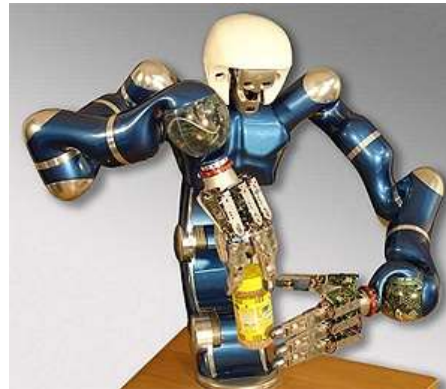


# Control System Design for Automated Driving

## Lecture 01





## Class Information

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  - Phone : 02-910-4671
- Teaching Assistant
  - 고연우 (Email : [rhduSDn9380@kookmin.ac.kr](mailto:rhduSDn9380@kookmin.ac.kr),  
Phone : 02-910-5578)
- Text book : Lecture Notes

## Class Goal

- 교과목 개요

- 최근 자동차 공학은 점차로 전자제어부품의 비중이 높아지고 있으며 이를 이용한 첨단 운전자지원 시스템 및 능동안전시스템의 개발이 진행되고 있다.
- 본 수업에서는 자율주행 제어시스템 설계에 필요한 차량동력학 모델링을 비롯하여 차량제어 시뮬레이션에 널리 활용되는 매트랩과 시뮬링크 소프트웨어를 배우고 실습을 수행하고자 한다.
- 또한 Automated Driving Toolbox를 활용하여 Closed-Loop 자율주행 시뮬레이션을 수행함으로써 자율주행 분야 실무경험을 체득한다.

- 수업 목표

- 본 수업에서는 종방향, 횡방향 차량 동력학을 매트랩 시뮬링크를 사용하여 모델링 함으로써 차량동력학에 대한 이해를 높이고 이를 통하여 자율주행 차량제어 알고리즘을 적용하는 프로젝트를 수행한다. 이를 통하여 향후 첨단 운전보조 시스템으로부터 자율주행 자동차에 이르기 까지 필요한 실무지식을 학습한다.

