AI for Mobile Robots
- CSIP5202 -

Foundation of Robotics

Overview

- Unit teaching plan
- Assessments
- Software
- Overview of robots

Teaching Plan

TOPIC
Foundation of robotics
Environments and simulators
Sensors
Actuators
Low and high level control
Feedback control
Knowledge representation
Vision system
Co-operative robots

Assessment

- Coursework 1 (Lab Portfolios) – 44%
  - Implement a robot controller for a given task
  - Write a report and analysis
- Discussion Board – 6%
  - Contributions per topic
  - No large piece of code (i.e. assignment) to be submitted, please.

Software

- iRobot Create Toolbox Simulator (MATLAB)
- CoppeliaSim Edu (MATLAB, Python etc)
- Any other you wish to use but please let me know first

Software

- iRobot Create Simulator MATLAB Toolbox
  - Simulates the iRobot Create robot (not available physically)
  - Simulates noise and physics of the environment
  - Has a variety of sensors
  - Simple to use and program in MATLAB

Software

- CoppeliaSim Edu
  - A full, standalone simulator
  - Simulates any type of robot (mobile and non-mobile)
  - Extensible
  - Use a remote API: a wide range of languages can use this
  - MATLAB API is available in the labs
  - Can be used with python

Software

- It’s up to you what you want to use
- The labs and assignments are software-agnostic
- You should be able to find the functions in the software (and other libraries of the programming language) to help you achieve the tasks
- For anyone not confident in their ability in programming, then I’d recommend using the iRobot Create Toolbox Simulator

In general

- Any help, queries, questions etc that you require come and see me as soon as possible. I'm here to help you.
- I'm available by email (expect a response in 48 hours, unless it's really urgent).
- For any help with the software, check online first (there's a good community for CoppeliaSim Edu and MATLAB help), but if a group of you have the same problem then I can add additional help on LearningZone for everyone.

Foundations

- Basics
  - Embodiment
  - Simulation
  - Intelligence
- Robots
  - Components
  - Tasks
  - General-purpose robots

Foundations: Motivation

- Why study mobile robots
- Two main reasons:
  - Application
    - To create robots to be used in hostile environments
      - Underwater
      - Bomb disposal
      - Planetary exploration
      - Nuclear power stations
  - Theory
    - To investigate intelligent behaviour
      - Artificial intelligence
      - Cognitive science
      - Psychology

Foundations: Intelligent Agents

- The word “agent” means “to do”
  - An entity that produces an effect
- “agent” is used to describe both software simulations and/or actual hardware implementations of robots
  - Robot
    - Physical machine
    - A simulation including the physical and geometrical aspects
  - Agent
    - Numerical computer model
    - Physical machine

Foundations: Solution vs. Implementation

- At initial stages, software agents can be used as the primary mechanism to investigate robotics
  - Advantages
    - Duplicable, reliable and repeatable
    - Flexible, configurable and safe
  - Disadvantages
    - Simulations are not the same as physical implementation!
- Many people believe that true intelligent behaviour only emerges when a physical agent interacts with its environment
  - Can that environment be simulated

Foundations: Intelligence

What is Intelligence?

Robots: Tasks to be solved

- Learning
- Interaction
- Cooperation
- Manipulation
- Planning
- Reasoning
- Navigation
- Perception

Robots: Where robotics is heading

- Robotics are evolving to include products in:
  - Medical industries
  - Entertainment
  - Industrial automation
  - Hazardous environments
  - Transportation and Shipping

Robots: Components

- A robot is made of 5 main component classes:
  - Body
  - Sensors
  - Actuators
  - Computing power and software
  - Energy source

