BLG456E
Robotics
Introduction to the course

Lecture Contents

- Why and what robotics.
- Course plan.

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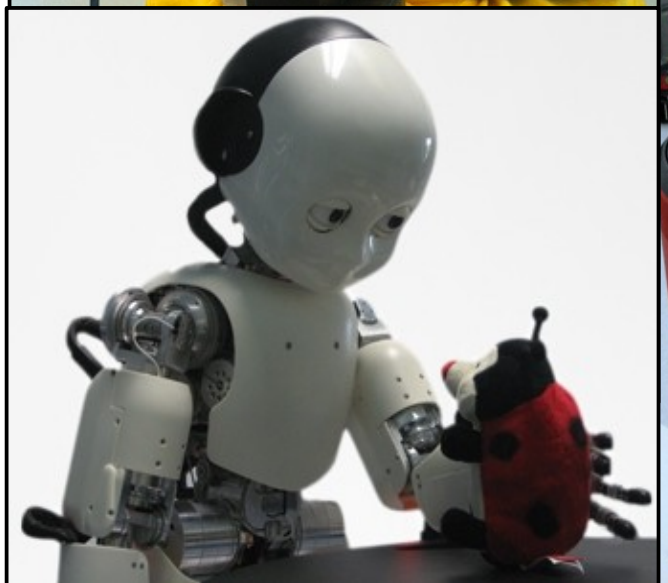
Autonomous Robotics

- Building artificial systems that are:
  - **Embodied.**
  - **Acting.**
  - **Problem-solving**.
- Why do this?
  - **Applications!**
  - **Cognitive models.**



Why robots?

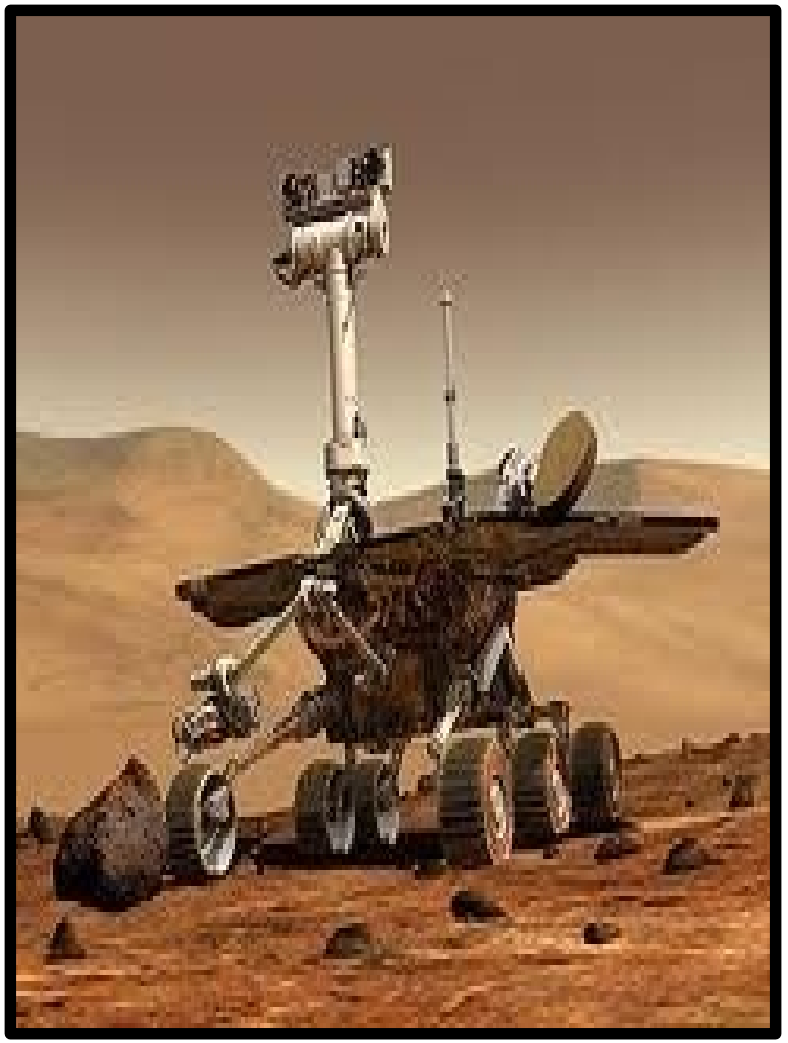
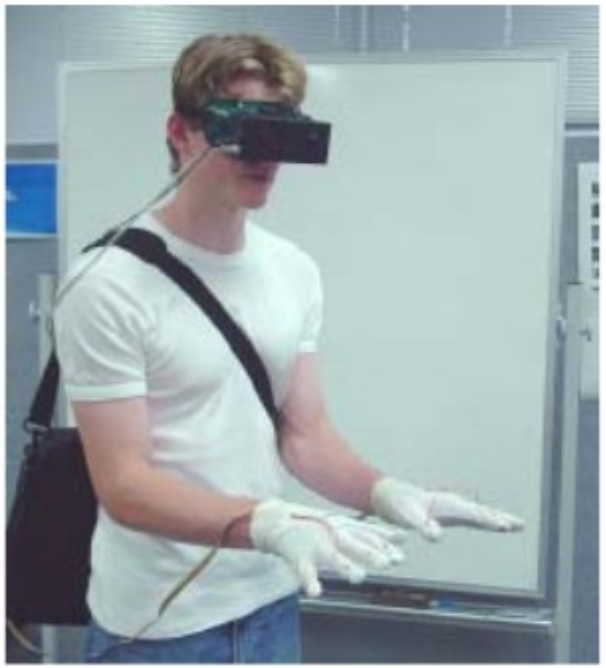


