CS 4758/6758: Robot Learning

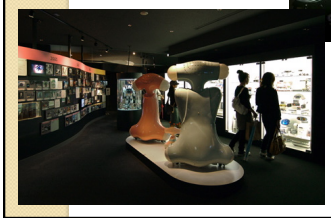
Spring 2012.

Ashutosh Saxena

Past: Robots in Factory Environments

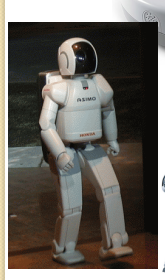
Known environment. Fixed task.

Robots Today



Robots

Robots in our Houses



Manual Scripting vs Learning.

- Consider the following task:
  - Robot has to pick up and place an object.

```
Move to P1 (a general safe position)
Move to P2 (an approach to P3)
Move to P3 (a position to pick the object)
Close gripper
Move to P4 (an approach to P5)
Move to P5 (a position to place the object)
Open gripper
Move to P1 and finish
```

What's the problem with this?

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Human Spaces

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Machine Learning: Focus of this course.

- To model noise in the sensor data.
- To perceive data from vision / 3D sensors.
- To estimate positions of robot/environment.

- To learn complex controllers.
- To make decisions in
  - *New* environments.
  - Environments with a lot of variations.

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Picking up and Placing Objects

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See Course-Info Handout.

- Piazza.

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Course Staff

TAs:
Mark Verheggen
Igor Labutov

Project TAs:
Abhishek Anand
Hema Koppula
Ian Lenz

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Pre-reqs

- Knowledge of basic computer science principles and skills, at a **level sufficient to write a reasonably non-trivial computer program**.
  - C/C++ or C# knowledge required. Linux/Python knowledge preferable.
- Probability, statistics and Linear algebra. **Strong mathematical skills** are required.

Robotics involves a lot of **hard-work** and **hacking**.

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"It is never wise to let a robot know that you are in a hurry."

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Pre-req Prelim

Prelim (25 minutes) on Jan 26, Thursday.

- Required to pass for enrolling in CS 4758/6758.
- If you pass the prelim, a PIN for enrolling in the course will be provided.

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Project

- A major project in the course.
  - 45% of the grade in CS 4758.
- Develop/implement learning algorithms for two robots.
  - Aerial Robot.
  - Personal Robot.

http://www.cs.cornell.edu/Courses/cs4758/2012sp/projects.html

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Best project award.

Object Placement. Kevin Yang, Michael Lyons, Paul Kiernan. (more)

Best video award.
Runner-up for best project.

Box Manipulation with Adept Arm. Paul Heran Yang, Tiffany Low. In *RSS workshop mobile manipulation*, 2011.

Best demo award.
Runner-up for best project.

Learning and Reacting to Hand Signals. Garrett Bernstein, Nyk Lotocky, Dan Gallagher.

Most Outstanding idea.

Robotic Annoyance Detection. Samuel Sinensky, David Diner.

Runner-up, best video award.

fAce Crusher: The Evasive Action. Mevlana Gemici, Yuandong Zhuang.

Runner-up, best demo award.

Human Robot Collaboration using Micro-delegation. Igor Labutov, Jason Yosinski. Demo in *RSS workshop on RGBD cameras*, 2011.

Saxena

Robots in this Course: I

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Robot Learning

- Basics: kinematics, statistics, ROS.
- Sensing: Filtering and state estimation (Particle filters, Kalman filters)
- Supervised Learning, HMM.
- Perception (Kinect, Point-cloud library, algorithms)
- Reinforcement Learning and Control.

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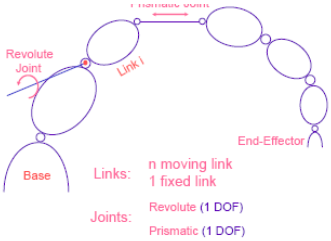
Manipulators: Kinematics

- Coordinate transforms.
- Robot Operating System.



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Vision and Perception

- Basic computer vision.
- Learning algorithms for 3D perception, e.g., from sensors such as Microsoft Kinect.
  - Point-cloud library.

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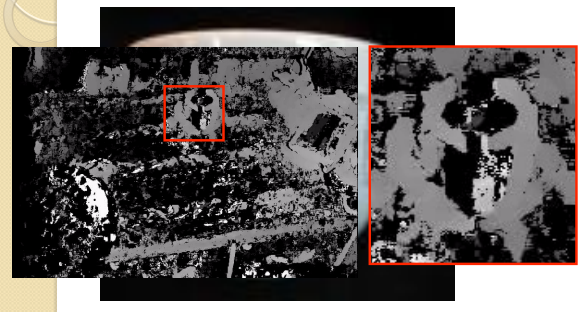
3D Perception



(Stereo point cloud)

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Learning algorithms

- Supervised Learning: k-NN, SVM, etc.
  - Given the noisy sensor data, estimate the desired output.
- Hidden Markov Models and Kalman Filters.
  - State estimation and modeling temporal behavior.

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Cloth Grasp Point Detection based on Multiple-View Geometric Cues with Application to Robotic Towel Folding

Jeremy Maitin-Shepard
Marco Cusumano-Towner
Jinna Lei
Pieter Abbeel

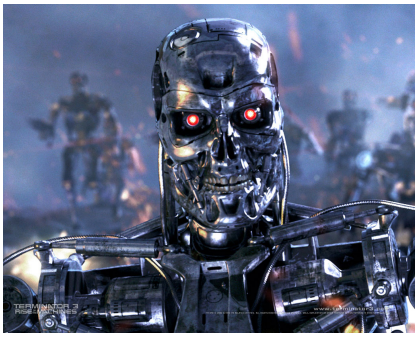
Department of Electrical Engineering and Computer Science
University of California, Berkeley

International Conference on Robotics and Automation, 2010

Robots in this Course: II

Control/Decision Making

- Markov Decision Processes.
- Reinforcement Learning and Control.



That's all folks for today.