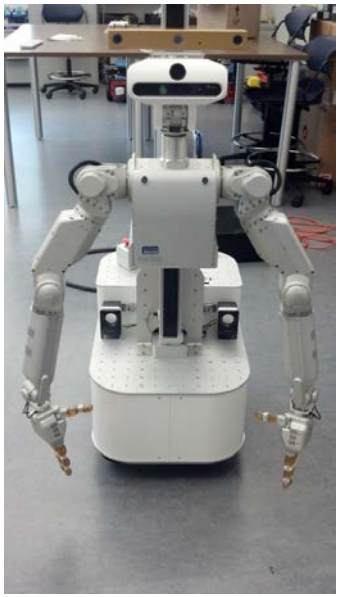
CS494/529:
Autonomous Mobile Robots

Fall 2014
Tuesday/Thursday 11:10-12:25 PM

Instructor: Dr. Lynne E. Parker

TA:
Ying Qu



Outline

- Overview syllabus and class policies
- Introduction to class
- Reading assignments (due by next class):
  - Chapter 1 of text
  - Online NSF Article – Special Report on Robotics:

    http://www.nsf.gov/news/special_reports/robotics

    (Note that there are 7 sections: Overview, Helping Hands, Robots and Biology, etc.)

Overview of Syllabus and Class Policies

(See handout)

What is a Robot?

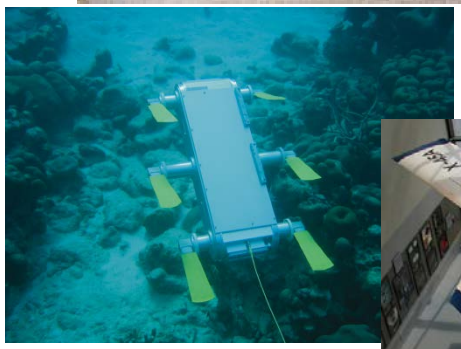
- Notion derives from 2 strands of thought:
  - Humanoids -- human-like
  - Automata -- self-moving things
- "Robot" -- derives from Czech word *robota*
  - "*Robota*" : forced work or compulsory service
- Term coined by Czech playright Karel Capek
  - 1921 play "R.U.R" (Rossum's Universal Robots")
- Current notion of robot:
  - Programmable
  - Mechanically capable
  - Flexible
- Our working definition of *robot:* physical agent that generates "intelligent" connection between perception and action

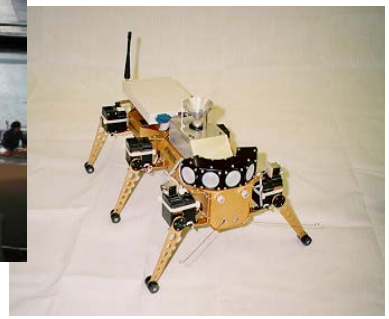
We'll be studying *mobile* robots

- What is a "mobile" robot?
  - One whose entire body moves with respect to the environment

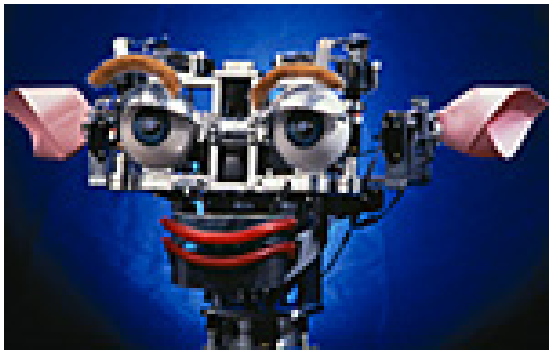
- Examples of *mobile* robots:





