



Programming for Robotics ROS for Beginners

Course 3

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Overview Course 3

- ROS publisher
- rqt User Interface
- TF Transformation System (Optional)
- Robot models (URDF) (Optional)
- Simulation descriptions (SDF) (Optional)

ROS C++ Client Library (*roscpp*)

Publisher

- Create a publisher with help of the node handle

```
ros::Publisher publisher =  
nodeHandle.advertise<message_type>(topic,  
queue_size);
```

- Create the message contents
- Publish the contents with

```
publisher.publish(message);
```

More info

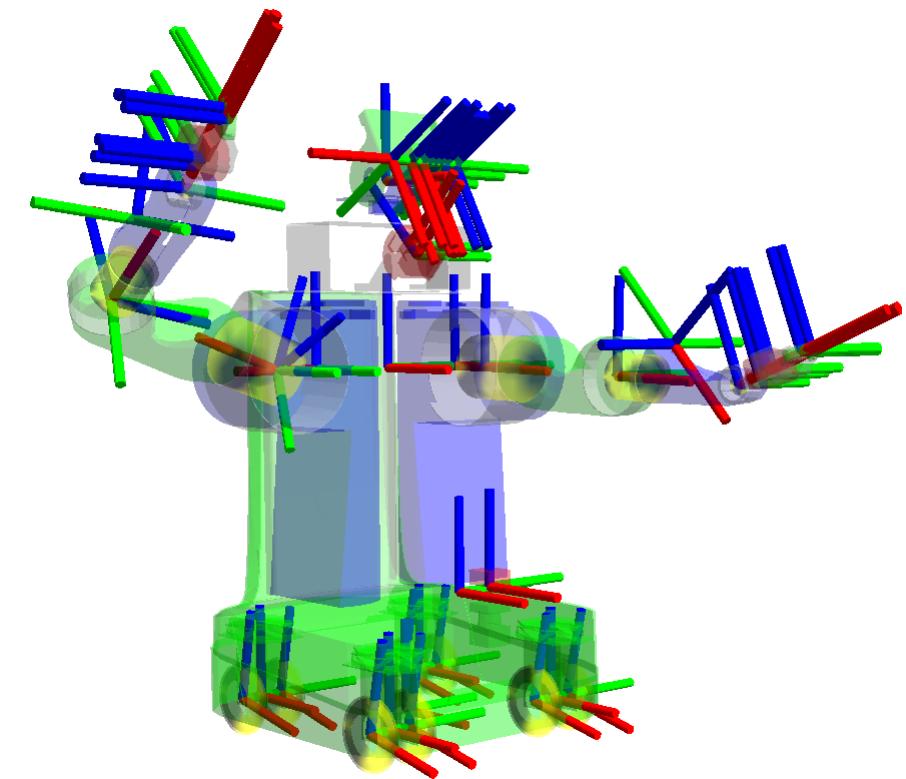
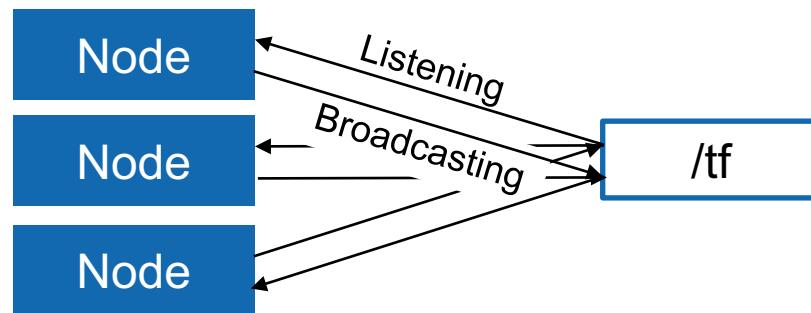
<http://wiki.ros.org/roscpp/Overview/Publishers%20and%20Subscribers>

talker.cpp

```
#include <ros/ros.h>  
#include <std_msgs/String.h>  
  
int main(int argc, char **argv) {  
    ros::init(argc, argv, "talker");  
    ros::NodeHandle nh;  
    ros::Publisher chatterPublisher =  
        nh.advertise<std_msgs::String>("chatter", 1);  
    ros::Rate loopRate(10);  
  
    unsigned int count = 0;  
    while (ros::ok()) {  
        std_msgs::String message;  
        message.data = "hello world " + std::to_string(count);  
        ROS_INFO_STREAM(message.data);  
        chatterPublisher.publish(message);  
        ros::spinOnce();  
        loopRate.sleep();  
        count++;  
    }  
    return 0;  
}
```