Robots: Components vs Disciplines

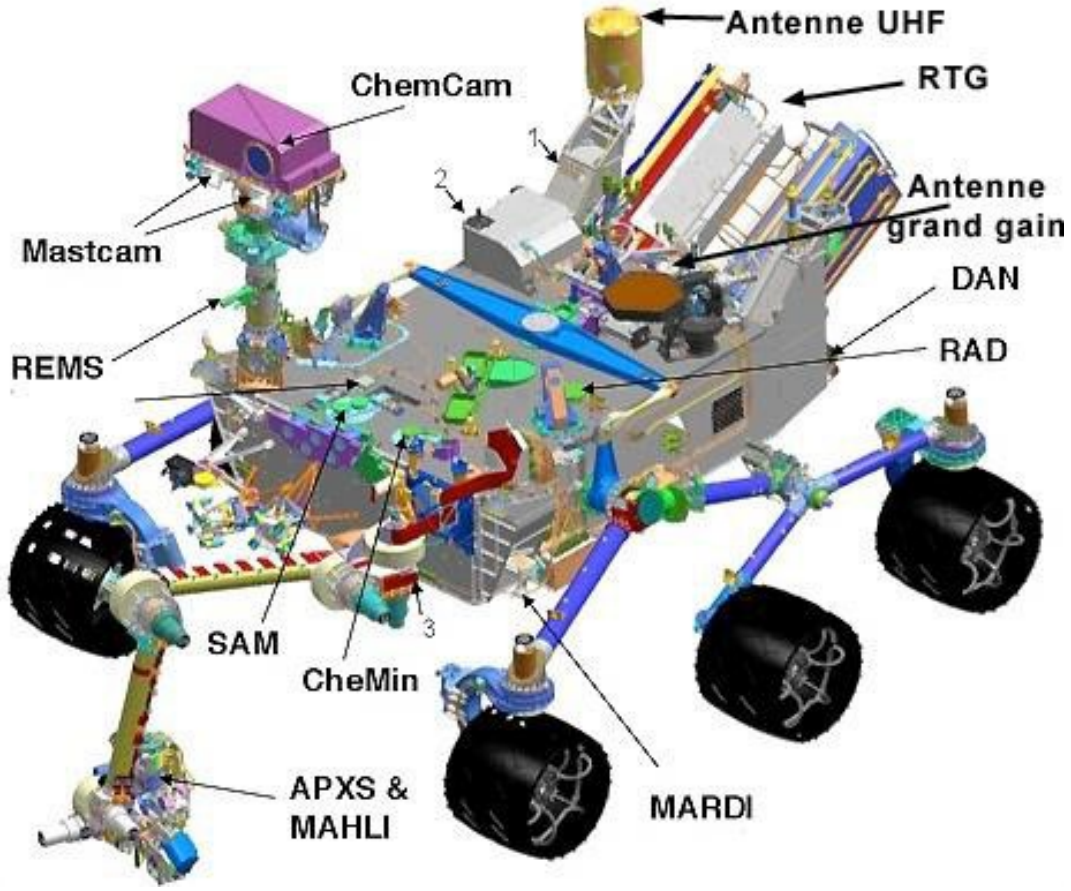
- As computing people, we don’t build or design all components of robotics but we are concerned with all:
  - Body: mechanics, mechatronics
    - Understand the abilities and limitations
    - In the simulator, it involves considering the physics and geometry
  - Sensors: chemistry or materials, electronics
    - Very important
    - Understand the meaning of the data they provide and their limitations
  - Actuators: mechanics, mechatronics, electronics
    - Understand how to drive them and represent their state

Robots: Components vs Discipline

- Computing power: Electronics
  - Understand its architect
- Software: Computer Science, Control Theory, Artificial Intelligence
  - All of it
- Energy Source: Chemistry, electronics
  - How to manage it as a resource
  - How it impacts the components of the robot

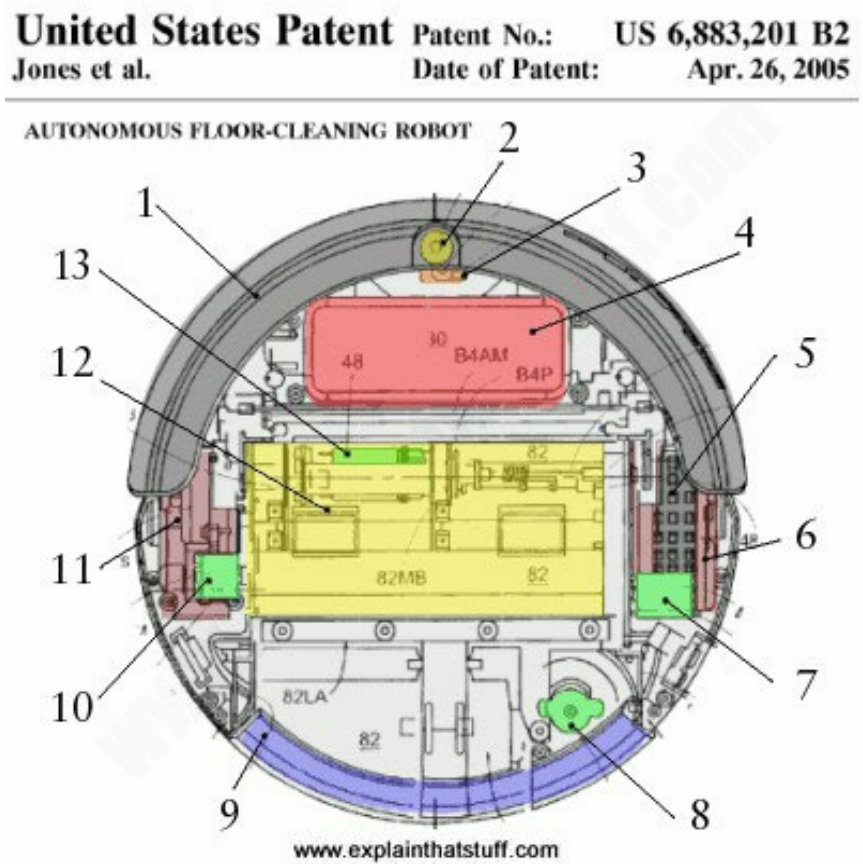
- The programmer needs to understand the whole system.