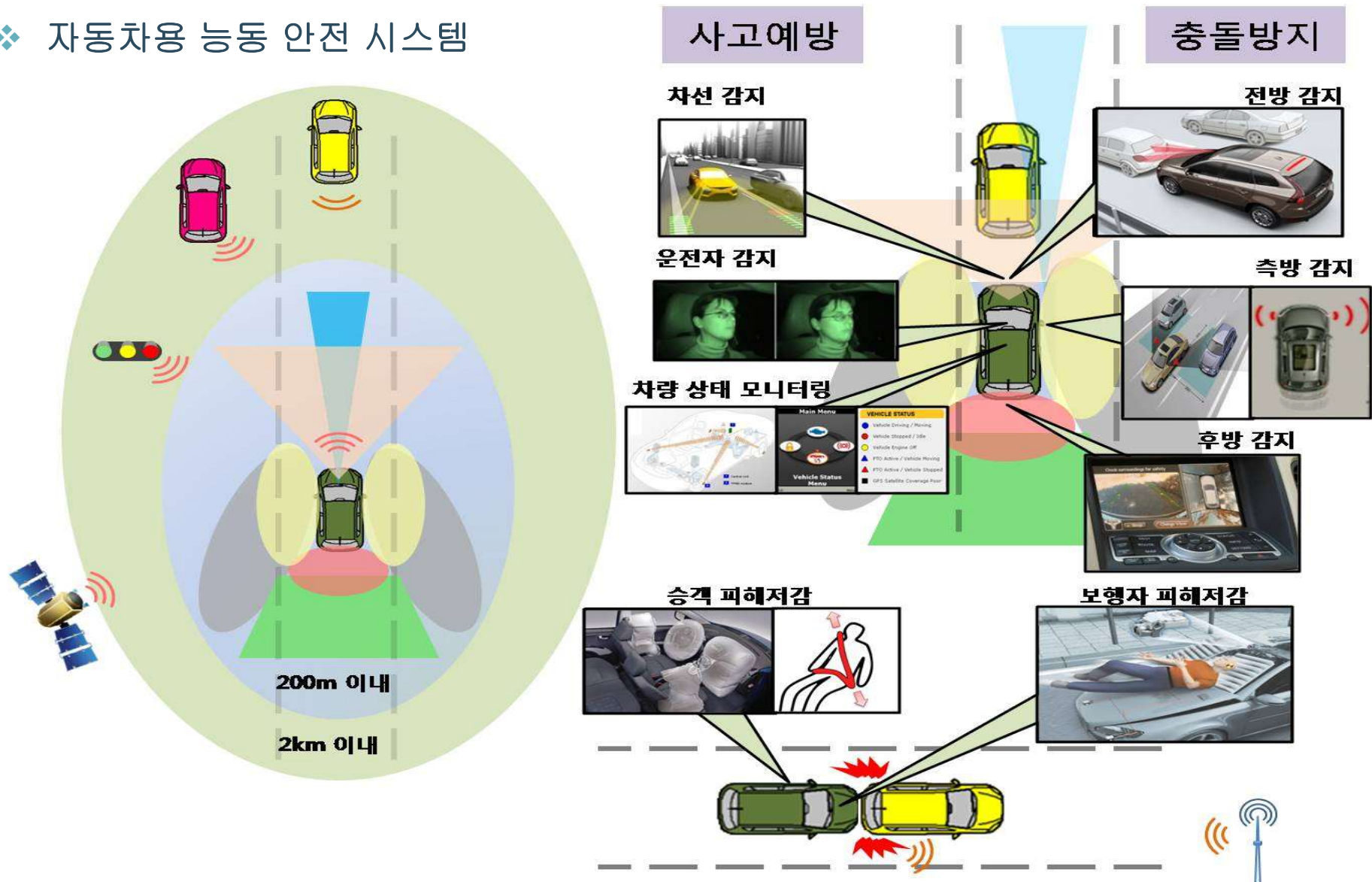


## Course Schedule

- Day 1 : Class Introduction, Introduction to Matlab Simulink  
Simulink Parameters and Blocks  
Subsystems and Control Examples
- Day 2 : Vehicle Longitudinal Dynamics  
Simulink Model of Vehicle Longitudinal Dynamics
- Day 3 : Vehicle Lateral Dynamics  
Simulink Model of Vehicle Lateral Dynamics
- Day 4 : State Flow Toolbox
- Day 5 : Automated Driving Simulation Software

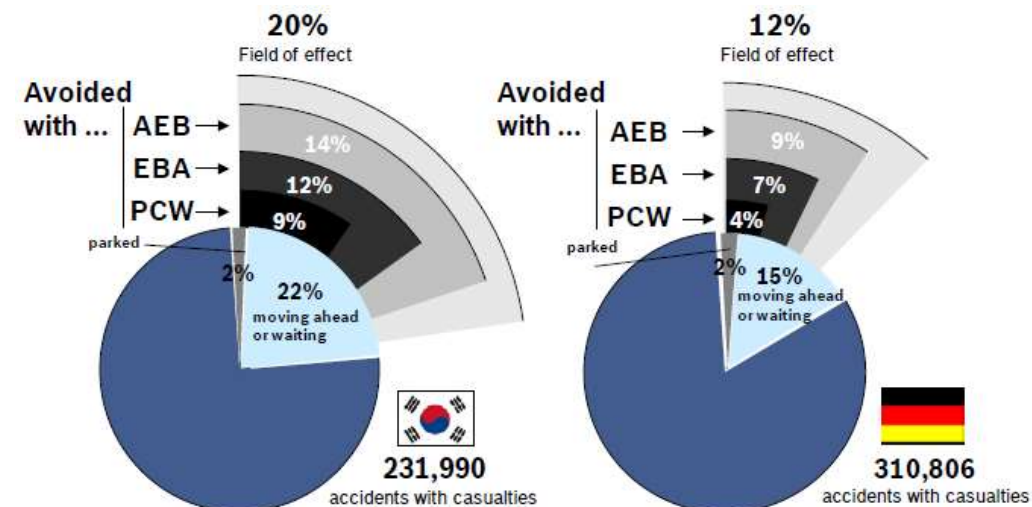
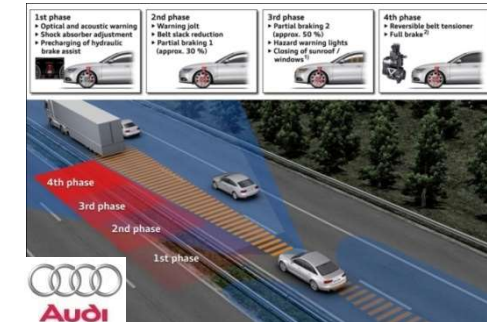
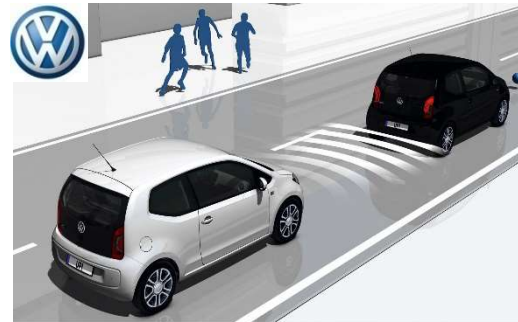
# Active Safety Systems

