Lecture 10-5 Vehicle Steering Control

week 14 12/4/2014 Thurs

- Lane keeping model
- Lane keeping control

System Control

10-5 Vehicle Control: State Feedback and pole placement

Professor Kyongsu Yi

Vehicle Dynamics and Control Laboratory

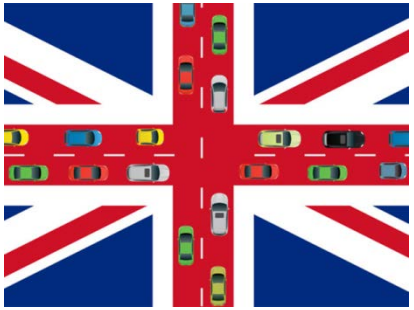
Seoul National University

Automated Driving Worldwide

Mercedes Self-Driving Car Bertha Comes to California

BMW's Chinese Robocar Tests Will Use Baidu's Maps

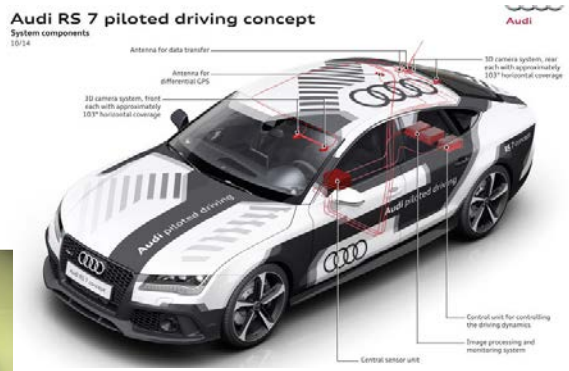
The UK Oks Self-Driving Cars on Its Roads Soon



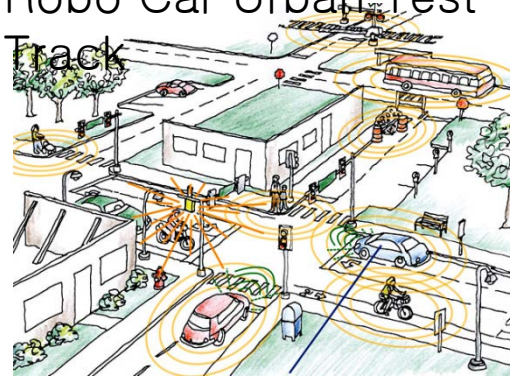
GM To Pour All Resources Into Single Car That Can Be Safely Driven Down Street And Back

"Future Truck 2025"

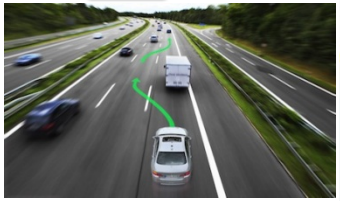
Self-driving Audi RS7 aims for 149 mph in driver-free race lap



University of Michigan Robo Car Urban Test Track



Tesla **produces self-driving vehicles**



Aims to "90% Autopilot" By 2015

Robotic Road Train

Semiautonomous cars
will play follow the leader, giving drivers a rest and saving fuel

Illustration: Tavis Coburn
IEEE Spectrum November 2012

Semi-autonomous cars

무인 자동차 시대 〈上〉 볼보 군집주행 개발현장 르포 ◇운전자 없이 달리는 무인 자동차 ◇연비·도로 효율성 획기적 개선

그래픽=조선일보 디자인편집팀

맨 앞차만 사람이 운전 대열에 붙어 통신 연결하면 기차처럼 줄이어 달려
도로 효율성 3배 높아지고 최대 20% 연비 개선 효과도 아직은 복잡한 도로선 못 써

2012-9-26 조선일보

상용화 센서 기반 HK SSC 검증 플랫폼 구축 ADV6

Camera : 영상 취득용

Vision Sensor
(Mobileye : C2-170)

Autobox

Long range Radar
(Delphi : 77GHz)

