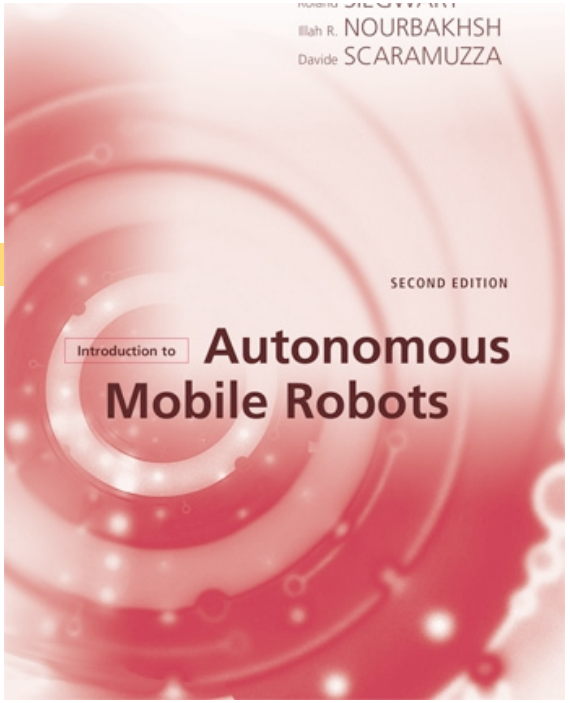
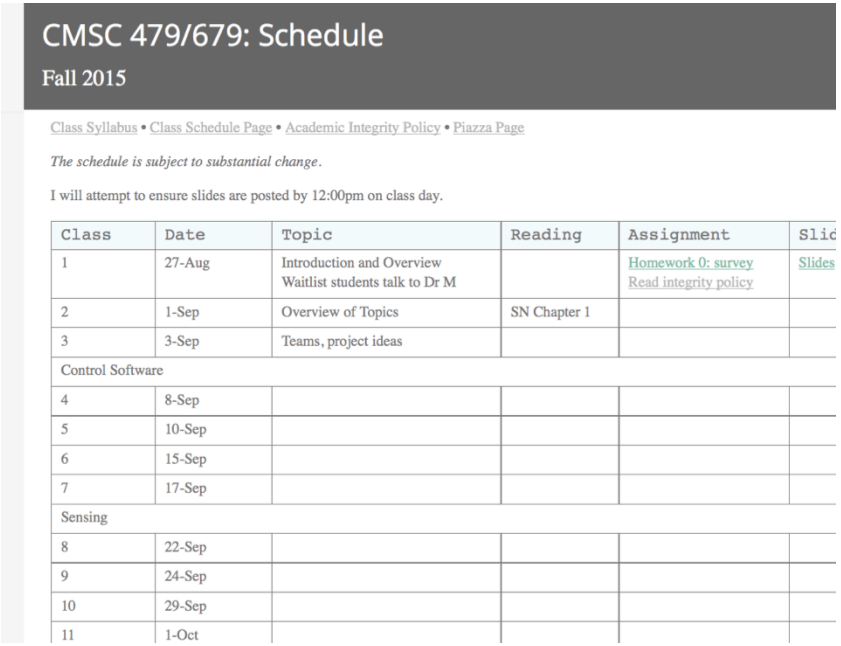
CMSC 479/679
Fall 2015

Dr. Cynthia Matuszek

Bookkeeping



- Syllabus: tiny.cc/robotics-syllabus
- Schedule: tiny.cc/robotics-schedule
- Piazza (forum): tiny.cc/robotics-forum
  - Join (use your full name, poke around)
- Text: 2nd edition needed
- Survey 1 due last night
  - If you haven't done this, **do it.**
  - tiny.cc/robotics-survey-1
- Academic integrity (or, where do I sign?)



CMSC 479/679: Schedule

Fall 2015

Class Syllabus • Class Schedule Page • Academic Integrity Policy • Piazza Page

The schedule is subject to substantial change.

I will attempt to ensure slides are posted by 12:00pm on class day.

