

ADAS

ADVANCED DRIVER ASSISTANCE SYSTEM COMPONENT & SYSTEMS FUNCTION *THE FUTURE OF CALIBRATION*

STEVE ZACK 8.20.19



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- The Future of Calibration
- Calibration Errors

ADAS

How the system works

ADAS

Overview

- ADAS is an advanced technology that provides a safer driving experience.
- ADAS uses camera, radar, LIDAR, ultrasonic, infrared, GPS to monitor the vehicle surroundings and detect potentially dangerous situations.
- When the vehicle senses a potentially dangerous situation the vehicle will warn the driver or take corrective action to prevent a collision.

ADAS

Overview

- Passive system – When the vehicle senses a potentially dangerous situation the vehicle will warn the driver in the form of warning light, audible indication (tone) or haptic feedback (vibration).
- Active system – When the vehicle senses a potentially dangerous situation the vehicle will take corrective action to prevent a collision.

ADAS

Overview


- The purpose of ADAS is to provide a safer driving experience for the vehicle, driver and passenger and the surrounding environment.
- ADAS primary goal is to reduce accidents.

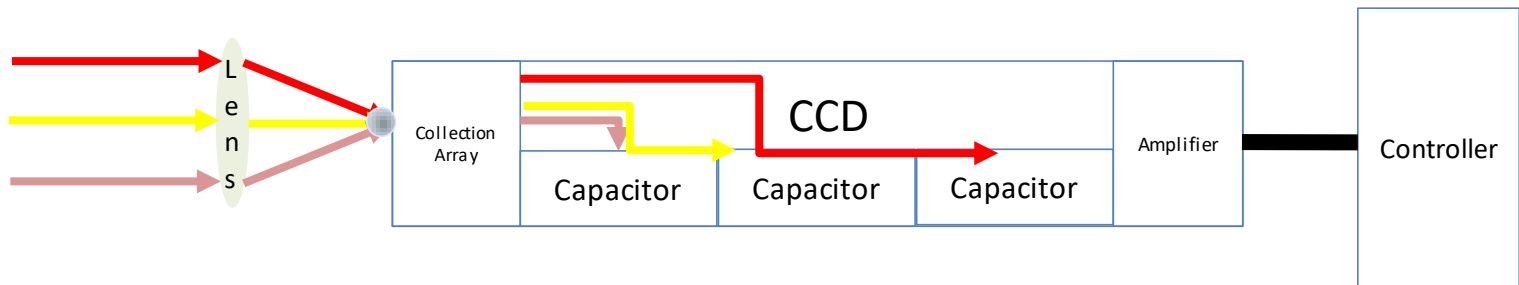
ADAS

How the camera works

Camera

How it works

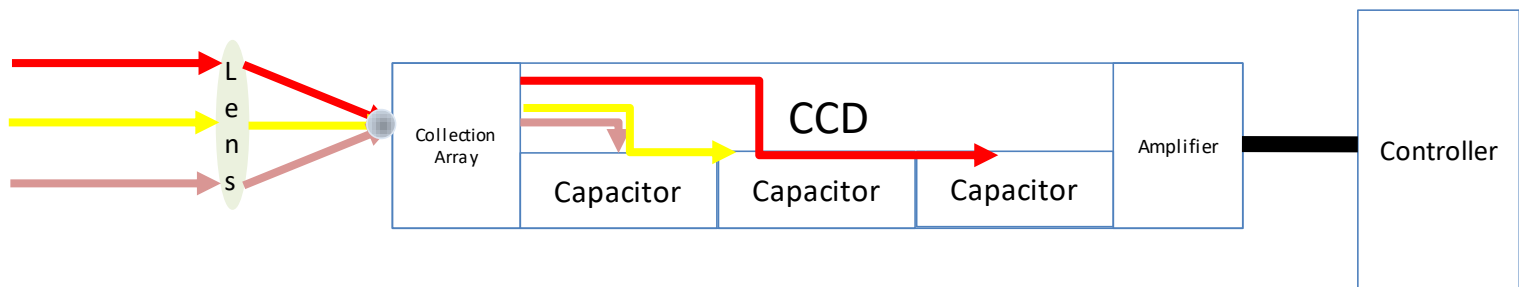
- The light that reflects off an object in front of the lens passes through the lens and is collected at a focal point .
- It then passes to a CCD – Charge Coupled Device.



Camera

How it works

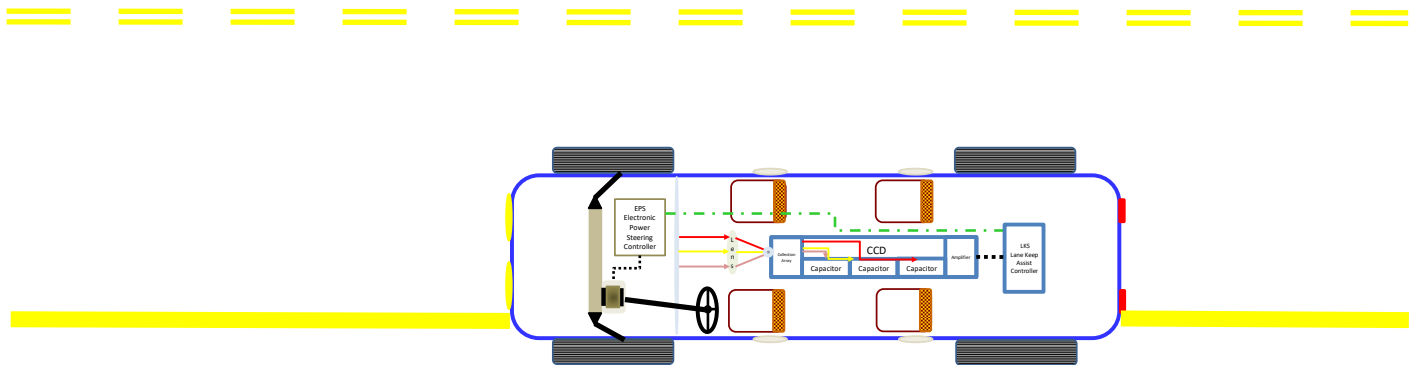
- Camera image – CCD – Charged Coupled Device.
 - CCD has many dots – Pixels arranged on grid.
 - Pixel has a Photodiode that absorb light energy.
 - Photodiode converts light energy to voltage.
 - Voltage is sent to a capacitor.



Camera

How it works

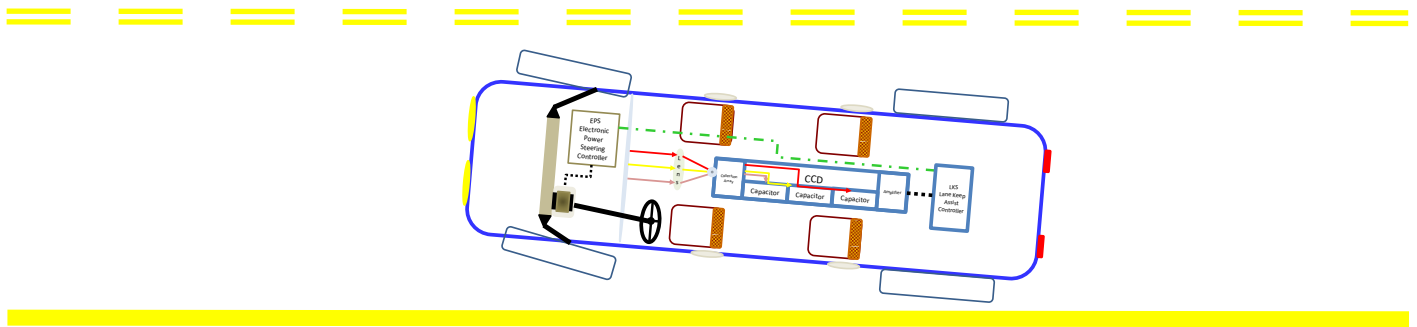
- The CCD collects the light at the collection array where each color of the spectrum, based on the intensity of the light, is sent to a capacitor.
- The capacitor will send it to the amplifier where it is converted to a voltage and then sent to the controller for calculation.
- Many recordings are taken over given period of time which the controller will use to calculate the distance and identify deviation from normal conditions based on location, speed and distance.