Robot: Mars Curiosity Rover



Drawing-of-the-Mars-Science Laboratory - Curiosity (rover) - Wikipedia

Robots: Roomba



1. Obstacle detection bumper at the front.
2. Infrared detector for communicating with lighthouses and docking station.
3. Wheel drop sensor.
4. Lithium metal-hydride rechargeable battery pack (14.4 volts and 3600mAH)
5. "Knobby" treaded wheels
6. Wheel sub-assembly.
7. Electric motor drives the right wheel.
8. Electric motor powers vacuum.
9. Handle for removable dust bin.
10. Electric motor drives the left wheel.
11. Wheel sub-assembly.
12. Self-contained brush mechanism.
13. Electric motor powers brushes.

Artwork from US patent#6883201: Autonomous floor-cleaning robot by Joseph Jones et al, iRobot Corporation, courtesy of US Patent and Trademark Office. This patent was filed December 16, 2002 and granted April 26, 2005.

Robots: Amazon

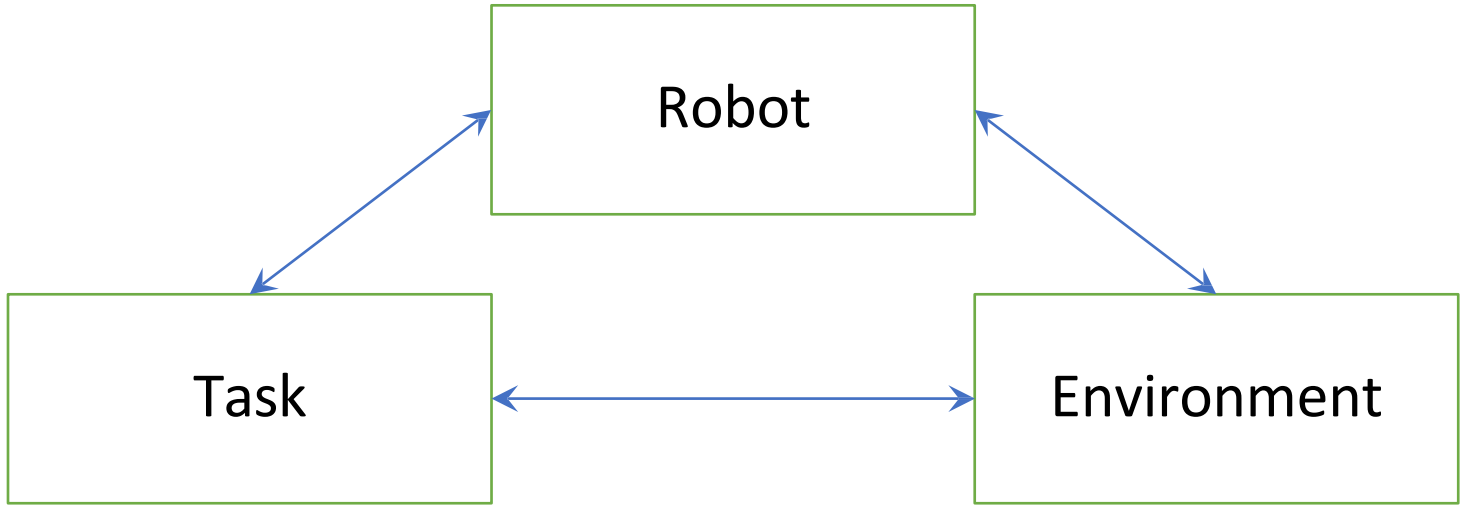
Kiva

Titan

https://spectrum.ieee.org/robotics/robotics-software/three-engineers-hundreds-of-robots-one-warehouse
https://www.aboutamazon.com/news/operations/amazon-robotics-robots-fulfillment-center