## ❖ 자동차용 능동 안전 시스템



# Active Safety Systems Overview

## - Autonomous Emergency Braking (AEB)



Sources: StBA DESTATIS 2009/ GIDAS: ROTA KOREA 2009/ KOTI/KOTMA 2010

< AEB 시스템으로 인한 후방 추돌 사고 회피율 추정 >

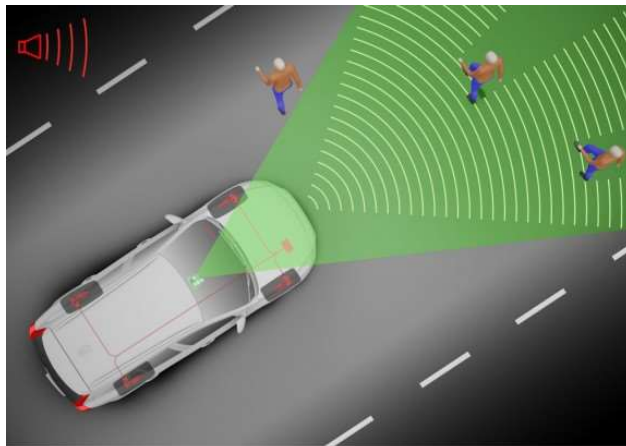
Reference : “Benefit analysis of predictive rear end collision avoidance and mitigation systems for South Korea using video documented accident data”, AVEC 2012



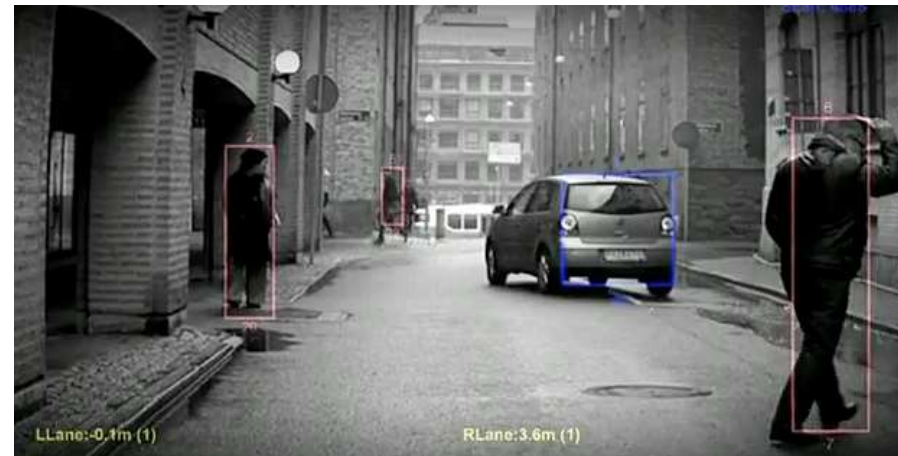
## Active Safety Systems Overview

### - Pedestrian Detection

- Volvo S60 Fusion of Radar & Vision



Pedestrian Detection with full auto brake consists of a radar unit integrated into the car's grille, a camera fitted in front of the interior rear-view mirror and a central control unit. The radar's task is to detect objects in front of the car and to determine the distance to them. The camera determines what type of object it is. In an emergency situation, the driver receives an audible warning combined with a flashing light in the windscreen's head-up display. At the same time, the car's brakes are pre-charged. If the driver does not react to the warning and an accident is imminent, full braking power is automatically applied.