Camera

How it works

- The algorithm uses the image and vehicle speed to calculate how closely and rapidly the vehicle is approaching an object.
- The controller then commands the corrective action.
- The systems we are discussing is LKAS (Lane Keep Assist) and a EPS (Electronic Power Steering).
- The LKAS controller commands the EPS controller to steer the vehicle back into the lane.



Camera

How it works

- White Light blinds the camera.
- The color white contains all of the colors of the rainbow.
- Red, Orange, Yellow, Green, Blue, Indigo, Violet.

Camera

How it works

- When white light shines into a camera or your eye you are blinded as a result all colors have combined.
- As long as there is nothing to act as a prism that would reflect or bend the seven individual colors of white, light from the sun will blind you.
- You are not actually blinded, you are only seeing white.
- White is created by all the colors being combined.

Camera

How it works

➤ Advantages:

➤ Fast

➤ Accurate

➤ Disadvantages:

➤ Does not work well in Bright Sun Light

➤ Does not work well in Fog

➤ Does not work if the road lane markers are covered in ice or snow

➤ Cannot see bicycles as they weave and are very narrow

Camera

How it works

- Most manufacturers use Mono or singular camera
- Mercedes Benz uses a stereo camera on some models
- Subaru uses a Stereo camera

- Uses:
 - FFC – Forward Facing Camera
 - LDW – Lane Departure Warning
 - LKAS – Lane Keep Assist System

ADAS

How the radar works

Radar

How it works

- There are two types of radar:
- Active radar which transmits a signal that is reflected back to the radar's receiver.
- Passive radar which depends on the object sending a signal to the radar's receiver.

Radar

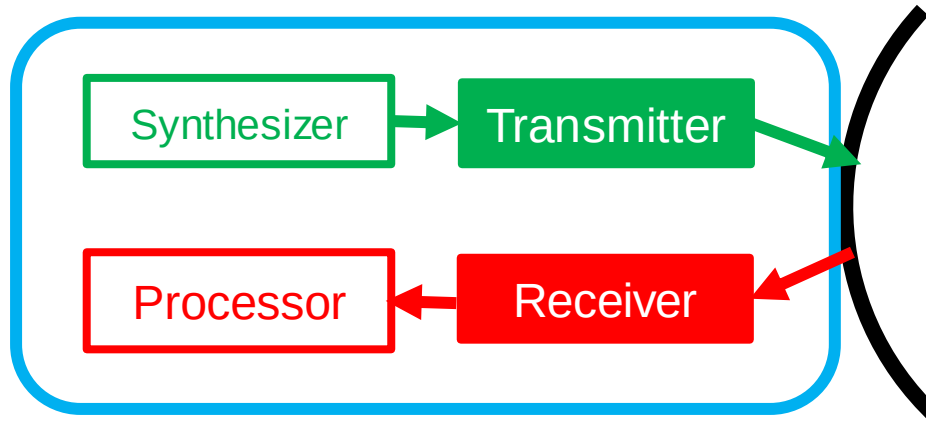
How it works

- There are two types of data transmission:
- Doppler Effect - As an object moves closer to another object the radar radio wave changes frequency.
- Millimeter Wave (mmWave) a radar that uses short- wavelength radio waves in the millimeter range.
- Frequency Modulated – FMCW: High resolution with a wide sweep in the GHz range at low frequency in the MHz range, lower power requirements.

Radar

How it works

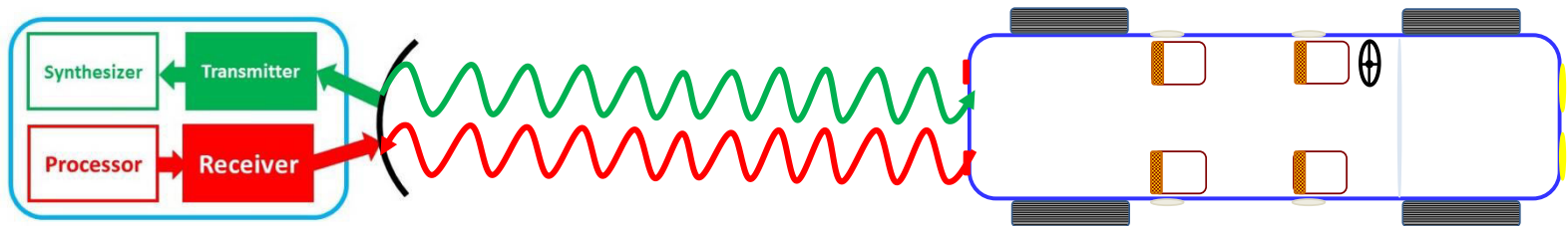
- A radar has a synthesizer to create a chirp or radio wave at specific frequency.
- Transmitter to send the radio wave.
- An antenna to receive the signal.
- A processor to calculate the objects location.



Radar

How it works

- A radar transmits a radio wave at specific frequency.
- When the **radio wave** contacts an object.....

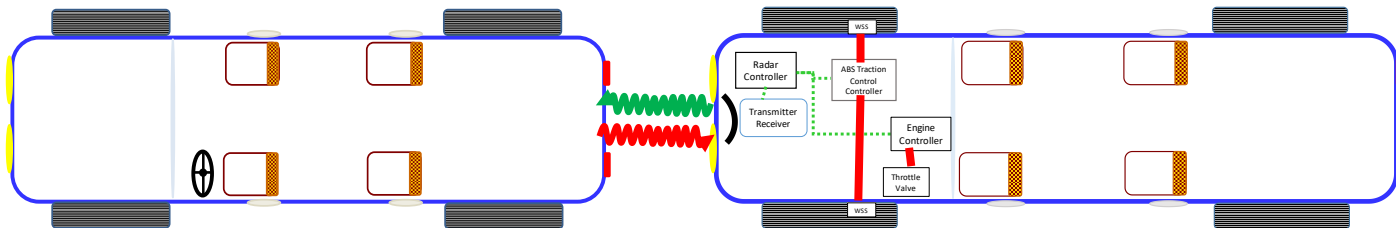


-the **radio wave** bounces off of that object and returns to the radar.

Radar

How it works

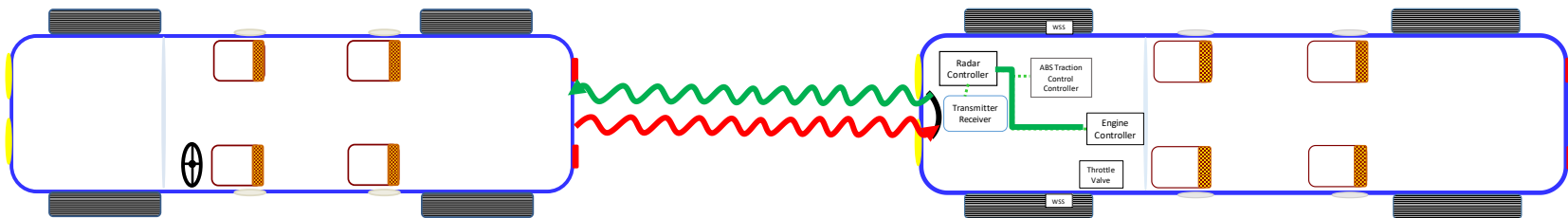
- The radar, based on the specific frequency the radio wave sent out, receives the radio wave back.
- The distance is calculated based on the time it took for the radio wave to return.



Radar

How it works

- The radar's calculated time is transmitted to the controller.
- The controller calculates the required strategy to avoid the object.
- The controller will apply corrective action to adjust the speed (cruise control) or braking before the vehicle arrives to the object, successfully reducing speed or stopping.



Radar

How it works

➤ Advantages:

- Operates well in Fog
- Operate well in Bright Sun Light
- Operate behind plastic enclosures, i.e. Bumper Fascia

➤ Disadvantages:

- Does not operate covered in snow
- Does not operate covered in ice

Radar

How it works

- Uses:
- SRR – Short Range Radar – corner – blind spot detection, lane change assist, cross traffic alert, automated parking.
- MRR – Medium Range Radar – front – adaptive cruise control, emergency braking.
- LRR – Long Range Radar – front – adaptive cruise control, emergency braking.

ADAS

How the Lidar works

Lidar

How it works

- Lidar – Light Detection And Ranging (aka – Laser Radar)
- Radar – radio wave range detection
- Lidar – light wave range detection
- Lidar uses short light pulses
- Intensity of the Lidar signal is based on the time elapsed since transmission.

