# Robotics and Autonomous Systems

## Lecture 1: Introduction

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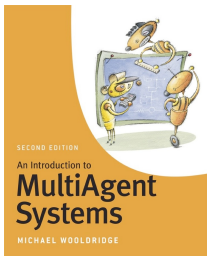
# Acknowledgements


- The robotics slides are heavily based on those that Roland Siegwart and Illah Nourbakhsh and provide along with their book:

- The agents slides are heavily based on those given to me by Mike Wooldridge and are taken from his book:



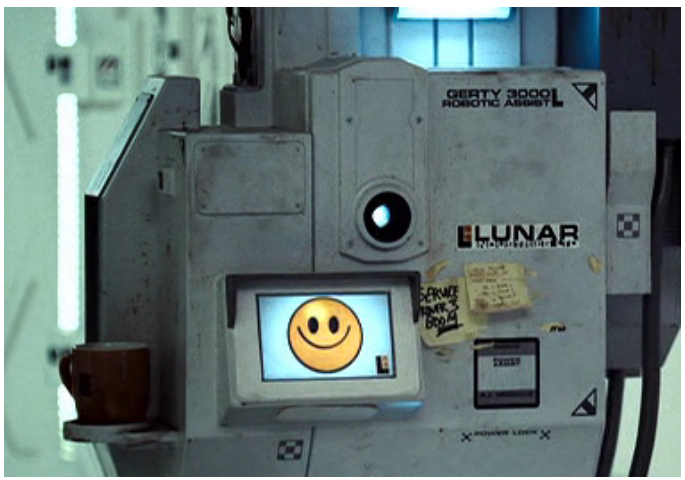

- Thanks to Mike Wooldridge, Davide Grossi and Simon Parsons who all contributed to the material presented in this course.

# Today

- Module Information
  - Aims and learning outcomes
  - Contents, outline
  - References
  - Practical matters, assessment
- Introduction
  - What is robotics?
  - What are agent systems?
  - Some examples of robots.

# What is a robot?

- But first, what do you think?



# Module aims

1. To introduce the student to the concept of an autonomous agent.
2. To introduce the key approaches developed for decision-making in autonomous systems.
3. To introduce a contemporary platform for programming agents and multiagent systems.
4. To introduce the key issues surrounding the development of autonomous robots.
5. To introduce a contemporary platform for experimental robotics.

# Learning outcomes

1. Explain the notion of an agent, how agents are distinct from other software paradigms (e.g., objects), and judge the characteristics of applications that lend themselves to an agent-oriented solution
2. Identify the key issues associated with constructing agents capable of intelligent autonomous action
3. Describe the main approaches taken to develop such agents
4. Use a contemporary agent programming platform (e.g. AgentSpeak) for developing significant software or hardware-based agents
5. Identify key issues involved in building agents that must sense and act within the physical world
6. Program and deploy autonomous robots for specific tasks

# . . . and the following soft skills

1. You will be able to practice how to work in groups:
   - discussing solutions together
   - distributing tasks and managing time
   - giving and keeping deadlines
   - respecting each others ideas
2. You will be able to practice how to manage a computer science project spanning over several weeks
   - planning ahead
   - keeping track of design challenges and choices made

Don't underestimate the challenge of either of these aspects.

# Module structure

- **PART 1:** Robotics
  Principles of robotics, the NXT platform and the LeJOS programming language.
- **PART II:** Autonomous systems
  Principles of agent theory, robots viewed as agents (autonomous systems), and the Jason programming language, agent coordination.

