PR2 Simulation

ROS + PR2 Training Workshop

Motivations

applications and goals

1. Interactive research development.

2. Regression testing (http://vault.willowgarage.com/wgdata1/vol1/hsu/door_3_5x.avi).

3. Design, optimization.

4. Predictive control, planning.

5. Monte Carlo simulation / perturbation analysis.

6. Visualization.

Software Platforms

1. PR2 Simulator is based on the Open Source project Gazebo of the Player/Stage/Gazebo project. It uses Open Dynamics Engine for physics and Ogre for rendering. (http://ros.org/wiki/simulator_gazebo)

Simulation Fidelity

Physics fidelity / how the PR2 is simulated

1. Constrained rigid body dynamics. Velocity based complementarity formulation.

2. Contacts are modeled by inelastic collisions with simplified friction pyramid.

3. Fixed time stepping (1kHz).

4. Constant coefficient viscous friction joint damping.

5. http://ros.org/wiki/pr2_simulator
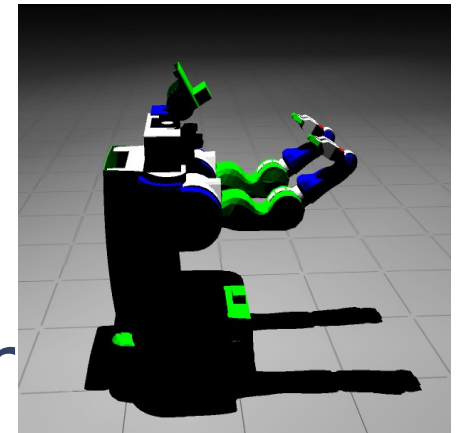
Simulation Fidelity

Physics fidelity / numerical errors

1. Joint velocity "jitters" vs. slow simulation. Numerical errors vs. simulation efficiency.
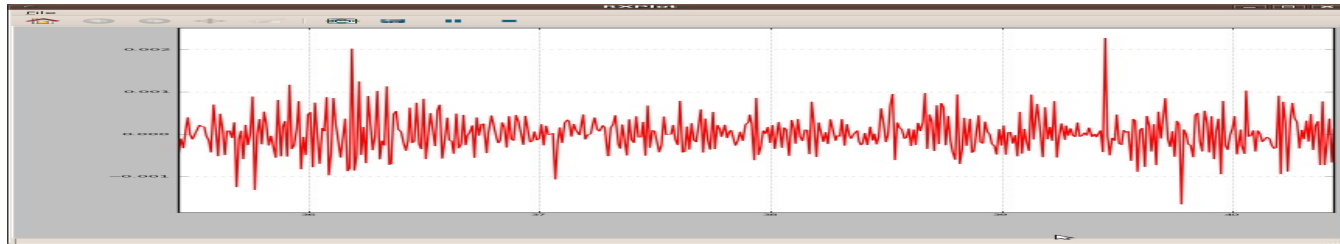

2. Joints with high reduction ratios (torso_lift and gripper joints) are numerically stiff without proper modeling of low joint efficiency and high viscous damping. Currently an artificial stabilizer is applied to improve simulation efficiency.

Simulation Fidelity

Real world vs. simulation

1. ROS parameter use_sim_time and /clock topic.

2. Self collision checks are disabled by default.

3. Anti-gravity arms.

4. Laser scan duration.

5. Robot start up race conditions

6. pr2.machine vs. sim.machine (see pr2_machine.package).
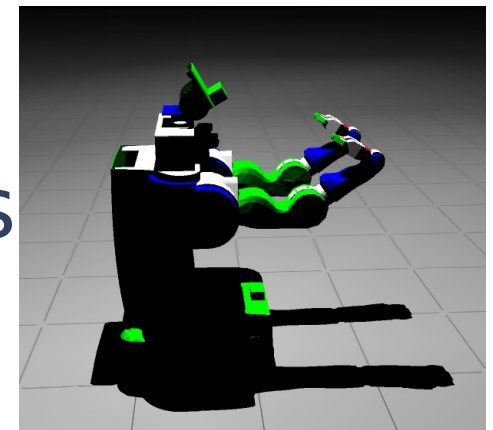
Simulation Fidelity

PR2 simulation fidelity

→ Manipulation - Mechanism Controllers

  → Simulated real-time PR2 etherCAT node communicates actuator states (motor effort and position encoder values) through ROS.

→ Perception - Sensors

  → Simulated sensor nodes for cameras, lasers, imu streams data / offers services through ROS.

Applications

PR2 Simulation Examples in C-Turtle

1. Opening Doors

2. Plugging In
   (http://vault.willowgarage.com/wgdata1/vol1/hsu/plugin_rev3_cut_3x.avi)

Simulator Tutorials

1. http://www.ros.org/wiki/pr2_simulator/Tutorials/BasicPR2Controls