherwise difficult or impossible to obtain.
- **Automatic Emergency Braking :-** Automatic emergency braking uses sensors to detect whether the driver is in the process of hitting another vehicle or other objects on the road.
- **Crosswind Stabilization :-** The sensors in this system can detect strong pressure acting on the vehicle while driving and apply brakes to the wheels affected by crosswind disturbance.
- **Driver Drowsiness Detection :-** Driver drowsiness detection warns drivers of sleepiness or other road distractions.
- **Driver Monitoring System :-** The driver monitoring system is another way of measuring the driver's attention.
- **5G and V2X :-** This hot new 5G ADAS feature provides communication between the vehicle and other vehicles or pedestrians with increased reliability and lower latency.

Future Scope :-

The increasing amount of automotive electronic hardware and software requires significant changes in today's automobile design process to address the convergence of conflicting goals:

- Increased reliability
- Reduced costs
- Shorter development cycles

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The trend is shifting from distributed ADAS electronic controller units (ECUs) to a more integrated ADAS domain controller with centralized ECUs. This means that we are currently at what SAE International designates as Level 2 (Partial Driving Automation), where the vehicle can control both steering and accelerating/decelerating but falls short of self-driving because a human sits in the driver's seat and can take control of the car at any time.

Sensors in ADAS:-

Advanced Driver Assistance Systems (ADAS) rely on various sensors to enhance vehicle safety and provide assistance to drivers. Some common sensors used in ADAS include:

1) **Cameras:** Cameras are widely used in ADAS for various purposes such as lane departure warning, traffic sign recognition, pedestrian detection, and surround view systems. They capture visual information and can provide crucial data for decision-making algorithms.

2) **Radar:** Radar sensors use radio waves to detect objects around the vehicle. They are effective in measuring the distance and relative speed of vehicles, pedestrians, and other obstacles. Radar sensors are commonly used for adaptive cruise control, collision avoidance, and blind spot detection.

3) **Lidar (Light Detection and Ranging):** Lidar sensors emit laser pulses and measure the time it takes for the pulses to reflect off objects, creating a detailed 3D map of the vehicle's surroundings. Lidar is highly accurate and is used in applications such as autonomous emergency braking, pedestrian detection, and mapping for autonomous driving.

4) **Ultrasonic Sensors:** Ultrasonic sensors emit high-frequency sound waves and measure the time it takes for the waves to reflect off objects. They are often used for parking assistance systems to detect nearby objects and provide audible or visual warnings to the driver.

5) **Infrared Sensors:** Infrared sensors detect heat emitted by objects and are used in applications such as night vision systems and pedestrian detection. They can help improve visibility in low-light conditions and enhance the detection of pedestrians and other objects.

6) **GPS (Global Positioning System):** GPS is used in ADAS primarily for navigation purposes, providing real-time positioning and mapping data. GPS data can be integrated with other sensor data to enhance the accuracy of ADAS functions such as lane-keeping assistance and adaptive cruise control.

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Conclusion :-

In conclusion, Advanced Driver Assistance Systems (ADAS) represent a critical evolution in automotive safety, aiming to reduce accidents caused by human error. With various levels of automation, from basic driver assistance to potential full autonomy, ADAS technologies continue to advance rapidly. Leveraging a range of sensors including cameras, radar, lidar, and GPS, these systems enable functionalities such as adaptive cruise control, automatic emergency braking, and driver monitoring. As the automotive industry progresses towards higher levels of automation, challenges around regulatory compliance, technological integration, and safety standards remain paramount. Embracing these advancements, while addressing associated challenges, holds the key to realizing a safer, more efficient driving experience for the future.