CS686:
High-level Motion/Path Planning Applications

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Course URL:
http://sglab.kaist.ac.kr/~sungeui/MPA

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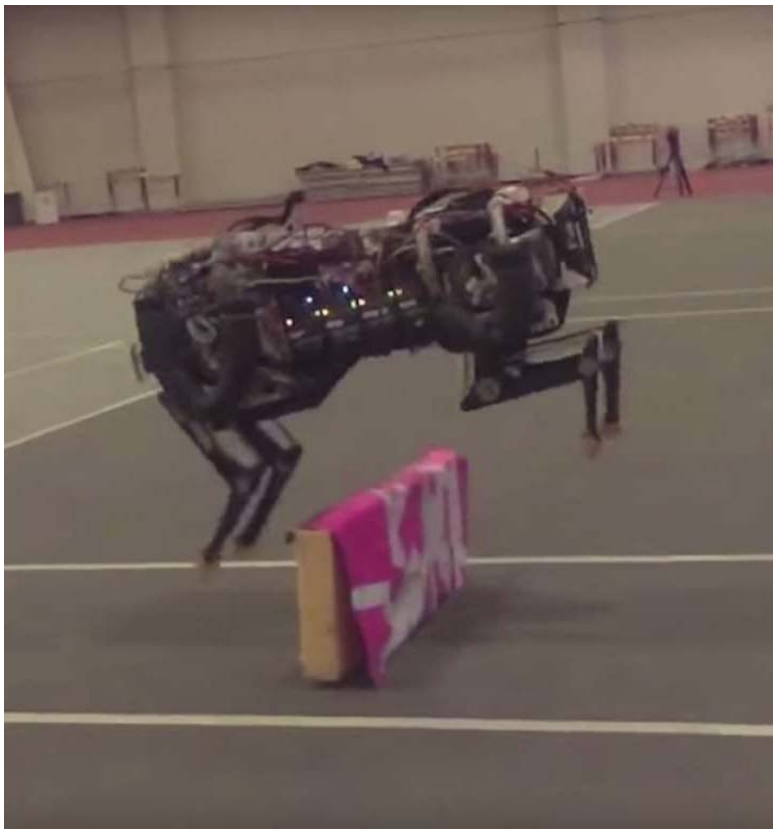
Class Objectives

- **Discuss my general research view on motion planning**
- **Discuss related applications**

Our Research Directions

- Many robots are available
  - Different sensors and controls
- Basic controls are developed with such robots
  - Primitive motions are developed together
- Therefore, motion/path planning are widely researched



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Our Research Directions

- General motion planning tools
  - Primitive controls are available at HW vendors
  - How can we design a standard MP library working with those different robots?
  - For example, OpenGL for the robotics field; vendors support OpenGL, and programmer uses OpenGL for their applications

Our Research Directions

- **High-level motion strategy are necessary**
  - **Optimal paths given constraints**
  - **Handling multiple robots for certain tasks**
  - **E.g., how can we efficiently assemble and disassemble the Boeing plane?**

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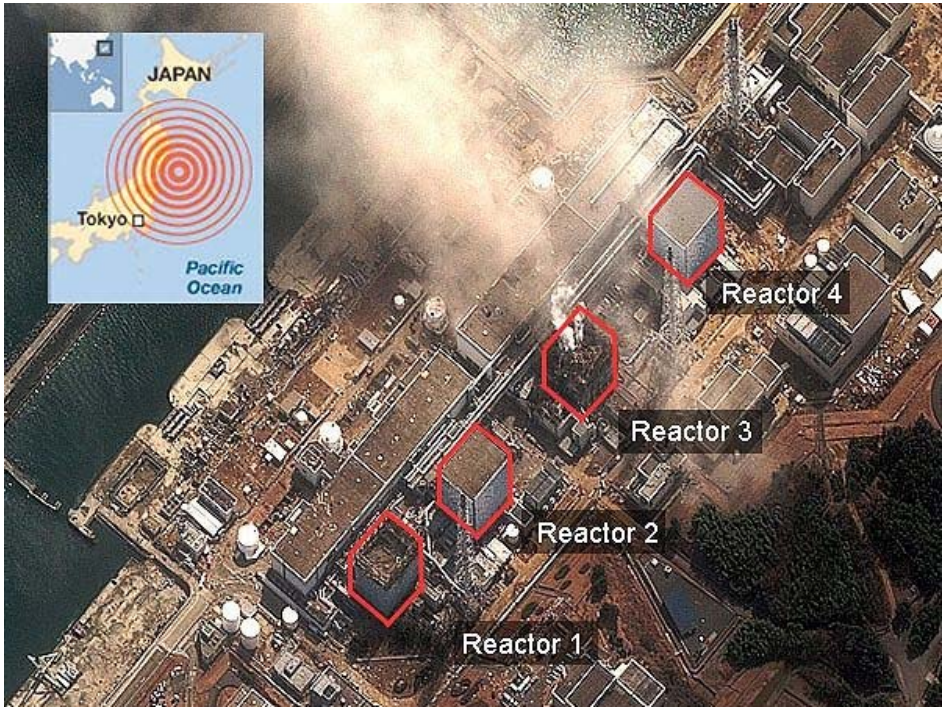
Our Research Directions