# Module outline

- 10 weeks (of 12 weeks)
- 30 lectures with a mix of Theory (principles of robotics and agent systems) and Practice (code)
- 10 supervised lab sessions (1 per week) + free lab access
- Self study and practice (as much as needed to understand the material and gain mastery of the subject)
- Two assignments (combined weight 100%) to be carried out in teams
- The first assignment will be published early in Week 2
- Teams are decided by the lecturer and are non-negotiable
- The individual mark for each assignment will depend on the mark obtained by the team, weighted by the amount of contribution of the individual to the team

# Assessment

- First assignment (50%)
- Second assignment (50%)

# Peer group assessment

**COMP329: Peer Group Assessment Form**

YOUR NAME:
TEAM NAME:

Please assess the level of contribution of each of your colleagues **and yourself**, during the group software project. Score each team member (a through e) using a points scale of 0 to 6:

- 6 is for an **outstanding** contribution
- 5 is for a **very good** contribution
- 4 is for a **good** contribution
- 3 is for an **acceptable** contribution
- 2 is for a **poor** contribution
- 1 is for a **very poor** contribution
- 0 is for **no** contribution.

**A grade of zero should be given only in exceptional circumstances, and your project monitor should already be aware of these.**

| *Student Names* | Student 1 | Student 2 | Student 3 | Student 4 |
|---|---|---|---|---|
| **Contributions** (from 1 to 6) | | | | |
| *Was s/he regularly at group meetings, available for discussion, planning and action?* | | | | |
| *Did s/he contribute to the needs of the* | | | | |

# Project log

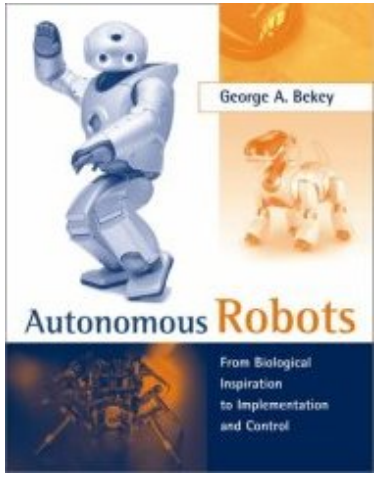
- Each group will be asked to keep a project log, made available online
- The project log should contain information about, for instance:
  - which subproblems is the group tackling
  - what solutions have been considered and how they are performing
  - what problems is the group facing
  - ...
- It should, at the end, give an idea of the trajectory the group has taken towards the proposed solutions of the assignments
- I will use it to monitor how each group does and it will contribute to the mark for each assignment.

# Practical matters

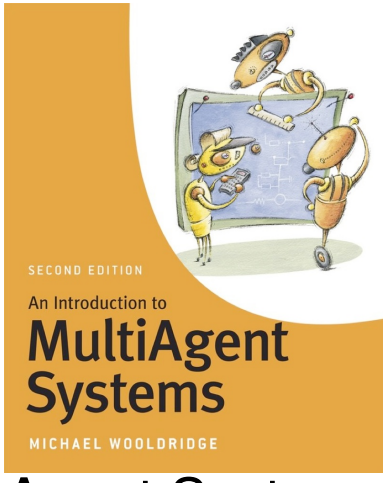
- Access to robots and lab:
  - The Robot Lab will be open during the usual lab hours.
  - You can borrow robots during Helpdesk opening hours.
  - You will leave your student card as a deposit when you check out a robot.
- Module website:
  - `cgi.csc.liv.ac.uk/~rmw/329_info.php`
  - It will contain slides, bibliography, assignments and extra materials and will be used for public announcements concerning the course

