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ADAS – Autonomous Vehicles
&
Accident Reconstruction

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Date: 1/05/2023

ADAS – Autonomous Vehicles

Advanced Driver Assistance Systems (ADAS) were first being used in the 1950's with the adoption of the anti-lock braking system. Early ADAS include electronic stability control, blind-spot information, and traction control.

As technology evolved, an increasing number of systems to improve driver, passenger, pedestrian, and vehicle safety have been introduced into vehicles.

ADAS Systems include:

Collision Avoidance	Blind Spot Detection
Pedestrian Detection	Driver Drowsiness
Lane Departure Warning	Adaptive Headlights
Night Vision	Adaptive Cruise Control
Lane Keeping Assist	Rear Cross Traffic Alert
Traffic sign recognition	Parking Assistance
Anti-lock Braking	Electronic Stability Control
Traction Control	Alcohol Ignition Interlock
Tire Pressure Monitoring	Hill Descent Control
Rain Sensors	GPS
GNSS	Heads Up Display

ADAS uses a combination of sensor technologies to perceive the world around the vehicle, and then either provide information to the driver or take action when necessary.

Automotive ADAS sensors include:

Cameras	Radar
Lidar	Sonar
Infrared/Thermal	Ultrasound
360° Cameras	

The following graphics illustrate the typical ADAS system operations in a vehicle.

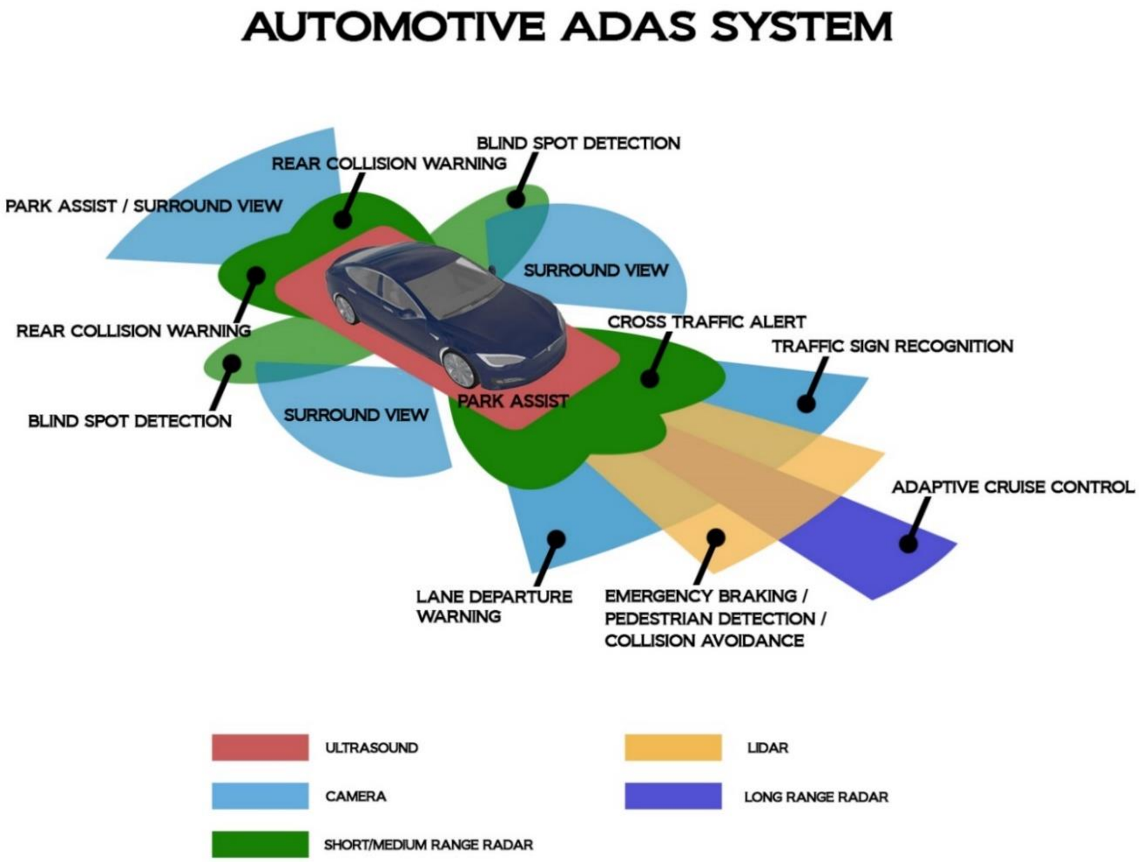
AUTOMOTIVE ADAS SYSTEM
BLIND SPOT DETECTION
REAR COLLISION WARNING
PARK ASSIST / SURROUND VIEW
SURROUND VIEW
REAR COLLISION WARNING
CROSS TRAFFIC ALERT
TRAFFIC SIGN RECOGNITION
BLIND SPOT DETECTION
SURROUND VIEW
PARK ASSIST
ADAPTIVE CRUISE CONTROL
LANE DEPARTURE WARNING
EMERGENCY BRAKING / PEDESTRIAN DETECTION / COLLISION AVOIDANCE
ULTRASOUND
LIDAR
CAMERA
LONG RANGE RADAR
SHORT/MEDIUM RANGE RADAR