- **High-level motion strategy are necessary**
  - **Optimal paths given constraints**
  - **Handling multiple robots for certain tasks**
  - **E.g., “Clean them!”**

Our Research Directions

- **High-level motion strategy are necessary**
  - **Optimal paths given constraints**
  - **Handling multiple robots for certain tasks**
  - **E.g., dangerous places for human**



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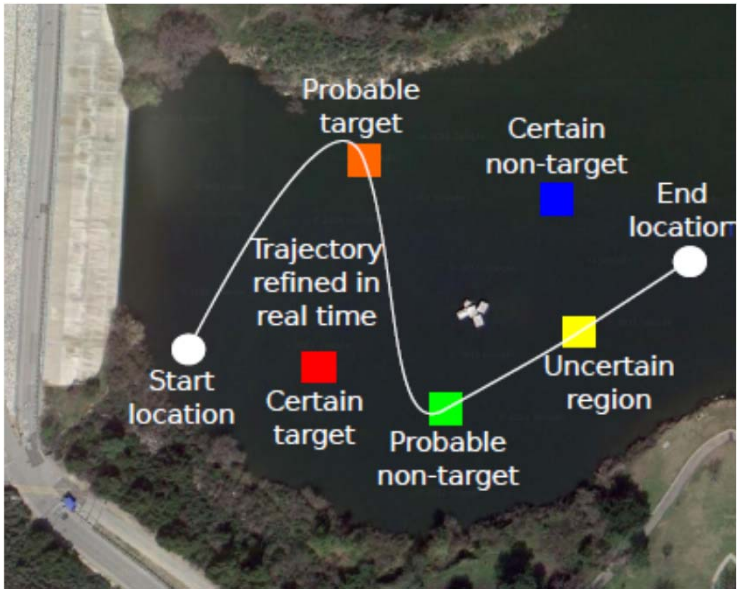
Task Search and Classification

- **Identify and classify a number of initially unknown targets**
  - **Useful for tedious, dangerous, or impossible for humans (underwater, disaster sites, etc.)**
  - **How can effectively perform this process during limited deployment time?**



Long-horizon Robotic Search and Classification using Sampling-based Motion Planning
Hollinger, et al.

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Task Search and Classification

- **Environment (e.g., ocean) monitoring**

Different marine sensors, Smith et al.

