

# Adding a Sensor to the PR2

ROS + PR2 Training Workshop

Kevin Watts

# Modifying the PR2

---

You may want to modify the PR2 for research

- Add sensor or device
- Add functionality
- Change color

Today, we'll add a Hokuyo laser scanner to the side platform



# What We're Doing Today

Add Hokuyo laser scanner  
on the side panel

We'll be able to scan  
sideways!

It's easy to demonstrate

- Near side USB port
- Have a ROS driver



# Modification Procedure

---

Today's goal - show you how to modify PR2

- How to contact Willow Garage
- What to watch out for
- Simple hardware modifications
- Software configuration
- Where to go for help

We're following tutorial on wiki

[http://www.ros.org/wiki/pr2\\_robot/Tutorials/Adding a Hokuyo to the PR2](http://www.ros.org/wiki/pr2_robot/Tutorials/Adding_a_Hokuyo_to_the_PR2)

# PR2 Modifications

---

## Safety first

- PR2 design is carefully validated at Willow Garage
- Changes to some HW or SW may be dangerous
- Can damage the PR2

## Willow Garage support

- We might be able to offer tips for adding sensors
- We can't help with everything
- Some changes make it hard for us to help you

# Before You Modify...

## Pre-modification checklist:

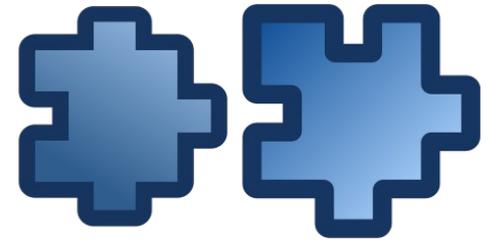
- Ask you lab supervisor and safety rep
- Check Willow Garage Support
  - If specification not listed, make sure to ask us

The screenshot shows the Willow Garage Support website. At the top, there is a navigation bar with the Willow Garage logo and the text "Willow Garage Support". Below this is a secondary navigation bar with links for HOME, ROBOT DOCUMENTATION AND FORUMS, MANAGE, ACCOUNT, RECENT, VIEWS, and NEW. The main content area is titled "Willow Garage Support" and includes an RSS icon. A welcome message reads "Welcome to Willow Garage Support" with the date "Melknee Wise Apr 21" and "Announcements (unpin)". Under the heading "PR2 Documentation", there are four columns: "PR2 Manual" (with a folder icon), "Repair and Replacement Procedures" (with a wrench and screwdriver icon), "Modularity Specification" (with a puzzle piece icon), and "Spare Parts" (with a box icon). Each column contains a brief description of the resource. Below this is a section for "Mailing Lists & Tickets" with four columns: "ROS Users Mailing List" (with "ROS users" text), "PR2 Users Mailing List" (with "PR2 users" text), "PR2 Admin Mailing List" (with "PR2 admin" text), and "PR2 Help Request" (with a ticket icon). Each column includes a short description of the service.

**Note:** Under the Beta Program Agreement, permanent modifications to the PR2 *must* be approved by Willow Garage.

# Adding Sensor Pre-check

- I'm supervising myself today
- Checked Willow Garage Support
  - Checked power requirements of the laser
  - PR2's power system is OK
- Remove and Replacement Procedures
  - Shows me how to remove covers
  - Computer configuration, AUX USB port