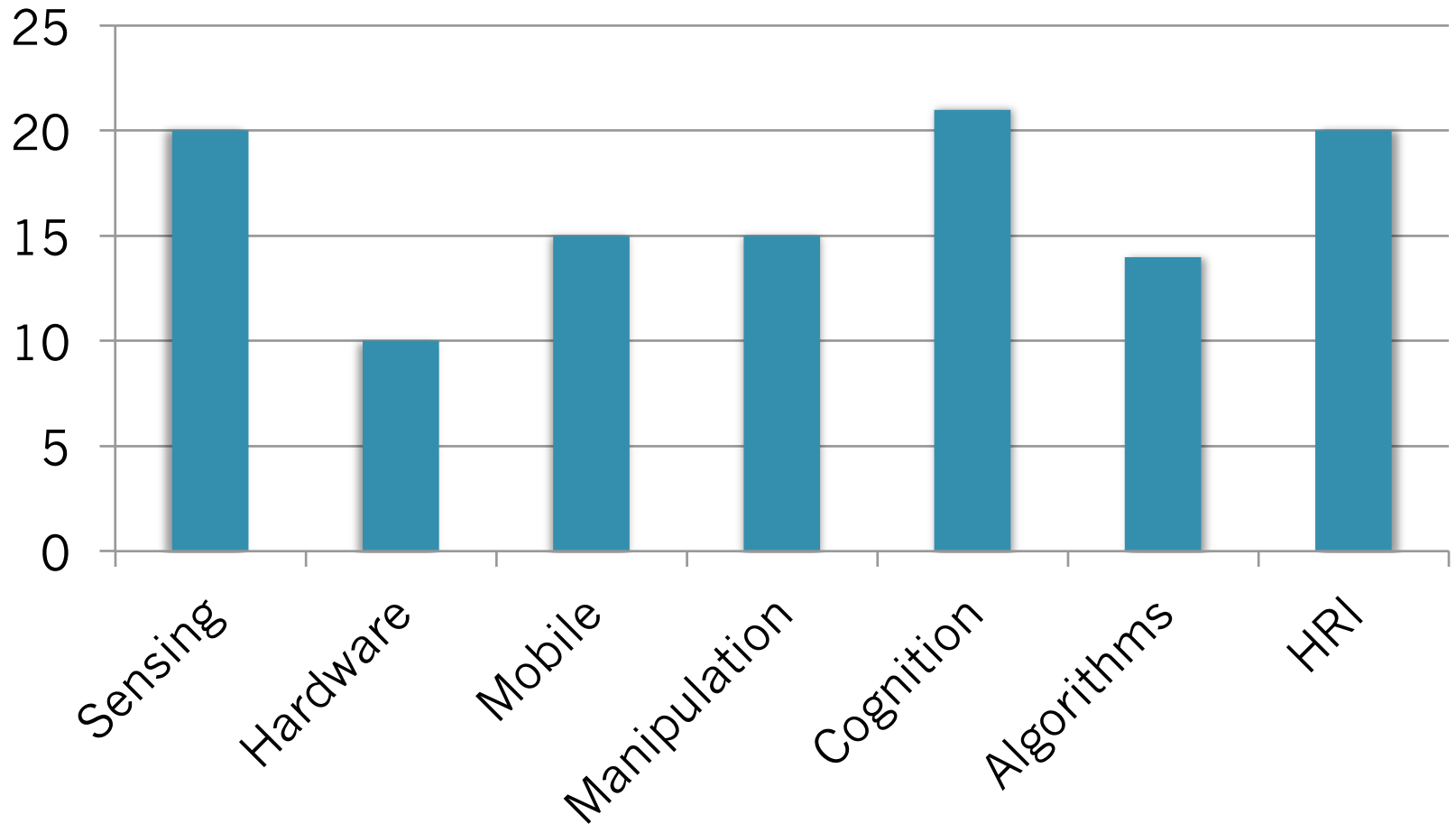
Class	Date	Topic	Reading	Assignment	Slic
1	27-Aug	Introduction and Overview Waitlist students talk to Dr M		Homework 0: survey Read integrity policy	Slides
2	1-Sep	Overview of Topics	SN Chapter 1		
3	3-Sep	Teams, project ideas			
Control Software					
4	8-Sep				
5	10-Sep				
6	15-Sep				
7	17-Sep				
Sensing					
8	22-Sep				
9	24-Sep				
10	29-Sep				
11	1-Oct				