Lidar

How it works

- Lidar measures:
- Range
- Angle and height
- Position/location, roll, pitch and heading
- Amplitude of the lights intensity

Lidar

How it works

- Lidar is a light source that sends a light particle at specific speed recording the time of it's departure and it's return, calculating time it takes for the light to return.
- Light travel at 186,000 miles per second or 300,000 kilometers per second.

Lidar

How it works

Lidar Computer:

- Analytical computer to calculate data.
- Clock to record time of transmission and receiving of light beam.
- GPS – Global Positioning System – for comparing location at 3 points X, Y and Z.
- IMU – Inertial Measuring Unit – to measure Pitch, Roll and Yaw.

Lidar

How it works

Transmitter:

- Laser provides the timed light pulses with a spinning mirror that varies its measuring angle by raising up and down.
- Beam expander increases signal strength.

Receiver:

- Telescope to collect scattered light photons.
- Stop Chopper opens the light field to let in the light from the Lidar transmitter.
- Optical Analyzer detector to sort out and select specific light and convert the light to an electrical signal.

Lidar

How it works

- How a laser light works:
 - High voltage causes a quartz flash tube to emit a bright light.
 - The light excites atoms in a crystal to higher energy level.
 - The excited atoms emit particles of light or photons.
 - Photons bounce in all directions and off one another amplifying the photon energy.

Lidar

How it works

➤ How a laser light works:

- Mirrors at either end of the laser tube continue the bouncing of the photons back and forth increasing energy.
- The laser light is emitted at the end of the mirror tube and is now in phase, directional and traveling in parallel able to travel considerable distances straight and narrow.

Lidar

How it works

- How laser light works:
 - Pulse of light is emitted from a transmitter at recorded time containing a group photons going in one direction.
 - As the photons contact an object they are reflected back to a receiver.
 - The receiver records the time that the reflection is received.
 - The recorded transmission time is subtracted from the recorded reception time.
 - The speed of light is multiplied by the time traveled and divided by two.

Lidar

How it works

- How laser light works:
 - The laser will project the light at speed of to 150,000 pulses per second.
 - The precise time of the light is recorded.
 - The speed of the mirror spin is recorded for each light beam shot.
 - The angle of the mirror for each light beam shot.
 - The light will pass through an expander to increase the light intensity.

Lidar

How it works

- At the receiver there is a Stop Chopper that only opens the field of view for the light transmitted by the Lidar.
- When the light is received the precise time is recorded.
- The light allowed to pass into the telescope.
- The light is then collected by the Optical Analyzer Detector where the light photons are converted to electrical signals by Photodiodes.

Lidar

How it works

- The electrical signal is received by the Analytical Computer.
- The electrical signal is sent to an Analog Digital converter.
- The Analytical Computer will review the time of the light transmission and when it was received.
- The Analytical Computer determines the action to be taken by the vehicle.

Lidar

How it works

- Very dense air can result in nitrogen and oxygen molecules dispersing the Lidar light.
- Particles such as liquids i.e. clouds, rain, hail or mineral particles i.e. dust, pollen, soot can disperse the light.
- Absorption of light as a result of molecules and particles.
- Background light, Day time sun light and night time moon or star light are filtered out during the calculation.
- White light aids in overcoming molecular dispersion by absorbing the affected molecule.

Lidar

How it works

➤ Disadvantage

- Cannot penetrate dense forest
- Large amounts of data to process
- Expensive

➤ Advantage

- Fast response
- Accurate

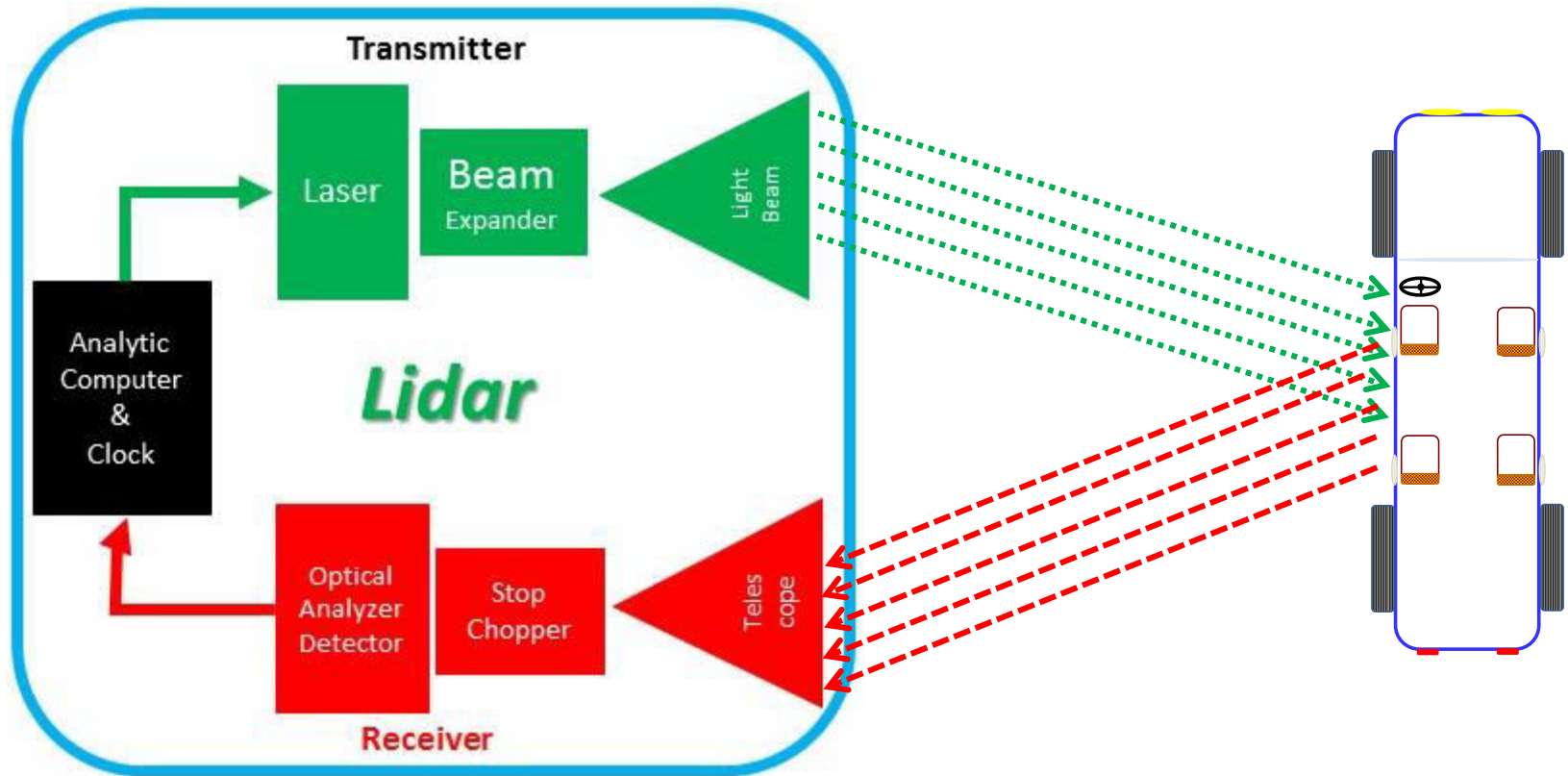
Lidar

How it works

- Uses:
- Blind spot detection
- Lane change assist
- Cross traffic alert
- Adaptive cruise control
- Emergency braking

