COMP5121
Mobile Robots

Foundations

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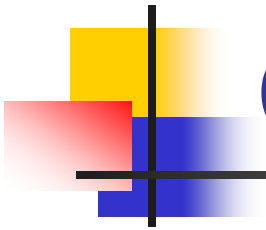
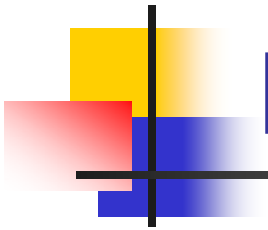


Overview

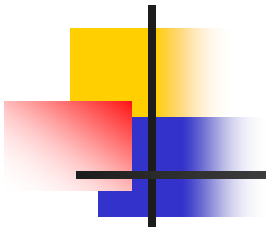
- Basics
  - agents, simulation and intelligence
- Robots
  - components
  - tasks
  - general purpose robots?
- Environments
  - structured
  - unstructured
  - partially structured

Basics



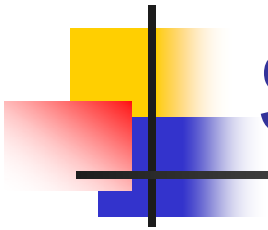
Motivation

- Why study autonomous mobile robots?
- Two main reasons
  - applied
    - to create robots to be used in hostile environments
      - underwater
      - planetary exploration
      - nuclear power stations
      - bomb disposal
  - theoretical
    - to investigate intelligent behaviour
      - artificial intelligence
      - cognitive science
      - psychology



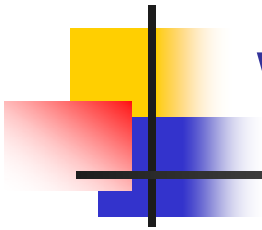
Intelligent Agents

- The word ‘agent’ means “to do”
  - an entity that produces an effect
- Consequently, ‘agent’ is used to describe both software *simulations* and / or actual hardware *implementations* of robots
  - robot
    - physical machine
  - agent
    - numerical computer model
    - physical machine



Simulation v. Implementation

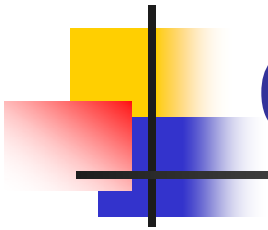
- Perhaps software agents could be used as the primary mechanism to investigate robots
  - advantages
    - cheap
    - flexible
  - disadvantages
    - a simulation is not the same as a physical implementation!
- Many people believe that true intelligent behaviour only emerges when a physical agent interacts with its environment



What is Intelligence?

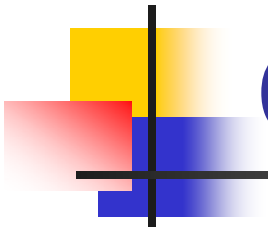
- Intelligence is very difficult to define
  - *The extent to which we regard something as behaving in an intelligent manner is determined as much by our own state of mind and training as by the properties of the object under consideration. If we are able to explain and predict its behaviour or if there seems to be little underlying plan, we have little temptation to imagine intelligence. With the same object, therefore, it is possible that one man would consider it as intelligent and another would not; the second man would have found out the rules of its behaviour.*
    - Alan Turing, 1947

Robots



Components

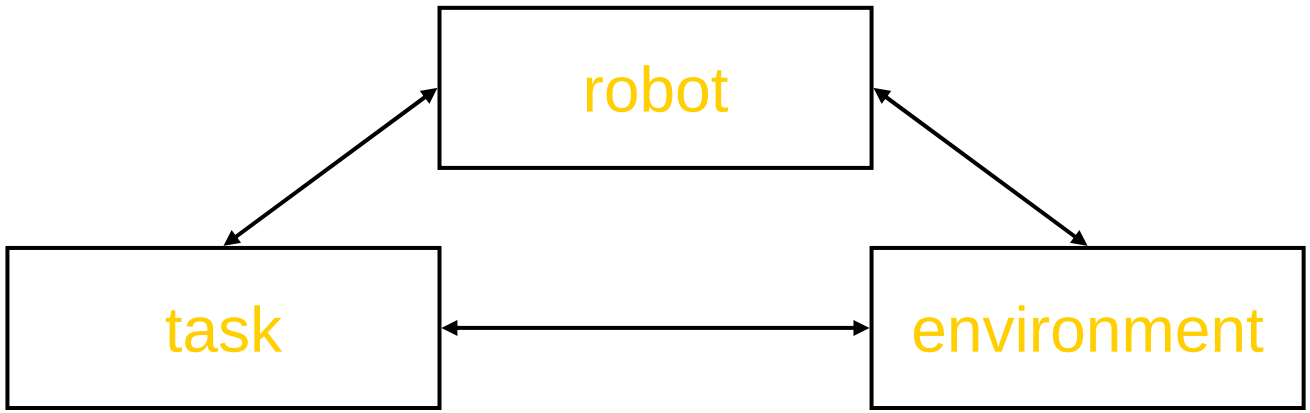
- A robot comprises Five main component classes (1)
  - body
    - mechanical support or structure of the robot
    - can determine some abilities or limitations (space, shape, weight ...)
  - sensors
    - *devices used for the detection or measurement of physical properties to which they respond*
    - provides the inputs to the robot
  - actuators
    - *devices which act → moves to mechanical action, communicates motion to, or impels (an instrument, machine, or agent)*
    - effects the outputs from the robot