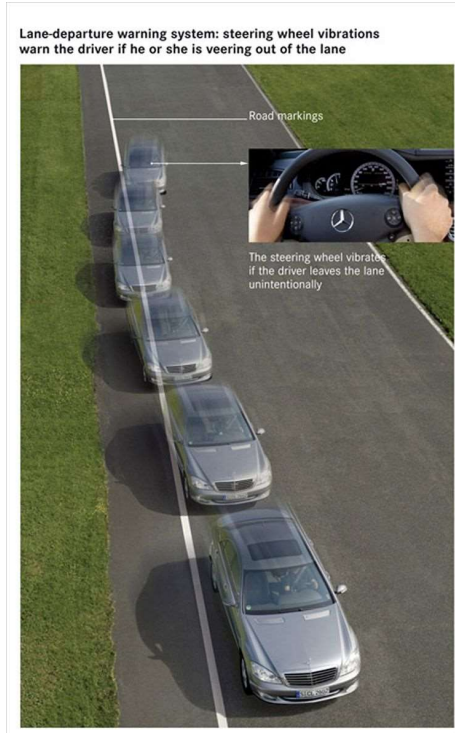
- Toyota - Night Vision



- Mobileye - Camera Vision



## - Lane Keeping Assistant System



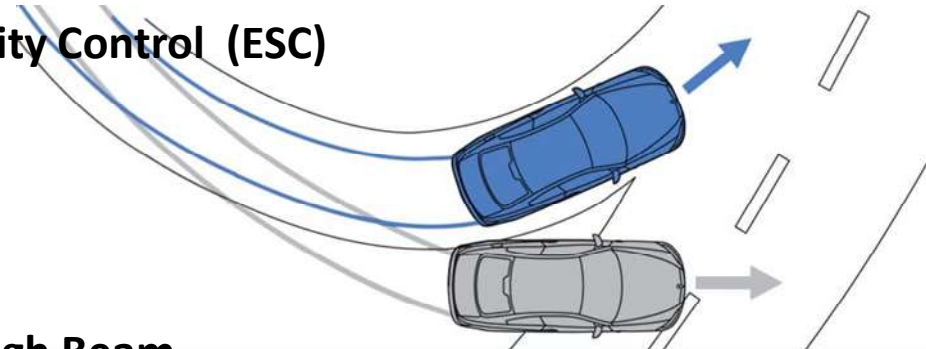
## - Blind Spot Detection



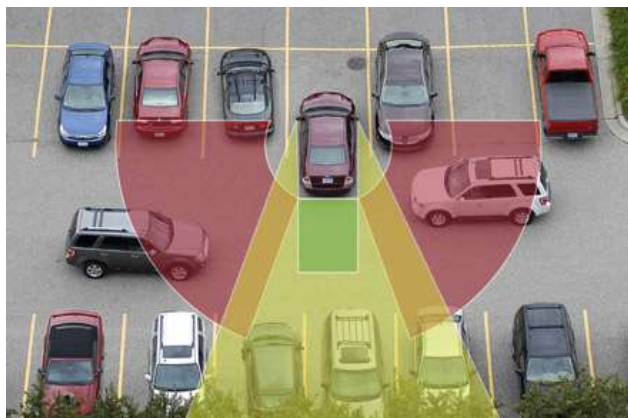
## - Drowsiness Alert



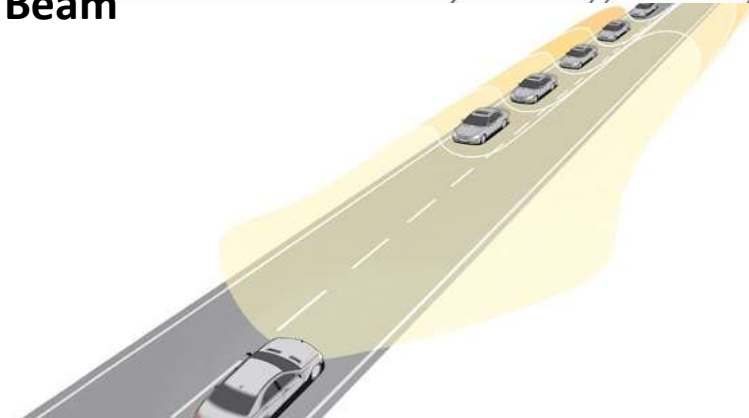
## - Electronic Stability Control (ESC)



## - Rear Traffic Crossing



## - Auto High Beam





## Active Safety Systems Overview

- Active Safety : Preemptive measures to reduce the possibility of **crashes**

- Anti-lock braking



rol



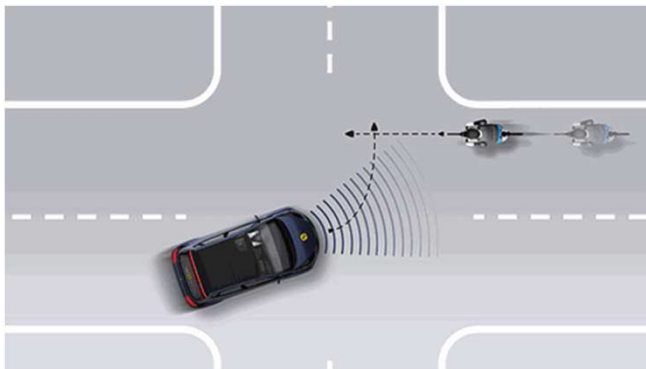
- Passive Safety : Reactive measures to reduce severity of **injuries**

- Airbag, Active Headrest and etc.