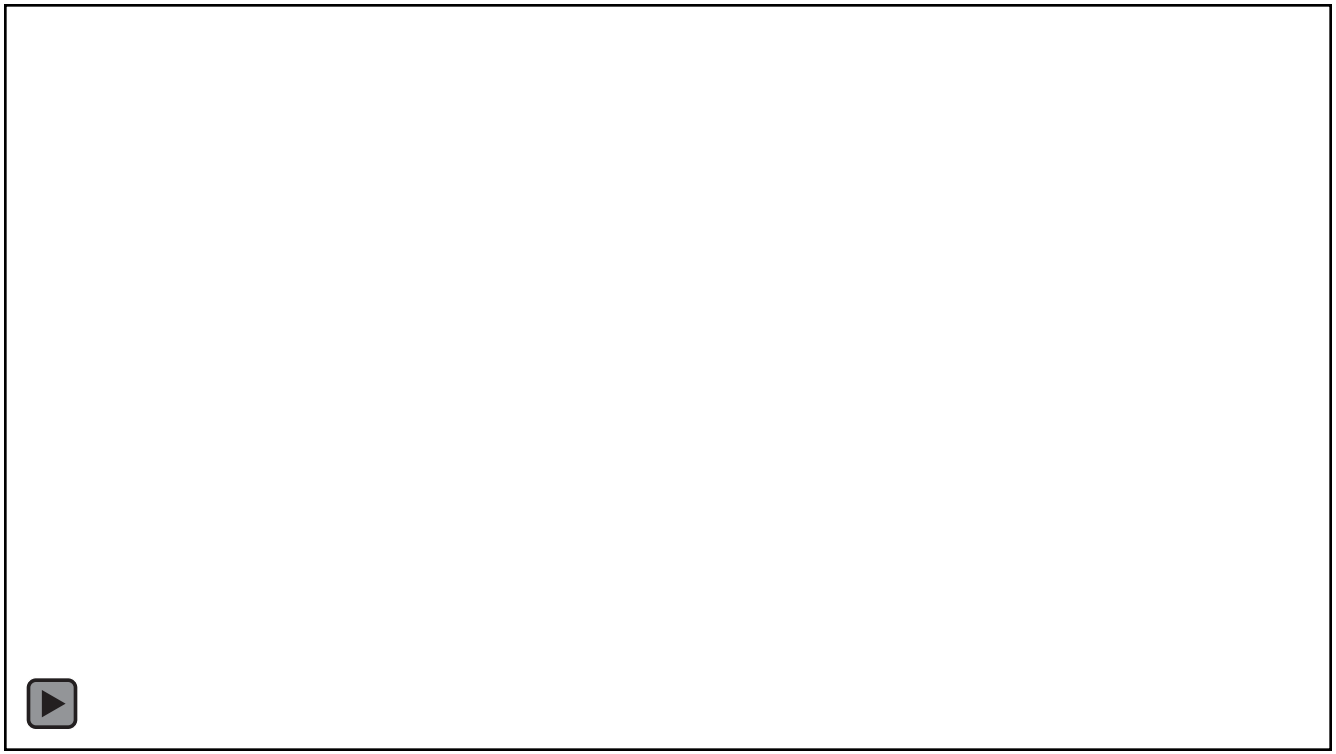


- Examples of *non-mobile* robots:

Today – We have so many cool robot systems!