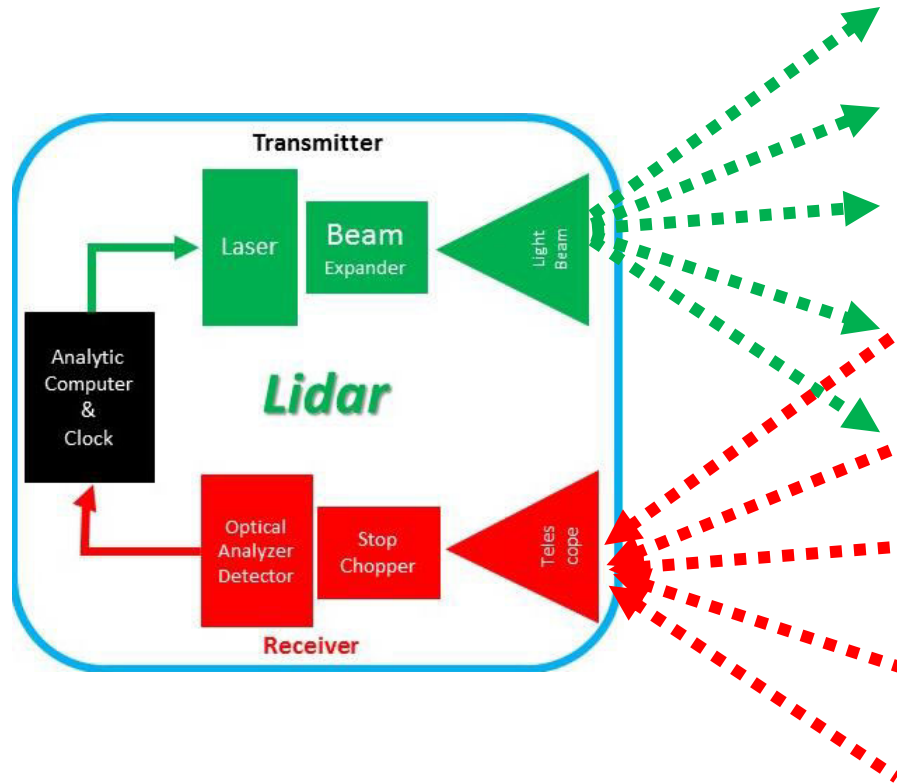
Lidar

How it works



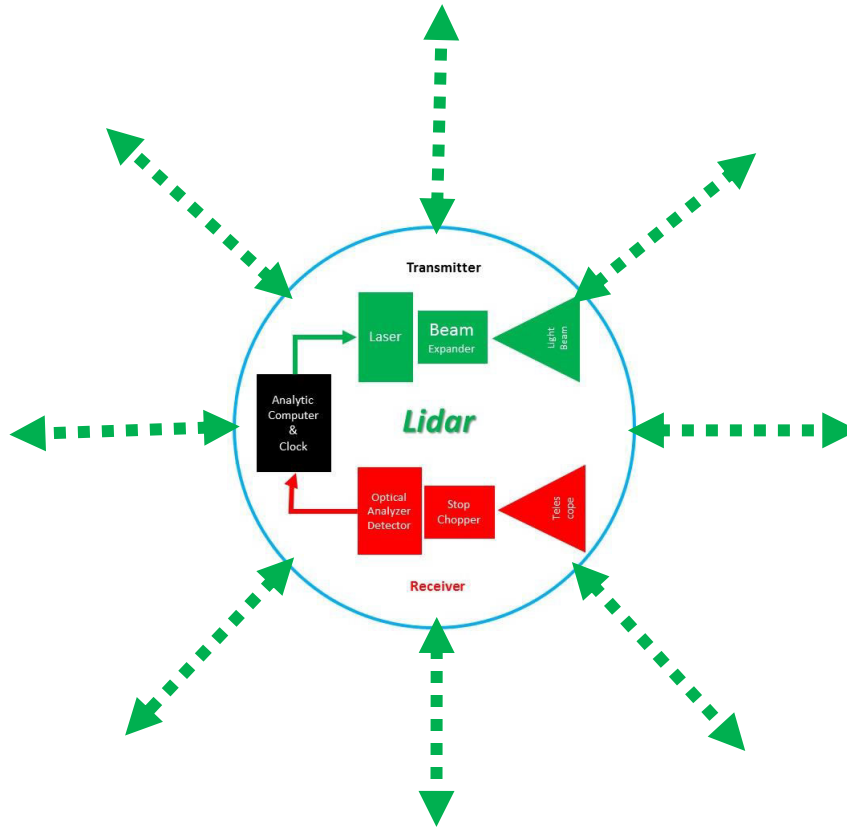
Lidar

How it works



Lidar

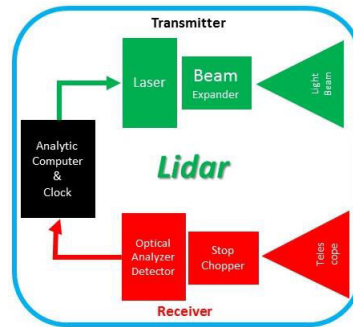
How it works



Lidar

How it works

- The Analytical Computer's map of the vehicle looks like the left side of the vehicle.



ADAS

How Ultrasonic works

Ultrasonic

How it works

- Ultrasonic distance ranging
- Utilizes ultrasonic waves to echo sound off an object
 - An ultrasonic wave is transmitted
 - When it contacts an object it bounces back (echo's)
 - The amplitude of the returning wave determines the distance
 - A large wave the object is in close proximity
 - A small wave the object is farther away

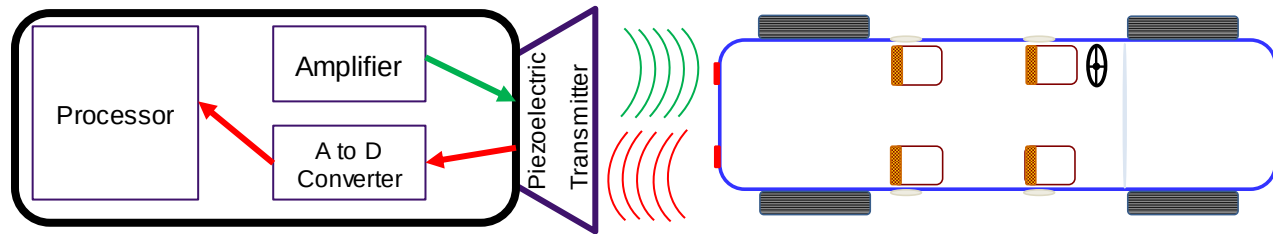
Ultrasonic

How it works

- The Ultrasonic sensor components
 - Amplifier
 - Piezoelectric Transmitter
 - A to D Converter
 - Processor

Ultrasonic

How it works



Ultrasonic

How it works

➤ Advantages:

- Inexpensive
- Uses very little memory due in part only need to know value of the acceptable distance for an alert.

➤ Disadvantages:

- Care must be taken when repairing damaged components.
- Painting the sensors results in clogging the transmitter.
- It is recommended to replace the sensor with pre-painted components.

Ultrasonic

How it works

- Uses:
 - Park Assist
 - Blind Spot Detection

- Sensor are located:
 - Front Bumper
 - Rear bumper
 - Fender wells
 - Mirrors
 - Rocker panels

ADAS

How corrective action works

ADAS

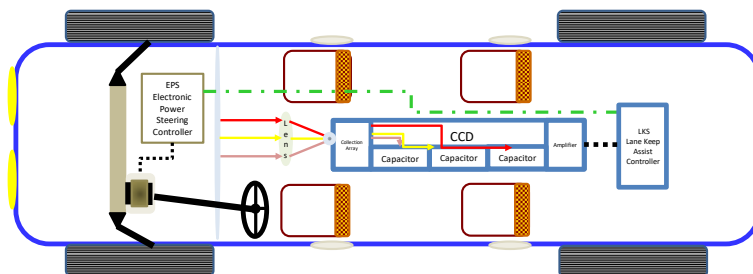
How corrective action works

- The human brain can command a reaction of the muscle to move to avoid injury at speeds of 390 feet per second.
- Computer processing speed can command an actuator to function at 128 MHz or 128 million times a second.
- The ADAS system is much faster at recognizing issues and taking corrective action.