Rear-side Radar
(Delphi : 24GHz)

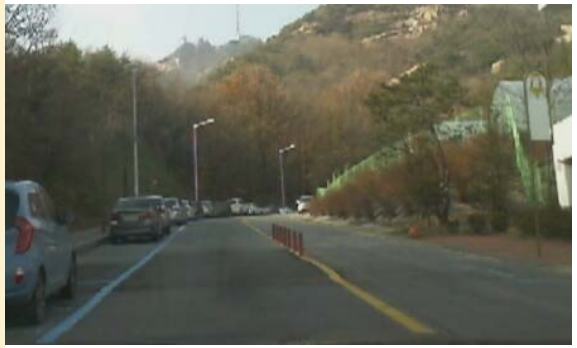
Laser Scanner
(IBEO 장착 환경 구축)

RT3002

Automated Driving on Urban Roadways

- 총거리 : 1.2 km
- 신소재공동연구소(A) → 제 2공학관(B)

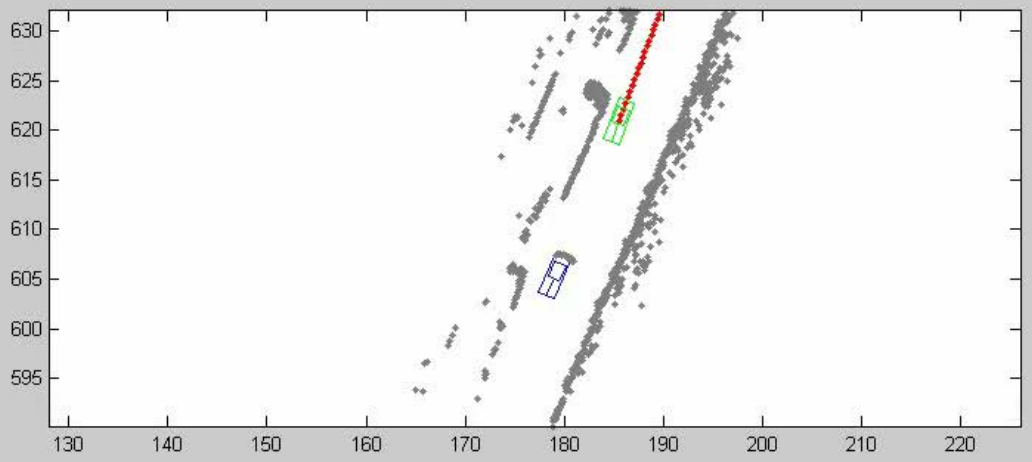
Parked Vehicle

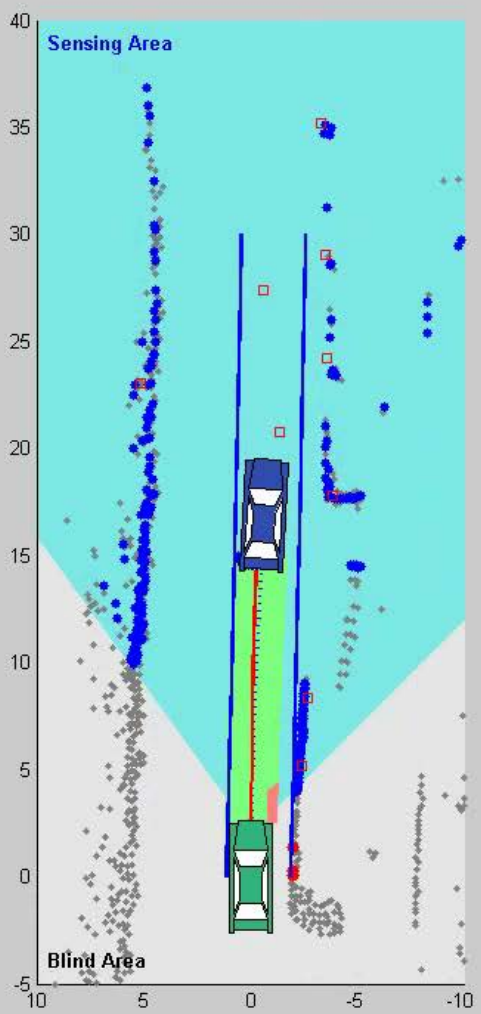


Non-vehicle Obstacle
- Pedestrian
- Guardrail

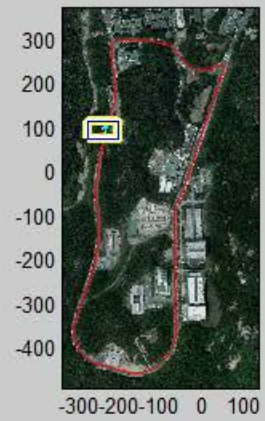
Other traffic Participant
- Preceding Vehicle