Figure 1

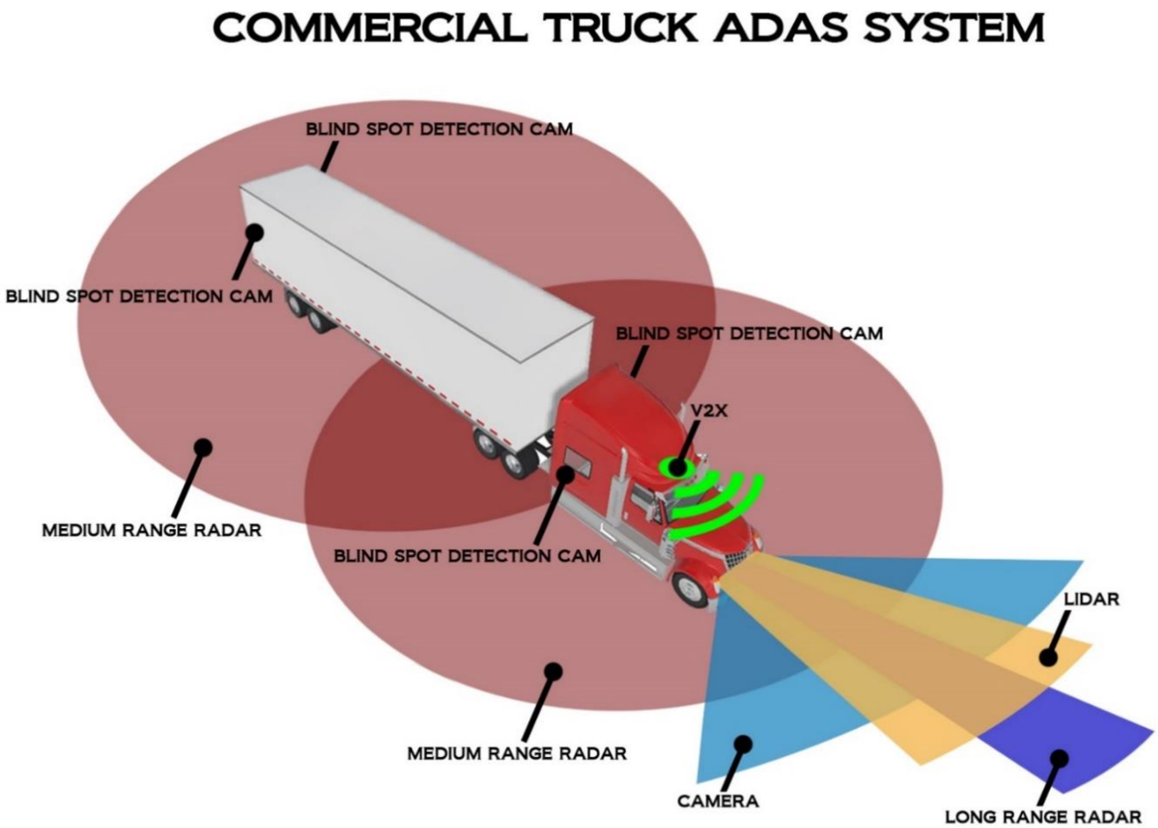

Figure 2

ADAS technologies are evolving and being refined covering an increasingly broad range of passive and active systems. As varying levels of driver assistance technologies enter the market from an equally varied mix of manufacturers, the job of understanding how a vehicle's ADAS functions is becoming more complex. ADAS extends from driver/passenger comfort and convenience features to accident prevention and injury mitigation.