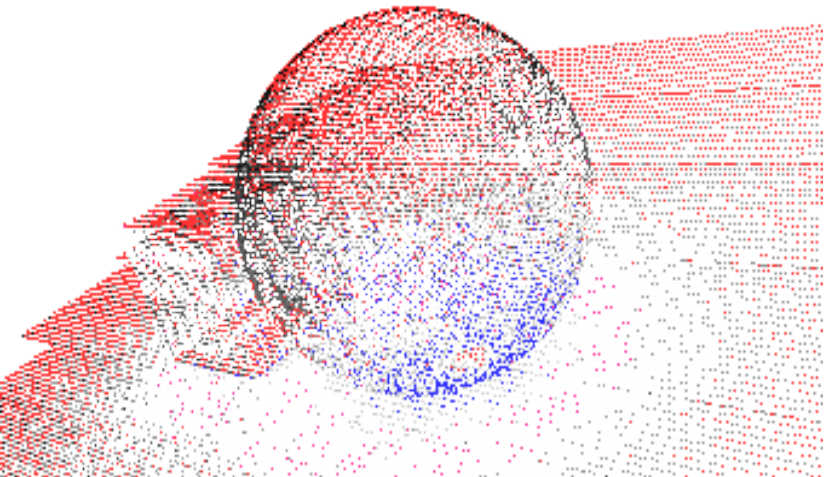
Image by Maas Digital LLC for Cornell University and NASA/JPL

- Example applications:
  - Human assistance in office and home.
  - Waste site exploration, construction.
  - Search and rescue.
  - Dynamic industrial processes.
  - Automated experimentation.
  - Manufacturing.
  - Warehousing and transportation.
  - Environmental monitoring, agriculture and surveillance.

Why robots?



Meers & Ward 2004



- Other areas that benefit:
  - Augmentation
  - Machine intelligence
  - Semi-autonomous systems
  - Cognitive science
  - Lots more.

What tasks **should** robots do?

