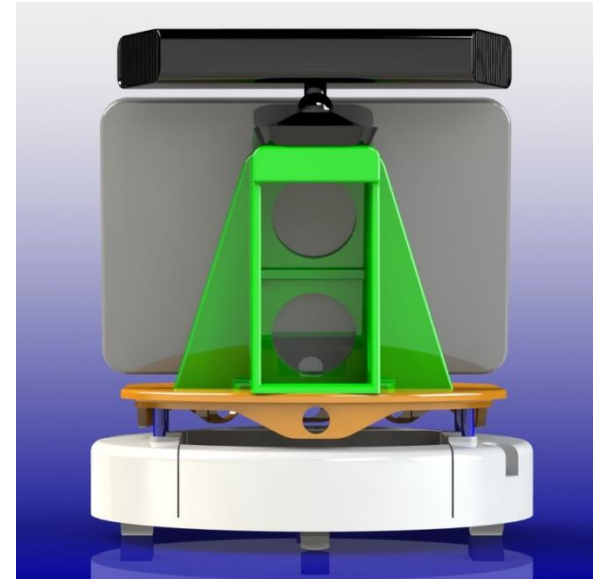
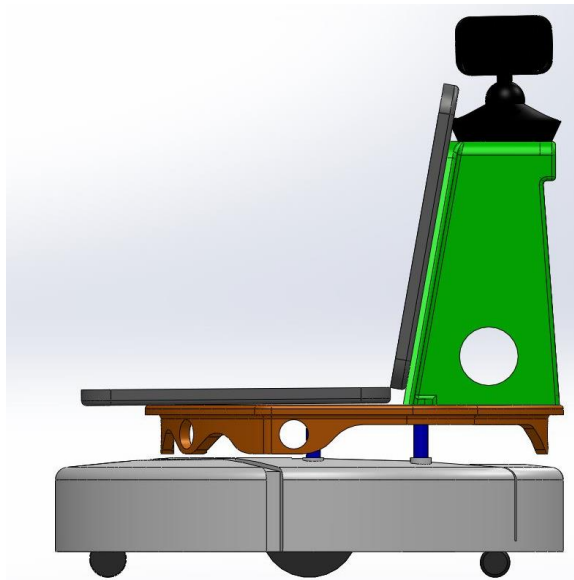


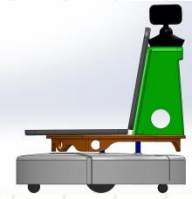
MAE 493G, CpE 493M, Mobile Robotics

1. Introduction to Mobile Robotics



Instructor: Yu Gu, Fall 2013

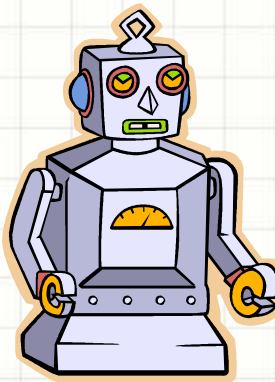
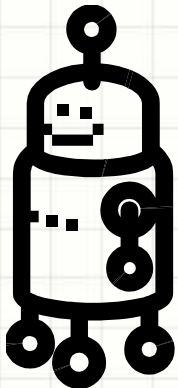




What is a Robot?

From Merriam-Webster:

- 1a : a machine that looks like a human being and performs various complex acts (as walking or talking) of a human being; also: a similar but fictional machine whose lack of capacity for human emotions is often emphasized;
- 1b : an efficient insensitive person who functions automatically;
- 2: a device that automatically performs complicated often repetitive tasks;
- 3: a mechanism guided by automatic controls.





What is a Robot (and Robotics)?

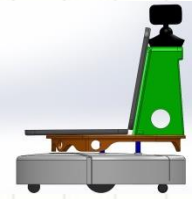
From [Wikipedia](#) (as of today...):

- A robot is a mechanical or virtual agent, usually an electro-mechanical machine that is guided by a computer program or electronic circuitry.
- **Robotics** is the branch of technology that deals with the design, construction, operation, and application of robots, as well as computer systems for their control, sensory feedback, and information processing. (The term robotics was coined by Isaac Asimov)

[Boston Dynamics Robots](#)



Video



What is a Mobile Robot?