Aerial Vehicles – University of Pennsylvania Quad-Rotors

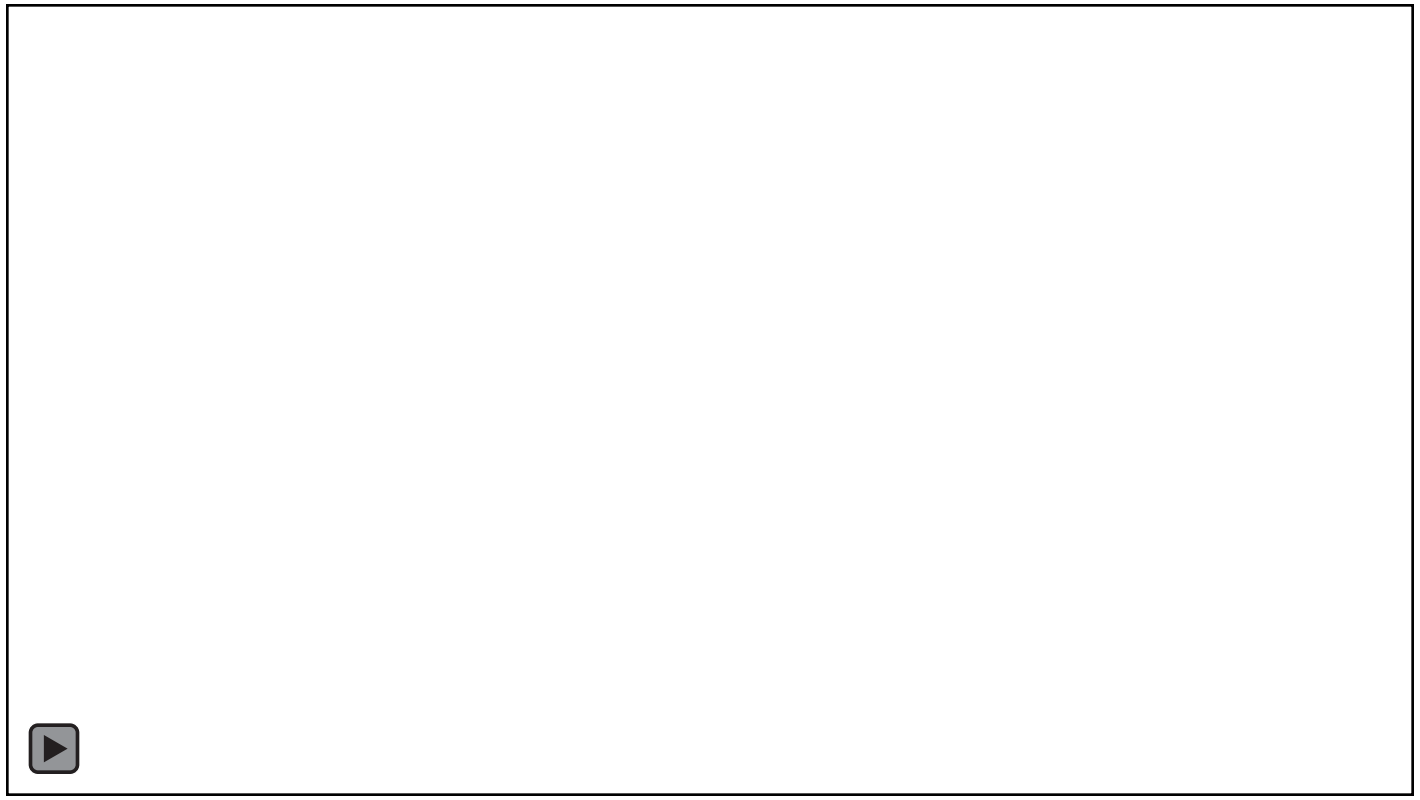


More cool multi-robot systems!

Swarms of Ground Robots – EU Swarm-Bots Project

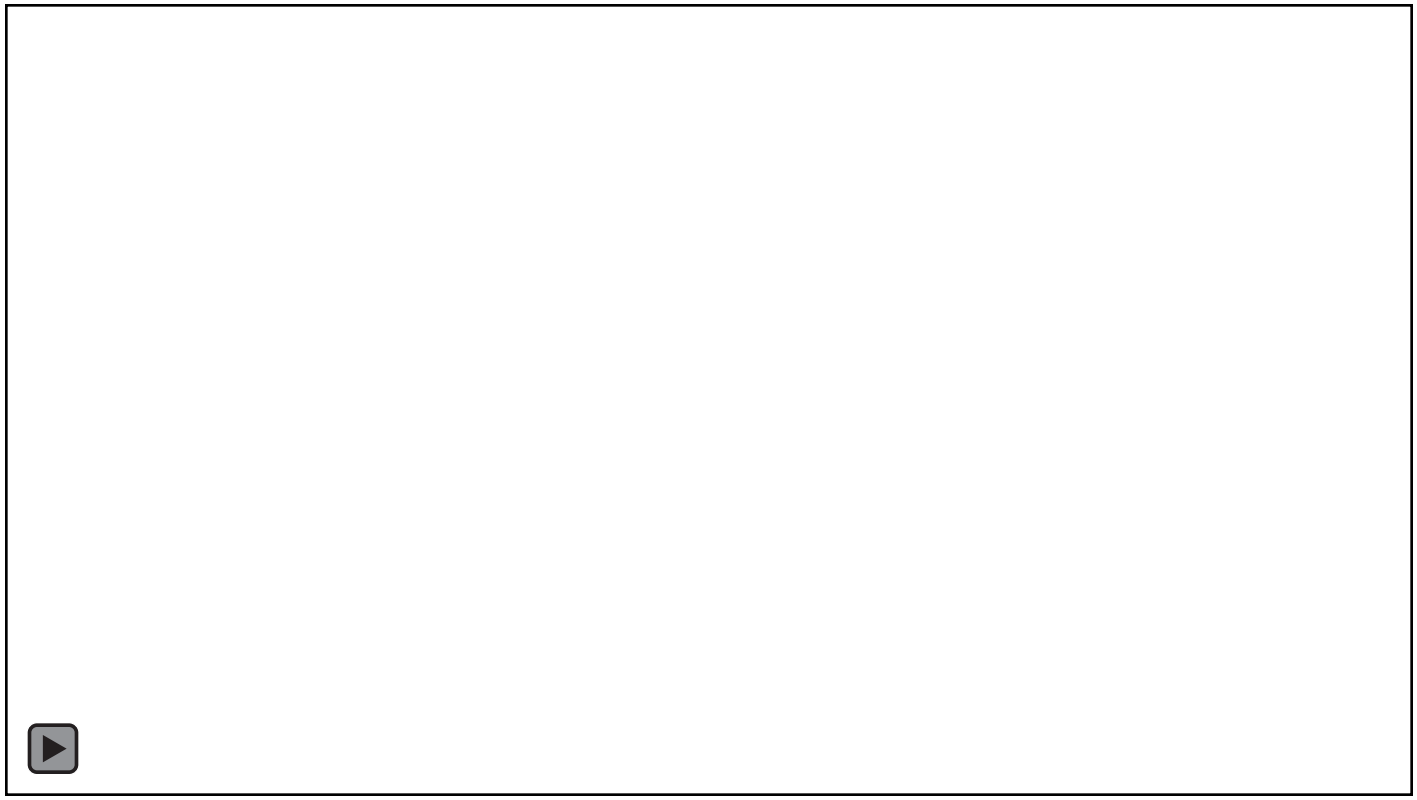
And more…!