Today's Class

- Survey results (preliminary)
- Current robots
- Terminology and concepts

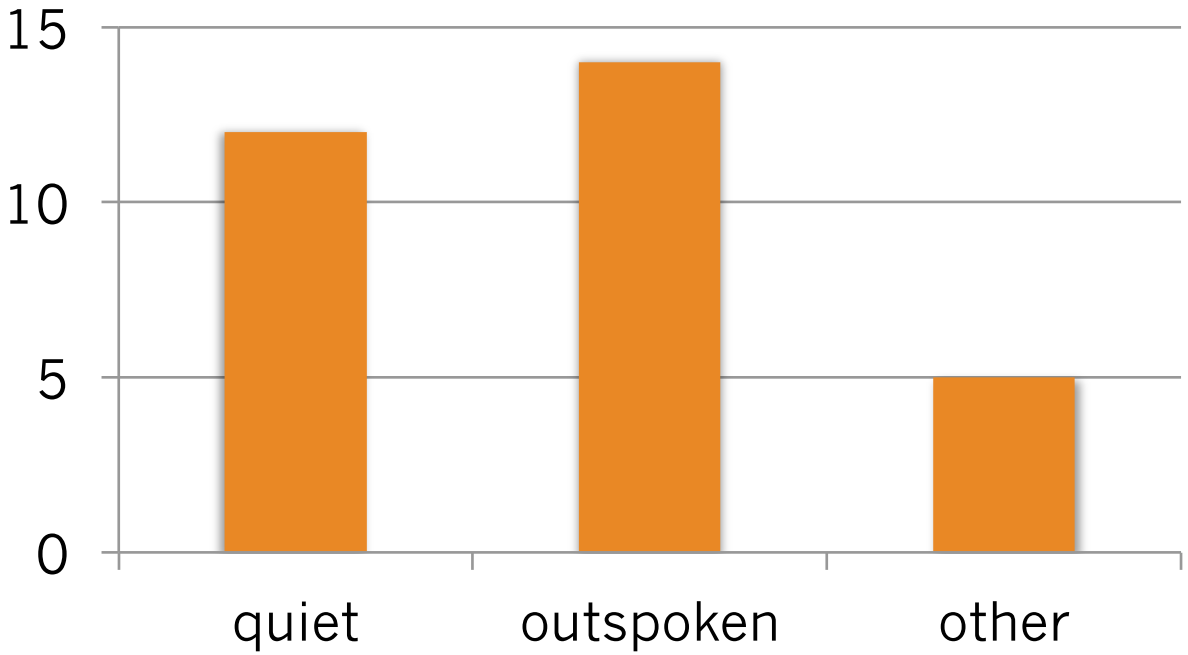
Interests

- Areas of interest are very evenly spread



Participation

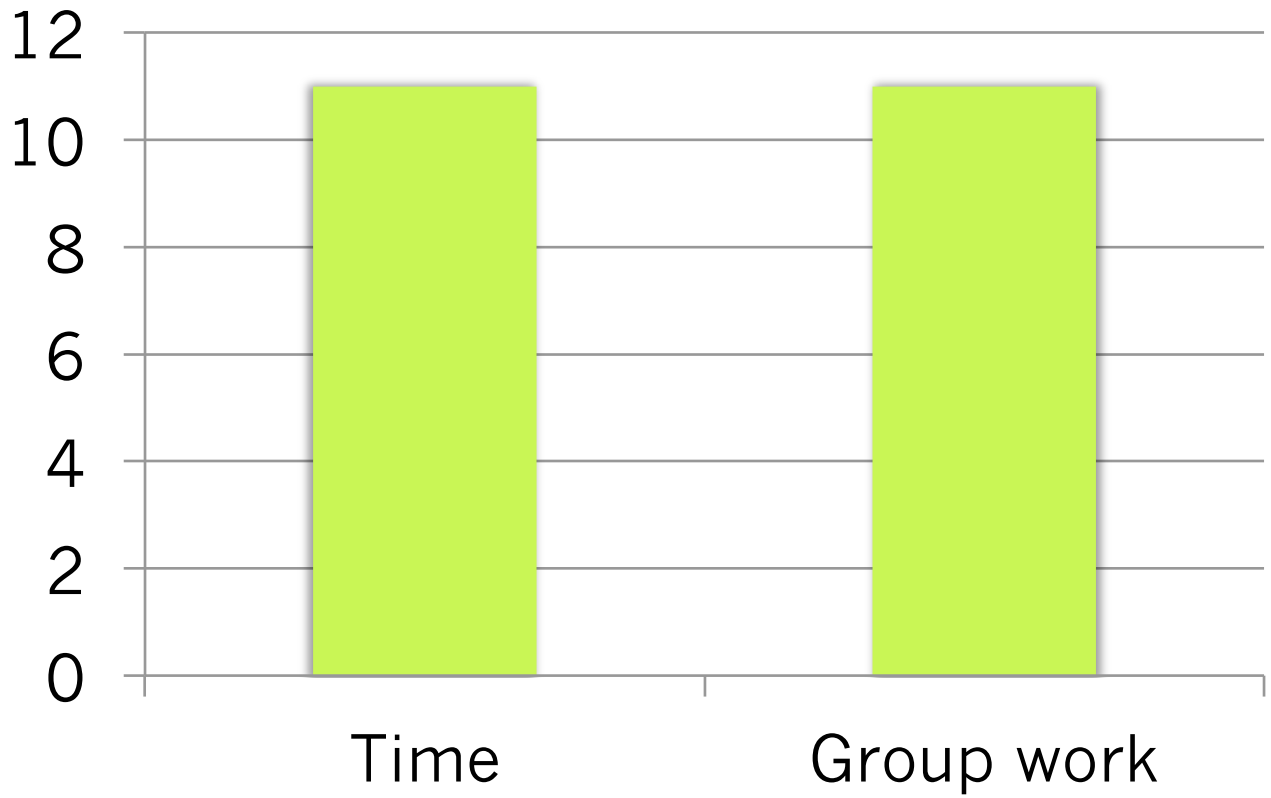
- Very common concern



- Engage with material, look for opportunities

Group Work and Time

- Time management is a real concern



General Topics

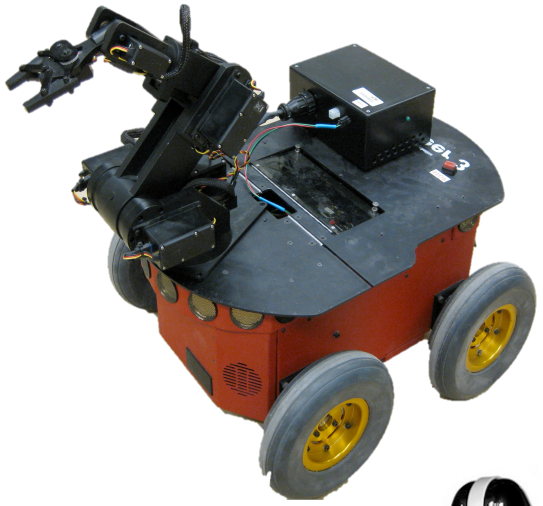
- Hardware Design
- Sensing
  - Environment Models
- Actuation
  - Mobility
    - Mapping
    - Localization
  - Manipulation
- Motors