Mobile robots have the capability to move around in their environment and are not fixed to one physical location.

Mobility and *embodiment* are the two emphasizes.



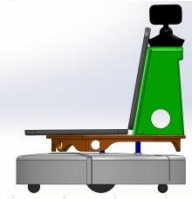
Industrial Robot



Mobile Robot

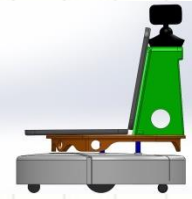
Google

Internet Robot



A Little Bit of History...

- Engineers throughout the history have been trying to build animal and human like autonomous machines;
- The word **robot** was first used by the Czech author Karel Čapek in his 1921 play R.U.R. (Rossum's Universal Robots). According to Čapek, the word was created by his brother, Josef from the Czech "robota", meaning servitude;
- In 1948, Norbert Wiener formulated the principles of cybernetics, the basis of practical robotics;
- Unimate, the first industrial robot ever created began work on the General Motors assembly line in 1961;
- Roomba, a robotic vacuum cleaner, was first released in 2002. (over 8 million were sold since...)



Three Laws of Robotics

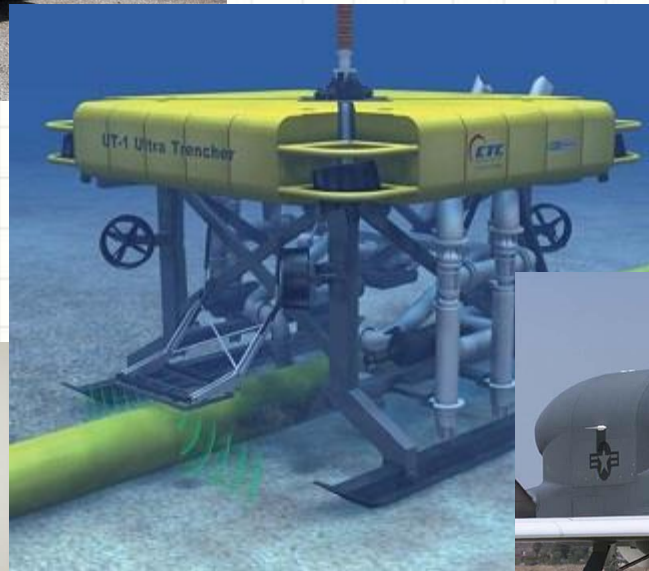
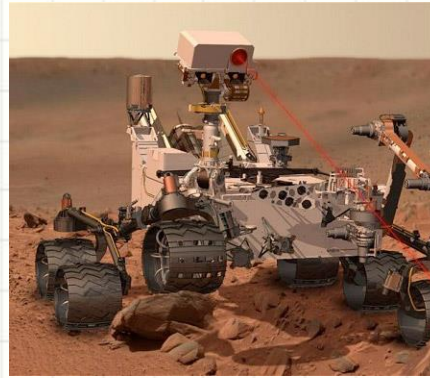
The Three Laws of Robotics by Isaac Asimov (1941) are:

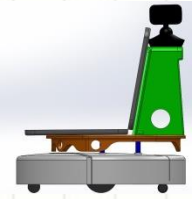
1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

There is just one issue: robots can follow these laws but humans don't...



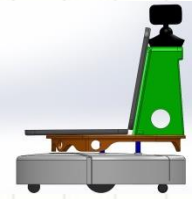
Mobile Robots...





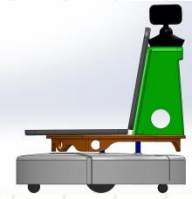
Application of Mobile Robots

- Dirty, dull, and dangerous jobs;
- Places that are inaccessible for humans;
- Tasks require superhuman abilities (power, strength, speed, precision...);
- Research;
- Education and entertainment;
- However, robots are still not as intelligent and flexible as humans. (We still have pilots, but not elevator operators...)