Underwater Swarms – EU CoCoRo Project



Even more…!

Robot Soccer

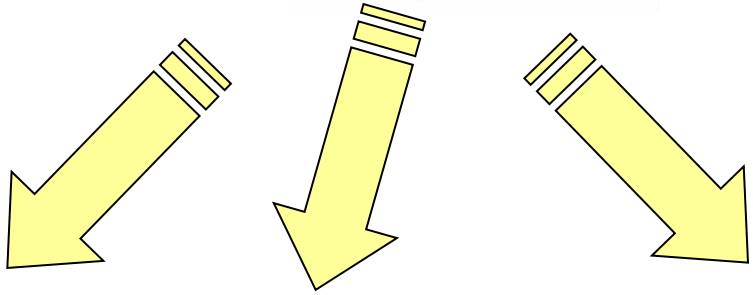


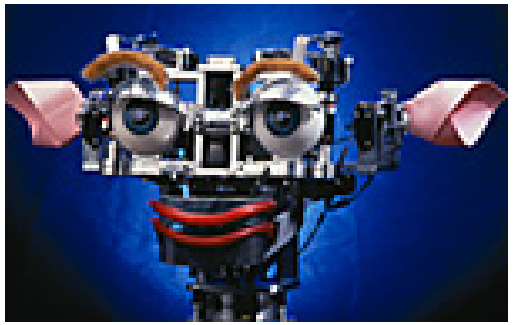
Strengths: What are mobile robots good at?

- Providing specialized access – hazardous environments (no air, melting nuclear power plants, etc.), distance/time (Mars)
- Reducing operating costs – lower overhead, reduced maintenance costs (gentler treatment of the machinery)
- Increasing productivity – “permanent” availability, more hours, higher throughput
- Improved product quality – accuracy, consistency
- Inventing new human services! – human interactivity

State of Robotics Applications

- Moving from manufacturing, industrial manipulators to:
  - Entertainment robotics
  - Personal service robots
  - Medical robots
  - Industrial applications beyond factory (e.g., mining, agriculture)
  - Hazardous applications (e.g., military, toxic cleanup, space)
  - And others…





Purpose: What Could Mobile Robots Do? (i.e., applications)

- Space (Robonaut, Sojourner, Opportunity, Spirit, etc.)

- Cleaning (Roomba)

- Agriculture (Demeter harvesting robot)

Purpose: What Could Mobile Robots Do? (i.e., applications) (con't.)

- Medical service

- Mining/excavation (Groundhog robot)

- Entertainment robots

Purpose: What Could Mobile Robots Do? (i.e., applications) (con't.)