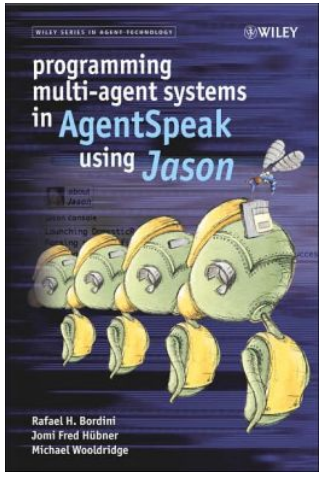
# Bibliography

## Robotics




## Agent Systems



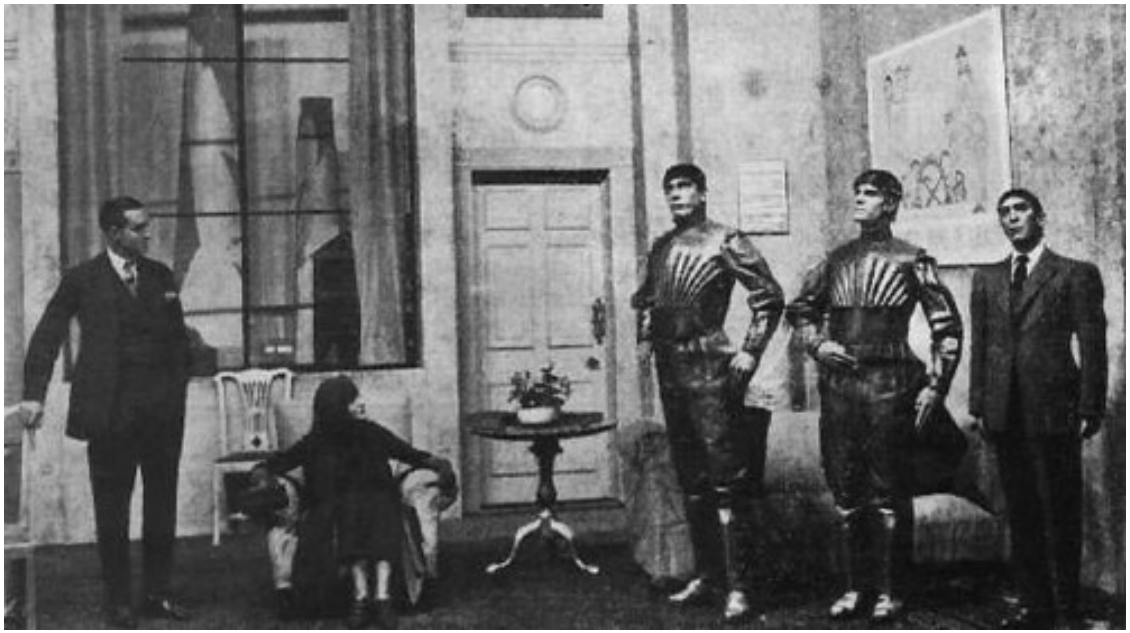
# What is a robot?

# What is a robot?

- "...a programmable, multifunction manipulator designed to move material, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks" Robot Institute of America (1980)

- "...[a] physical agent that performs tasks by manipulating the physical world" Russell and Norvig (2003).

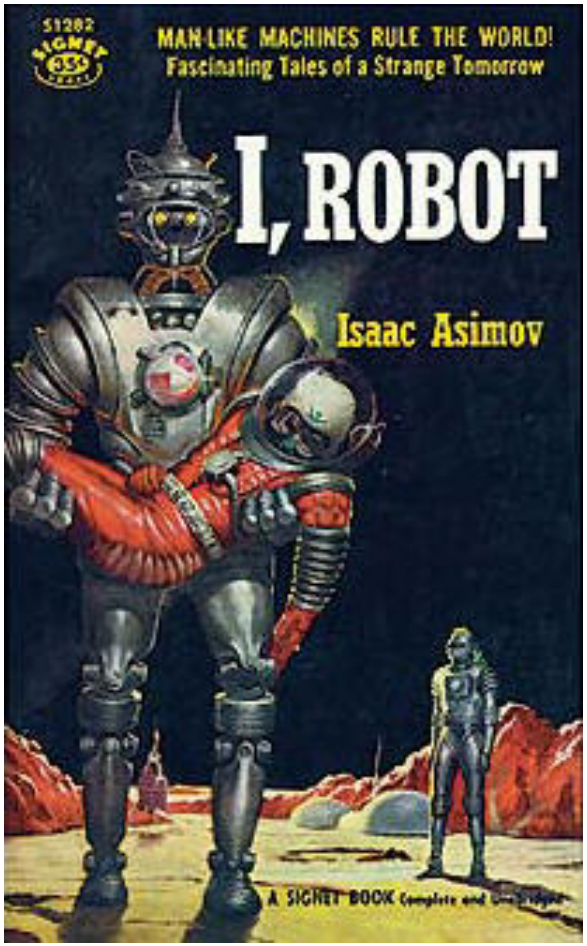
# What is a robot?



