Science Module: Advanced Driver Assistance Systems (ADAS)

Describes individual advanced driver assistance systems (ADAS) currently available and under development that form the foundation for autonomous vehicle technology.

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WHAT IT DOES

Autonomous driving systems ultimately perceive the environment, process observations, and plan a response in order to perform automated functions for the human passenger. These automation functions allow the driving system to perform a wide range of tasks involving steering, braking, accelerating, and monitoring the environment. While automation functions that currently exist on the market only allow for the driving system to assist the driver with such tasks, automation functions of higher level autonomous driving systems will allow the system to perform such tasks without driver input.

Advanced driver assistance systems (ADAS) are systems that automate specific driving tasks and operations such as acceleration, steering, and braking for better safety and performance or otherwise aid the driver to promote safer and more efficient driving. ADAS vary in the level of automation they allow; some lower-level systems offer alerts and suggestions to the passenger to aid in passenger operation of the system, while others disable passenger control to operate the system entirely in automated mode.

RELEVANT SCIENCE

Components of an ADAS could include:

- Adaptive cruise control (ACC) allows the vehicle to adapt to the speed of the traffic environment by automatically accelerating or decelerating depending on the speed of surrounding vehicles. ACC uses RADAR and/or LIDAR to continuously map distances between the vehicle and surrounding vehicles. More advanced systems can adjust speed based on predictions of other vehicles' behavior such as lane changes or braking.
  - Hill descent control (HDC) allows the vehicle to descend a decline at a safe speed by applying brakes without any brake input from the driver. HDC uses sensors to detect inclines and ACC to decelerate and brake.
  - Hill start control (HSC) allows the vehicle to climb an incline without slippage. HSC uses sensors to detect inclines and ACC to accelerate.
  - Set speed is the cruise control travel that the vehicle will not exceed when in ACC mode. This set speed may be determined by the driver or use speed limit database information from GPS positioning and crowdsourcing.
  - Traffic jam assist is a feature of ACC that takes over in slow driving environments and is designed to navigate the vehicle through traffic jams with constant stop-and-go movements.
- Automatic emergency braking (AEB) allows the vehicle to avoid an impending forward crash by applying the brakes. AEB uses cameras, RADAR, and/or LIDAR sensors to monitor the speeds of surrounding vehicles and detect decelerations or lane switches in time to avoid or mitigate the crash.
  - Automatic emergency reverse breaking (AERB) allows the vehicle to avoid an impeding reverse crash by applying the brakes. AERB also relies on cameras, RADAR, and/or LIDAR sensors.
  - Back-up warning, also referred to as rear cross traffic warning, alerts the driver of objects behind the vehicle when the vehicle is in reverse. The system relies on rear sensors for object detection.

  - Blind spot warning alerts the driver when it senses another vehicle entering their blind spot and when the driver turns on the turn signal while a car is in the adjacent lane.
  - Crosswind stabilization allows the vehicle to compensate for crosswinds by braking. The system detects side gusts of wind through sensors that monitor rotational movement of the wheels and counteracts its force by applying brakes on the wheels of the side experiencing the wind.
  - Crash imminent braking occurs when the driver does not brake to avoid a crash and replaces braking by the driver.
  - Curve speed warning alerts the driver when the vehicle does not slow down when approaching a curve in the road to help keep the vehicle from taking a turn too quickly.
  - Dynamic brake support applies brakes when the driver brakes but does not brake hard enough to avoid the incoming collision and supplements braking by the driver.
  - High speed warning alerts the driver when the vehicle is traveling at a speed above the speed limit. The system uses GPS data of the car's position and a database of speed limit information or uses a camera to read speed limit signs to determine when the vehicle has surpassed the speed limit.
  - Lane departure warning alerts the driver when it senses the tire of the vehicle touching a lane marker (if the turn signal is not on) to help keep the vehicle from drifting out of its lane.
  - Pedestrian Automatic Emergency Braking (PAEB) allows the vehicle to apply the brakes when pedestrians are in danger of being hit by the vehicle. PAEB relies more heavily on camera sensors than RADAR and/or LIDAR sensors for accurate image detection of humans.
- Park assist (PA) allows the vehicle to move from a traffic lane to a parking spot without driver input. This system maneuvers into the parking spot by using sensors to monitor the surrounding environment and coordinating control of steering, acceleration, deceleration, and braking functions.
  - Automatic parallel parking is a specialized feature that allows the vehicle to move form a traffic lane into a parallel parking spot.
- Electronic stability control (ESC) improves vehicular stability when the driver attempts an extreme steering maneuver by maintaining traction between the tires and the road. This feature applies counter steering and automatic braking of individual wheels to keep the car headed in the intended direction when the driver misperceives the need for steering or steers inappropriately for the situation at hand.
- Signal and object detection allows the vehicle to detect objects or signs relevant to the vehicle decisions such as traffic signals, traffic signs, road obstacles, and relevant objects that are not other vehicles. These detection systems rely on sensors and database information from GPS location and crowdsourcing. Common objects that the system will need to be able to detect include pedestrians, bicyclists, traffic signs, and a range of obstacles.
- Lane keeping assist (LKA) allows the vehicle to maintain its position in the lane by adjusting the direction of the vehicle according to lane markings and steering the vehicle back into the lane markings when it drifts. This feature uses cameras to detect lane markings.
  - Turn assist stops the vehicle when steering left to turn at an intersection upon detecting an incoming vehicle, pedestrian, or obstacle.

BACKGROUND

Further reading.

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