

# Welcome to CSE 571 Robotics

**Instructor** Dieter Fox

**Teaching Assistants**  
Adam Fishman  
Junha Roh

**Duckietown Tsar**  
Karthik Desingh

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## Organization

- Zoom lectures: T/Th 10:00 – 11:20 (recordings on Canvas)
- Zoom office hours
  - Dieter: Fri 10:30am
  - Adam: Tue/Thy 3:00pm
  - Junha: tbd
  - Karthik: Duckiebots assembly workshops tbd
- Tasks
  - 3 homeworks covering Gaussians, particle filters, RRT planning, and deep learning (40%)
  - 2 projects on Duckietown platform (60%)
- Readings: Papers and chapters from *Probabilistic Robotics*

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## Organization

- Late policy  
You are allowed to use **6 late days throughout the quarter**. After this, assignments turned in late will incur a penalty of 20%, for each day. Please plan ahead and don't expect more.
- Academic Honesty Policy  
While we **encourage students to discuss homeworks**, each student **must write up their own solution**. It's fine to use a source for generic algorithms (with attribution), but it is not allowed to copy solutions to the problems. Additionally, **students may not post their code online**. If we determine that a student posted their code online, they will get an automatic 50% reduction on the entire assignment (math + code) and if they copy code for the problems from another student or from online, they will get an automatic 0% for the entire assignment (and possibly reported to the college).

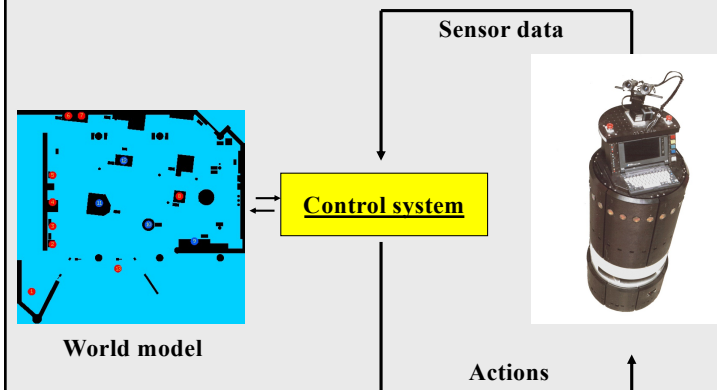
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## High-level View on Robot Systems



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## Industrial Robotics Today



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## Minerva (CMU + Univ. Bonn, 1998)



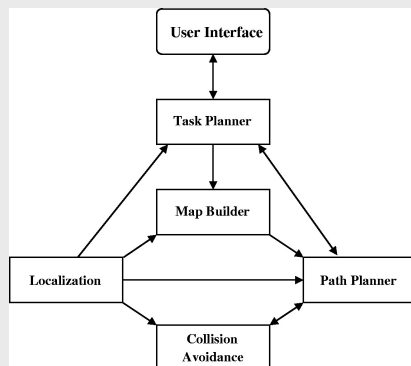
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## Architecture of the Control System



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## RoboCup: Integrated System Research

- Focus on addressing all problems at once
  - Hardware development
  - Perception
  - Low level control
  - High level planning and decision making
  - Multi robot systems

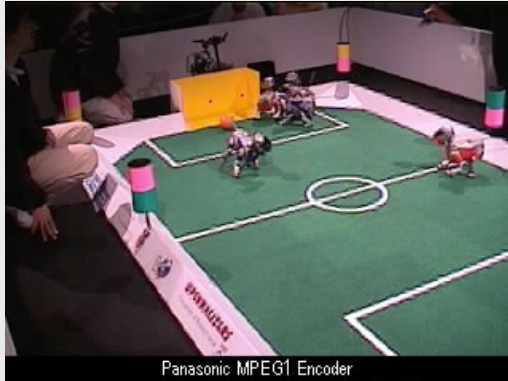
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## RoboCup-99, Stockholm, Sweden



Panasonic MPEG1 Encoder

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## RoboCup: Standard Platform



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## DARPA Urban Challenge 2007



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## Self-Driving Cars



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## Robots in Warehouses (Kiva@Amazon)



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## Amazon Prime Air



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## DARPA Robotics Challenge 2015



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## Getting out of Car



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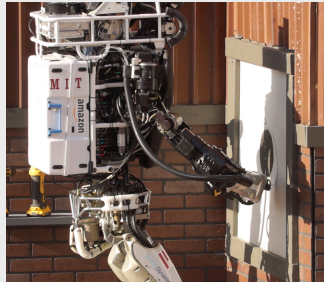
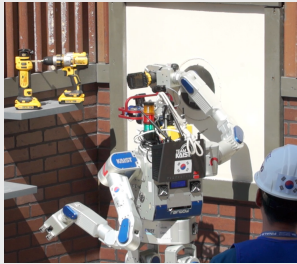
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## Drilling Hole



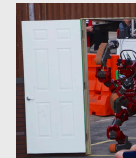
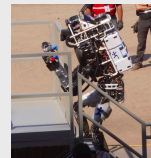
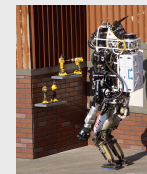
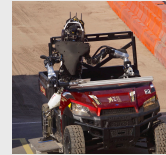
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## Humanoid robots