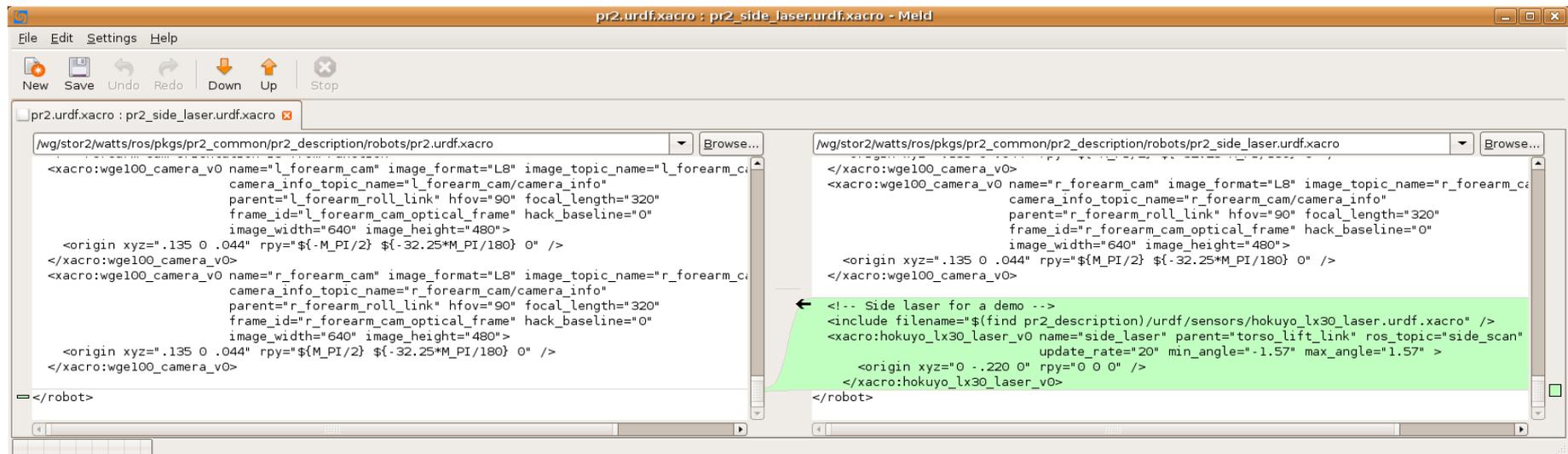
# Software Configuration

## Add new Hokuyo scanner in URDF

URDF mods: <http://www.ros.org/wiki/urdf/Tutorials/AddingSensorsToPR2>

Need to measure location of sensor relative to PR2 coordinate center

Coordinates: <http://pr.willowgarage.com/wiki/PR2/CoordinateSystems>



```
pr2.urdf.xacro : pr2_side_laser.urdf.xacro - Meld
File Edit Settings Help
New Save Undo Redo Down Up Stop

pr2.urdf.xacro : pr2_side_laser.urdf.xacro
/wg/stor2/watts/ros/pkg/pr2_common/pr2_description/robots/pr2.urdf.xacro
<xacro:wge100_camera_v0 name="l_forearm_cam" image_format="L8" image_topic_name="l_forearm_c
camera_info_topic_name="l_forearm_cam/camera_info"
parent="l_forearm_roll_link" hfov="90" focal_length="320"
frame_id="l_forearm_cam_optical_frame" hack_baseline="0"
image_width="640" image_height="480">
<origin xyz=".135 0 .044" rpy="${M_PI/2} ${-32.25*M_PI/180} 0" />
</xacro:wge100_camera_v0>
<xacro:wge100_camera_v0 name="r_forearm_cam" image_format="L8" image_topic_name="r_forearm_c
camera_info_topic_name="r_forearm_cam/camera_info"
parent="r_forearm_roll_link" hfov="90" focal_length="320"
frame_id="r_forearm_cam_optical_frame" hack_baseline="0"
image_width="640" image_height="480">
<origin xyz=".135 0 .044" rpy="${M_PI/2} ${-32.25*M_PI/180} 0" />
</xacro:wge100_camera_v0>
</robot>

/wg/stor2/watts/ros/pkg/pr2_common/pr2_description/robots/pr2_side_laser.urdf.xacro
</xacro:wge100_camera_v0>
<xacro:wge100_camera_v0 name="r_forearm_cam" image_format="L8" image_topic_name="r_forearm_c
camera_info_topic_name="r_forearm_cam/camera_info"
parent="r_forearm_roll_link" hfov="90" focal_length="320"
frame_id="r_forearm_cam_optical_frame" hack_baseline="0"
image_width="640" image_height="480">
<origin xyz=".135 0 .044" rpy="${M_PI/2} ${-32.25*M_PI/180} 0" />
</xacro:wge100_camera_v0>
<!-- Side laser for a demo -->
<include filename="$(find pr2_description)/urdf/sensors/hokuyo_lx30_laser.urdf.xacro" />
<xacro:hokuyo_lx30_laser_v0 name="side_laser" parent="torso_lift_link" ros_topic="side_scan"
update_rate="20" min_angle="-1.57" max_angle="1.57" >
<origin xyz="0 -.220 0" rpy="0 0 0" />
</xacro:hokuyo_lx30_laser_v0>
</robot>
```

