15-491 – CMRoboBits: Creating Intelligent Robots

Introduction

Instructor: Manuela Veloso
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TAs: Stephanie Rosenthal and Richard Wang
http://www.andrew.cmu.edu/course/15-491
Computer Science Department
Carnegie Mellon
What is a *Robot*?

- Many *robots*...
AI BO ERS-7

- 3-Axis Accelerometers
- 576MHz MIPS CPU
- Wifi Card
- Foot Pads
- Microphones
- LEDs
- CCD Camera 208x160 pixels
- IR Proximity Sensor
What is a Robot?
Intelligent Complete Robot

Sensing, modeling the world

Perception

Behaviors, action selection, planning, learning
Multi-robot coordination, teamwork
Response to opponent, multi-agent learning

Cognition

Motion, navigation, obstacle avoidance

Action

Sensors

Actuators

External World

Sensing, modeling the world

Behaviors, action selection, planning, learning
Multi-robot coordination, teamwork
Response to opponent, multi-agent learning

Motion, navigation, obstacle avoidance
Course Motivations

- Robots are *integrated intelligence*:
  - Sensing & perception
  - Behavior & cognition
  - Learning from the real world
  - Motion & kinematics
  - Multi-robot cooperation & coordination
The CMRoboBits Course

- Making robots accessible to all
- How do you solve problems in “real-time”?  
- Sensors are inherently noisy. How do you develop behaviors robust to errors?
- How do you coordinate the actions of multiple robots?
CMRoboBits Fall 2008

- Multiple robots
- iRobot Create, www.irobot.com
- Scribbler, www.scribblerrobot.com
Centralized Perception, Centralized Control

Robot team is autonomous as a whole

10 robots + golf ball
5 robots per team
Color markers for ID

Global vision
Wireless Link
Offboard computation

SCS
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15-491 CMRoboBits
def main():
    while True:
        L, R = getIR()
        if L and R:
            move(0,0)
        elif L:
            move(0.6,-0.5)
        elif R:
            move(0.6,0.5)
        else:
            move(0.6,0)
CMRoboBits Main Topics

- Motion
- Sensing
- Behaviors
- Multi-robot coordination
Actions

- Effector – any device to effect on the environment
  - Legs, wheels, arms, fingers, speakers, etc
  - Physical work of some kind – walking, talking
- Actuator – a mechanism that enables the effector
Passive Actuation (e.g. Delft, MIT, Cornell)
Active Actuation

- Electric motors
  - Most common
- Hydraulics
  - Fluid pressure changes, the actuator moves
  - Powerful, precise, large, lots of care
- Pneumatics
  - Air pressure
- Photo-reactive materials
  - React to light, small work, micro-robotics
- Chemically, thermally, … reactive materials
Control

- Holonomic
  - Controllable DOF = TDOF
  - Helicopter (6 DOFs)

- Nonholonomic
  - CDOF < TDOF
  - Car 2/3, parallel parking

- Redundant
  - CDOF > TDOF
  - Human arm
  - Many solutions to moving from one place to another
Uncertainty of Robot Actions

- Example: AIBO kicks as planned motions
  - frame-based with kinematic interpolation
Handling Uncertainty: Model-Based Kick Selection

- Modeling effects of different kicks
  - Angle analysis
  - Strength analysis
Sensors

- Bump sensors
- Accelerometer
- Vision
Cognition: Behaviors

Score
- not see ball
- next to goal and ball
- not next to ball

Recover
- not see ball
- timeout

Approach
- see ball
- not see ball

Search
- see ball
- not see ball
Conclusion

- Working within the perception, cognition, action loop
- Working with multiple robots
- Microsoft Robotics Studio – MSRS

- An exciting course.

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