Welcome

Introductions
Setup and usage
Core concepts
Tutorials
  Building a mobile robot
  Controlling a mobile robot
  Building a world
  ROS integration
  DRC Simulator
Setup and Usage
Setup and Help

Install

• Does everyone have Gazebo installed?
• Can everyone run Gazebo?
  
  $ gazebo

Help

• answers.gazebosim.org
  Ask questions and find answers to Gazebo problems

• gazebosim.org/wiki
  Tutorials, and user maintained documentation

• gazebosim.org/api
  Doxygen generated code documentation

• gazebosim.org/user_guide
  Written guide to using Gazebo
The Graphical Interface

Design Principles
• Balance between world navigation and model centric navigation
• Make the most common actions easily accessible

System Perspective
• Gazebo consists of two parts
  Server: physics engine, sensor generation
  Client(s): Graphical interface, command line tools, your custom application

New in Version 1.2
• Simplified mouse controls
• Drag-and-drop models
• Consolidated simulation information
• New style
Using the Graphical Interface

GUI Documentation
http://gazebosim.org/user_guide/started_gui.html

Everyone: start Gazebo
Core Concepts
Elements within Simulation

World
• Collection of models, lights, plugins and global properties

Models
• Collection of links, joints, sensors, and plugins

Links
• Collection of collision and visual objects

Collision Objects
• Geometry that defines a colliding surface

Visual Objects
• Geometry that defines visual representation

Joints
• Constraints between links

Sensors
• Collect, process, and output data

Plugins
• Code attached to a World, Model, Sensor, or the simulator itself
Element Hierarchy

- World
  - Scene
  - Physics
  - Model
    - Link
    - Collision
    - Visual
    - Sensor
    - Plugin
      - Plugin
        - Plugin
        - Light
Element Types

Collision and Visual Geometries
• Simple shapes: sphere, cylinder, box, plane
• Complex shapes: heightmaps, meshes

Joints
• Prismatic: 1 DOF translational
• Revolute: 1 DOF rotational
• Revolute2: Two revolute joints in series
• Ball: 3 DOF rotational
• Universal: 2 DOF rotational
• Screw: 1 DOF translational, 1 DOF rotational
Element Types

Sensors
• Ray: produces range data
• Camera (2D and 3D): produces image and/or depth data
• Contact: produces collision data
• RFID: detects RFID tags

Lights
• Point: omni-directional light source, a light bulb
• Spot: directional cone light, a spot light
• Directional: parallel directional light, sun
Exercise 1: Building a mobile robot
Exercise 1
Overview

Topics Covered
• Construction of a two-wheeled mobile base
• Attaching meshes to visual elements
• Attaching sensors to links
• Constructing a simple gripper
• Attaching a gripper to a mobile base

Wiki Tutorials
http://gazebosim.org/wiki/Tutorials
Section: Building a Robot
Exercise 2: Controlling a mobile robot
Exercise 2
Simulation Controls Overview

Animation vs. Dynamic control

• Animation
  Fast.
  Disregard physics, constraints*.
  No collision responses.

• Dynamic control
  Velocity control - leveraging integrator only
  Force control - leveraging physics engine (f = ma)
  Can be computationally intensive

• Controllers with sensor feedback.
• Gazebo's built-in PID class.
Exercise 2
Simulation Controls Overview

Topics Covered
• Animating pose of rigid body links with the animation engine.
• Controlling pose of rigid body links by setting velocities.
• Controlling joints by applying forces.
• Controlling a robot with its simulated onboard sensor.
• Controlling a joint with Gazebo's builtin PID class.

Wiki Tutorials
http://gazebosim.org/wiki/Tutorials
Section: Controlling a Robot
Exercise 3: Building a world
Exercise 3
Overview

Topics Covered
• Constructing a world using the graphical interface
• Modifying world parameters
• Controlling the world via a plugin

Wiki Tutorials
http://gazebosim.org/wiki/Tutorials
Section: Making a World
Exercise 4: ROS Integration
Exercise 4
ROS Integration Overview

Gazebo in ROS or ROS in Gazebo?
• ROS wrapped thirdparty Gazebo installation (http://ros.org/wiki/simulator_gazebo)
  Fuerte ← Gazebo 1.0.x
• Gazebo standalone installation (http://gazebosim.org)

Model Description Formats: COLLADA, URDF, SDF, SRDF, YADF?
• Solidworks to URDF exporter
  http://ros.org/wiki/sw_urdf_exporter
• URDF Dependencies
  http://ros.org/wiki/urdf
  URDF support built at compile time in Gazebo 1.2.x*
    sudo apt-get install ros-fuerte-urdfdom
Exercise 4
ROS Integration Overview

ROS Fuerte

Gazebo 1.0.x

- pr2_simulator
- simulator_gazebo
- ros_comm
- urdfdom
- visualization_common

OGRE 1.7.3 w/ Cg support

drcsim 1.0.x

gazebo 1.2.x
Exercise 4
ROS Integration Overview

Gazebo Plugins with ROS dependencies

• For simulating ROS drivers for real robots
  - http://ros.org/wiki/wge100_camera_firmware
  - http://ros.org/wiki/prosilica
  ...

• Using high level ROS applications with Gazebo
  - http://ros.org/wiki/navigation
  - http://ros.org/wiki/pr2_interactive_manipulation
  - http://moveit.ros.org
  ...

Open Source Robotics Foundation
Exercise 4
ROS Integration Overview

Topics Covered
• Managing ROS dependencies
• Building a Gazebo plugin with ROS

Wiki Tutorials
http://gazebosim.org/wiki/Tutorials
Section: ROS Integration
Exercise 5: DRC Simulator
Exercise 5
DRC Robot Overview

DRC Robot Dynamics Model
• Initial URDF generated from simplified CAD model subject to change.

DRC Robot Sensor Suite
• Real sensor suite hardware TBD.
• For now, "Best guess" sensor suite.
  Hokuyo laser
  Stereo camera
Exercise 5
DRC Robot Overview

DRC Robot Dynamics Controls API

- Initial simulation tutorials "place holder" controllers derived from PR2 controllers
- Walking controllers interface TBD.
Exercise 5
DRC Robot Overview

Topics Covered

- Visualize and log sensor data with rviz and rxbag.
- DRC Robot basic joint control using PR2 mechanism controllers.
- Teleporting the DRC Robot.
- Customizing the DRC Robot world contents.
- Animating the DRC Robot with ROS JointTrajectory messages.

(\text{http://gazebosim.org/wiki/trajectory_msgs})

Wiki Tutorials

\text{http://gazebosim.org/wiki/Tutorials}

Section: DRC Tutorials
Exercise 6
Beer and Questions