Use robotic sensor networks

- each node can move autonomously or work with others

Marine sampling

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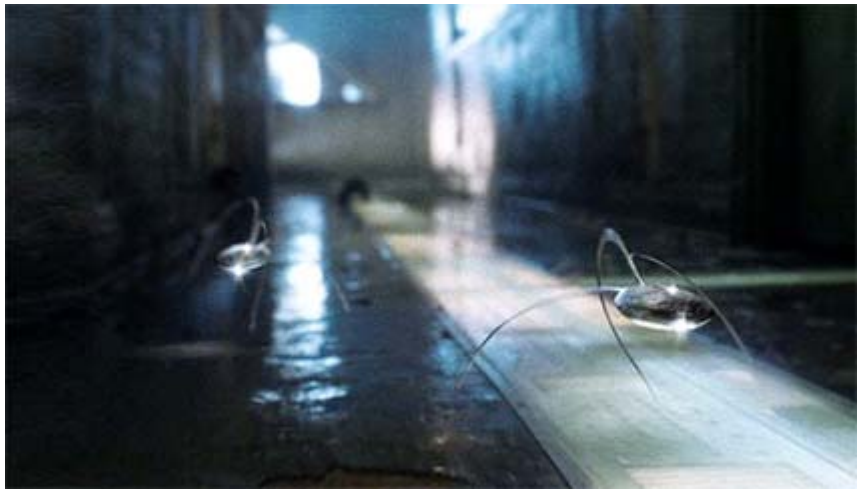
Minority Report



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Planning with Dynamics

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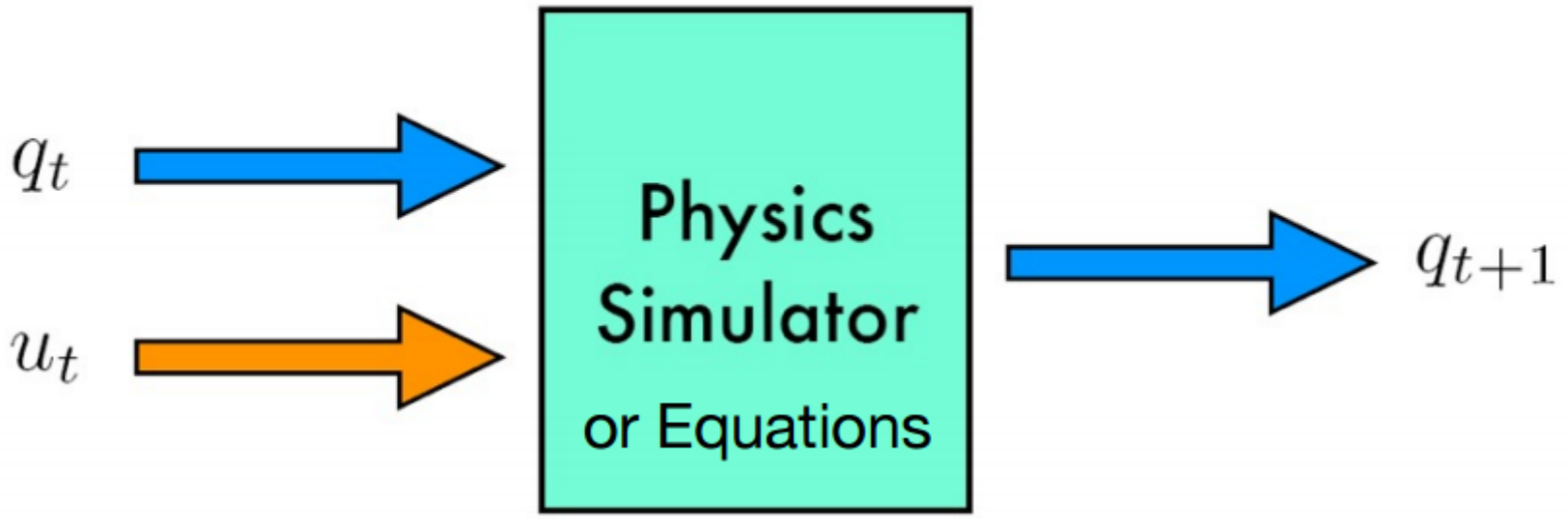
Physical Systems Planning



$$F(q_t, u_t) = q_{t+1}$$

Space of controls is defined

Kavraki

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Physical System Planning

Given

1. an initial state $q_0 \in Q$

2. a goal set $G \subset Q$

The discrete physical systems planning problem is to compute a sequence $u_0, \ldots, u_N$ such that:

$$F(q_i,u_i) = q_{i+1}$$

and $q_{N+1} \in G$ is contained in the goal set.

