CS1951R:
Introduction to Robotics
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Build, Program, and Fly your very own Drone
Battery Safety

- Don’t leave charging unattended.
  - Blue chargers will drain the battery.
- Don’t use if less than 11.3 volts.
- Don’t use if they get too hot.
- It’s okay if it is less than 11.3 when flying.
Software Engineering for Robotics

- Lots of different processes talk to each other.
- Processes live on different computers.
- Development trees live in different source control repository.
- Dependency management!
ROS

- ROS is many things
  - Standard for message passing and RPC calls
  - Standard for organizing large repositories of code for different purposes. (Compiling, running, dependency management.)
  - Implementations of useful robotic libraries.
    - TF (Transform library)
    - Rviz (Visualization)
    - rosjs (Javascript/web page integration)
    - Many more!
roscore

- ROS Master runs an XML RPC server to talk to nodes on port 11311.
- Each ROS node is a program that does something.
- Nodes publish and subscribe on topics.
- Environment variables
  - ROS_MASTER_URI
  - ROS_IP and/or ROS_HOSTNAME
Ros set up

- How do nodes talk to each other?

![Diagram showing rosmaster, Node 1, and Node 2 communicating](image-url)
ROS Packages

- Dependencies between other packages?
  - PYTHONPATH
  - LD_LIBRARY_PATH

- Build tools.
  - CMake and Catkin
Design Scenario

- Robot wants to send IR stream.

- `state_controller.py` – receives camera, IR, IMU and sends control commands

- How should `state_controller.py` get IR input?
  - Function call?
  - Message passing?
Transform Library
RViz
ROSBridge and rosjs
ROS

• ROS advantages
  – It is the current standard. Everyone uses it.
  – It provides a mechanism for most common robotics problems.

• ROS disadvantages
  – Very (overly) complicated.
  – Dependencies are still hard (but easier than before ROS).
  – Some poor design decisions related to message passing, etc.
PID Controllers
Video
\[ u(t) = K_p e(t) + K_i \int e(\tau) d\tau + K_d \frac{de(t)}{dt} \]