- Security (MDARS interior robot)

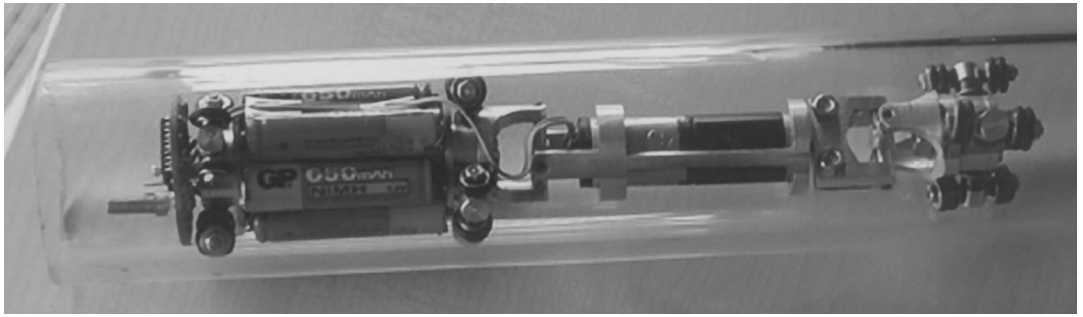
- Distance driving (Stanley)

- Military (Packbot)

Purpose: What Could Mobile Robots Do? (i.e., applications) (con't.)

- Handicapped Aides (Japan's WL-16RIII)

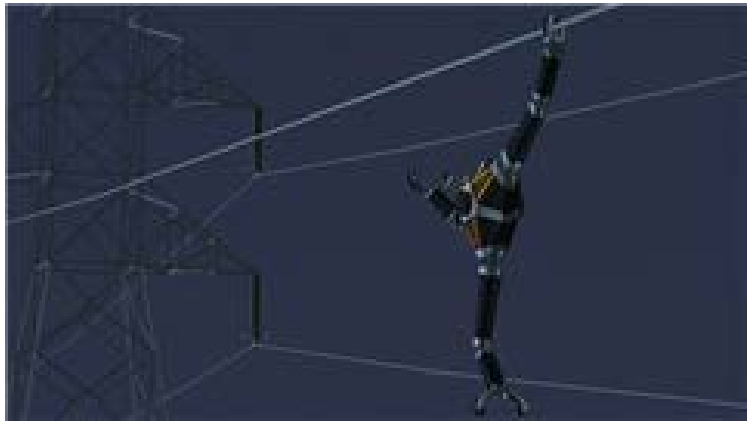
- Undersea (Oberon)



- Pipe inspection

Purpose: What Could Mobile Robots Do? (i.e., applications) (con't.)

- Lawn Care (Cyber Blue)

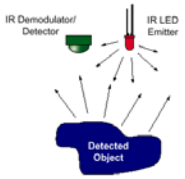


- Power Line Inspection (WireMonkey)

And many, many more applications!

What is in a Robot?