These topics overlap in many places!

- Control
  - (Inverse) Kinematics
  - Dynamics
  - Motion planning
- Cognition
  - Machine learning
  - Classic AI
  - Others
- Human-robot interaction

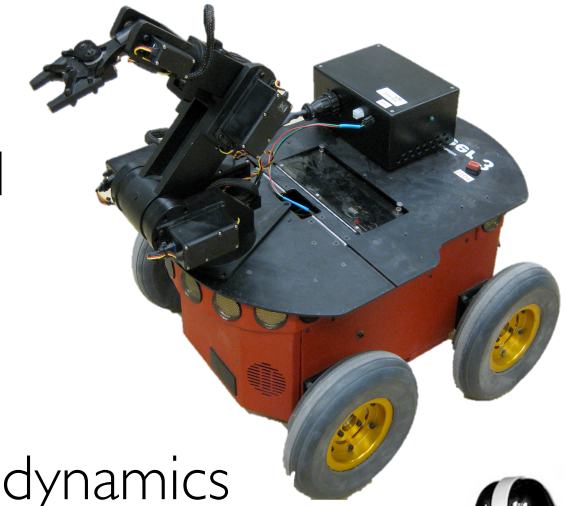
What Subsystems Are There?

- Or: what does a robot need to know?
  - Where am I?
  - What's around me?
  - How am I posed?
    - How do I change it?
  - What do I want to do?
    - With respect to the environment?
    - Where do I go, and how?
    - What do I want to change?
  - How do I do that?
  - Who needs to be involved?
    - People? Other robots?