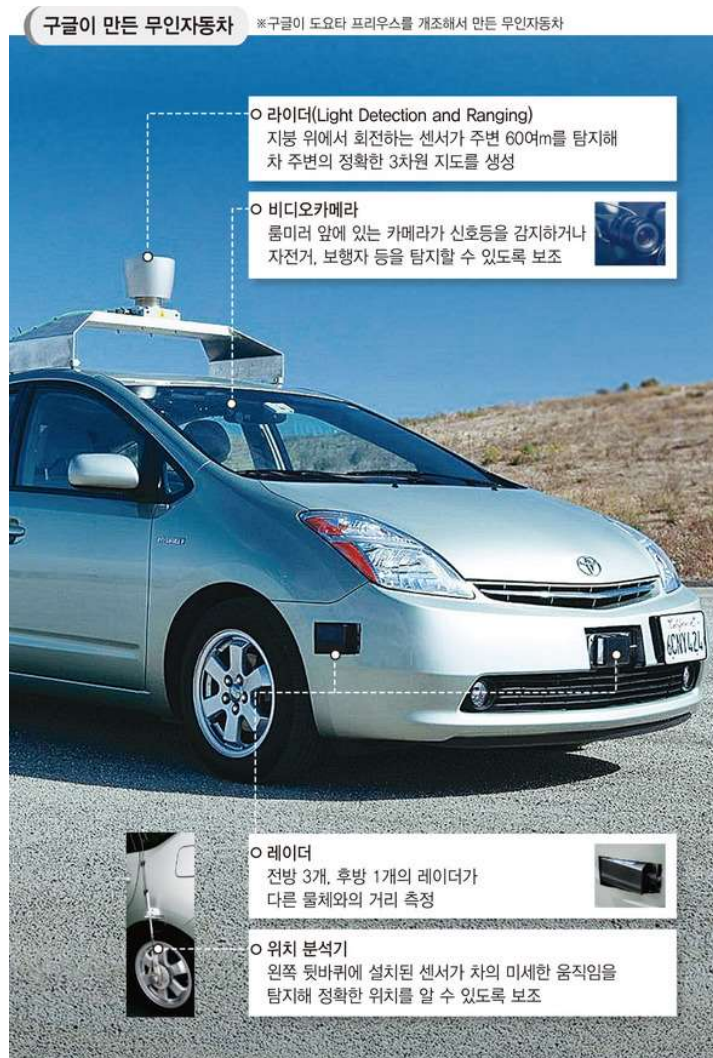
## Active Safety Systems Overview

- European New Car Assessment Program
  - Voluntary vehicle safety rating system
- “Euro NCAP Advanced” Improvements
  - From 2014, **Autonomous Emergency Braking** requirements were introduced.
  - From 2016, AEB Pedestrian requirements were added.
  - From 2018, AEB included Cyclists.
  - From 2020, AEB reverse and AEB Turn Across Path introduced.