# Software Configuration

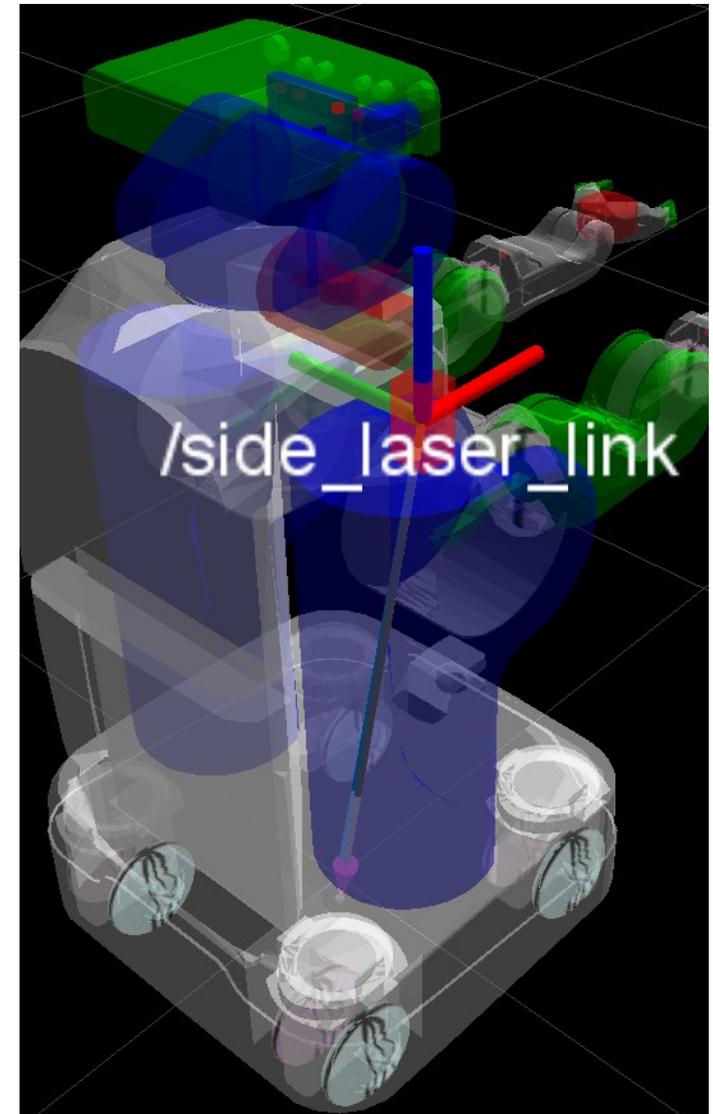
Add driver to  
“/etc/ros/robot.launch” on PR2

- New file “my\_robot.launch”  
for this demo

Add diagnostic Analyzer for  
Hokuyo data

- [http://www.ros.org/wiki/pr2\\_robot/Tutorials](http://www.ros.org/wiki/pr2_robot/Tutorials)

Test in gazebo



# Before Opening PR2

PR2 is designed to operate with covers ON

When taking covers off, use extreme caution

- Power is OFF
- Wearing wrist strap for ESD
- Use proper tools (toolkit)

Inform your local safety rep

Contact Willow Garage first



*Risk of damage to your PR2 and harm to yourself*

# Modification Procedures

---

Modifications like this aren't that hard...

But the downside of a mistake is huge



# Opening PR2

---

Always shut down robot before removing covers

- `sudo pr2-shutdown`
- When red lights on server go out, safe to turn off

Remove covers using correct hex key, T-handle wrench

- Remove and replace instructions at Willow Garage Support

# Mounting Sensor

---

We need to secure the sensor and bracket to the robot

- Sensors are expensive, mount securely

Cables must be secured to robot before we continue

Wear a wrist strap at all times



# Plugging in Sensor

---

Plug in to AUX USB port, near head

- Port connects to c1 on PR2
- AUX USB port has USB, firewire passthroughs

Plug in 12V power cable to Hokuyo sensor

Reinstall cover



# Computer/Sensor Configuration

---

Turn on robot, flip main breaker

Look for “/dev/ttyACM0” on “c1”