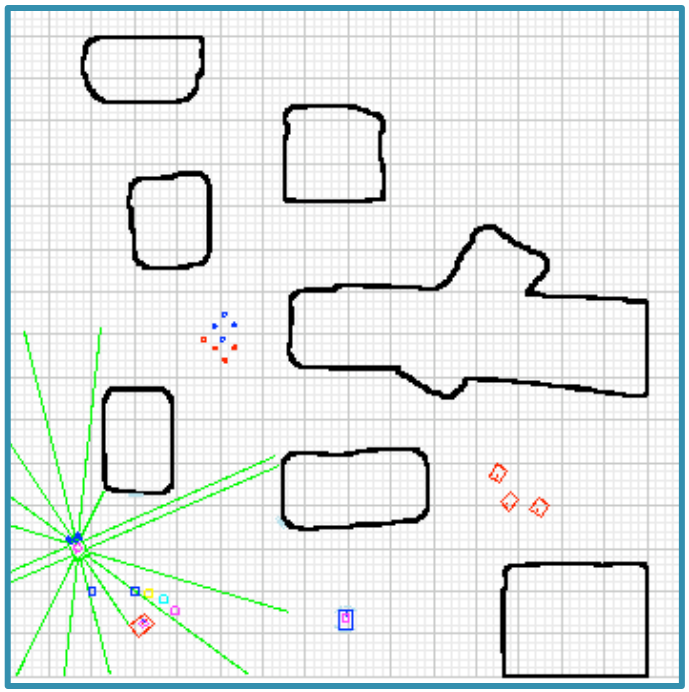


What Subsystems Are There?

- Sensing
  - Perceiving the world
  - Creating a *world model*
- Actuation
  - Doing something in the (physical) world
  - Mobility, manipulation, …
- Control
  - Navigation, motion planning, kinematics, dynamics
- Cognition and Learning
- Interfaces