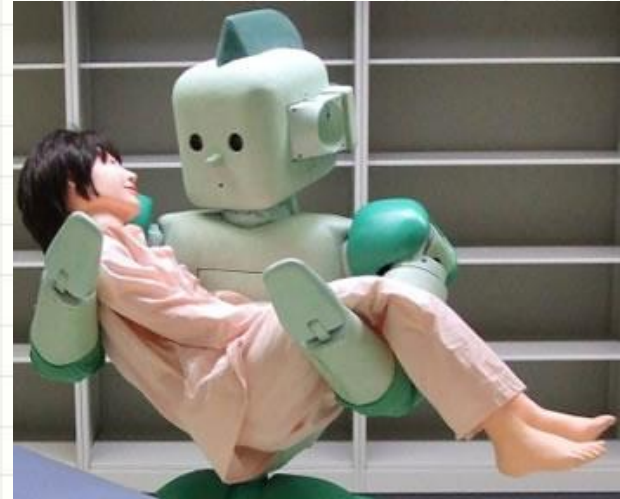


Robot Application: Industry



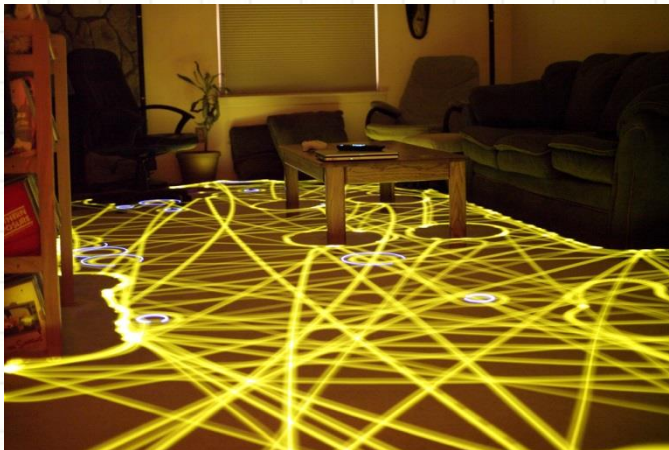


Robot Application: Healthcare

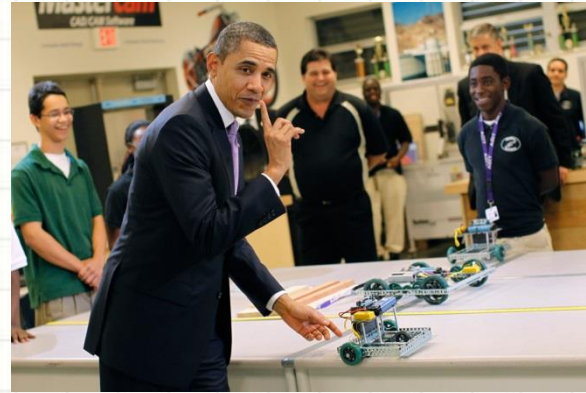
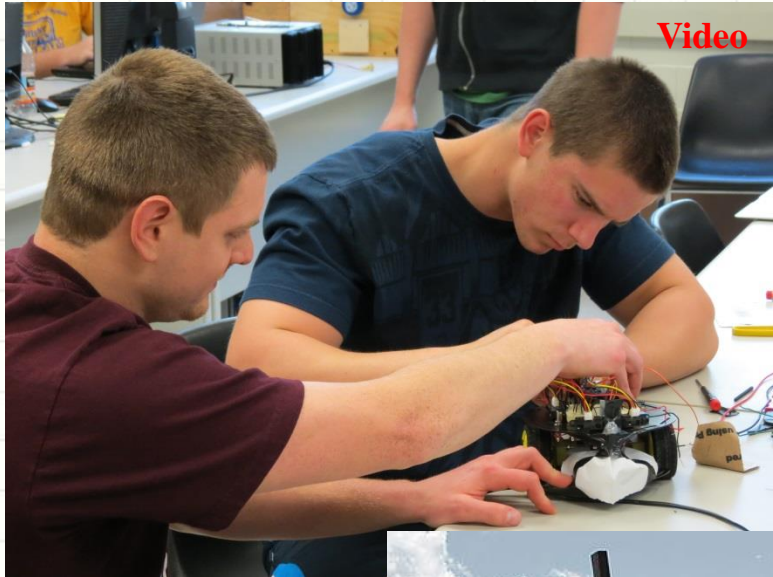