Planning with Dynamics

- **Adding dynamics is essential to increase physical realism**
- **Techniques from control theory can be used to create better paths**
- **Still fairly open**

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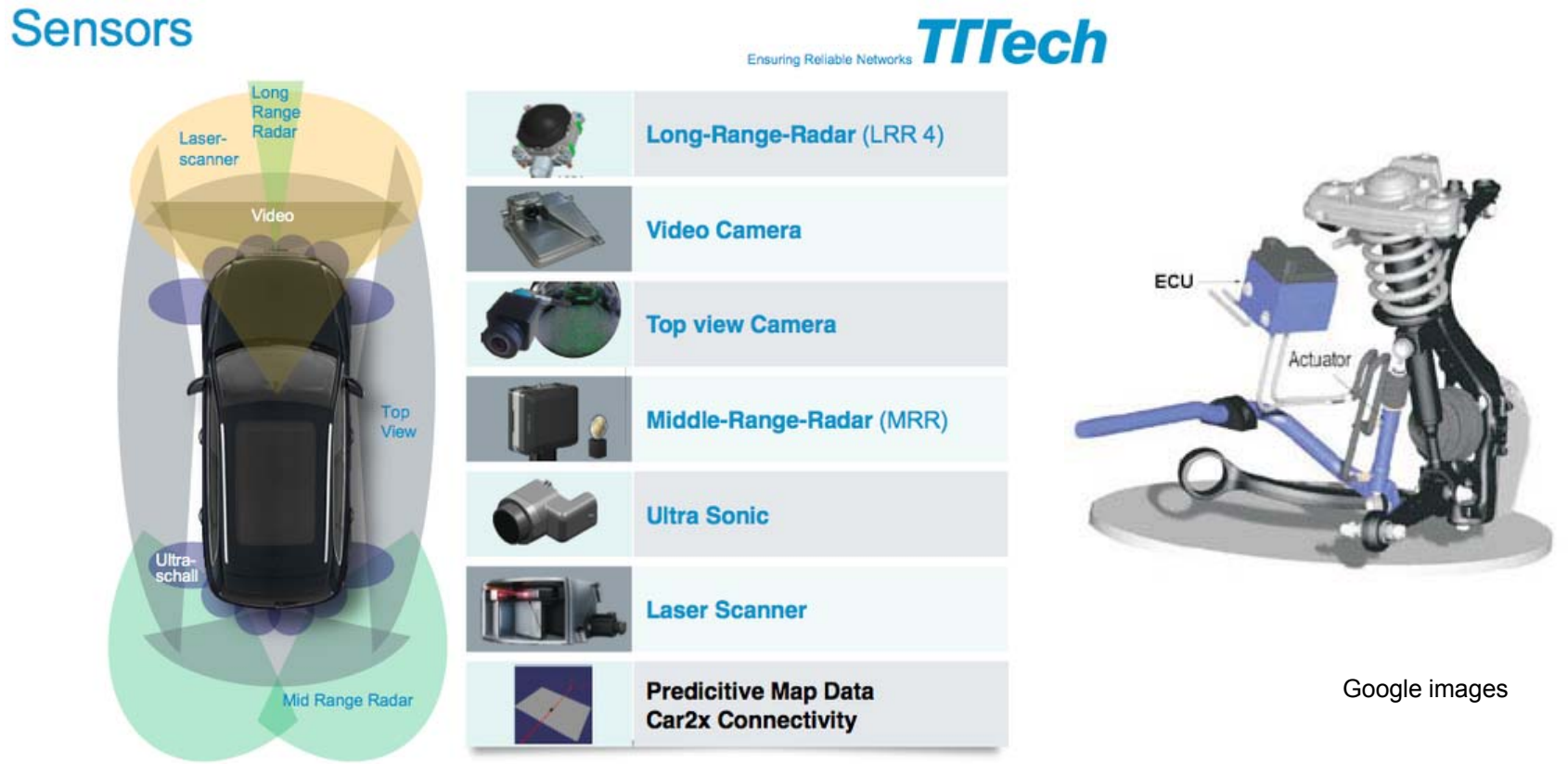
Case Study: Self-Driving Cars