High Level View



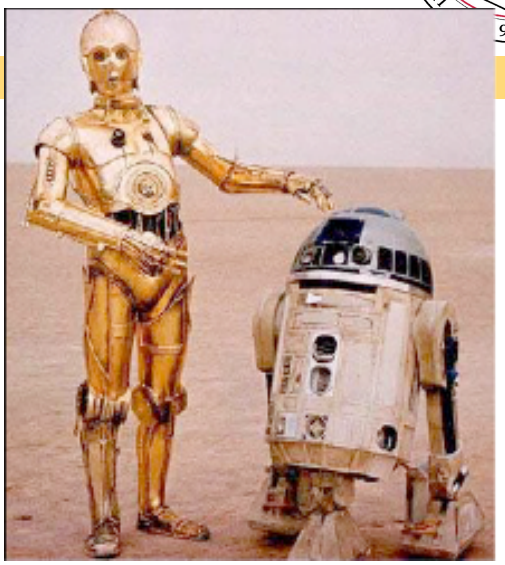
World Model

Sensor data

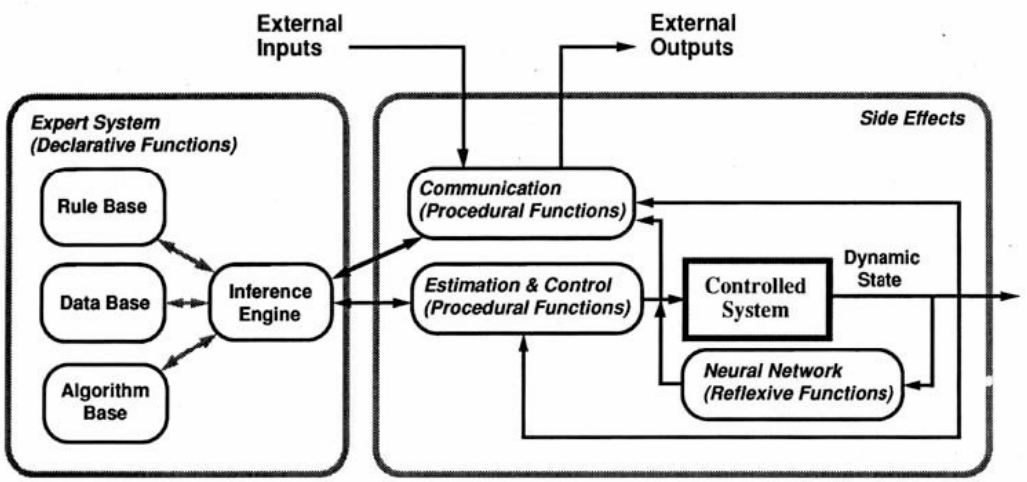
Control System

Actions

Control: The Brain



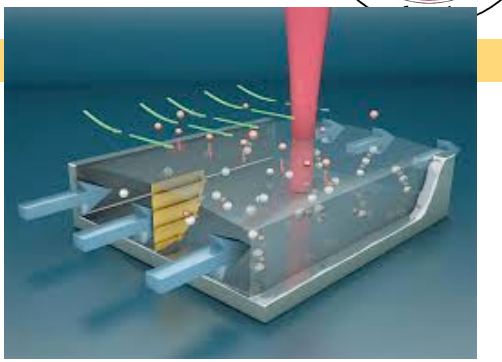
- Open loop, i.e., no feedback
  - Instructions
  - Rules
- Closed loop, i.e., feedback
  - Adapts
  - Can learn



Sensors

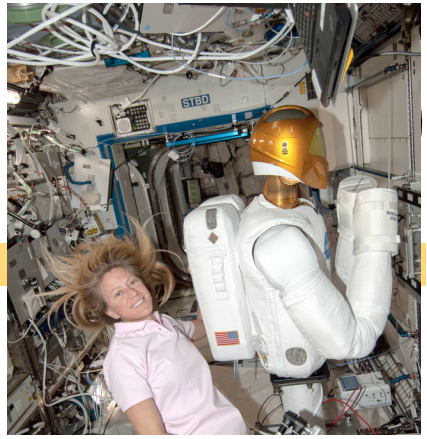
- Perceive the world
  - **Passive sensors** capture signals generated by environment.
    - Background, lower power. E.G.: cameras.
  - **Active sensors** probe the environment. Explicitly triggered,
    - More info, higher power consumption. Example: lidar
- What are they sensing?
  - The **environment**: e.g. range finders, obstacle detection
  - The robot's **location**: e.g., gps, wireless stations
  - Robot's **internals**: joint encoders
- Proprioception
  - Close your eyes - where's your hand?

Some Typical Sensors

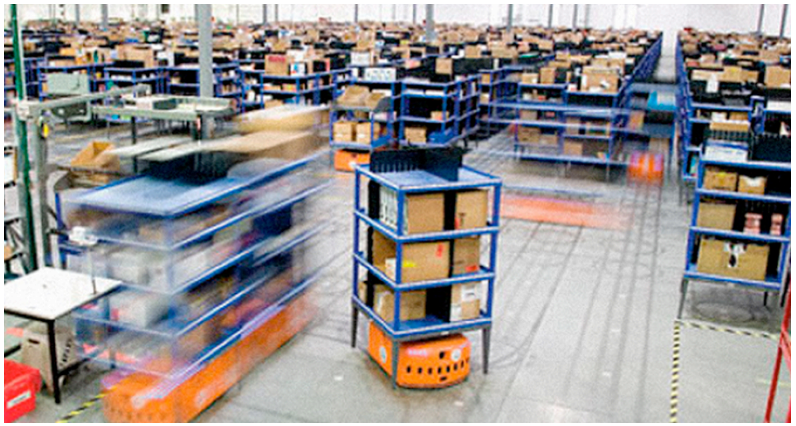


- Optical
  - Laser / radar
  - 3D
  - Color spectrum
- Pressure, temperature, chemical
- Motion & Accelerometer
- Acoustic
  - Sonar, ultrasonic
- E-field Sensing

Robot Systems



- Manipulators
  - Anchored somewhere: assembly lines, ISS, hospitals.
  - Common industrial robots



- Mobile Robots
  - Move around environment
  - UGVs, UAVs, AUVs, UUVs
  - Mars rovers, delivery bots, ocean explorers

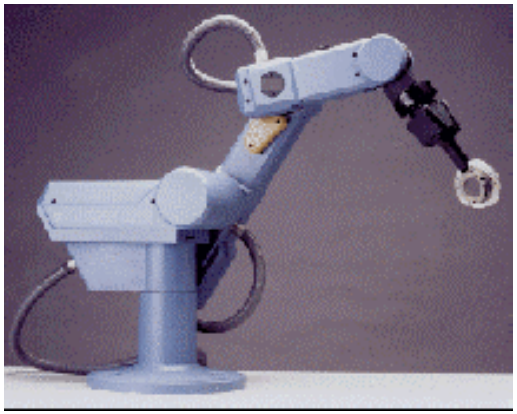
- Mobile Manipulators
  - Both move and manipulate
  - Packbot, humanoid robots