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## Boston Dynamics BigDog (2008)



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## Boston Dynamics Spot



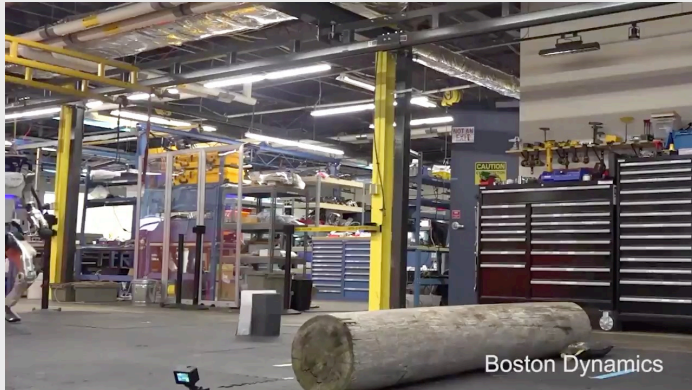
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## Boston Dynamics Atlas



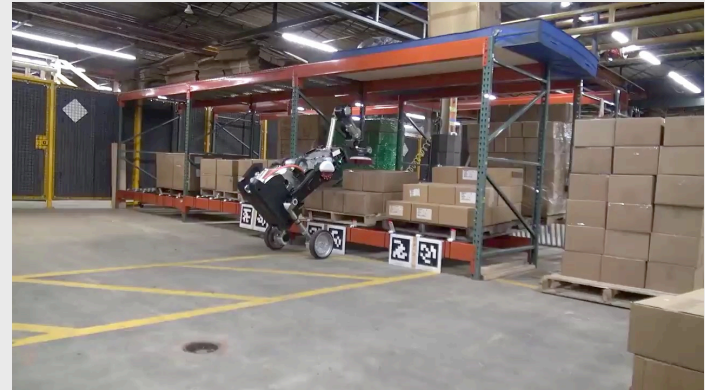
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## Boston Dynamics Handle



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## Industrial Pick and Place



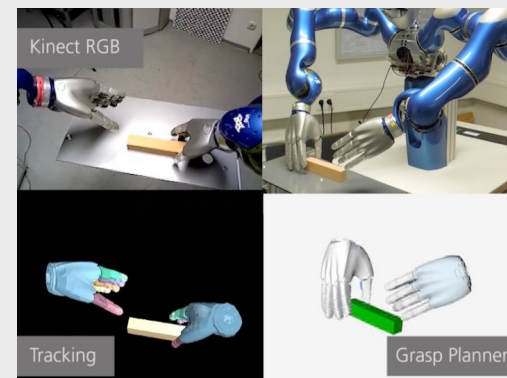
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## Manipulation

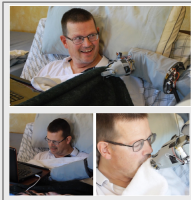


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## Service Robots



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## Dexterous Manipulation



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## HaptX Dataglove



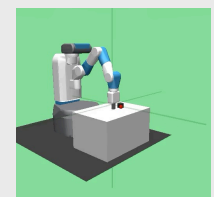
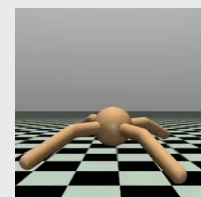
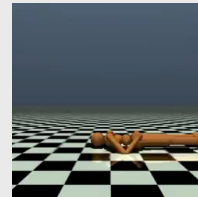
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## Simulation



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## Current Trends / Topics

- Self-driving cars, sidewalk delivery robots, warehouses, manufacturing sites, ...
- Drones
- Industrial pick and place
- Manipulation of everyday objects
- Complex household tasks (cooking, cleaning, ...)
- Object detection, 3D mapping, tracking, interaction
- Cobots, human robot interaction
- Deep learning for perception, control, imitation learning, recognition

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## Goal of this course

- Provide an overview of fundamental problems / techniques in robotics
- Understanding of estimation and decision making in dynamical systems
  - Probabilistic modeling and filtering
  - Deterministic and non-deterministic planning
  - Learning for perception and modeling

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## Course Outline

| Week  | Content  | HW / Project |
|---|--|--------------|
| #1  | Introduction / Probabilities                           |              |
| Probabilistic Models / State Estimation     |  |              |
| #2  | Gaussian processes, Bayesian filtering                 |              |
| #2  | Motion and sensor models                               |              |
| Filtering (localization, tracking, mapping) |  |              |
| #3  | Localization: grid, particle filters, EKF, UKF         |              |
| #4 / 5                                      | Mapping: SLAM, RGBD 3D Mapping                         |              |
| Planning / Control                          |  |              |
| #6 / 7                                      | Deterministic and sampling-based planning, exploration |              |
| #8  | Markov decision processes, inverse RL                  |              |
| Deep Learning                               |  |              |
| #9  | Model learning, visual navigation                      |              |
| #10   | Grasping   |              |

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