Robots: Linkage

- A robot, its task and the environment all depend on, and influence, each other



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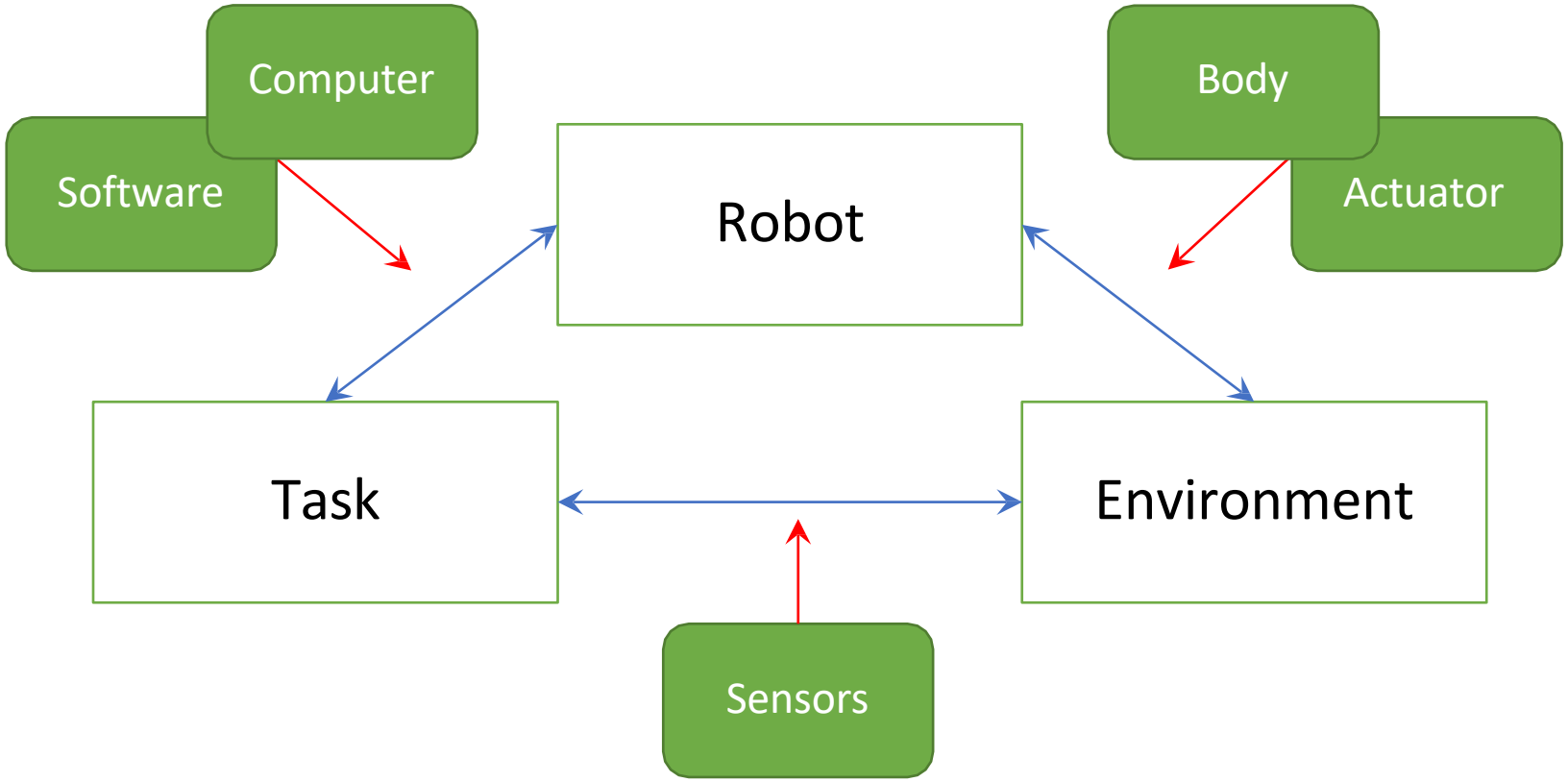

Robots: General Purpose vs Multifunctional

- A completely general-purpose robot is not possible… YET!
  - A general-purpose living thing tends not to exist.
    - What about human beings?
    - We are intelligent, versatile in the right environment and adaptable
    - However, we are poor at:
      - Flying
      - Swimming
      - Surviving in extreme conditions

We're great at generalising though!

- A robot's function is defined by its behaviour within an environment performing a task.
  - Only the simultaneous description of a robot, its task and the environment describes the robot completely
  - Yet… a robot by definition is Multi-Functional

Lab Work

- Your task is to:
  - Download and install the iRobot Create Simulator
  - Explore how to load, create and run a program

Questions?