- Oncoming Vehicle

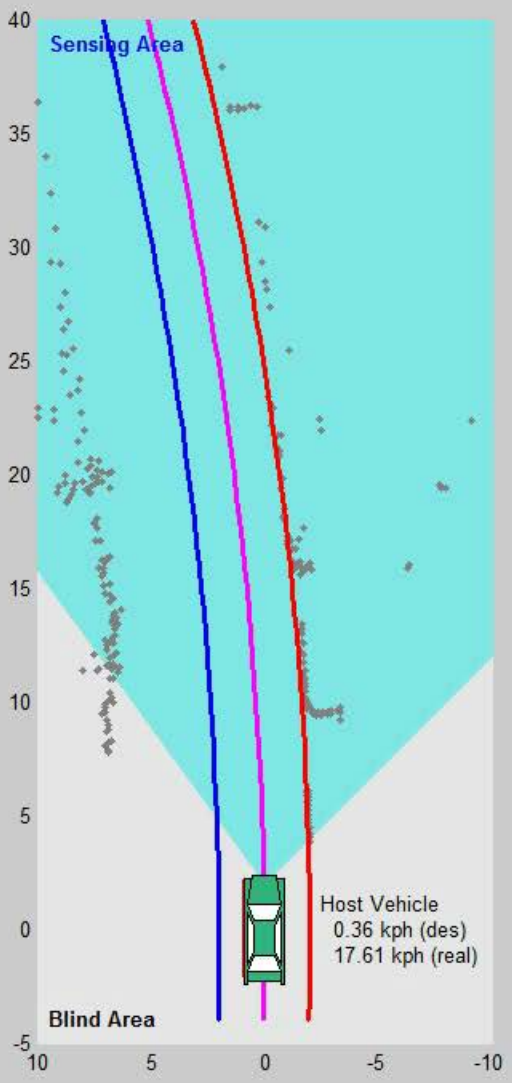

Automated Driving
System On


630
625
620
615
610
605
600
595
130
140
150
160
170
180
190
200
210
220


Sensing Area
Blind Area
40
35
30
25
20
15
10
5
0
-5
10
5
0
-5
-10

Automated Driving





Benefits and enabling technologies

- Safety
- Fuel saving
- Traffic efficiency

- Technologies
  - Risk management by Co-pilot
  - Eco driving by ADAS-GPS-map
  - v2X-ITS