ADAS

How corrective action works

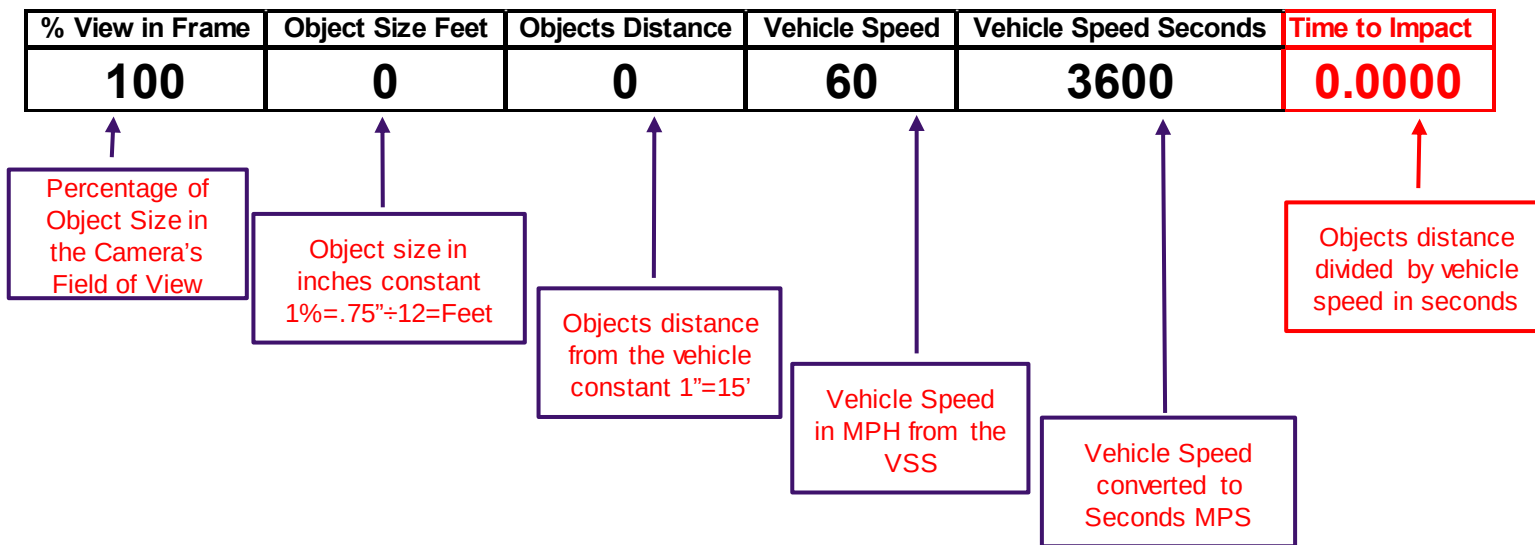
- The controller calculates the distance needed for corrective action based on the size of the object in the field of view (over multiple frames).
- As the object gets closer to the need for corrective action the vehicles controller will implement a corrective strategy.
- The calculation will use the objects size, as appears in the field of view times the vehicles speed to determine the time to take corrective action.