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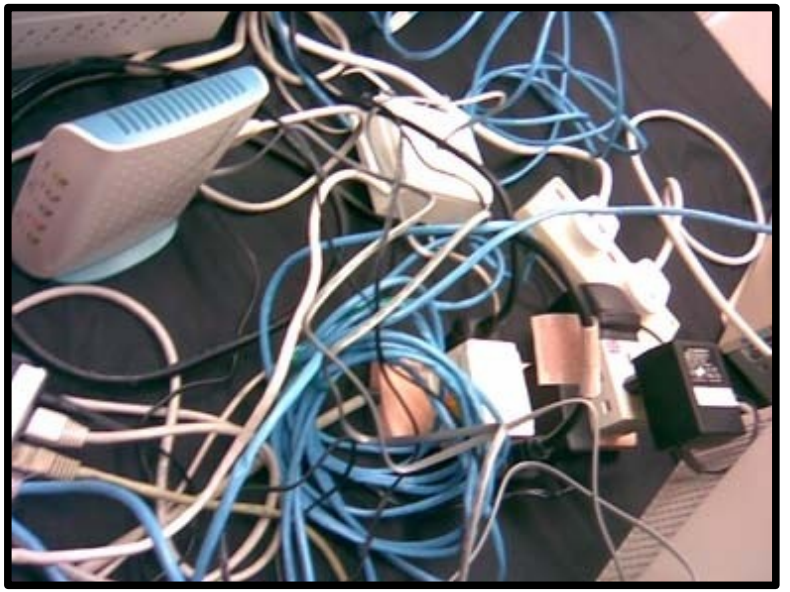

What tasks **should** robots do?

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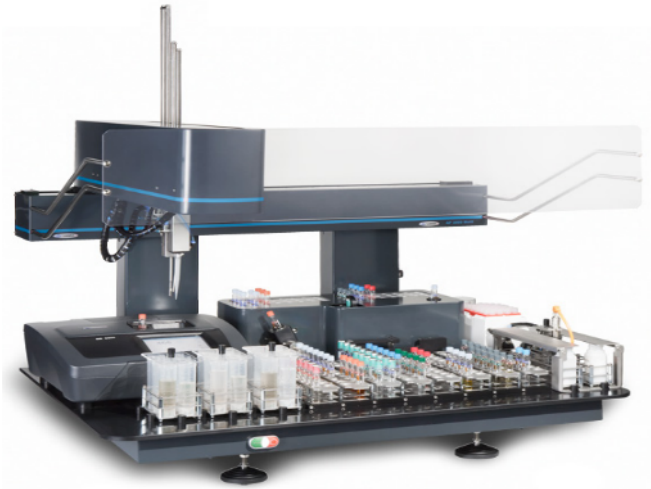
What kinds of robots are there?

Current robots

- Manipulators:
  - Factory assembly line.
  - International Space Station.
  - Laboratory robots.

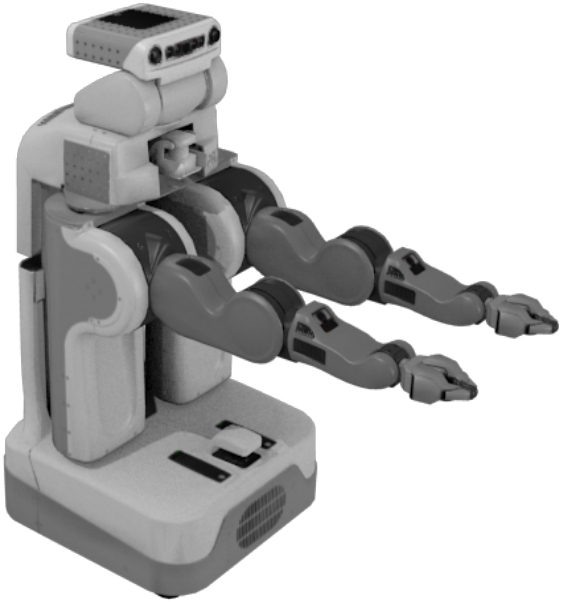


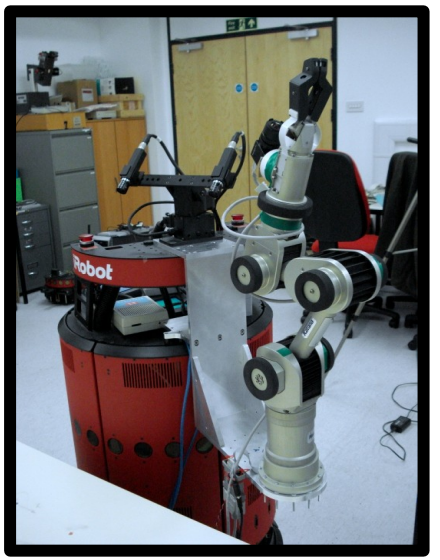
Current robots

- Mobile robots:
  - Unmanned Ground Vehicles (UGV/ULV).
  - Unmanned Air Vehicles (UAV).
  - Autonomous Underwater Vehicles (AUV).
  - Planetary rovers.