Control Issues

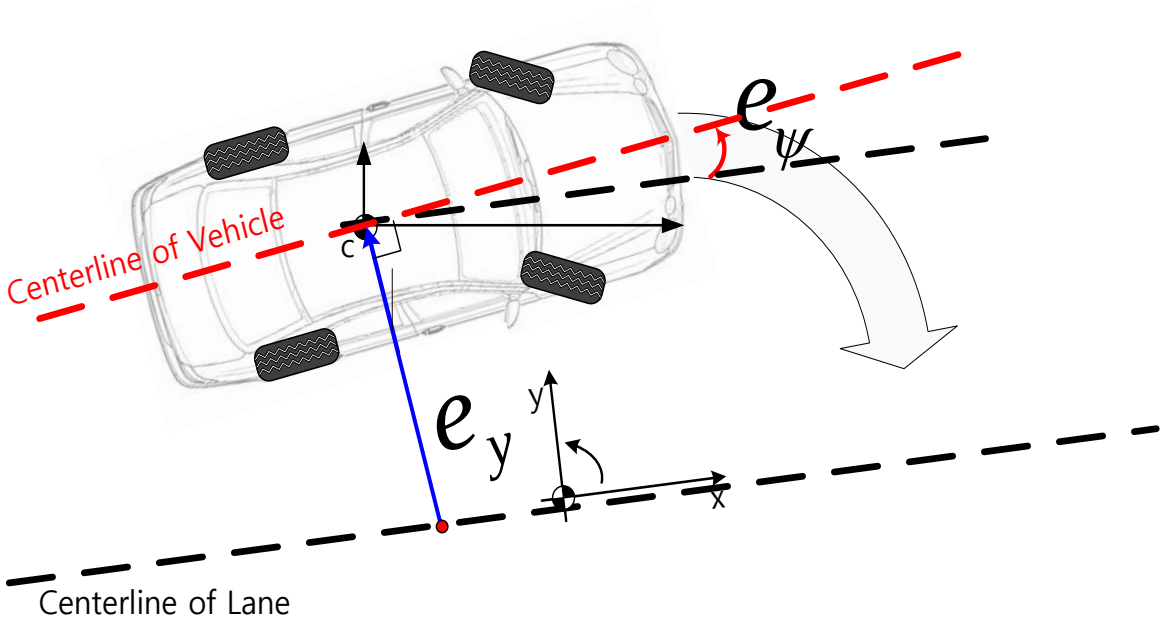
1. Sensor Information
    - Practical implementation

2. Control Methodology
    - Feedforward
    - Feedback

3. 제어성능
    - 제어성능
    - Measurement noise disturbance effect
    - Control System Module