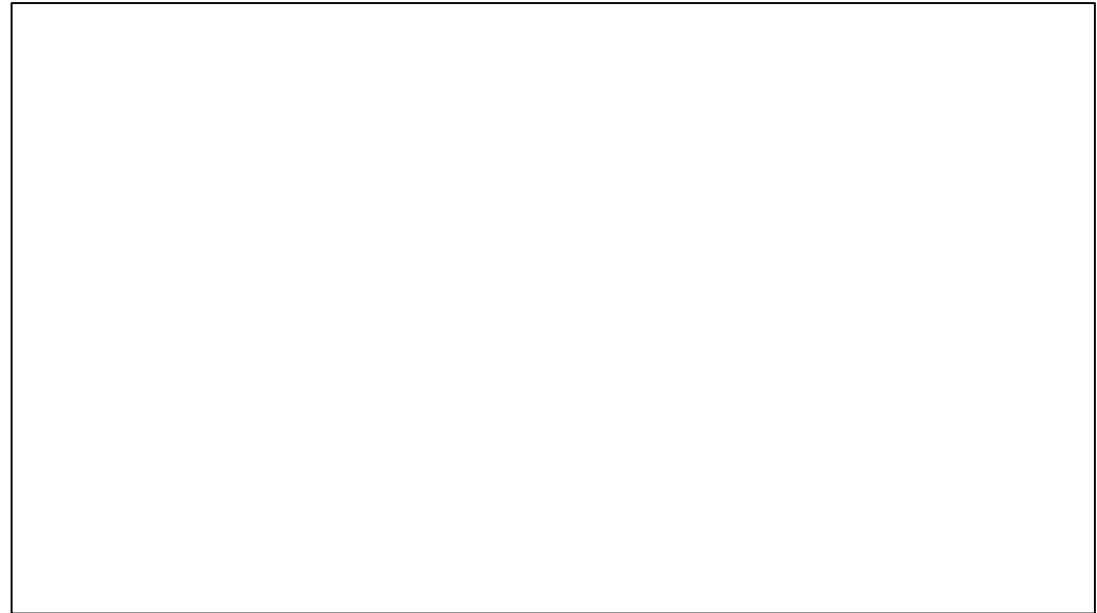


# 자율주행 자동차의 발전

## • Google 자율주행 자동차



## Waymo (구글 자회사) 자율주행 택시

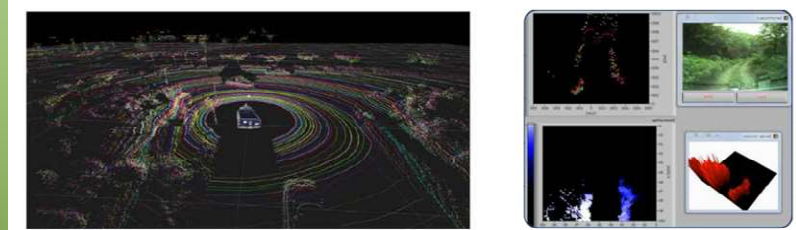


# 자율주행 핵심요소기술

## Sensor

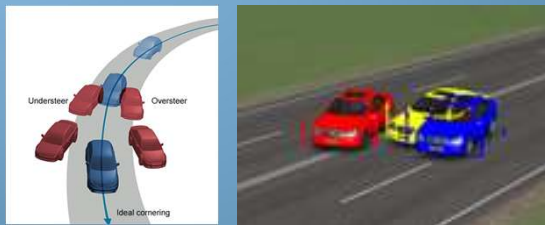


## Perception



Matlab Simulink

## Control



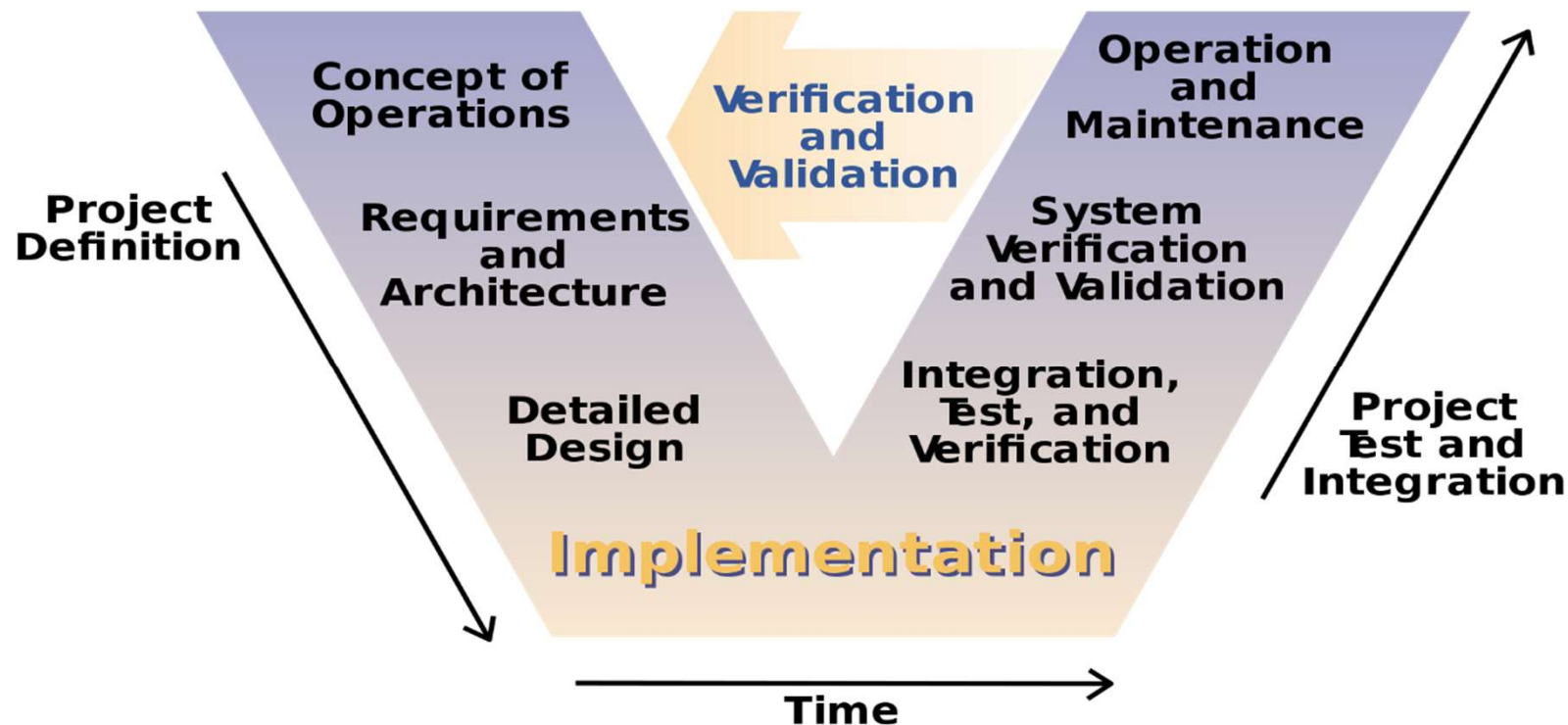
## Planning





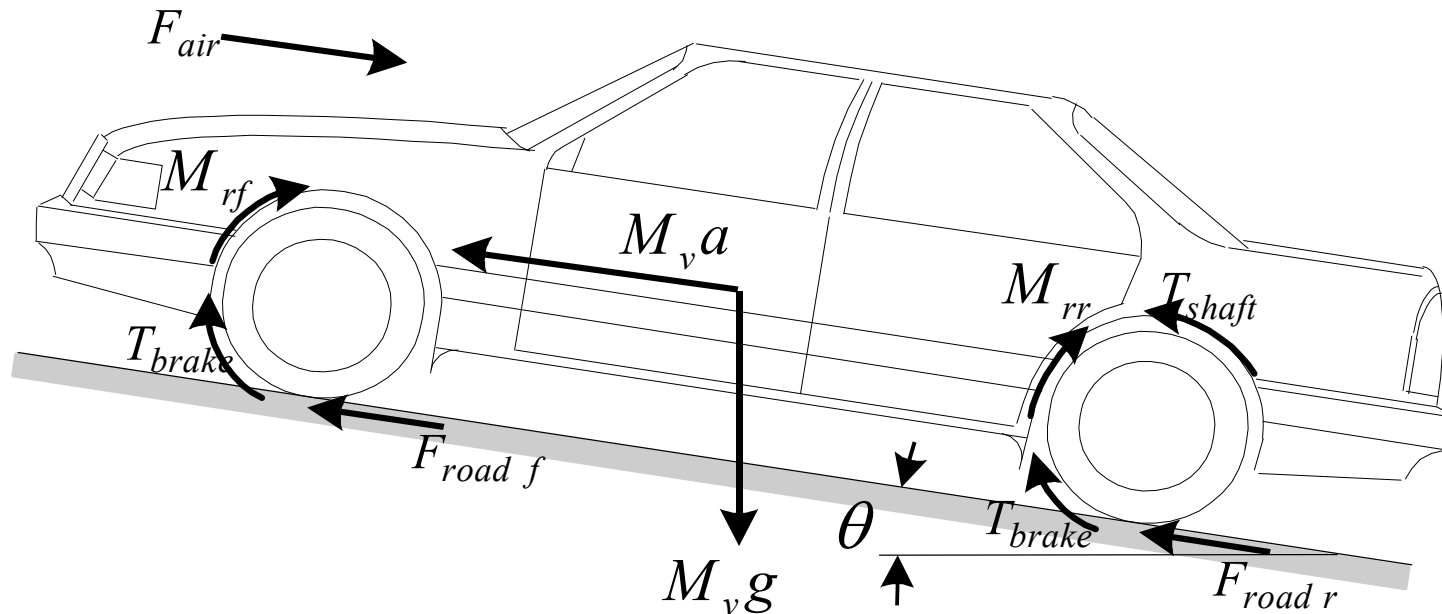