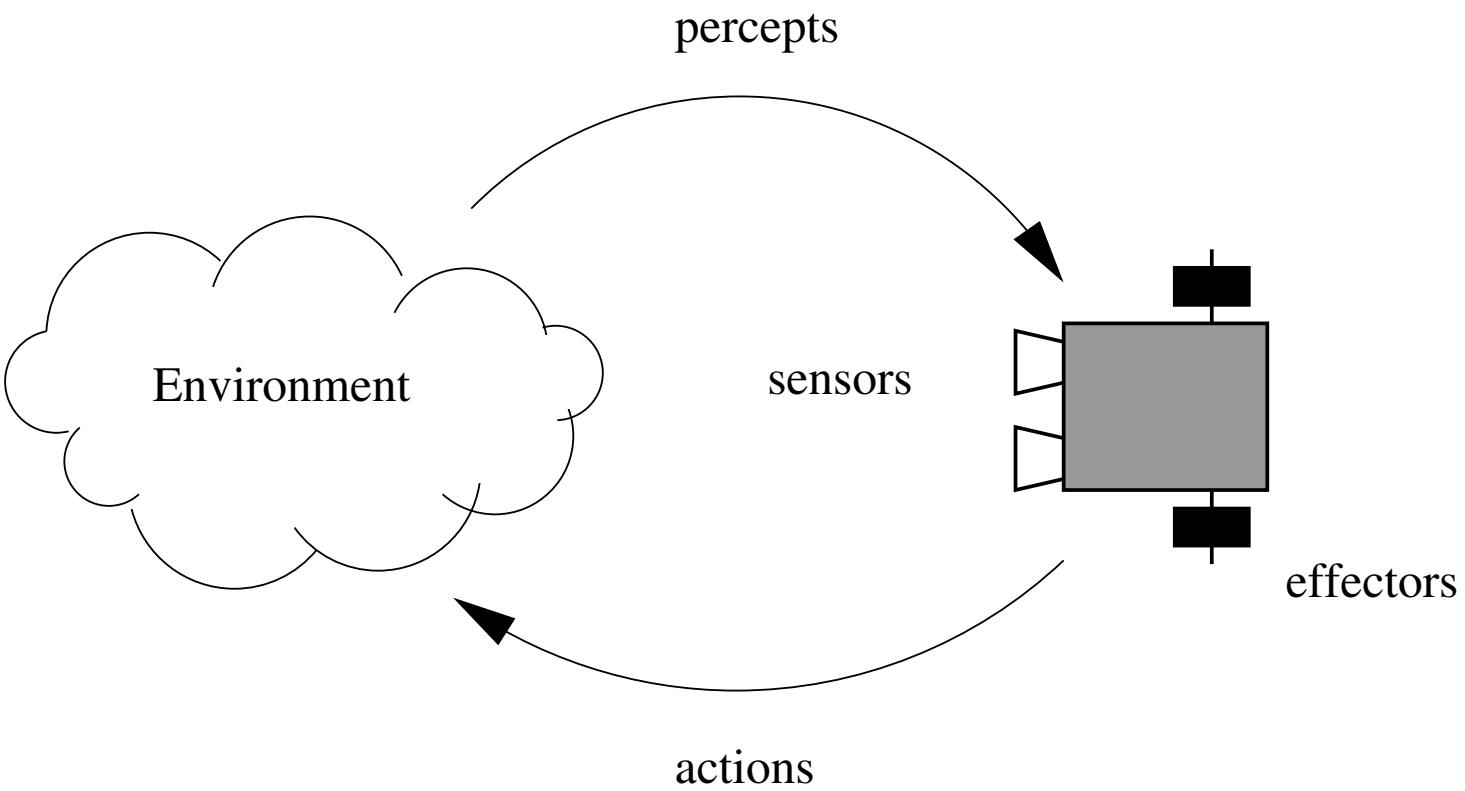
- The word “robot” was first used in Karel Capek’s play “Rossum’s Universal Robots” in 1920

# What is a robot?

- Isaac Asimov coined the term “robotics” in 1942.