Autonomous vehicle – self driving seems simple and self-explanatory, but what is not clear is that there are distinct degrees of autonomy. The SAE standard 3016 defines a vehicle level of autonomy from 0 to 5 based on the number of advanced driver-assistance systems utilized. Levels 0 to 2 require a human driver to be present and able to take control of the vehicle. Levels 3 to 5 means the vehicle monitors the driving environment and intervenes in dynamic situations should a human driver, if present, fail to react to system alerts.

Level 0 – No Automation

Just as the number suggests, vehicles that fall under Level 0 have zero autonomous features. A human driver must perform all the dynamic driving tasks. These vehicles may come with assists and safety warnings, like fixed-speed cruise control and blind-spot monitoring, but the acceleration, deceleration, and steering are under a driver's control. Typically, any 2000-model year vehicle and older is Level 0.

Level 1 – Driver Assistance

A Level 1 vehicle has at least one driver-assist feature that can manipulate speed and steering inputs; but all other driving tasks such as lane changing and turning remain the responsibility of the driver. Technology like adaptive cruise control, which maintains a set speed but also decelerates and even comes to a stop, is convenient in bumper-to-bumper traffic. But the driver must still control entering and exiting a highway.

Level 2 – Partial Autonomous Driving

Qualifying vehicles are equipped with at least two semi-autonomous features that work together in fixed scenarios. For instance, a combination of adaptive cruise control and lane keeping assist can minimize driver fatigue on long drives. However, these systems will deactivate if a driver's hand is not detected on the steering wheel after a certain amount of time has elapsed.

Level 3 – Conditional Automation

Where the previous levels mean a vehicle's driver assistance features can handle certain operations, a driver dynamics and observation of surroundings are handled by automated driving systems. But the technology is only autonomous under certain conditions, such as mapped roads and divided highways with physical barriers. A driver also must remain alert behind the wheel as a backup.

Level 4 – High Automation

Only at Level 4 is a human driver or presence unnecessary. The autonomous driving system will handle all aspects of driving and is capable of completing trips without human intervention. However, a Level 4 vehicle will still operate under restrictions including speed limits and areas defined by geofencing. These vehicles are confined within a software-enabled, location-based area.

Level 5 – Full Autonomous Driving

This would be peak autonomy – just like in the movies. Having no driver means no steering wheel, no pedals, and no shifter. Essentially, everyone in the vehicle is a passenger. At Level 5, there would be no limitations either, geographical or otherwise. However, this level of autonomy requires a massive amount of advanced software and sensors. It also needs an infrastructure that can support vehicle-to-everything (V2X) communications.

Fiction is the closest reality of fully autonomous vehicles. From federal laws to municipal groundwork, many factors remain at play and questions unanswered regarding our roadways evolving into a utopian world of truly driverless vehicles.

The following graphic illustrates the vehicle levels of autonomy.