Current robots

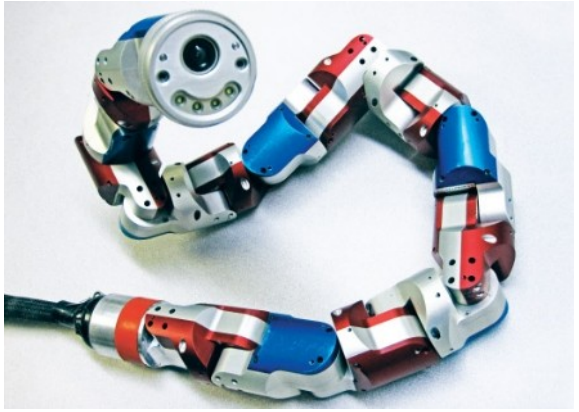
- Mobile manipulators.





Current robots

- Other (weird & wonderful) robots:
  - Humanoid robots.
  - Bio-inspired robots.
    - E.g. snakes, flies, geminoids.
  - Self-assembling.



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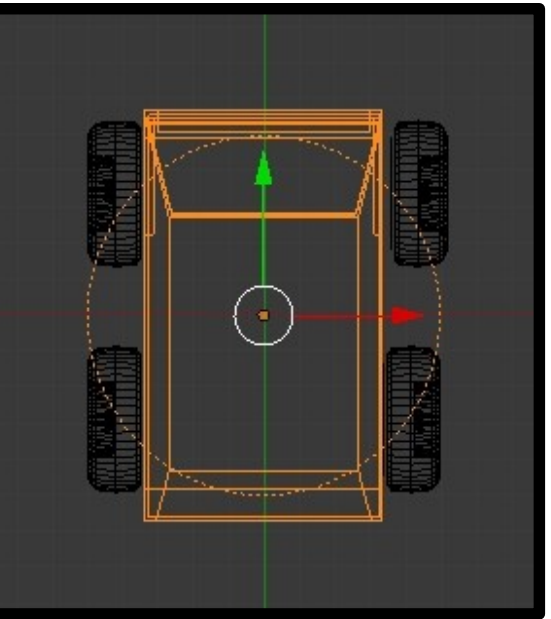
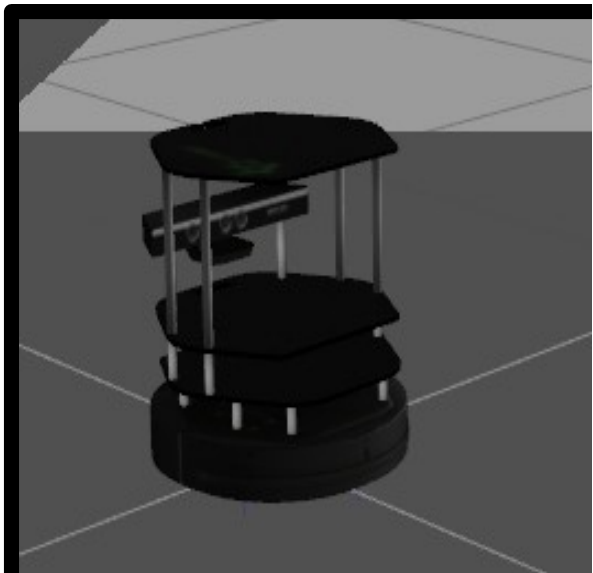
Course approach

- **Practical** application of the theory of robotics.
  - Focus on **autonomous mobile robots in 2D**.
- Theory → Practice.
- Apply:
  - Probability, calculus, geometry, algebra, control, planning, dynamics, kinematics, geometry, learning, software architecture, etc...