# Matlab Simulink 사용법

- V-cycle 기반 자동차 설계
  - 모델 기반 차량 시스템 설계 패러다임에서 시뮬레이션 활용의 중요성 대두
  - 제어 시스템의 복잡성이 높아짐에 따라 Simulink의 Code Generation 을 이용한 제어기 설계 보편화



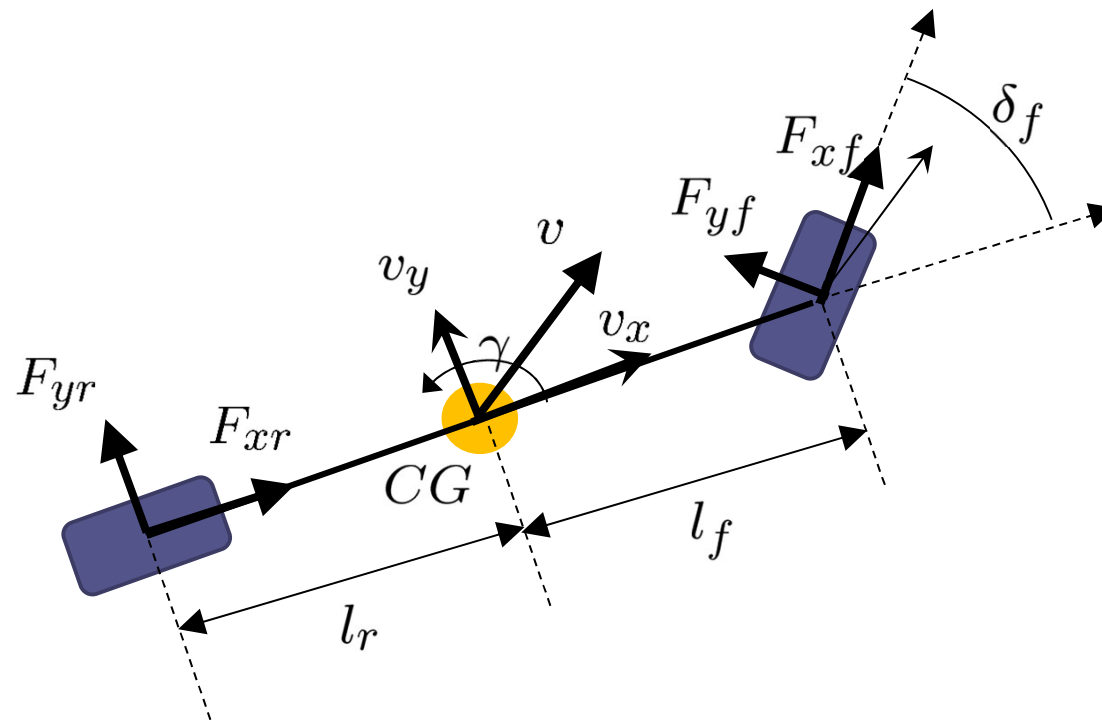
# Vehicle Longitudinal Model

- Simulink 기반 차량 종방향 모델 및 제어기 설계
  - Vehicle Dynamics, Wheel Dynamics
  - Engine & Transmission Model
  - Throttle & Brake Model
  - ABS Control Logic Design