Typical systems of autonomous vehicles: many sensors and ECUs



Google images

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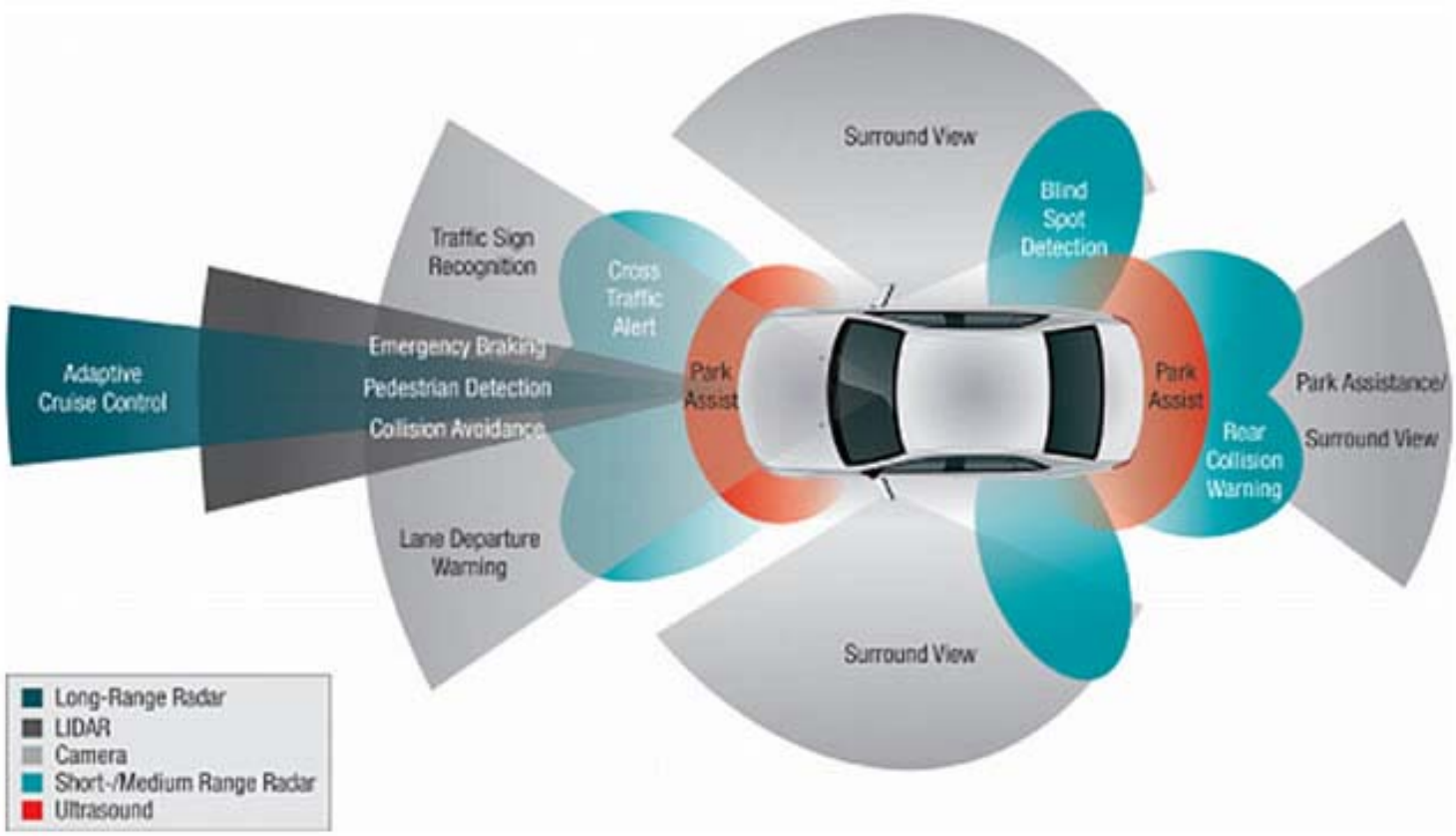
Plan of Development: Response to Plan

Evolve ADAS (Advanced Driver Assistance Systems) focusing on fast response to autonomous driving (high-level reasoning)



ADAS Sensors

- **Need to identify lanes, pedestrians, traffic signs, other nearby cars**
- **Combine radar for detection and camera for recognition**

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Technical Issues

- **High accuracy**
  - **99.99% is not enough for detection and recognition problems (e.g., detecting red signs)**
- **Weather challenges**