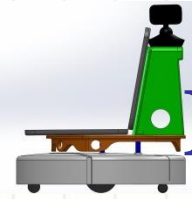


Robot Application: Service



Robot Application: Education

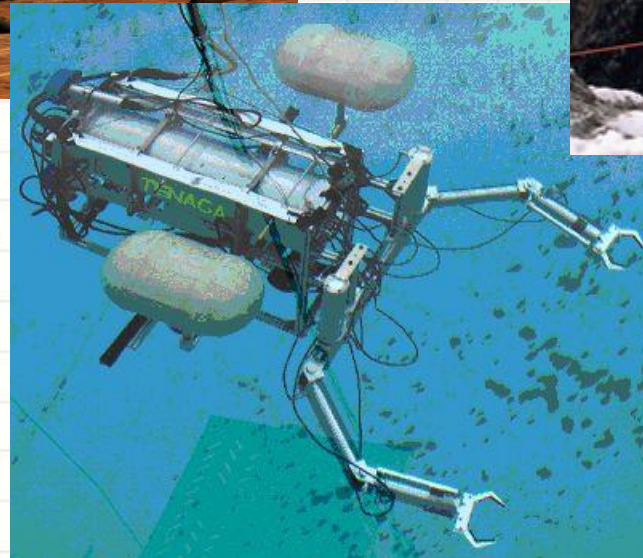
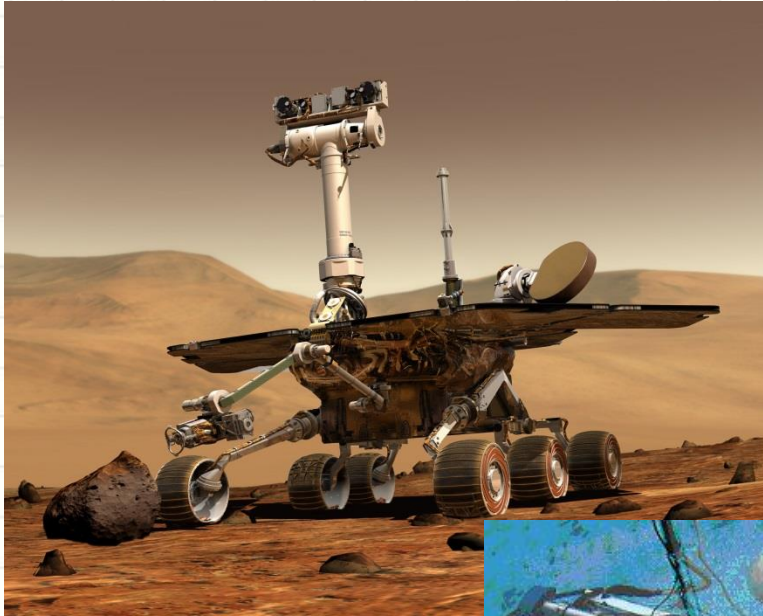


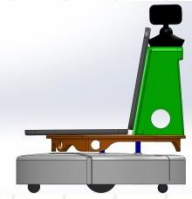


Robot Application: Disaster Response



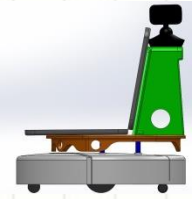
Robot Application: Exploration





Robot Application: Research

- Too many to list...

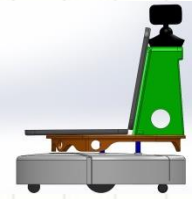


Main Research Issues

Locomotion, creating fancy machines.