[http://www.ros.org/wiki/hokuyo\\_node/Tutorials/UsingTheHokuyoNode](http://www.ros.org/wiki/hokuyo_node/Tutorials/UsingTheHokuyoNode)

- Note that existing Hokuyo scanners are on “c2”

Make sure you have correct permissions

- `sudo chmod a+rw /dev/ttyACM0`

You can get check the HK firmware or other device info using tools in `hokuyo_node`

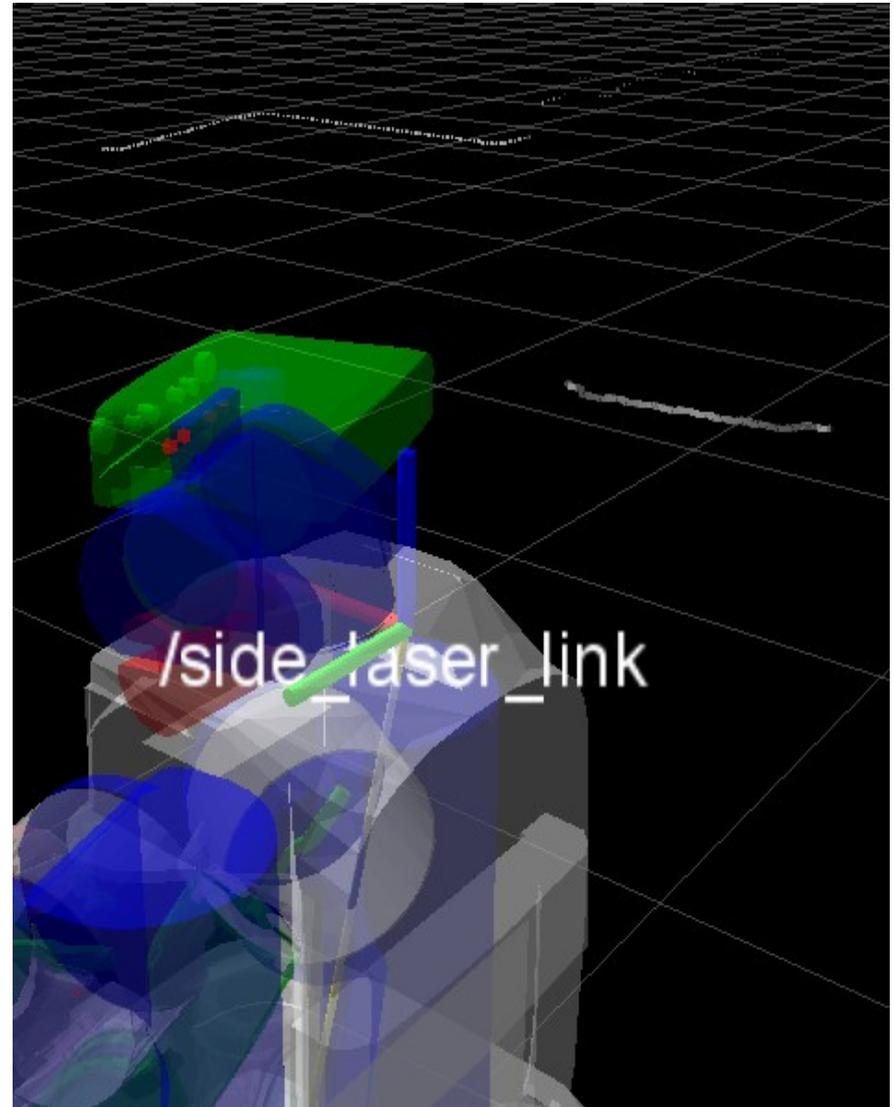
# Getting Sensor Data

Launch robot

– `sudo robot start`

Note that sensor shows up in dashboard/diagnostics

Can view sensor in rviz, and can see laser scans



# PR2 Configuration Review

---

In order to modify the PR2, and make it usable, I had to change:

- URDF (/etc/ros/robot.xml)
- Robot Launch File (/etc/ros/robot.launch)
- Computer Configuration/Permissions
- Physically mount cables, etc

These are the changes you will have to make for any modification to work.

# PR2 Modification Summary

---

Safety First

Contact Willow Garage Support

Ask other PR2 users

Test your code ahead of time

# Questions?