Bob Donaldson / Post-Gazette

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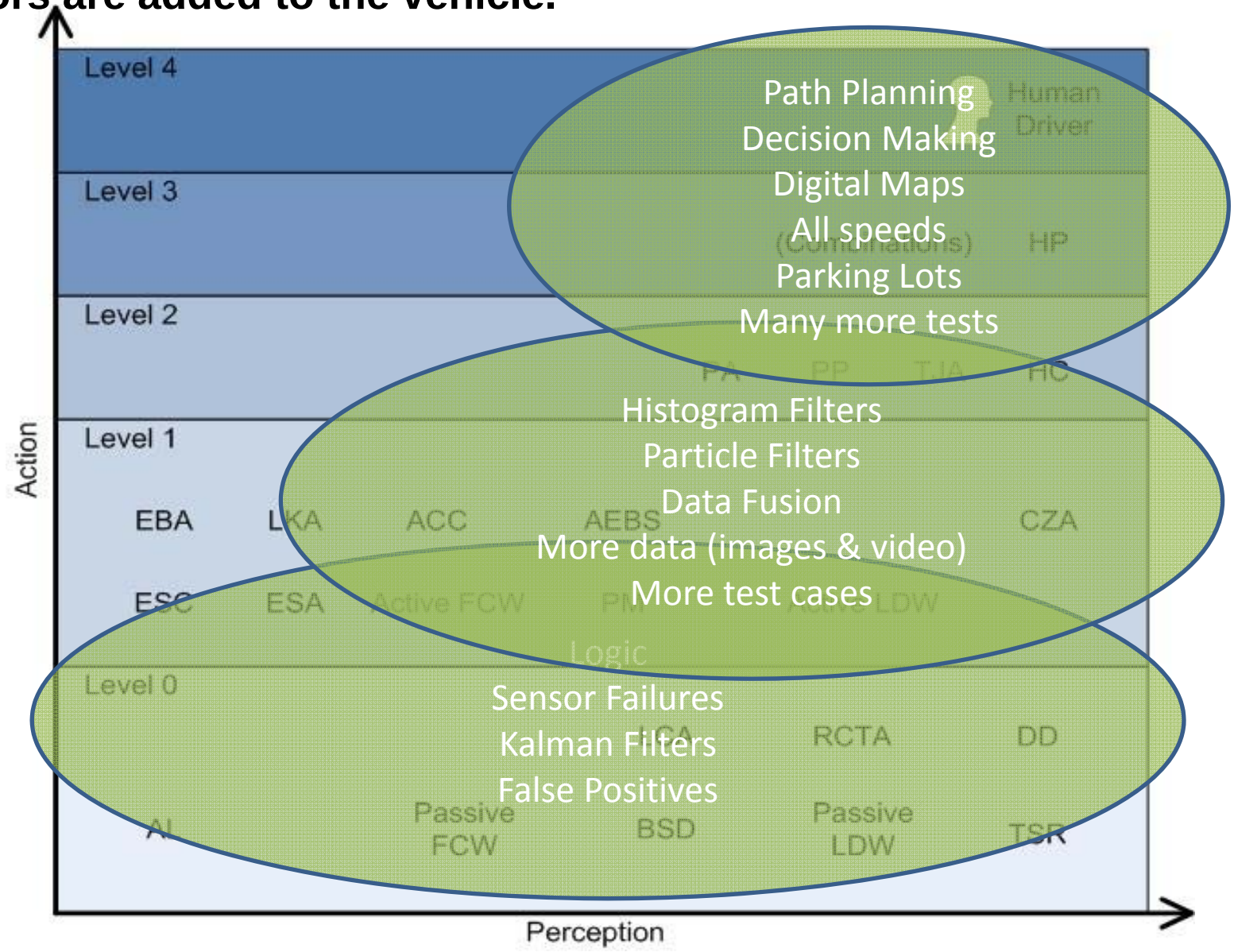
Testing & Certification