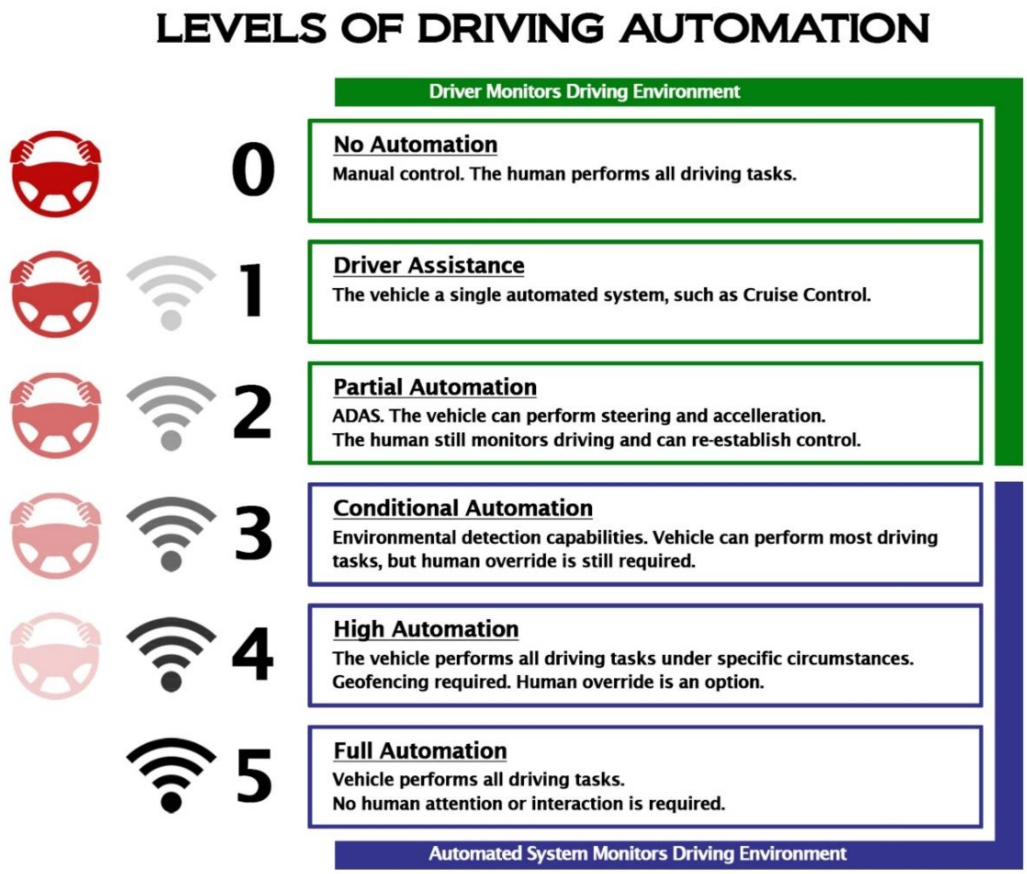

Figure 3

Regulations – Standards

Companies and regulators are navigating a patchwork of state and federal laws that could be a stumbling block to a worldwide implementation of autonomous vehicles.

There are inconsistencies in the regulations that exist.

Federal rules lack the granularity on many aspects of truck equipment that will be affected by higher levels of automation.

The slow development of performance standards and lack of regulatory action have delayed the development of collision avoidance technology.

The timeframe on which to have ADAS systems implemented on commercial vehicles and heavy trucks differs from that of the employment of this type of technology on passenger vehicles.

Collision avoidance technologies are not required on new commercial vehicles.

Autonomous vehicle manufacturers have taken a state-by-state approach.

ADAS System Verification

ADAS technologies involve complex systems in which sensor data must be synchronously captured, stored, modified, and executed. It produces a data management challenge involving data transmission and compression involving high performance computing systems and software.

Vehicle manufacturers are vigorously competing to produce ADAS systems. The system features and behavior in evaluating hazards and response needs to be clearly understood. The capabilities and limitations should be documented and available to the ultimate user.

A test and verification process needs to be implemented at the early stages of design to make sure the systems are failsafe and are made to comply with safety and design criteria. The testing and verification process is critical for safe, hazard free operations. The system level failure mode and effects analysis (FMEA), hazard analysis, and system requirements assessments have to be tested and evaluated. Design requirements must not only account for routine events of vehicle operations but also for events that the vehicle may possibly encounter. Validation of system design should be done with simulation testing to ensure that a system is free from any unreasonable risks due to unknown hazards. These types of simulations help to explore a wide range of possible event scenarios.

The driving public demands that these system features be both safe and reliable. Implementation of safety standards such as ISO-26262 Road vehicles - Functional safety is a good approach, but with the rapid change and development of new features, a more comprehensive program is needed. System level integrated functional safety design and system level testing and validation is going to be required.

ADAS safety concerns are:

Design Flaws	Software Glitches	System Integration
Technologies	Maintenance/Calibration	System Validation
System Hacking	Operator Training	

ADAS Calibration – Repair

ADAS relies on inputs from a variety of sensors that allow the system to see what is happening around the vehicle. The majority of sensors are precisely aimed and require recalibration if their positions are disturbed in any way.

Failure to properly calibrate a sensor can result in faulty information that will cause the ADAS to operate improperly or not at all.