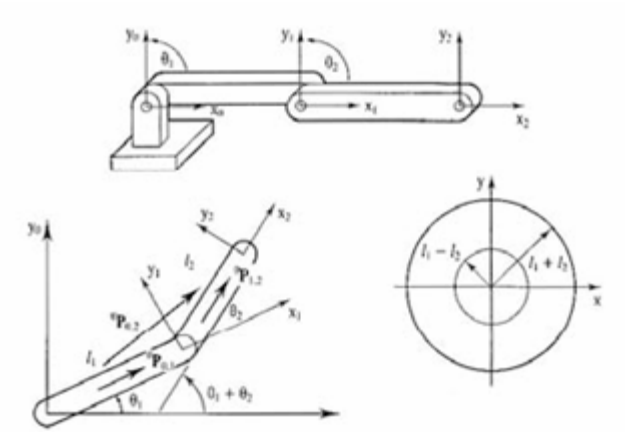
Actuators

- Take some kind of action in the world
  - Involve movement of robot or subcomponent of robot
- Robot actions can include
  - Pick and place: Move items between points
  - Path control: Move along a programmable path
  - Sensory: Employ sensors for feedback (e-field sensing)
  - Manipulation: interact with objects in the world

Some Typical Actuators

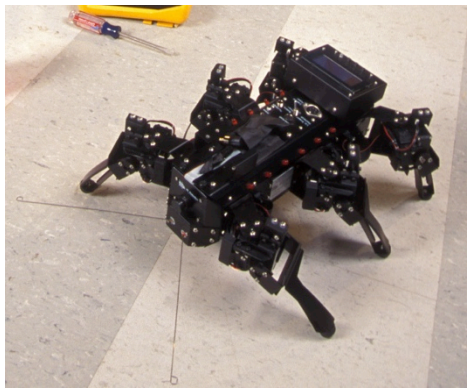
- Pneumatic
- Hydraulic
- Electric solenoid
- Motors
  - Analog (continuous)
  - Stepping (discrete increments)
  - Gears, belts, screws, levers
- What's missing?