ADAS

How corrective action works

ADAS Collision Algorithm

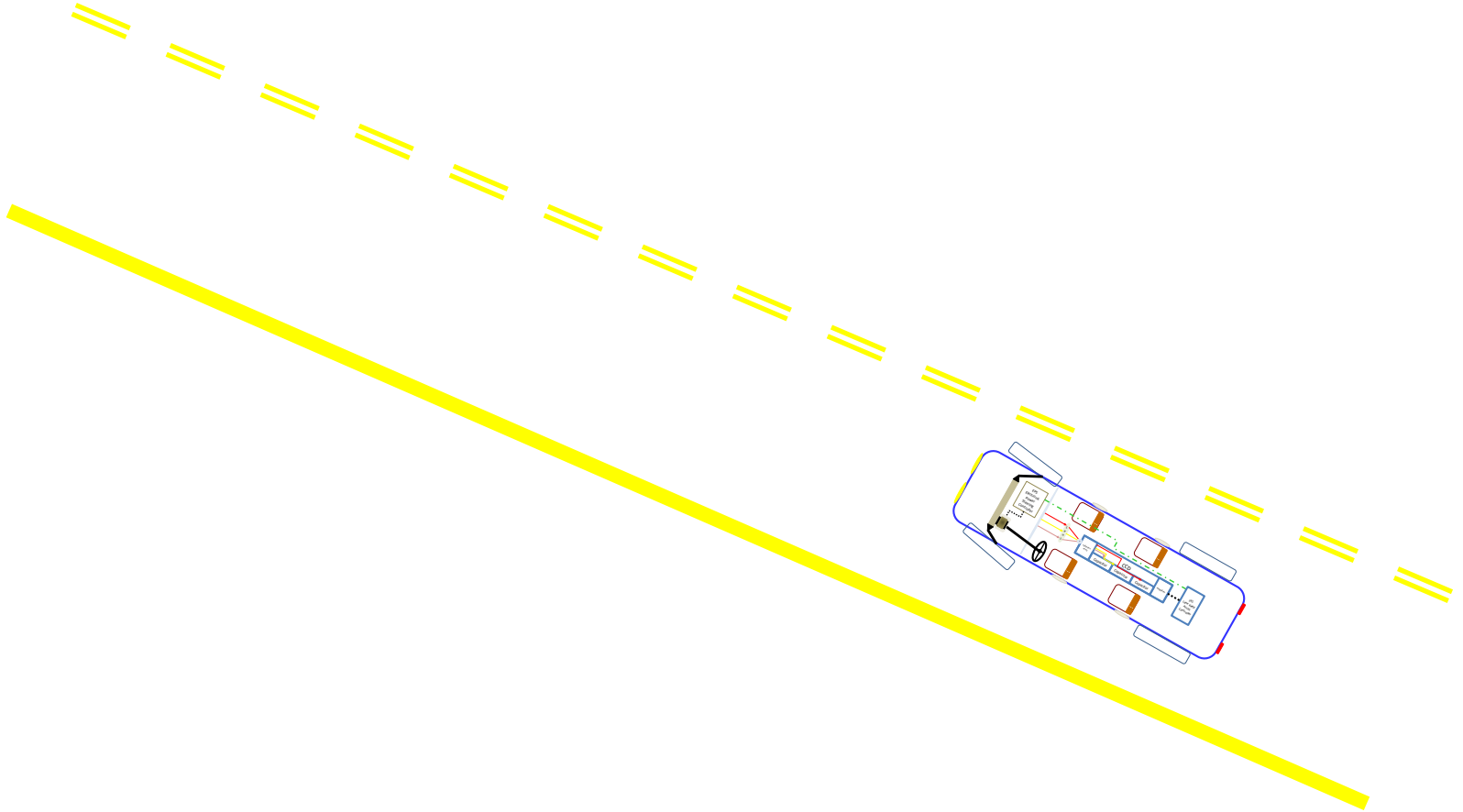


ADAS

How the corrective action works

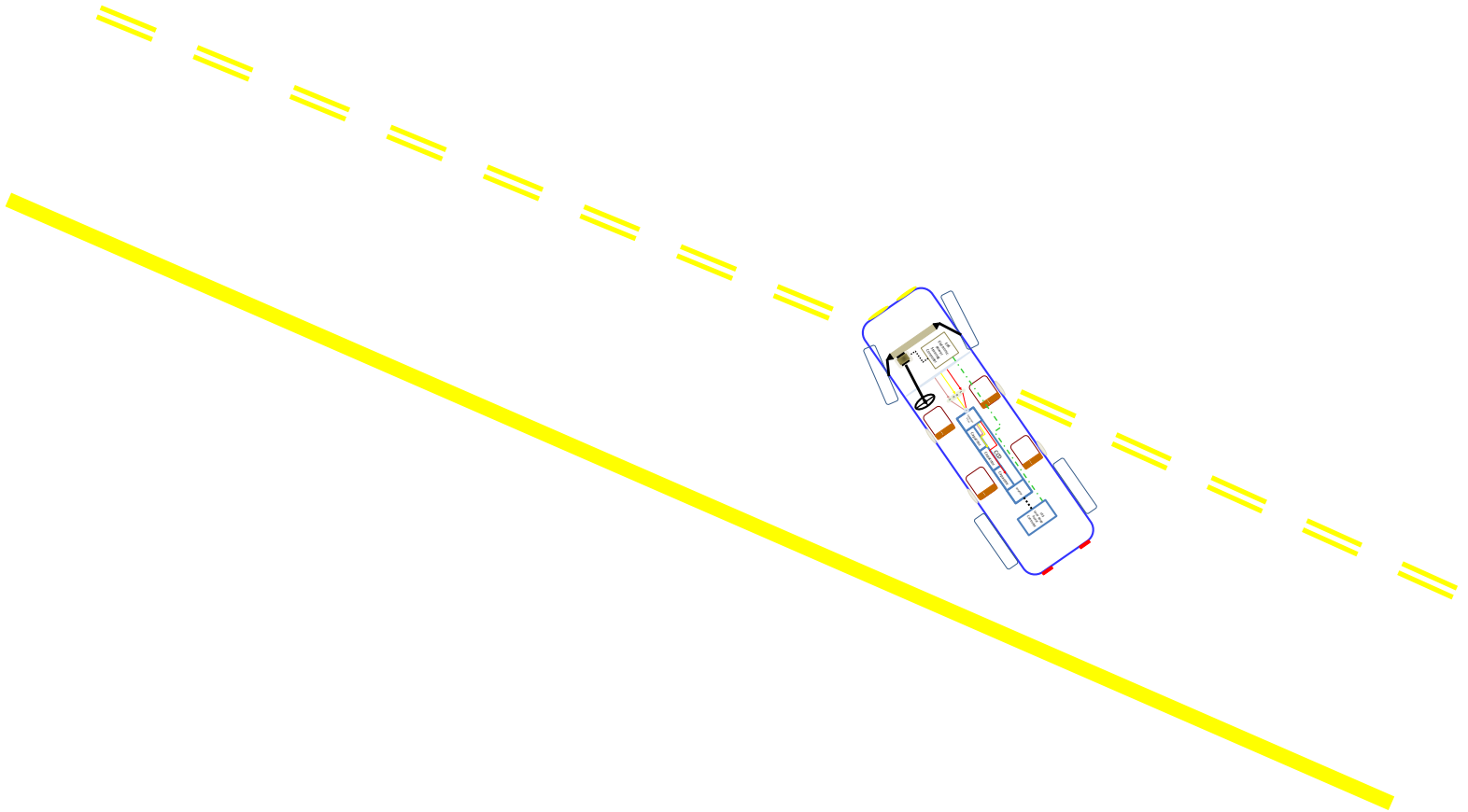
ADAS

How does it work



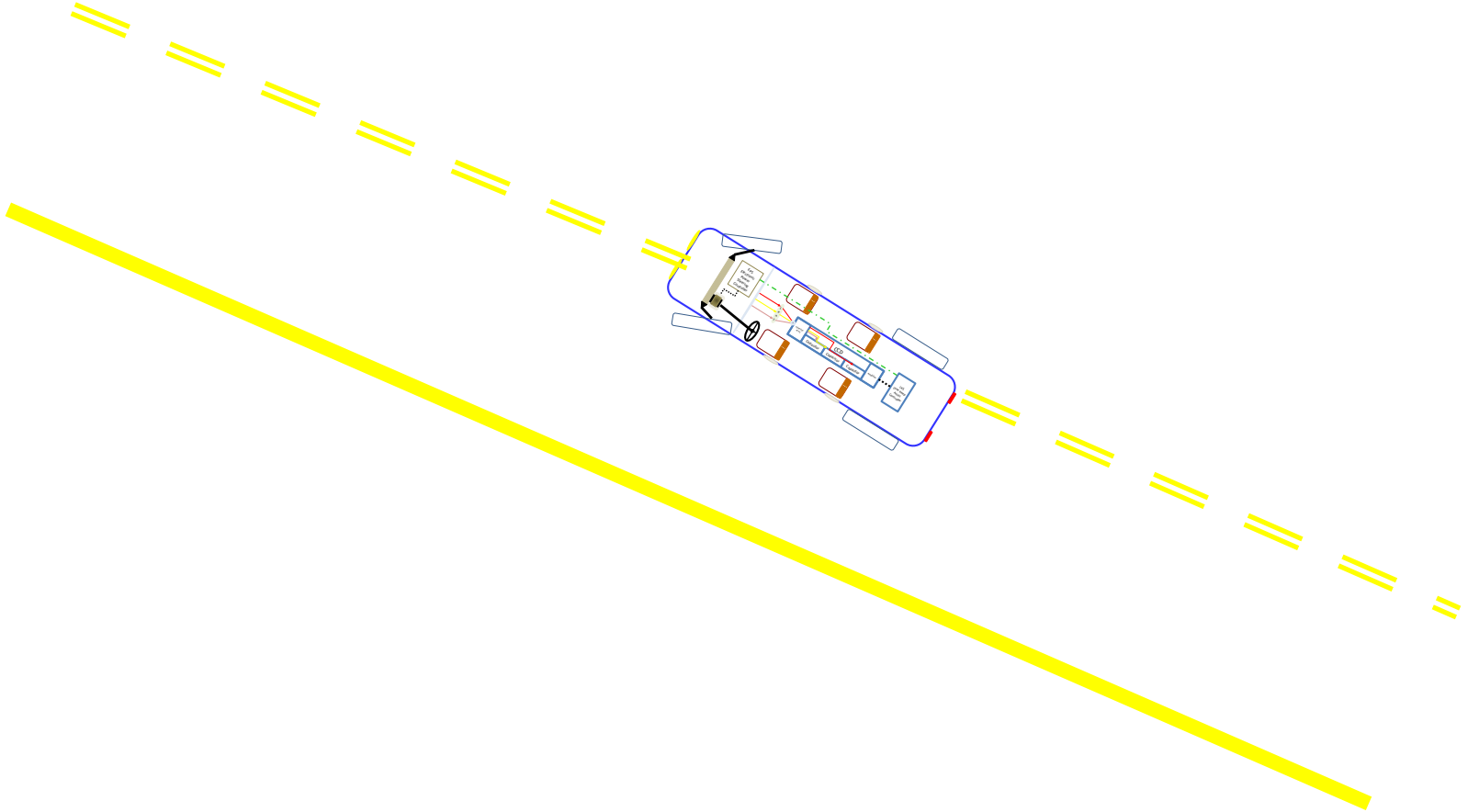
ADAS

How does it work



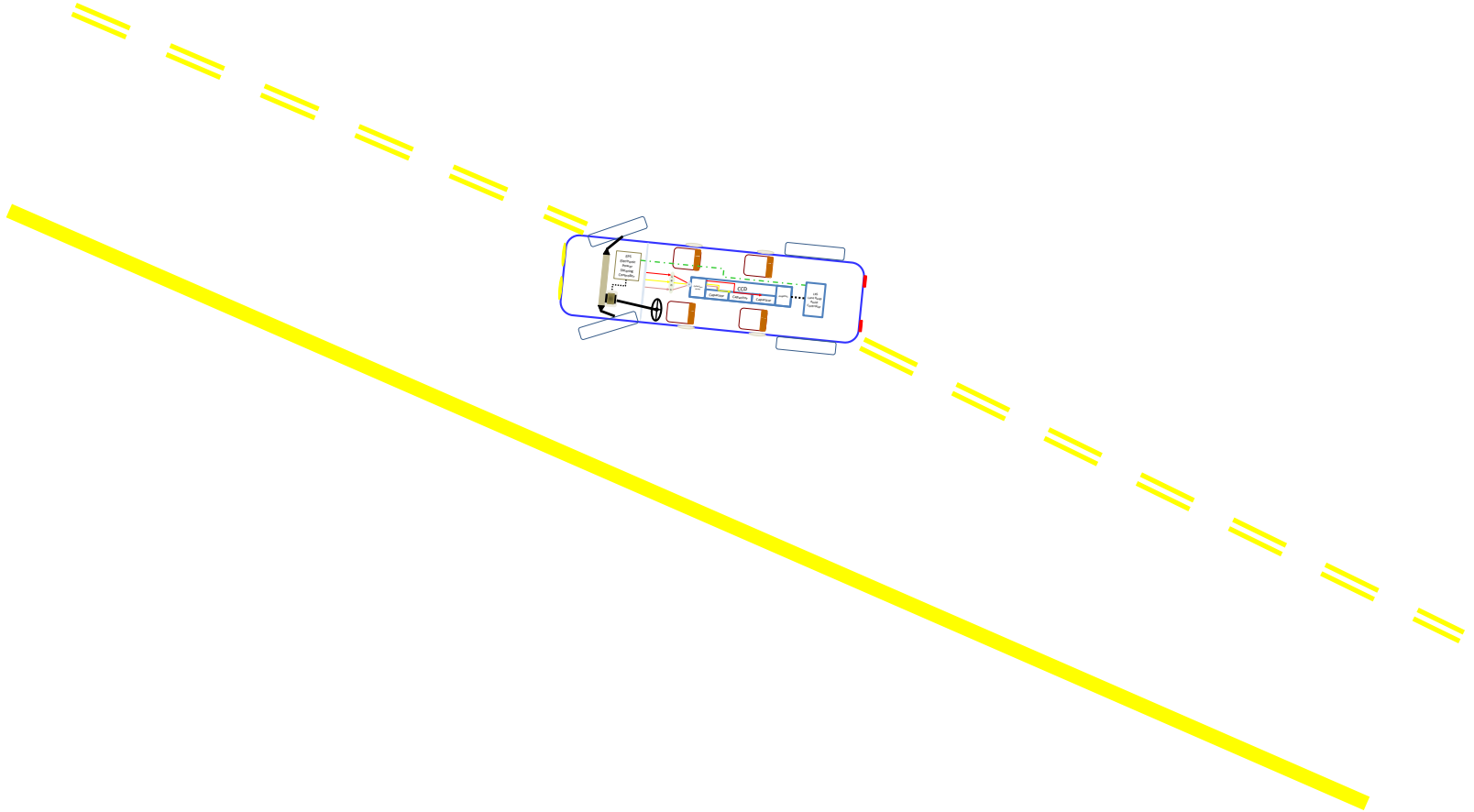
ADAS

How does it work



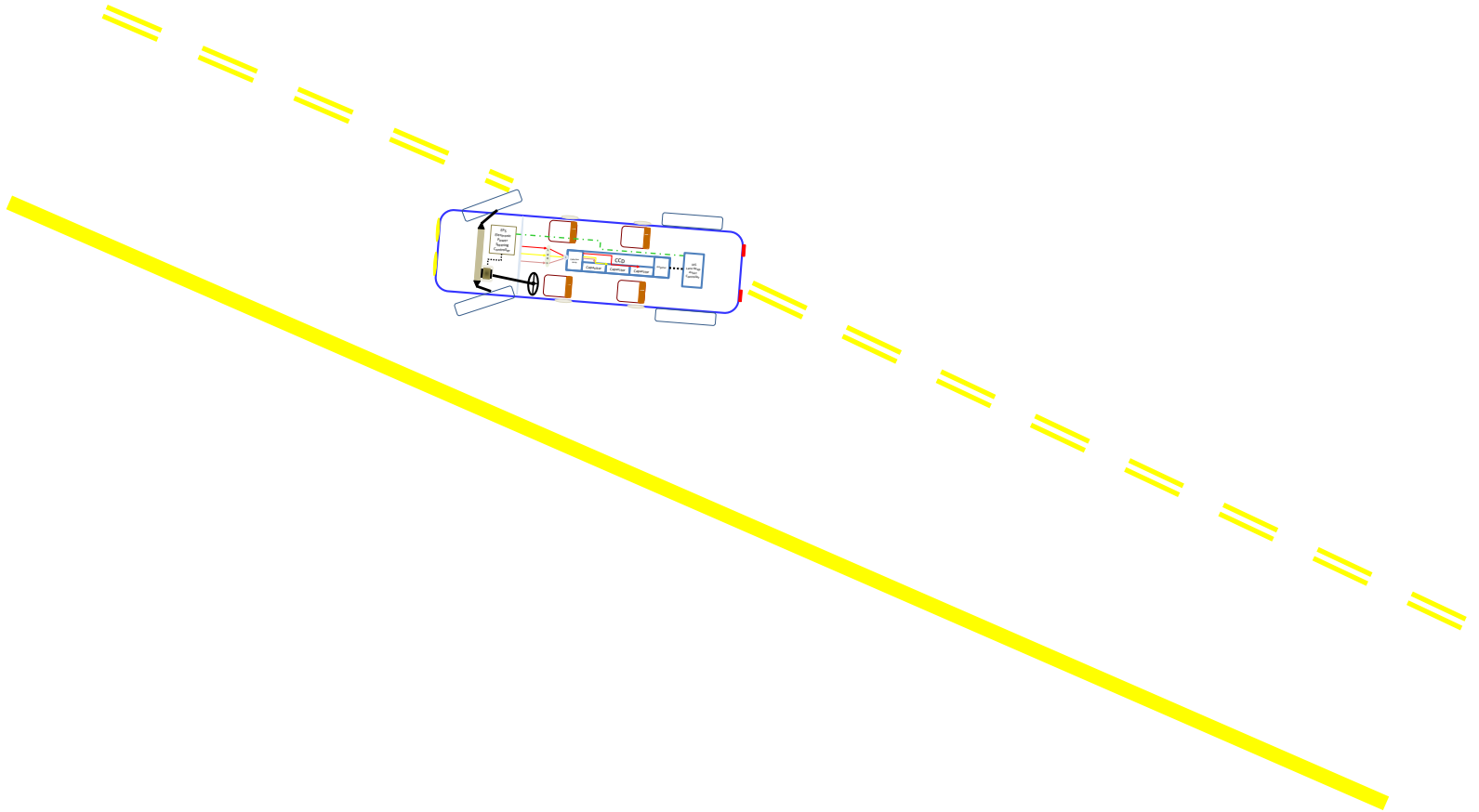
ADAS

How does it work



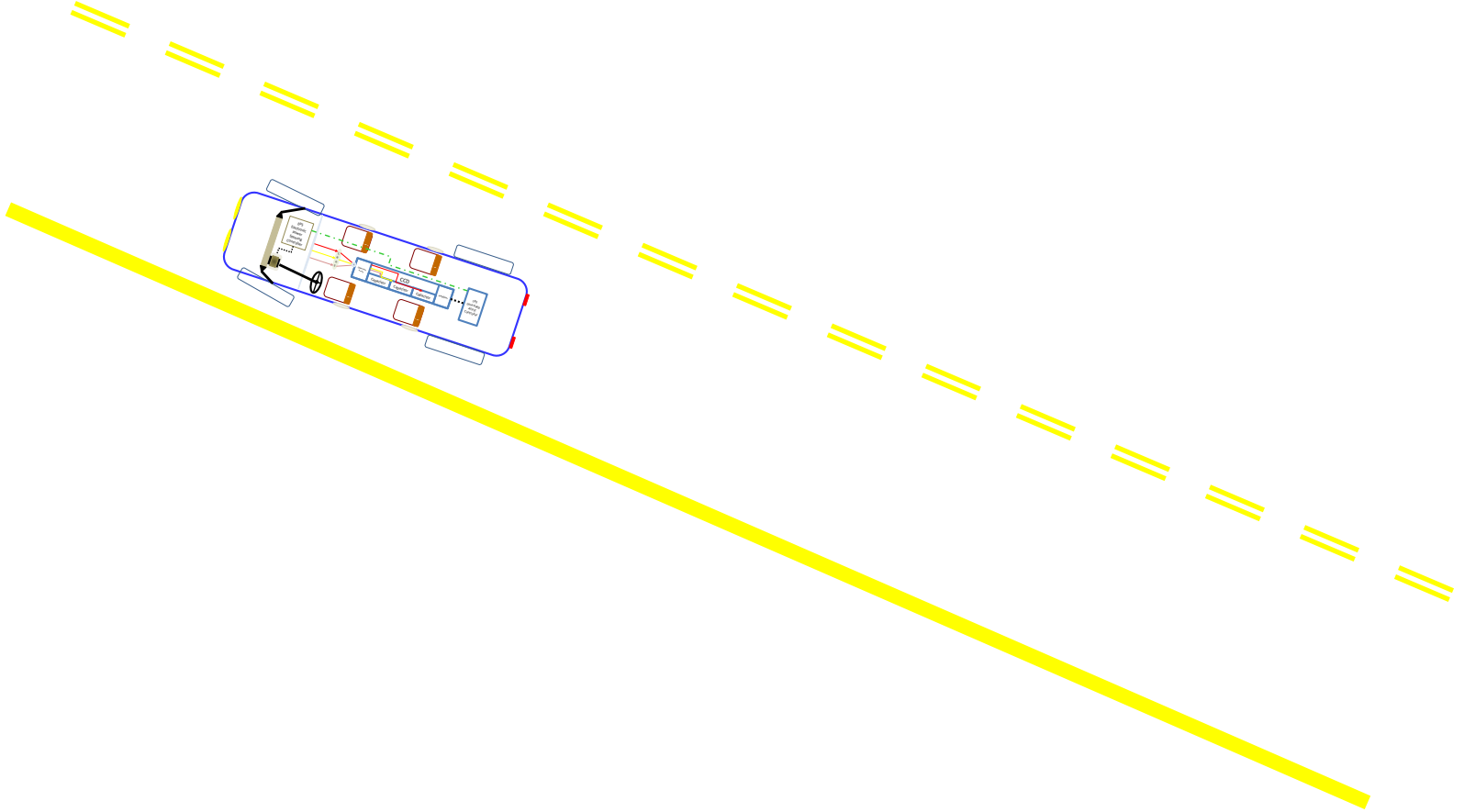
ADAS

How does it work



ADAS

How does it work





The Future of ADAS Calibration



BOSCH

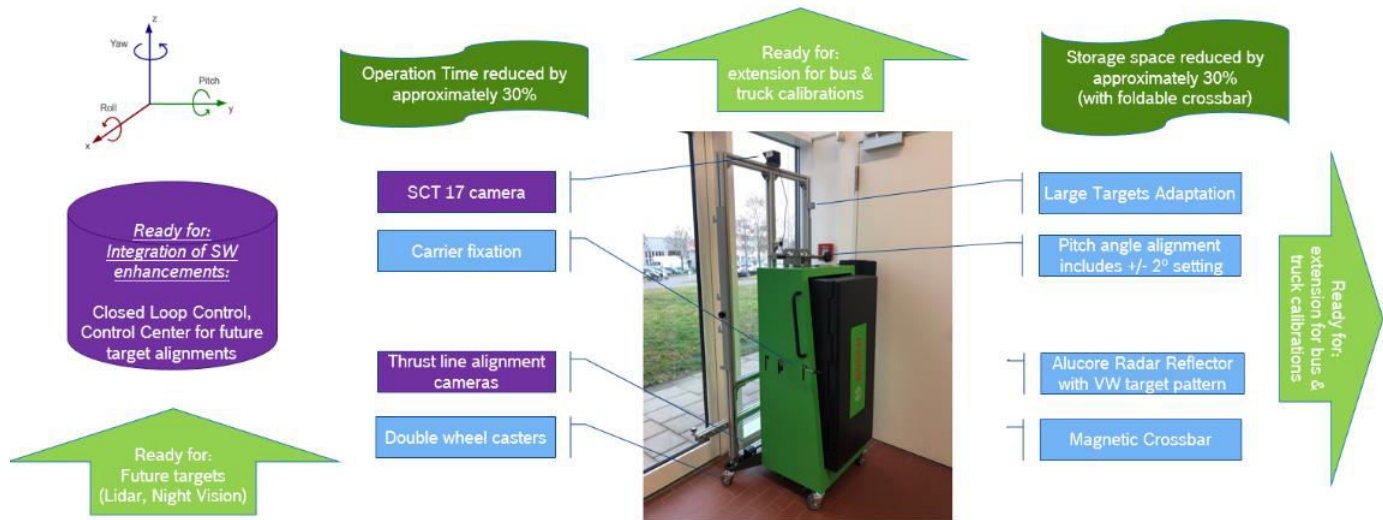
Invented for life

Camera Calibration

DAS-3000

➤ **Bosch** has an all new system for all system

➤ **Accurate**



Camera Calibration

Types of Calibration

- There are two types of calibration Static and Dynamic.
 - **Static**
 - Using a Target to align the vehicle.