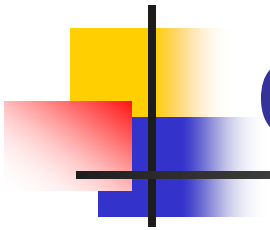
Components

- A robot comprises Five main component classes (2)
  - computing power
    - *Computer hardware and peripherals ➔ should be suited for real time processing*
    - can be see as the Brain of the robot (*having a brain does not necessarily means knowing how to use it !*)
  - software
    - programmed behaviour(s); data and ‘memory’
    - makes decisions for the robot ➔ Intelligence of the Robot (?)
  - Energy source
    - Where would you classify it?

Linkage



- A robot, its task and the environment all depend on, and influence, each other
  - e.g. a spider in the bath!
  - quantum physics (?)



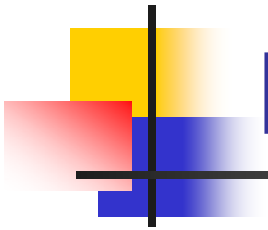
General Purpose vs. Multifunctional

- A completely general purpose robot is not possible ... yet
  - a general purpose living thing tend not to exist
    - humans are the most intelligent (???)
    - but humans are poor at
      - flying (c.f. swallow, swift, Arctic tern, housefly)
      - swimming (c.f. tuna, sperm whale)
      - surviving (c.f. scorpions, ants)

but humans are excellent generalisers!

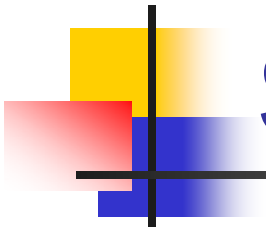
- A robot's function is defined by its behaviour within an environment performing a task
  - only the simultaneous description of a robot, its task and the environment describes the robot completely
  - Yet ... a robot by definition is ***Multi-functional***

Environment



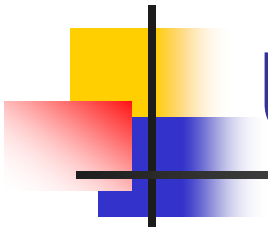
Environment Types

- There are many different types of environment in which a robot may be required to operate
- Environments are typically categorised by their degree of *structure*
- Although there is no solidly accepted definition of structures, environments can be split into one of the following categories
  - structured
  - partially structured (??)
  - unstructured



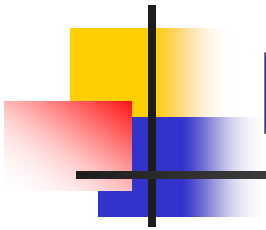
Structured Environments

- A structured environment has been specially designed for the robot to operate in
  - a factory floor with in-built ‘tracks’ to follow
  - an exact description of the environment can be supplied to the robot during its design phase
    - very little or perhaps no sensor data may be required
- There are usually no unexpected or unplanned dynamic aspects to the environment
  - the environment does not change
  - the robot can been ‘told’ in advance of how and when the environment will change, and how to deal with it



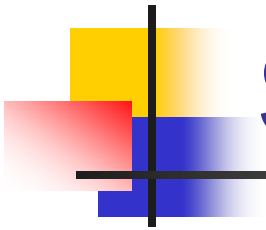
Unstructured Environments

- Complex environments for which no models or maps exist, or can even be accurately generated
  - robots generally operate purely in response to real-time sensor data
- Such environments usually have significant dynamic changes
  - natural, real-world as opposed to artificially created
  - may have unknown attributes
    - e.g. deep-sea exploration
  - or my be almost entirely unknown
    - e.g. planetary probes



Partially Structured

- Somewhere between the previous two extremes!
  - an environment which may be modelled to a certain extent, but with insufficient model detail to fully support task completion
- Possibly, the static component of the environment has been modelled, but the dynamic changes are unpredictable and must be sensed
  - for example, a factory floor with in-built ‘tracks’ to follow, but with unpredictable (e.g. human) obstacles to avoid
  - the second Mars explorer!



Summary

- Summary of this lecture
  - basics
    - agents, simulation and intelligence
  - robots
    - components
    - tasks
    - general purpose robots?
  - environments
    - structured, unstructured, and partially structured
- Next lecture
  - architectures and behaviours