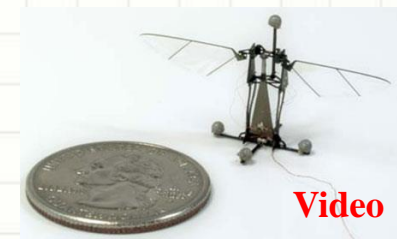
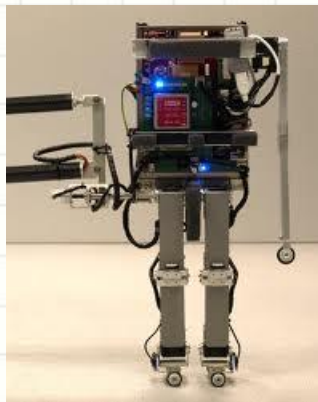
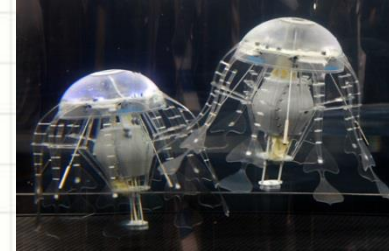
Intelligence

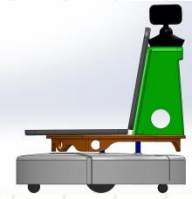
- Sensing, perform measurement of the environment and robot internal states.
- Cognition, make sense of the acquired data or available information.
- Decision Making and Planning, decide what do in the near or far future.
- Control, execute the plans.
- Interaction, figure out a way to understand and work with others.



Mobile Robot Locomotion

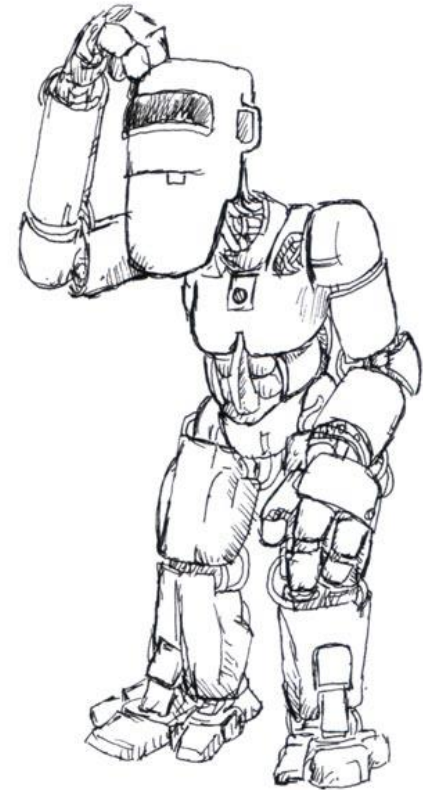
- Driving
- Walking
- Flying
- Flapping
- Swimming
- Jumping
- Rolling
- Vibrating
- Snaking...





Questions Asked by a Mobile Robot

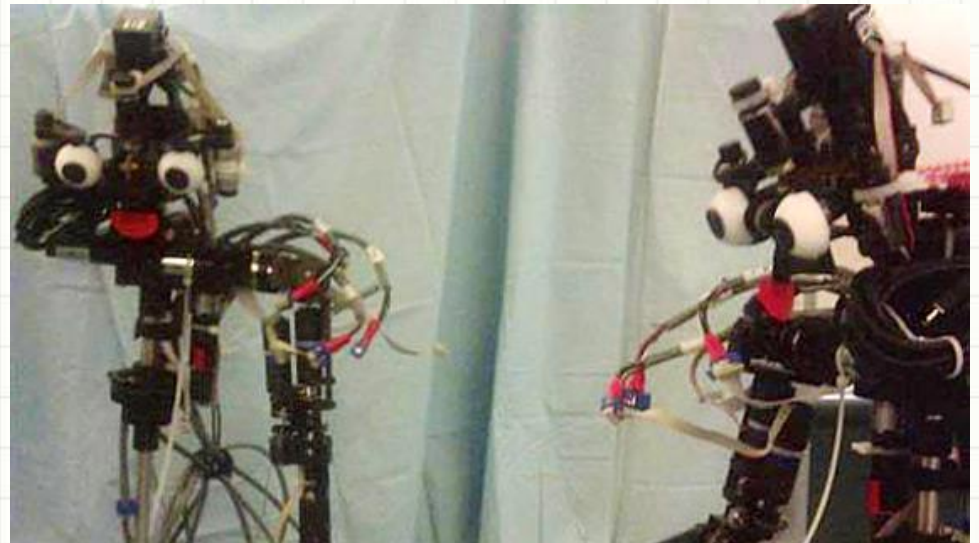
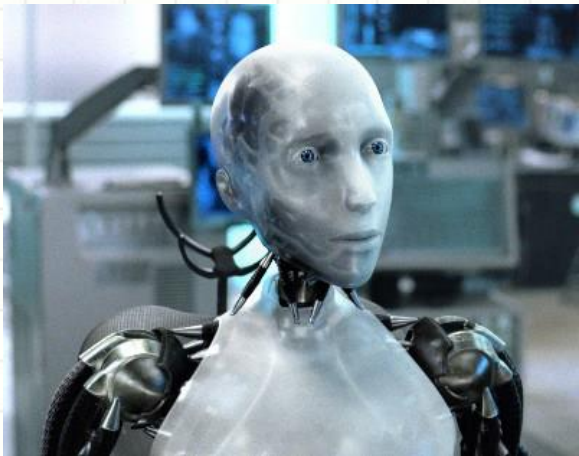
- Where am I?
- What am I doing?
- What can I do?
- How do I do it?
- How can I learn from others?
- How can I learn from mistakes?
- What others are doing?
- How do I work with them (robots and humans)?