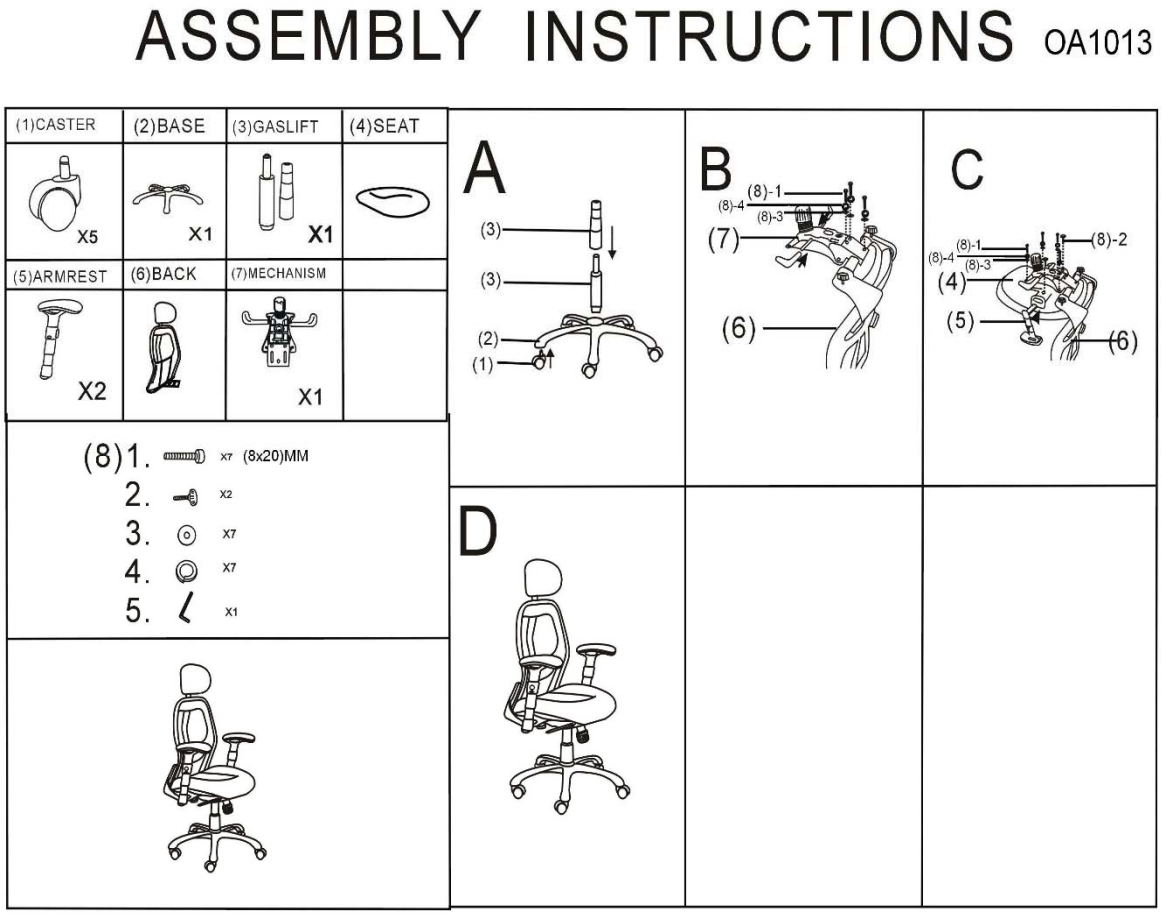
Testing becomes exponentially more complex as more sensors and actuators are added to the vehicle.



National Advanced Driving Simulator

Automated Planning w/ Motion Planning

- **Assemble the chair w/ or even w/o the instruction**



Class Objectives were:

- Discussed my general research view on motion planning
- Discussed related applications

Next Time..

- **RRT techniques**

Homework for Every Class

- **Come up with one question on what we have discussed today and submit at the end of the class**
  - **Write a question more than 4 times on Sep./Oct.**
  - **1 for typical questions**
  - **2 for questions with thoughts or that surprised me**
- **Go over the next lecture slides**
- **Browse 2 ICRA/IROS/RSS/WAFR/TRO/IJRR papers**
  - **Prepare two summaries and submit at the beginning of every Tue. class, or**
  - **Submit it online before the Tue. Class**

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