 - Using the ADS625 to calibrate.
 - **Dynamic**
 - Using the ADS625 to calibrate.
 - Road test to align the vehicle.
 - Driving the vehicle in the lane over specific time and speed.
- There are many vehicles which will require both static and dynamic performed in sequence.
- Bosch can calibrate all components Camera, Radar, Lidar

Camera Calibration

Who will be calibrating

➤ **Technicians and Businesses that will be calibrating**

- Body Shops
- New Car Dealers
- Alignment Shops
- Mobile Technicians
- Calibration Centers

➤ **How does a technician receive training**

- Vocational training systems – High School and Colleges
- Post school program centers for adult education
 - Classes offered by colleges after hours for adult education

ADAS

Calibration Errors

ADAS calibration requirements

Failed calibration / unable to calibrate

- Vehicle modification
 - Non-OE glass
 - Non-OE wheels/tires
 - Suspension raised/lower

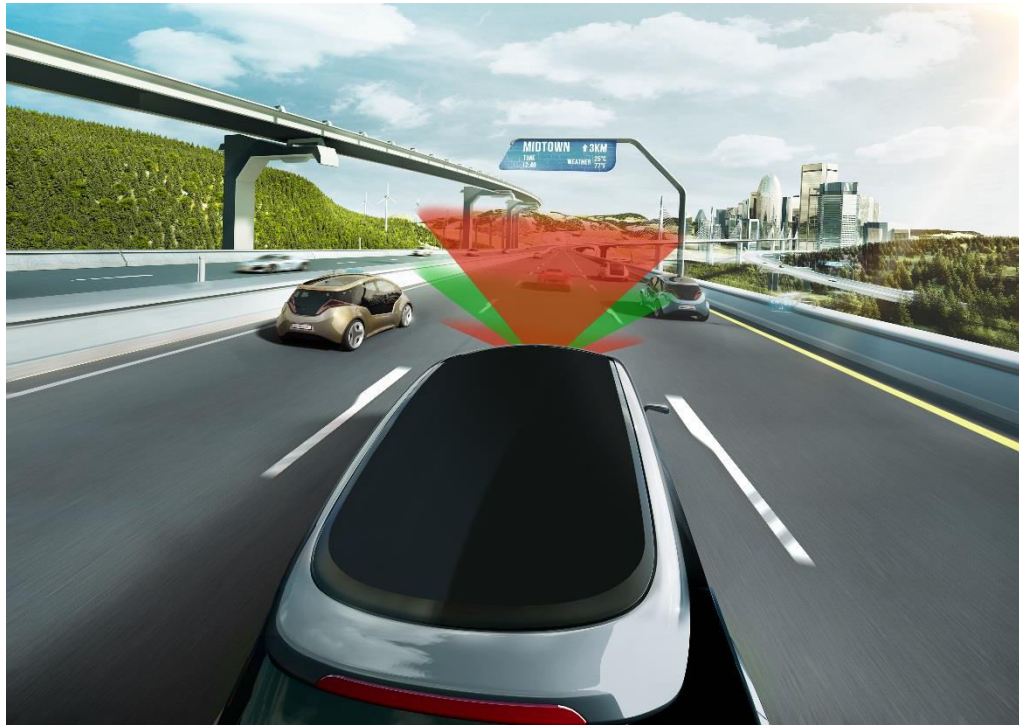
- Weather
 - Snow
 - Rain

- User error
 - Incorrect lane setup
 - Incorrect jig setup
 - Incorrect target use or placement

ADAS calibration requirements

Ride height modifications

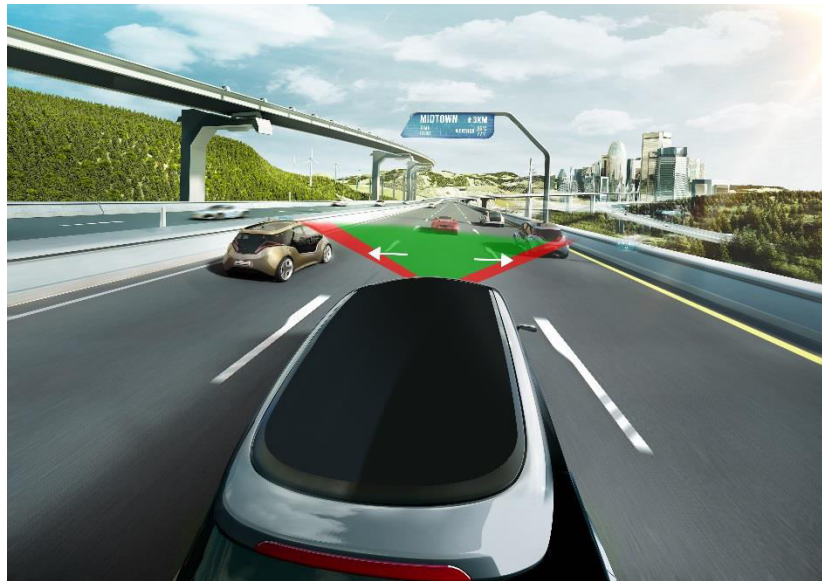
- A vehicle lowered 1" reduces the camera slope as much as 8%
- A vehicle raised 1" raises the camera slope as much as 7%



ADAS calibration requirements

Risks of improper or failed calibration

- Vehicle camera is beyond its tolerance limits
- Vehicle could exceed lane marker limits, endangering driver and others on the road
- Calibration error of 5° will force the vehicle to track 13.6" from center
- Inaccurate setup of the jig
- incorrect Target used



THANK YOU