- Sensors



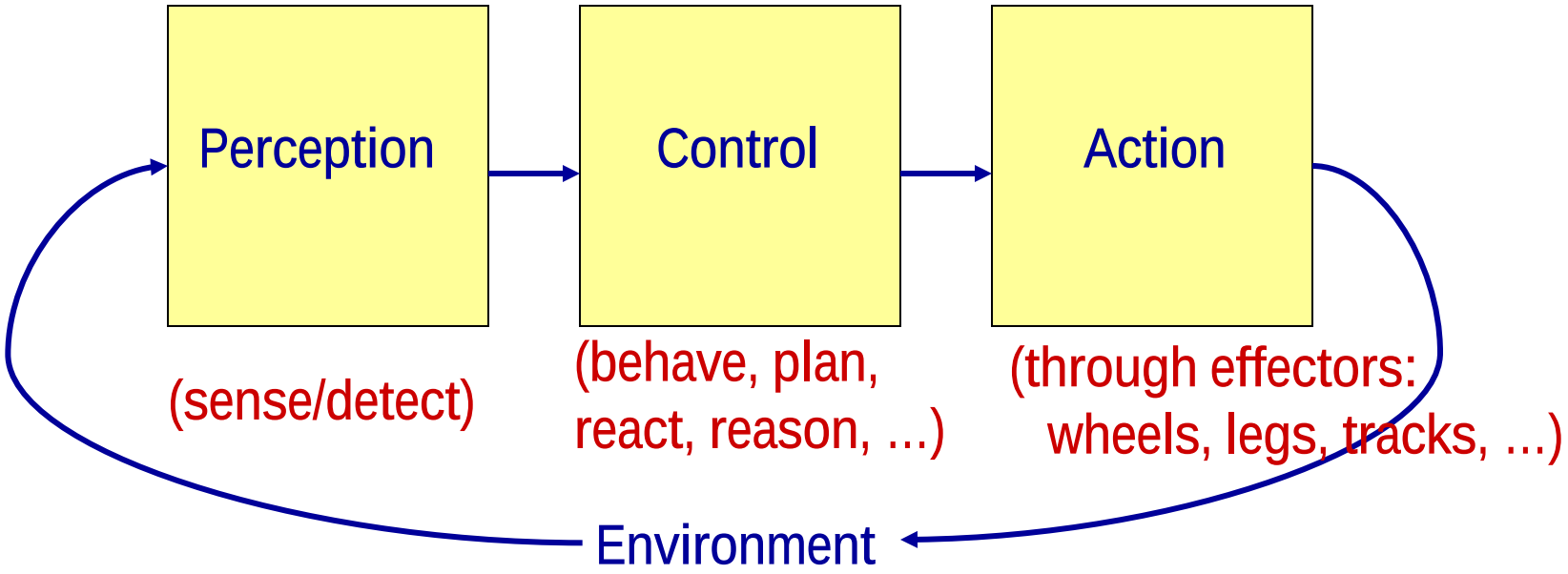
- Effectors and actuators (i.e., mechanical)
  - Used for locomotion and manipulation

- Controllers for the above systems
  - Coordinating information from sensors with commands for the robot's actuators

- Power

- Robot = an autonomous system which exists in the physical world, can sense its environment and can act on it to achieve some goals

What are Basic Robot Software Issues?



- How do you perceive?
- How do you control?
- How to you generate action?

Challenges

- Perception
  - Limited, noisy sensors
- Actuation
  - Limited capabilities of robot effectors
- Thinking
  - Time consuming in large state spaces
- Environments
  - Dynamic, impose fast reaction times

Uncertainty

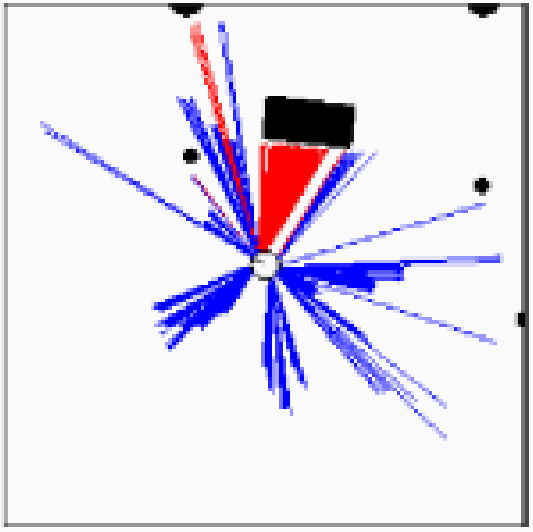
- Uncertainty is a key property of existence in the physical world
- Environment is stochastic and unpredictable
- Physical sensors provide limited, noisy, and inaccurate information
- Physical effectors produce limited, noisy, and inaccurate action
- Models are simplified and inaccurate

Uncertainty (cont.)

- A robot cannot accurately know the answers to the following:
  - Where am I?
  - Where are my body parts, are they working, what are they doing?
  - What did I just do?
  - What will happen if I do X?
  - Who/what are you, where are you, what are you doing, etc.?...

Example:

Odometry Data



Range Data

(pictures from Thrun, CMU)

This semester, we'll study various aspects of mobile robotics

Topics we'll cover:

- Robot control architectures
- Locomotion
- Representation issues
- Sensing/perception
- Adaptation
- Path planning
- Navigation
- Localization
- Mapping
- Multi-robot systems

More Movies of Robot Systems...

Remember: Your homework and reading assignments…

- Homework #1 (handed out in class; also available online)

- Reading assignments (due by next class):
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  - Online NSF Article – Special Report on Robotics:

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- Remember “mini-quizzes”!!