Error Dynamics : Position And Yaw Angle Error

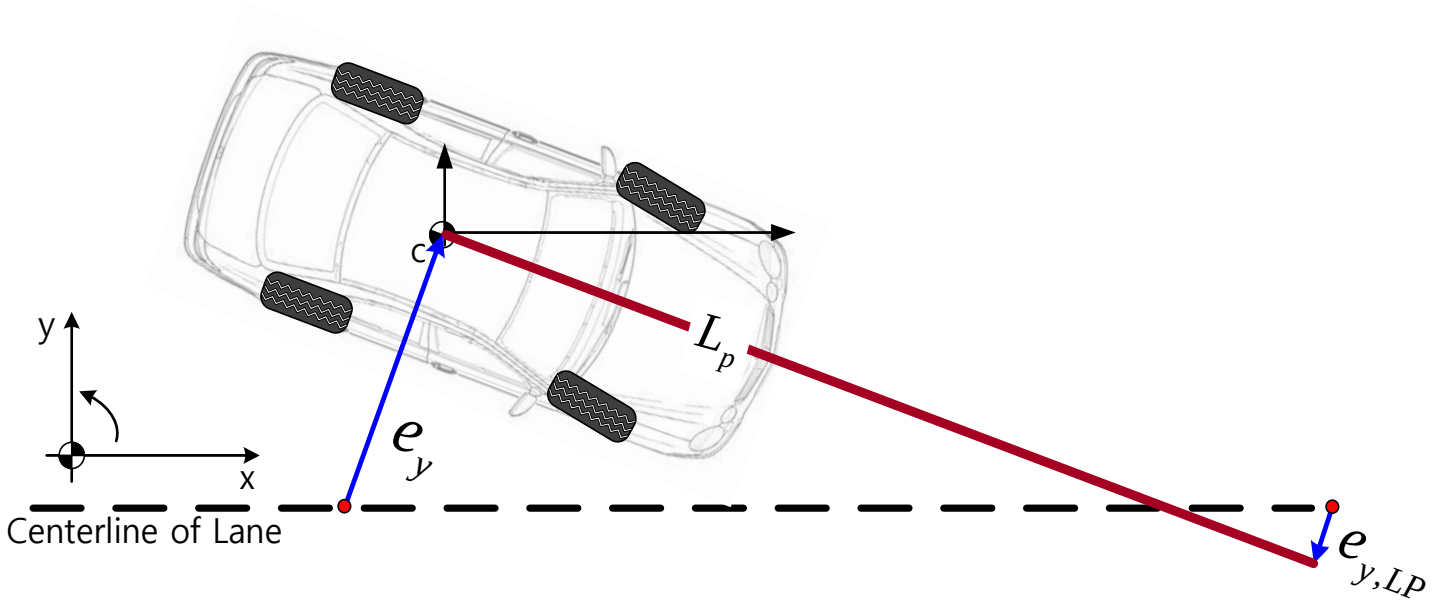
1. Position and Yaw Angle



$$e_y, e_\psi$$

Error Dynamics : Preview Distance Error Based

2. Position Error & Preview Distance Error (e_y, e_{ψ, L_P})



Error Dynamics : Theoretical Optimal Control

3. Theoretical : Map based Preview Optimal Control

$$\begin{bmatrix} \dot{e}_y \\ \dot{e}_\psi \end{bmatrix} = \begin{bmatrix} f(x,\delta,\omega) \\ f(x,\delta,\omega) \end{bmatrix}$$

