RSS I: Recap

RSS Lecture 20
Monday 12 April 2010
Prof. Teller & Dr. O'Reilly

Key Questions

- What were we trying to do in RSS?
  - What we covered this term, in lecture and lab
- Where might we go from here?
  - Other robotics-related activities at MIT and beyond

RSS I: Teaching Objectives

- Intensive introduction to mobile robotics
  - Focus on autonomous mobility & manipulation
  - End-to-end, systems perspective on robotics
  - Exposure to fundamental robotics algorithms
  - Mens et manus: lecture and lab
    - Hands on literally every aspect of a mobile robot
    - Generalists! With depth in some area of interest
  - Course challenge: 4-6 week scope
    - Authentic, intense team-based design experience
    - Flexibility to choose your technical focus & role
- Communications
  - Briefings, engineering documents, schedules
  - Team coordination and dynamics
  - Debates: consideration of policy and ethical perspectives

Robot Architectural Layers

- Controller board architecture
  - Power, sense data, control
- Signal-level motor control
  - PWM, closed-loop feedback
- Reactive behavior w/ analog sensing
  - Braitenberg with photoresistors
- … All of this was managed by you
  - Direct odometry handling, motor control etc.

Abstraction via Carmen

- One possible choice of robot "O/S"
  - Publish/subscribe message abstraction
  - Message-based event handling
  - Odometry and sensor time-stamping
  - Low-level motion primitives
  - Extensibility
- Alternatives:
  - USC Player/Stage
  - Microsoft RDS
  - Willow Garage ROS
  - MIT LCM
  - …

Higher-level Capabilities

- Object detection & visual servoing
  - Primitive computer vision, motor control
- Wall-following / local mapping
  - Filtering and estimation from noisy sonar data
- Global path planning and execution
  - Provided map, planning as search
- Manipulation
  - Inverse kinematics of a 3-DOF manipulator
  - Servo position control, integration w/ vision

Things We Didn't Get To

- Localization and SLAM
  - From bump sensors, sonar, vision, …
- State estimation
  - Inference under uncertainty (e.g. Kalman filter)
- High-level vision
  - Object recognition and classification
- Human-robot interaction
  - Speech, gesture, shared mental models, …
- High-level planning
  - Action selection, unstructured environments, …
- Distributed activity
  - Multiple communicating and coordinating bots

Areas We Didn't Get To

- Factory automation
- Walking, flying, swimming, climbing robots
- Biologically-inspired robots
- Medical robotics & haptics
- Mobile manipulation robots
- Space robotics
- Learning robots
- Assistive robots & exoskeletons
- Field and service robots
- Evolutionary robotics
- Neurorobotics

Where do we go from here?

- MIT subjects
  - Aero/Astro, EECS, MechE, Media Lab, IAP, …
- Research (UROPs, MEng, SM, PhD)
  - RRG (Nick Roy)
  - RLG (Tedrake)
  - RVSN (Teller)
  - DRG (Rus)
  - CMG (Deb Roy)
  - SMG (Breazeal)
  - ARES (Frazzoli)
  - MERS (Williams)
  - LIST (Asada)
  - HAL (Cummings)
  - NSL (Slotine)
  - Biomechatronics (Herr)
  - LISG (TLP, LPK)
  - COE (Leonard)
  - ACL (How)
  - HRG (Hover)

Where do we go from here?

- Industrial internships
  - Microsoft, iRobot, Willow Garage, BDI, Vecna, Evolution Robotics, Heartland Robotics, …
- Government / Academic labs
  - NASA, JPL, NRL, ARL, Sandia, Penn GRASP Lab, Berkeley, Stanford, CMU Robotics Institute, …

Summarizing…

- Tried to give you a taste of robotics…
  - In all its interdisciplinary glory: math (geometry, inference, estimation, optimization), physics, mechanical engineering, electrical engineering, computer science, cognitive science …
- … as an engineering endeavor
  - Systems thinking
  - Engineering tools and methods
  - Managing complexity
  - Deadlines and milestones
  - Team dynamics

At the end of the day

- RSS is a real engineering experience
  - Structured component (lectures, labs)
  - Less-structured component (challenge)
- With deliverables, communications
- Regardless of what you do next
  - We hope that the tools and techniques used in RSS will serve you well!
- … Break a leg in the challenge runs.