# Vehicle Longitudinal/Lateral Model

- Simulink 기반 차량 횡방향 모델 및 제어기 설계
  - Bicycle Model
  - Lateral Tyre Model
  - ESP Control Logic Design

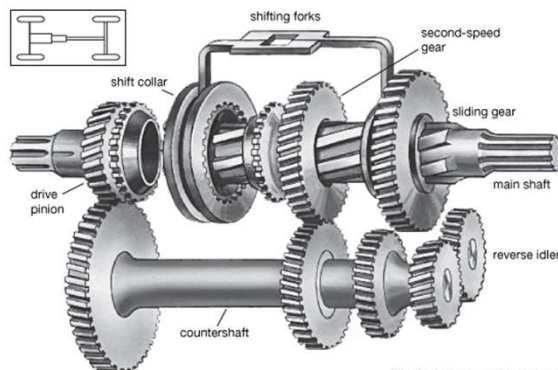


# State Flow Toolbox

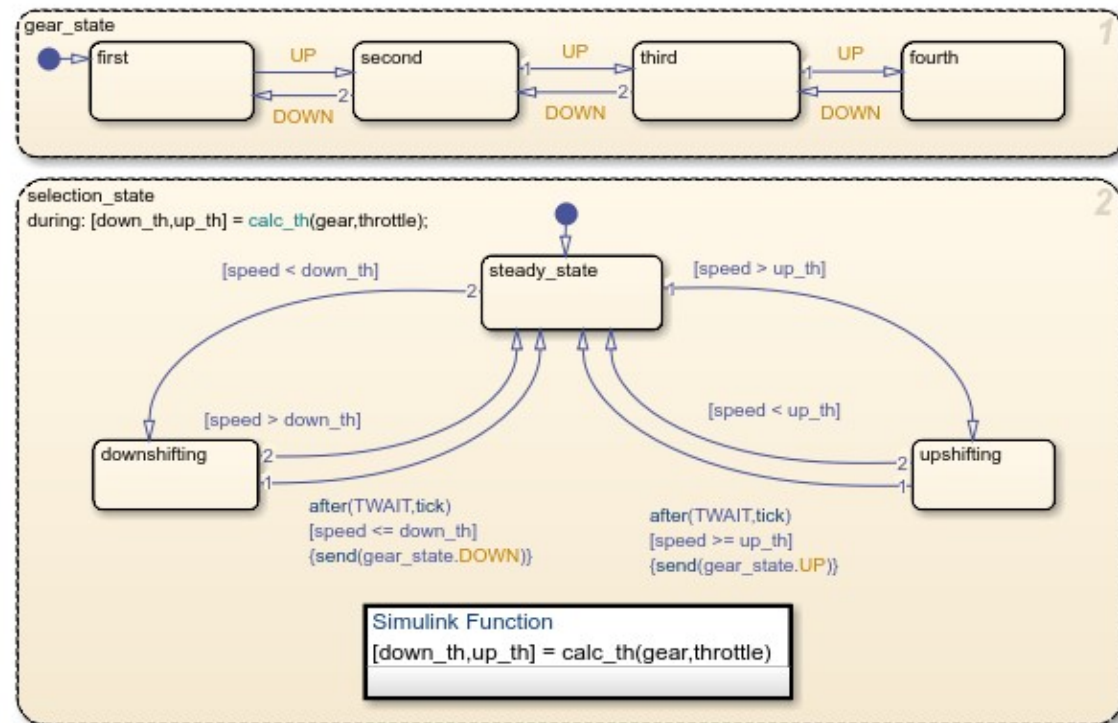
- Finite State Machine
  - Transmission Logic Example



How gears transmit power



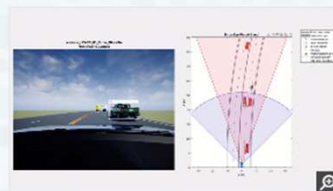
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# Automated Driving Toolbox

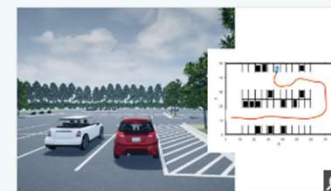
- Adas 및 자율주행시스템 설계, 시뮬레이션, 테스트



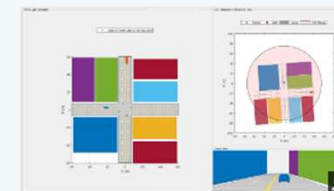
차선 추종 및 차선 변경  
문서 | 예제



자동 긴급 제동 및 전방 충돌 회피  
문서 | 예제



자동 주차 시스템  
문서 | 예제



교차로에서의 신호등 판단  
문서 | 예제