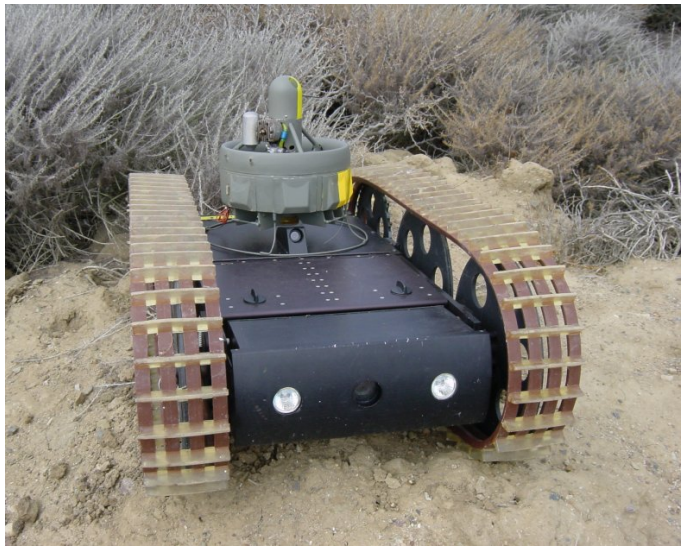




Mobility

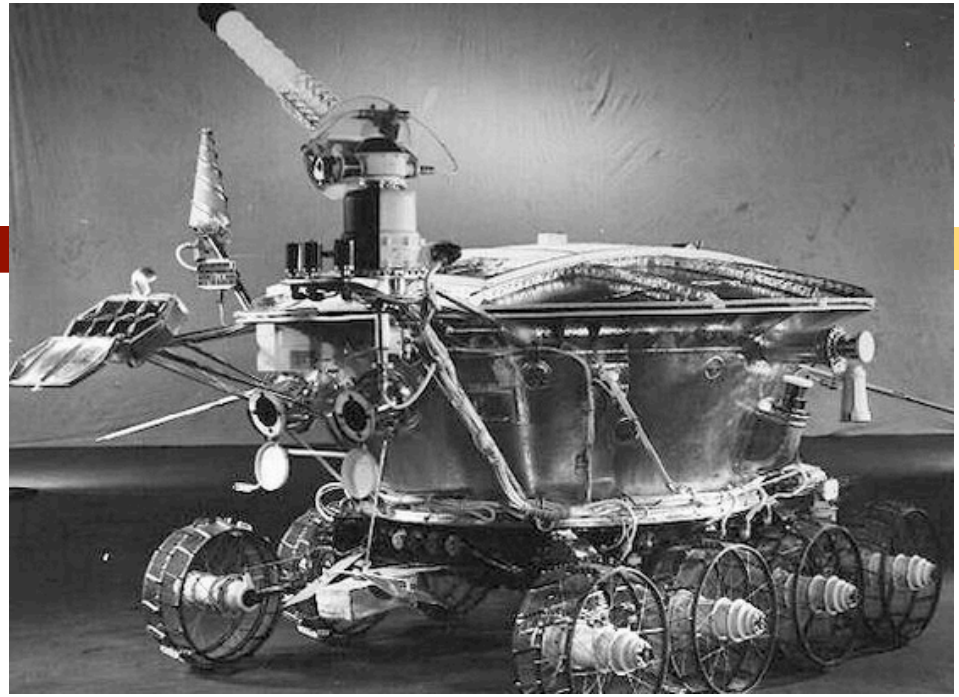
- Legs
- Wheels
- Tracks
- Crawls
- Rolls
- Treads
- …

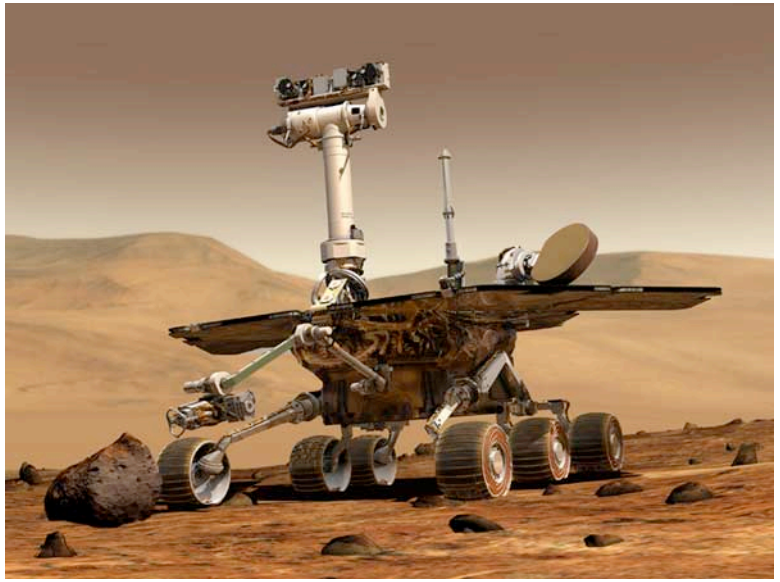




Mobile Robots

- Space Rovers
  - Key issues: mobility in rough terrain, time delay, temperatures, maintenance, joint infiltration
- Autonomous Robotic Cars
  - Key issues: dynamic environments, safety
- Flying Robots
  - Key issues: limited computation power and payload
- Personal Robots
  - Key issues: safety, human-friendliness





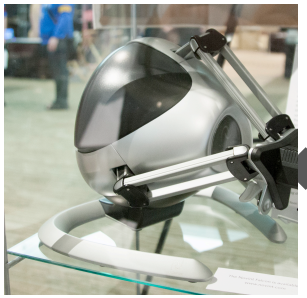
Mobile Robots: Cars

Mobile Robots: Factories

Project Possibilities

- Sensor based

- Actuator based
  - Manipulate objects
  - Move through an area
- Design & building
  - New end effector



- Cognition
  - Machine learning
  - Decision making

- HRI
  - Studies
  - Interface designs
- Algorithmic

For Next Class

- Join Piazza: tiny.cc/robotics-forum
- Think about project ideas
  - 1-2 ideas to share with your team next class
- Readings:
  - SNS 2.1
  - SNS 2.2