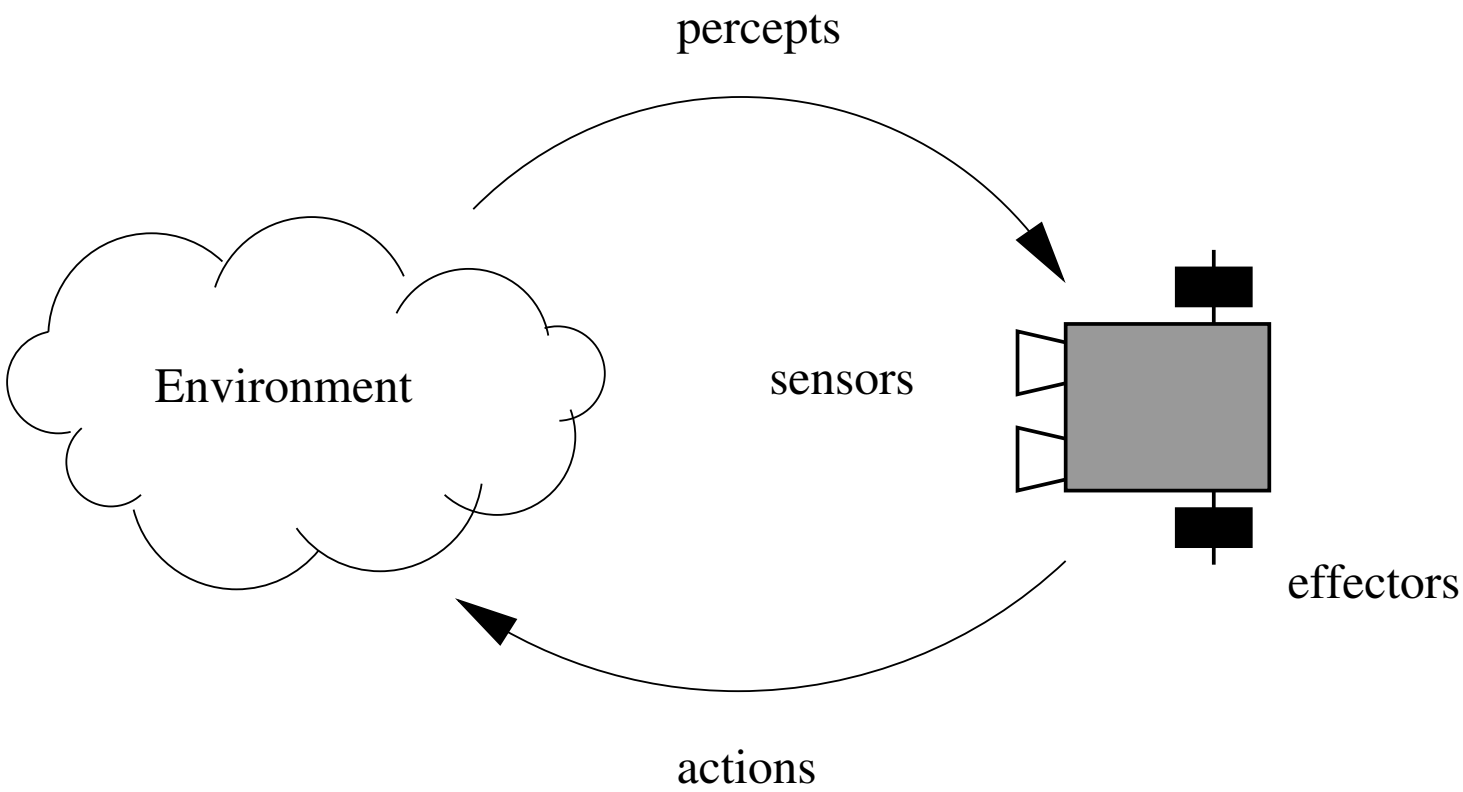


# What is an agent?




- An agent is a system that is situated in some environment, and is capable of autonomous action in this environment in order to meet its delegated objectives.

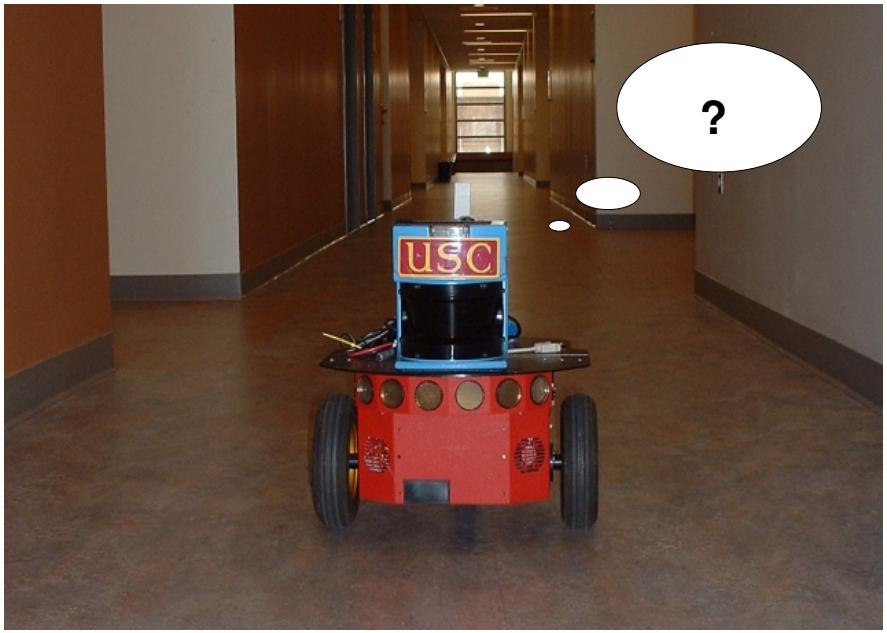
# What is an agent?




- The fundamental question is what action(s) to take for a given state of the environment.

# What is mobile robotics?

- In mobile robotics this becomes three questions:




  - Where am I ?
  - Where am I going ?
  - How do I get there ?

- The robotics part of this course is about answering those questions.