Experts recommend recalibrating the sensors and cameras after minor collisions, even if the ADAS equipment does not need to be replaced. Information about how to repair these vehicles is not always available, creating uncertainty for insurers and repairs shops. The use of OEM parts versus alternative parts can affect the quality of the ADAS system.

With more sensors comes better resolution, improved vehicle capability of sensing and reacting to situational changes. However, this would almost certainly result in higher repair costs if a collision occurs.

ADAS Training

A vehicle driver must remain active and engaged at all times. The proper function of ADAS technologies can be confusing. A driver must be aware of the system's operation and limitations.

As ADAS systems become more complex, driver training may need to be increased and enhanced to include more skills tests to accommodate the use of ADAS.

ADAS Limitations

It is important to know and understand the ADAS limitations of your vehicle, which can be confusing.

The operator's manual identifies ADAS system limitations. The following excerpts from Audi, Lexus, Ford, and Hyundai illustrates these types of limitations.

- As the driver, you are always completely responsible for all driving tasks. The assist systems cannot replace the driver's attention. Give your full attention to driving the vehicle and be ready to intervene in traffic situations at all times.
- Warning messages or indicator lights may not be displayed or initiated on time or correctly.
- Corrective intervention by the assist systems, such as steering or braking intervention may not be sufficient, or they may not occur. Always be ready to intervene.
- The system may not function correctly in unclear traffic situations.
- Do not overly rely on this system. Failure to do so may lead to an accident, resulting in death or serious injury.
- The system will not prevent collisions or lessen collision damage or injury in every situation.
- Under certain circumstances, the detection and display of certain surfaces and objects may be limited.

Comments from Consumer Groups

1. AAA – American Automobile Association

   AAA finds active driving assistance systems do less to assist drivers and more to interfere. AAA has repeatedly found that active driving assistance systems do not perform consistently, especially in real world scenarios. Technology needs to be improved. AAA found only 12% of drivers trust riding in a self-driving car.

- Profusion of brand names leads to consumer confusion- uniform terminology is needed.
- Capabilities and functions can be confusing.
- Drivers need clear understanding of capabilities and limitations.
- Drivers more likely to lose situational awareness.
- Little evidence to suggest whether current level 2 systems improve safety.
- More research is needed to determine safety.

2. Consumer Union

- Capabilities and functions can be confusing.
- Need clear understanding of limitations.
- Drivers lose situational awareness.
- Little evidence suggests improved safety.
- More research is needed to determine safety.

Industry Activities

1. American Trucking Associations (ATA)

- ATA is focused on SAE automated vehicle level 4. This level does not require a driver in certain conditions.
- More freight can be moved safely and drivers have more uptime and less downtime. Expects industry to have availability to adopt automated trucks by 2024.
- Autonomous trucking is being pushed forward by an increase in demand for fast deliveries coupled with a shortage of drivers.

2. United States Department of Transportation (US DOT)

US DOT has published an automated vehicles comprehensive plan, January 2021, to help modernize regulations and to motivate innovative vehicle designs. While working to improve safety and efficiency.

It has proposed rules regarding the safe integration of automated driving systems in equipped commercial motor vehicles.

3. Commercial Vehicle Safety Alliance (CVSA)

CVSA has announced new enhanced CMV inspection program for autonomous truck motor carriers. The program establishes a no-defect, point of origin inspection program for ADAS equipped commercial vehicles. CVSA trained motor carrier personnel will conduct the inspection procedure at the fleet’s point of origin before dispatch.

ADAS – Accident Reconstruction

Currently, the reconstruction of a vehicle accident relies primarily on physical evidence from the scene, post-accident position of the vehicles, extent of vehicle damage, tire marks, ECM data, and possibly camera data.

A vehicle with ADAS systems, as they increase in capability, must be analyzed in a different way. Accident reconstruction relies on data, for which ADAS could provide a trove, depending on how much access is provided via their OEMs and via privacy laws.

An ADAS autonomous vehicle may have about 40-100 computer processors. A glitch in any of the devices could result in an accident. There is limited commonality between OEM manufacturers in technologies and terminology.

As ADAS achieves increased implementation in the marketplace, one would expect that there would be some sort of a standardization.

After a vehicle crash, you would need to know:

- Was an ADAS autonomous system installed and/or involved?
- Did it function properly?
- Did it affect the outcome of the accident?