Telling a robot how to behave

Adam Finkelstein
COS 116: Spring 2010
Today: Understanding a simple robot

Why?

• Larger goal: seek an answer to

  “What is Computation?”

• Acquire insight into technology that will become pervasive within the next decade.

• First encounter with many themes of the course.
Robots in culture
Real robots
Discussion...

- Mars rover: what are the design principles?
Definition of “Robot”:

- A machine that can be programmed to interact with the physical environment in a desired way

- Key word: *programmed*
  - As opposed to cars, televisions, which are operated by people
Components of a robot

Three stages:

1. Sensors/Inputs: light, sound, motion...

   ▼

   Computing Hardware

   ▼

2. Computing Hardware

3. Outputs/Actions: motors, lights, speakers…
Our robot: Scribbler

Inputs

- Stall sensor
- Light sensors
- Obstacle sensor detector
- Button

Outputs

- Speaker
- Motor/wheels
- Line sensor (underneath)
- Obstacle sensor emitter
- Light outputs
Scribbler inside
Formal specification of actions

- Fact of life in computing: hardware is “dumb”
- Forces us to make nebulous concepts precise
  - What is language? Music? Intelligence?

- Running themes:
  - What is machine “intelligence”? 
  - Are there limits?
Controlling Scribbler

![Scribbler Control Panel](image)

- **Motor**:
  - LED
  - Pause
  - Sound
  - If <Condition> Then ... Else ...
  - Do ...
  - End Program

- **Move Forward for 1s**
  - Pause 0.5s
  - Move Back for 1s

- **Basic Motor Control**
  - Stop
  - Forward
  - Reverse
  - Left Turn
  - Right Turn
  - Left Spin
  - Right Spin

- **END**
Always remember…
(esp. for Scribbler labs):

- Microprocessor can do one thing at a time
- Very fast -- 20 million operations per second!
- Compound instructions: sequence within {...}
Why programmable?

- Benefits of a programmable device:
  - Flexible
  - Multi-use
  - Universal

- Main difference between computers and other technologies
Example 1: As a burglar alarm

If beam interrupted...
Example 2: As an artiste
Interesting note:
Scribbler is more stupid than you think

Do forever
{ =
  Move Forward for 1s
  Move back for 1s
} END

“Translator” written by Rajesh Poddar ‘08

3 pages of stuff like

GOTO Main

SenseObs:
  FREQOUT ObsTxLeft, 1, 38500
  IF (ObsRx = 0) THEN object_left = 1 ELSE
  object_left = 0
  LOW ObsTxLeft
  FREQOUT ObsTxRight, 1, 38500
  IF (ObsRx = 0) THEN object_right = 1 ELSE
  object_right = 0
  LOW ObsTxRight
  RETURN

SenseLine:
  HIGH LineEnable
  line_right = LineRight
  line_left = LineLeft
  LOW LineEnable
Where are things going?

- “Small cleaning agents” – Brooks
Where are things going?

DARPA Grand Challenge ($2 M prize):

- 132 mile race in the desert
- No human control!
- 5 teams, Stanford won in ~7 hours
The Princeton Entry

Undergraduate Project; reached the finals
Where are we going?
Where are things going?

- Automated highways
  
  (From Minority Report)

- Being actively researched
What is going inside us?

- “Da Vinci” Robotic surgery system

- More precise, though often still controlled by human
Why are multi-purpose robots so hard to build?

- Need precise instruments that act like: eyes, ears, hands, fingers, ...
- Need smart ways to use sensor data (ex: human eyesight vs. high-res camera)
Reminders

This week’s reading: Brooks
pp 12-21, pp 32-51.

This week’s lab: Web 2.0

(Take-home lab – posted on course web page.)