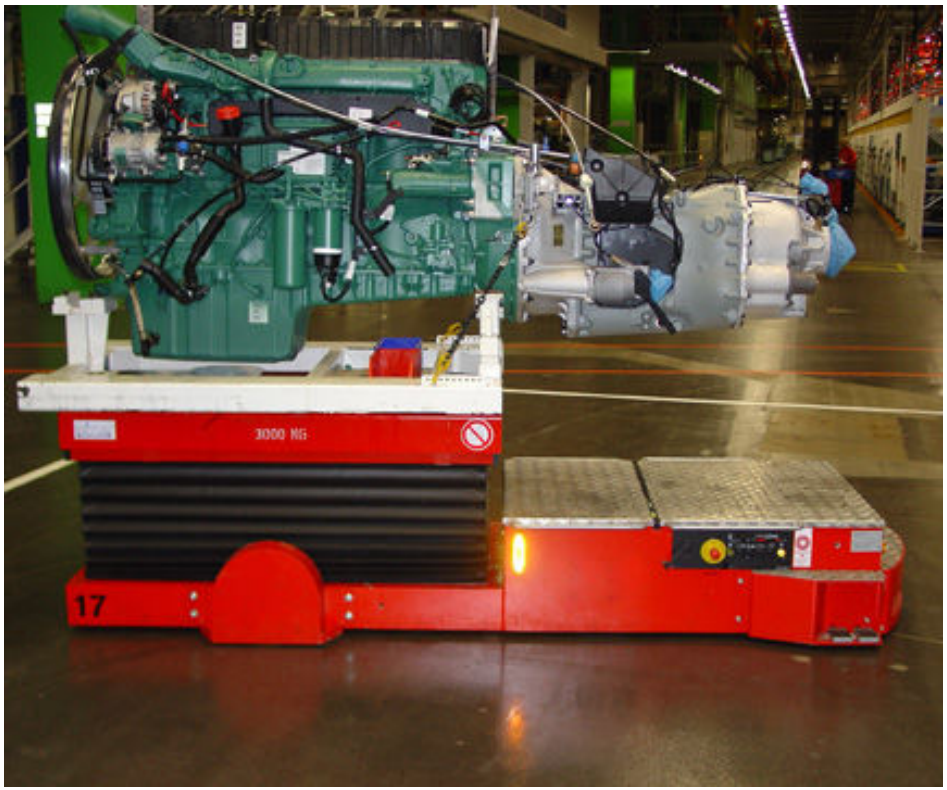
# Applications

- The following are some deployed robots.
- From the more mundane to the more experimental.

# Automatic Guided Vehicle

- Used to transport motor blocks from one assembly station to an other.

# Automatic Guided Vehicle




- Guided by an electrical wire installed in the floor but it is also able to leave the wire to avoid obstacles.

# Savione

- Delivery robot, currently being used in hotels to deliver items to guests.

# Kiva Systems

- Warehouse/Fulfillment concept by Kiva Systems (now Amazon Robotics).