$$\dot{x} = Ax + B\delta + F\underline{\underline{\omega}}$$

Known

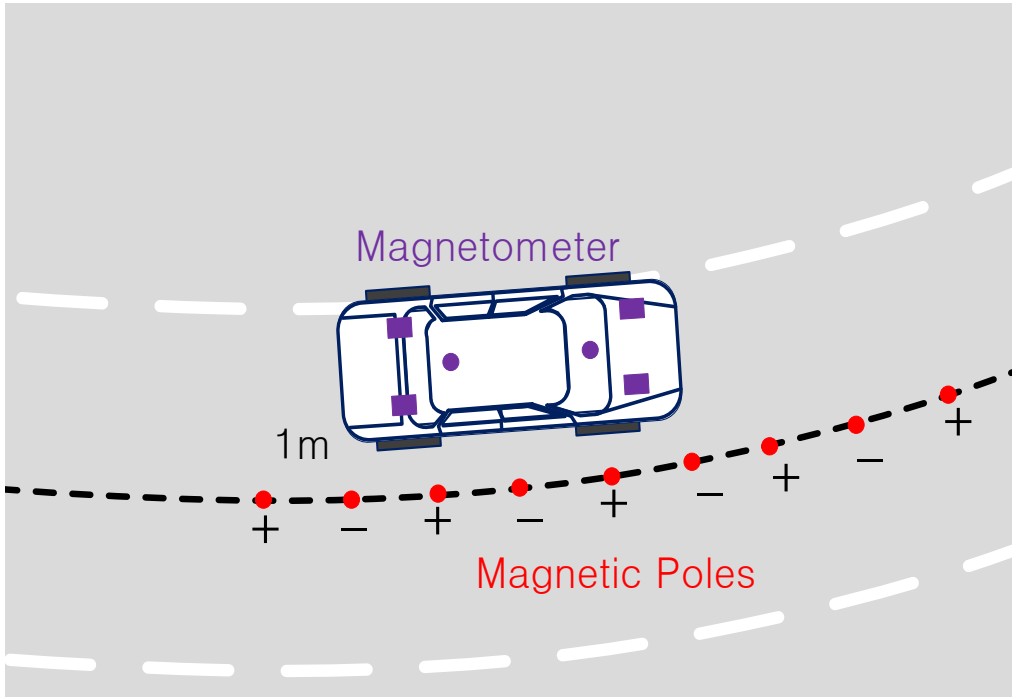
Measurements

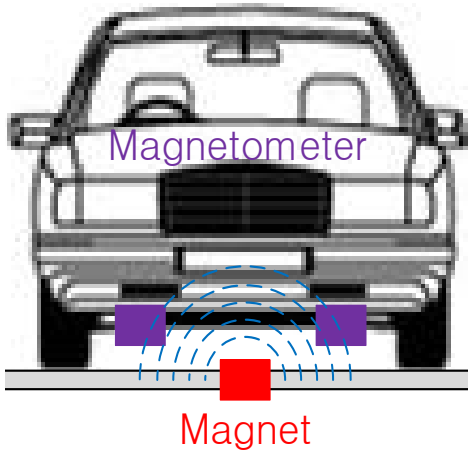
1. 1988-1990 : PATH - Magnetic Sensor

2. Vision / Camera : Commercially Available

3. GPS / MAP

Measurement : Magnetic Sensor

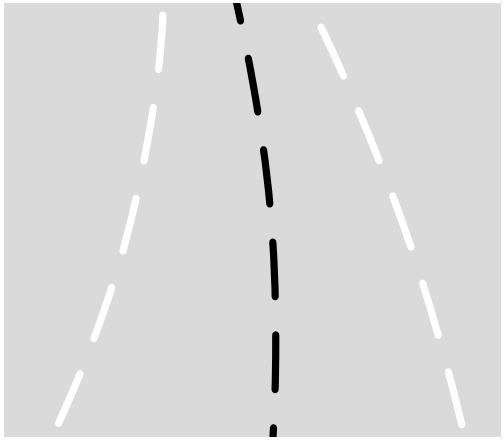




$$\Rightarrow \left[e_y, e_\psi \right]$$

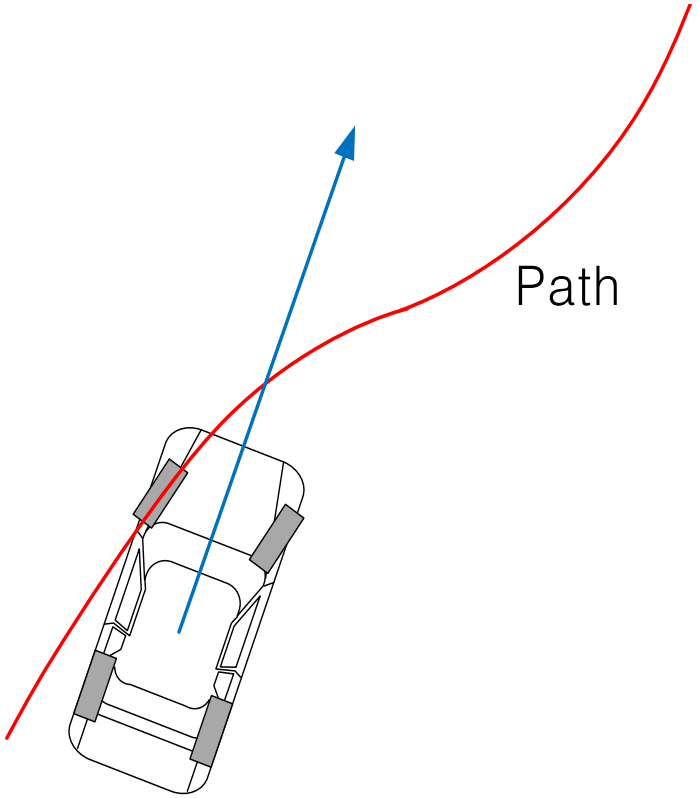
Measurement：Vision

Vision： $e_y, e_\psi, R(curvature)$



$$\begin{cases} LDW \\ LKS \\ LDAS \end{cases}$$

Measurement : GPS / MAP



$$x, y, \psi, \text{Map Path} \Rightarrow e_y, e_\psi$$

End of Steering Control

Fall 2014 System control