Lecture 2 (15 Sep 2021)
Advanced Driver Assistance System (ADAS)
Advanced Driver Assistance Systems are a set of electronic technologies designed to work together to automate and enhance vehicle safety by detecting potential danger, problems, or collisions, and warning and assisting the driver.
To make the future of autonomous vehicles a reality, technology innovation is needed to move from today's prototype autonomous vehicles to deployable safe, self-driving solutions.
1.3 million people die each year in road traffic crashes. The UN has set a target of halving the global number of deaths and injuries from road traffic crashes by 2030. Road traffic crashes cost most countries 3% of their gross domestic product. More than half of all road traffic deaths are among vulnerable road users: pedestrians, cyclists, and motorcyclists. 93% of the world's fatalities on the roads occur in low- and middle-income countries, even though these countries have approximately 60% of the world's vehicles. Road traffic injuries are the leading cause of death for children and young adults aged 5-29 years.

https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries
New cars in EU will need advanced safety systems from 2022

- intelligent speed assistance,
- alcohol interlock installation facilitation,
- driver drowsiness and attention warning systems,
- advanced driver distraction warning systems,
- emergency stop signals,
- reversing detection systems,
- event data recorders,
- accurate tyre pressure monitoring,
- advanced emergency braking systems,
- emergency lane-keeping systems.

Challenges?
ADAS Example Video
ADAS Sensors

**RADAR:**
- Provides:
  - Precise Distance measurement
  - Longitudinal Velocity Measurement
  - Robust against bad weather
  - Good performance during the night
- Not good resolution in lateral and elevation

**CAMERA:**
- Provides:
  - Specific object detection and recognition
  - Good resolution in lateral and elevation
  - Absence of velocity measurement
  - Not good performance during the night
  - Not robust to weather conditions

**LIDAR:**
- Provides:
  - Precise Distance measurement
  - Longitudinal Velocity Measurement
  - Good performance during the night
  - Good resolution in lateral and elevation
- Not robust to weather conditions
ADAPTIVE CRUISE CONTROL

- Similar to cruise control system, it allows you to fix the speed without pushing the throttle.
- In addition, the adaptive version automatically slows the speed when a vehicle is detected at the front and engages back to the set speed when there is no vehicle at the front.
Challenges:

- **Environmental parameter estimation:** road slope, aerodynamic disturbance, road friction coefficient
- **Controller tuning:** autonomously tuning the feedback controllers
- **Smooth switching and stop:** soft and stable transition between different modes
The front collision warnings system or FCW detects the vehicles in front of the driver’s car and alert the driver.
A. Greatly increased braking force
B. Automatic deceleration, even when brake is not applied (pre-braking)
C. Automatic deceleration, even when brake is not applied (braking)
The main objective behind the Lane Departure Warning (LDW) is to ensure the car is driven between the lanes.

In addition, as an extension, the system can be upgraded to the lane-keeping system (LKS), which means the vehicle takes control when the warning has been intimated to bring the car back between the lanes.
Intelligent speed assistance is in charge of warning in case of excess speed with respect to the speed limit and takes action by reducing it.

- ISA uses a speed sign-recognition video camera and/or GPS-linked speed limit data to advise drivers of the current speed limit and automatically limit the vehicle's speed as needed.
- ISA systems do not automatically apply the brakes but simply limit engine power preventing the vehicle from accelerating past the current speed limit unless overridden.

Mandatory on new models of car sold in the EU from 2022.
Pedestrian detection in ADAS has many roles. The main role is alerting the driver when a pedestrian or cyclist is entering the vehicle's path. Furthermore, some systems apply the brakes independently if needed when the driver is distracted.
Vision-based pedestrian detection architecture

DETECTING DRIVER FATIGUE

The fatigue detection system is build based on the usage of camera to detect the driver’s face and analyses the facial movement and identify signs of fatigue such as closed eyes or dropping head to warn the driver with a loud audible alert.
Vision-based method for detecting driver drowsiness and distraction in driver monitoring system.

Eye-detection results obtained using adaboost: (a) Frontal face (success), (b) rotated face (fail), and (c) closed eye

ADAS Challenges?