Robot Control Architectures

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Announcements

- Lab books
- We need your rubbish!
We’ve looked at low level control.

Today we’re going to look at software architectures for robot control.

We’re considering control at a slightly higher level here. We’ll raise the level of abstraction even higher in the next few lectures.
Shakey versus the Ants!

- Shakey was the first robot that could reason about its actions.
- Landmark in the ‘symbolic’ AI movement that was dominant till the 1980s.
- Incredibly successful. A huge number of fundamental advances came out of Shakey. E.g. A* search, STRIPS planning, the Hough transform.
- Ultimately flawed.
The Shakey Video

- Watch the Shakey video and think about
  - How were the systems within Shakey organised?
  - How did Shakey represent the world?
  - How did Shakey decide on a course of action?
  - What simplifying assumptions did the designers of Shakey make?
  - When would Shakey fail?
**Shakey Summary**

- Functional decomposition
- Represented the world using first-order logic.
- Actions chosen by planning in the world model
  - (Actually, used a slightly different representation for performance)
  - Massive cheats to make it work
    - Solid colours and strong lines so vision worked
    - Objects were easy to push, floor was smooth
    - No other agents in the environment (most of the time :)
- Long feedback loops make Shakey error prone
- Shakey didn’t transfer to the real world
In the 1980s people, mostly prominently Rodney Brooks, started looking at a different approach to robotics, dubbed *behaviouralism*.

Behaviouralism started by rejecting functional decomposition and attempts at reproducing human level intelligence.

Aimed at insect level intelligence embedded in the real world:
- Incremental increases in complexity.
- Behavioural decomposition
- No explicit representations
Rodney and the Ants

- Rodney Brooks on Robotics
Behaviours

- Simple units of interleaved action and perception
- Minimal processing requirements
- Often *reactive* – no internal memory of state
  - “World is the representation”
- Finite state machines also common
- E.g.
  - Avoid obstacles
  - Move towards light
The Subsumption Architecture

- Arrange behaviours in priority hierarchy
- E.g.
  - Avoid predator
  - Find food
  - Make sweet love
- High priority behaviours suppress lower priority ones
- Operate in parallel
- Distributed – no central controller or representations
Methodology

- Extensive testing in the real world
- Add behaviours incrementally
This course owes a lot to behavioural robotics
Successful for insect level behaviours
Short feedback pathways minimise error
Doesn’t transfer to more complex tasks
No method for creating behaviour other than trial and error.
Hybrid Architectures

- Combine behavioural robotics with representationalism.
- Parallel processes communicating through shared working memory.
- Processes updated on memory change.
- Choose level of representation appropriate for task.
Read “Intelligence without Representation” by Rodney Brooks. It’s a fun read no matter what you think of it.