# iRobot Roomba

Successful robotic vacuum cleaner

6 million sold by mid 2011

Simple, but effective, control strategy

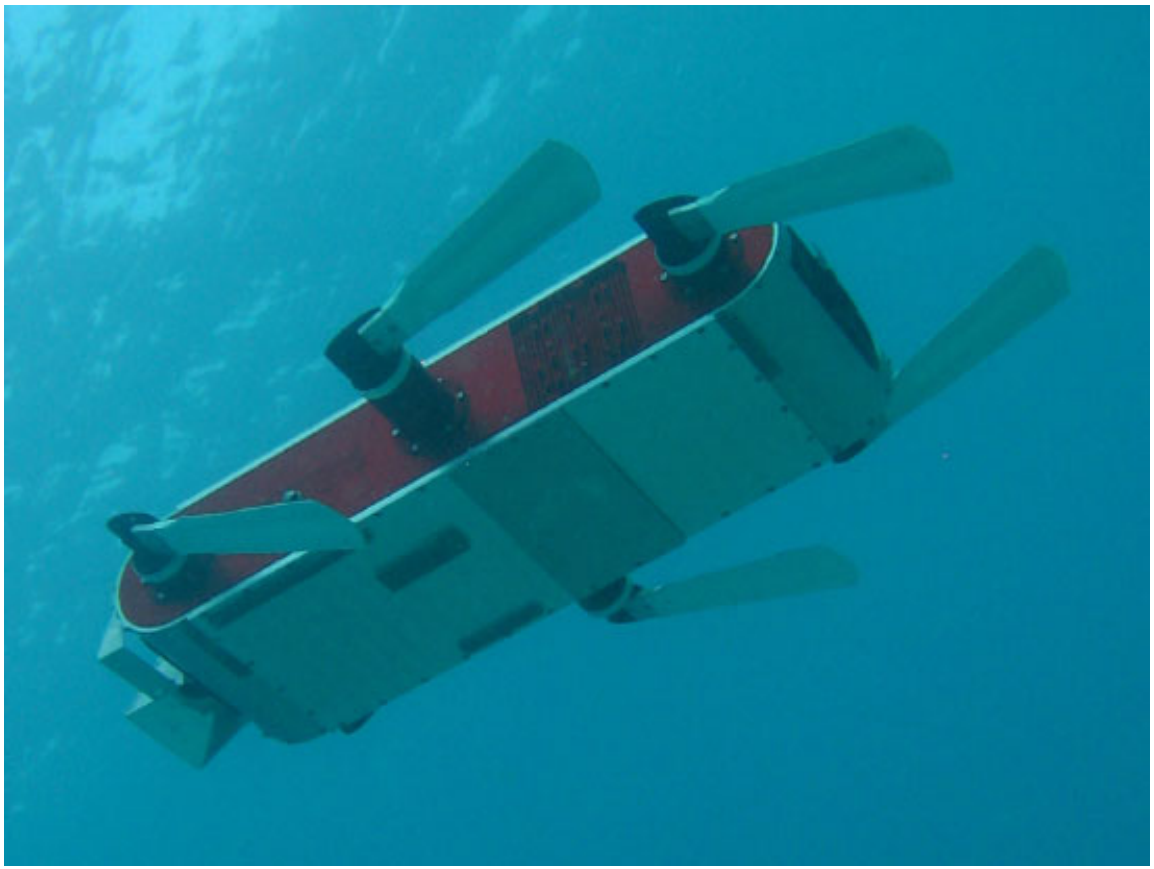
Touch sensors

Sonar in the more advanced models

# Pioneer inspection robot

- Teleoperated robot used to inspect the sarcophagus at Chernobyl.

# Autonomous Underwater Vehicles - Aqua2



- Numerous applications such as pipeline inspection, seafloor mapping andcurios coral reef inspection.

# Mars Rovers

- On Mars, teleoperation is a bit of a handicap. Why?

# iRobot Packbot

- A rugged, teleoperated platform for the military

# Atlantik Solar

- Record breaking 81 hours of autonomous solar-powered flight.

# Pulstech Forester

- First “industrial like” walking robot. Leg coordination is automated, but human operator navigates.

# Jibo Family Robot

# DARPA Grand Challenge

- The Grand Challenge involved autonomous navigation through the desert.

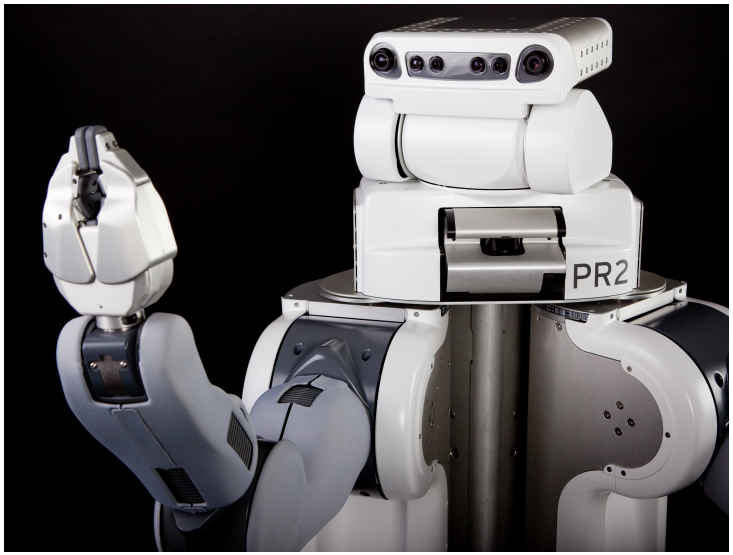
# DARPA Urban challenge

- The Urban Challenge took this into traffic.

# Google Car

- The Google car is intended to make this technology mainstream.

# Research Platforms



# Summary

- This lecture gave you the necessary information on the module.
- It also looked at some basic ideas in the area of mobile robotics.
- We identified the main problems to be solved.
  - The course will cover these topics (and others).
- We also looked at some deployed robots.