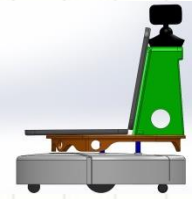




Questions Not Yet Asked by a Robot

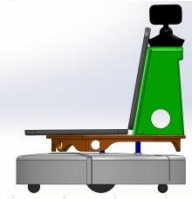
- Who am I?
- Where did I come from?
- What is the purpose of life?





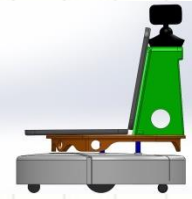
Moravec's paradox

- **Moravec's paradox** is the discovery by artificial intelligence and robotics researchers that, contrary to traditional assumptions, high-level reasoning requires very little computation, but low-level sensorimotor skills require enormous computational resources.
- *“The main lesson of thirty-five years of AI research is that the hard problems are easy and the easy problems are hard. The mental abilities of a four-year-old that we take for granted – recognizing a face, lifting a pencil, walking across a room, answering a question – in fact solve some of the hardest engineering problems ever conceived... As the new generation of intelligent devices appears, it will be the stock analysts and petrochemical engineers and parole board members who are in danger of being replaced by machines. The gardeners, receptionists, and cooks are secure in their jobs for decades to come.” - Steven Pinker, The Language Instinct, 1994*



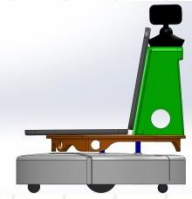
Evolution of Robotics Research

- Robotics has traditionally been an interdisciplinary area among mechanics, electronics, artificial intelligence, cybernetics, biology, psychology, computer vision, etc...
- Classic robotics (mid 80's) assume perfect information (models, measurements)
- Reactive paradigm (mid-80's) use no models and rely on a short connection between sensing and control
- Hybrid approaches (since 90's) were explored with model-based decision at higher levels and reactive functions at lower levels;
- Probabilistic Robotics (since mid-90's) explores inaccurate models and imperfect sensors. (G. Hager)



Summary

- Mobile robots are everywhere and with a growing population;
- They are mostly friendly (for sure);
- Robotics research is multi-disciplinary in nature;
- Researchers have been inspired by nature's designs;
- Robots have been replacing human labors, but also creating many new jobs in the mean time;
- Learning about robotics can help you to be better prepared for the future.



Further Reading

- Search Wikipedia for ‘Robotics’, ‘Mobile Robotics’, ‘Bio-Inspired Robotics’, ‘Artificial Intelligence’, and ‘Cybernetics’;
- Search ‘Robot’ and ‘DARPA Challenge’ on YouTube;
- [A Roadmap for US Robotics – From Internet to Robotics](#);
- [International Assessment of Research and Development in Robotics](#) (Long!);
- IEEE Spectrum, [Robotics](#);
- Science Daily, [Robotics](#).