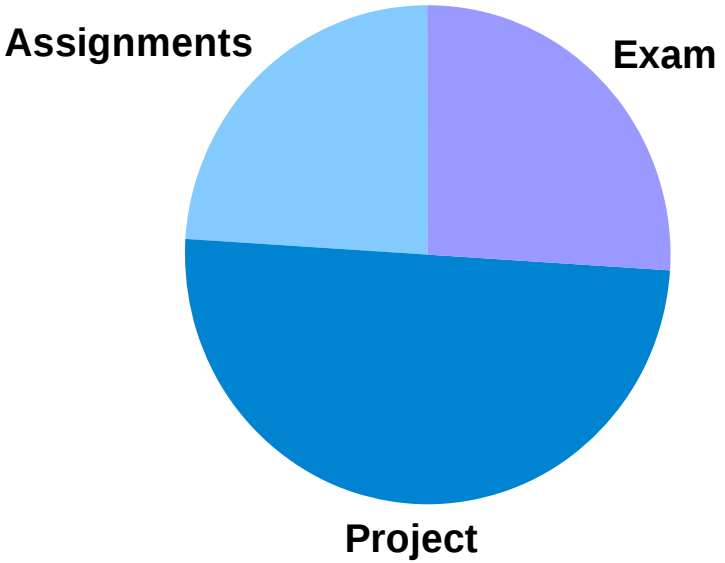


Exercises + Project

- Mostly in simulation (ROS + Gazebo).
- Some real robots available (maybe).

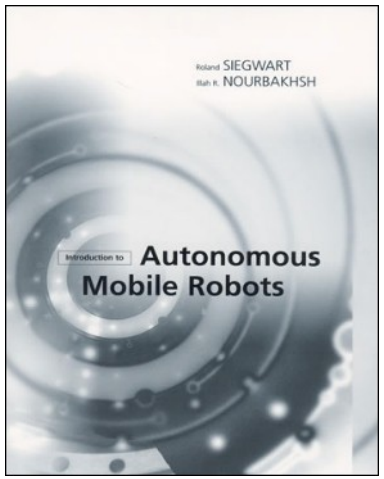


Assessment



- 2 assignments (24%).
  - **VF requirement**: Submit both (≥ 20% counts).
  - Practical fundamentals.
  - Start NOW.
- Project (50%).
  - In a group.
  - Proposal a requirement.
  - *Implement a solution, in simulation or on a real robot.*
  - Work package interim submission.
  - Report, demo & video.
- Final (26%).
  - Conceptual understanding.
  - Maths applied to robot problems.

Textbooks



Main:

Introduction to Autonomous Mobile Robots

Roland Siegwart and Illah Nourbakhsh, The MIT Press, 2004

Electronic version available & in library.

Extra reading:

Springer Handbook of Robotics

Bruno Siciliano and Oussama Khatib, Springer, 2008.

Electronic version available in library.

Planning Algorithms

Steven M. LaValle, Cambridge University Press, 2006.

Electronic version available online.

Computational Principles of Mobile Robotics

Gregory Dudek, Michael Jenkin, Cambridge University Press, 2010.

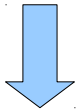
Electronic version available online.

http://wiki.ros.org/ROS/Tutorials

Project summary

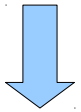
Teams of 1-6.

"Make a robot do something cool".



Suggested approach:

- Choose a platform (e.g. Turtlebot).
- Choose a problem (e.g. Path-planning in a cluttered room).
- Choose a solution or two (e.g. RRT-Star).
- Choose an evaluation (e.g. traversal speed)



"Solve the path-planning problem on the Turtlebot using RRT-Star and evaluate speed of traversal"

Project summary Step-by-step.

- 1: Preliminary Proposal.
- 2: Pre-proposal meeting.
- 3: Proposal:
  - Make robot A do X using method Y..
  - How to measure success.
- 4: Proposal Defence.
- 5: Work package 1 report & meeting:
  - Evaluated against proposal expectations for WP1.
- 6: Demo:
  - Robot, problem, solution.
  - Methods.
- 7: Report/Video (week 15):
  - Details of robot, problem & solution.

Assignments

- Assignment 1.
  - Obstacle-avoiding exploring robot in ROS/Gazebo (Turtlebot).
- Assignment 2.
  - Mobile robot control in ROS/Gazebo (Turtlebot).

(compulsory > 20%)