ROS (Robot Operating System)

An Introduction

Dr. Rainer Hessmer, February 2011
Hobby Robotics Evolution
- very simplified :-)

- Micro Controller Brain
  - Sumo
  - Line follower
  - Maze solver
  - Firefighting
  - ...

- Higher level logic benefits from PC
  - Magellan
  - Robot arm
  - ...

- Higher level logic requires PC
  - LEAF
  - SLAM
  - ...

from http://www-unix.oit.umass.edu/~blaylock/LegoRobotics/
But soon you hit a ceiling since ...

• You develop
  – Your own logging
  – You write your own messaging infrastructure (protocols)
  – Your own coordinate system transformations
  – Your own joystick driver
  – Your own basic navigation logic
  – Your own basic vision system
  – ...

• And you never catch up
Compare with PC Ecosystem

- Standardized Layers
- System software abstracts hardware
- Applications leverage other applications (e.g. database, web server) and huge sets of libraries
ROS – Open Source System Software for Robotics

Robotics Applications

ROS

Hardware
(PR2, Texai, etc. & your own)
ROS

• Headed up by Willow Garage
  (http://www.willowgarage.com)

• Three years old
  (http://www.willowgarage.com/blog/2010/11/08/happy-3rd-anniversary-ros)

• The software basis of Willow Garage’s PR2

• Exponential adoption
So what is it?

- A 'Meta' OS. Open Source!
  - Sits on top of Linux (preferably Ubuntu)
  - Windows implementation started
    (http://www.ros.org/wiki/cturtle/Installation/Windows)
- Agent based
- Message passing
  - Publish / Subscribe
  - Service (remote operation) invocation
- Package Management
- Name and Parameter Services
- Programming Language Support
  - C++
  - Python
  - Lisp?
So what is it? (cont.)

- Low level device abstraction
  - Joystick
  - GPS
  - Camera
  - Controllers
  - Laser scanners
  - ...

- Application building blocks
  - Coordinate system transform services
  - Visualization tools
  - Debugging tools (e.g., recording)
  - Robust navigation stack (SLAM with loop closure)
  - Arm path planning
  - Object recognition
  - ...
Where is it used?

• More than 50 robots use ROS (http://www.ros.org/wiki/Robots)

Including Hobby and Low-Cost Platforms
ROS now runs on many lower-cost, hobby-friendly platforms. 2010 started off with Andrew Harris providing ROS libraries for the Arduino and was quickly followed by I Heart Robotics's WowWee Rovio drivers. You can now use Lego NXT robots with ROS as well as Taylor Veltrop's drivers for Roboard-equipped humanoids. Companies have also contributed: Vanadium Labs provided ROS drivers for their ArbotiX line of robocontrollers. The ROS iRobot Create/Roomba community has also expanded greatly this year, with many institutions and individuals now providing drivers and libraries: Brown's RLAB, CU Boulder's Correll Lab, Aptima, Stanford, OTL, and ISR - University of Coimbra.

Key Concepts

- roscore: Name and Parameter server; singleton
- Package: A virtual directory holding one or more executables (nodes)
- Node: An agent communicating with ROS and other nodes via
  - Topics (publish / subscribe) using typed messages
  - Services: Request / Response paradigm (think of method or operation) via typed messages
Utilities Demo

- roscore
- roscd
- rosrun
- roslaunch
- rostopic
- rxgraph
- rosservice
- rospam
- rosconsole / rxloggerlevel / rosout
Python Implementation Demo

Source available at: http://code.google.com/p/drh-robotics-ros/
Communication Graph

- rxgraph
References

- ROS wiki: http://www.ros.org/wiki
- Willow Garage http://www.willowgarage.com/
- My own blog and web site
  _ http://www.hessmer.org/blog
  _ http://www.hessmer.org/
Questions?