TF Transformation System

- Tool for keeping track of coordinate frames over time
- Maintains relationship between coordinate frames in a tree structure buffered in time
- Lets the user transform points, vectors, etc. between coordinate frames at desired time
- Implemented as publisher/subscriber model on the topics `/tf` and `/tf_static`



More info
<http://wiki.ros.org/tf2>

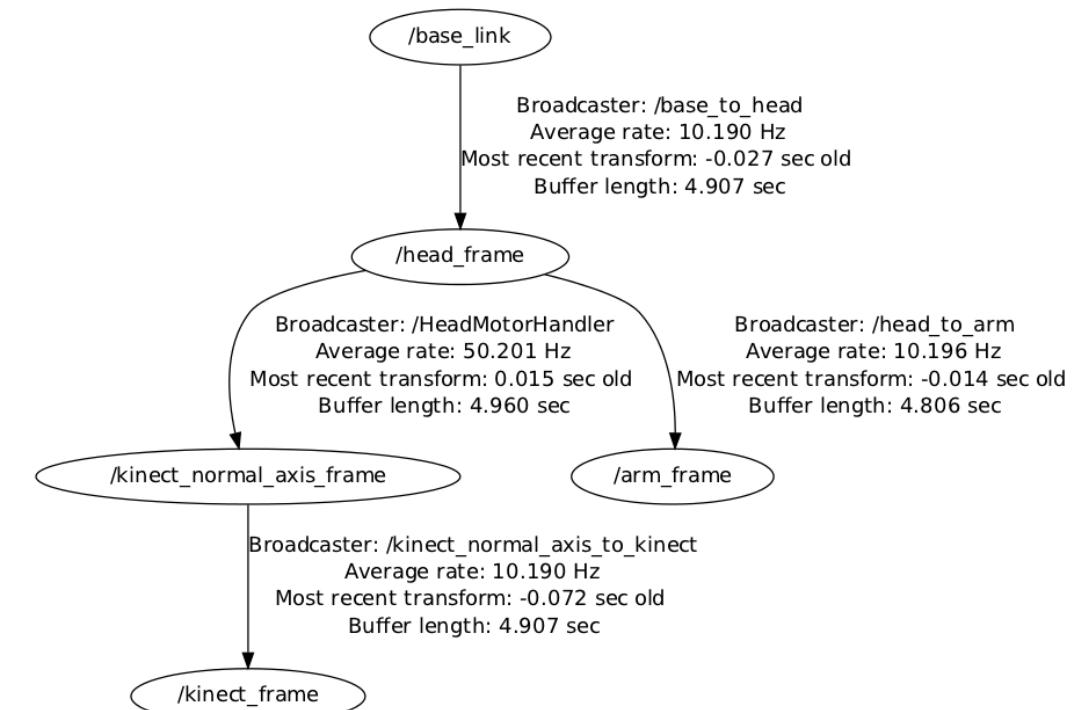
TF Transformation System

Transform Tree

- TF listeners use a buffer to listen to all broadcasted transforms
- Query for specific transforms from the transform tree

tf2_msgs/TFMessage.msg

```
geometry_msgs/TransformStamped[] transforms
std_msgs/Header header
  uint32 seqtime stamp
  string frame_id
string child_frame_id
geometry_msgs/Transform transform
  geometry_msgs/Vector3 translation
  geometry_msgs/Quaternion rotation
```



TF Transformation System

Tools

Command line

Print information about the current transform tree

```
> rosrun tf tf_monitor
```

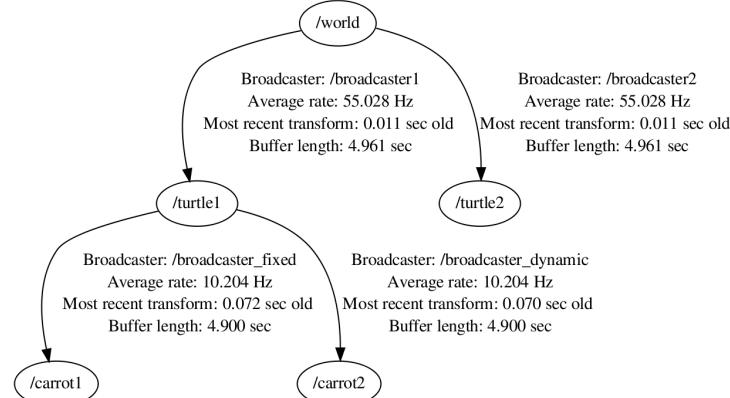
Print information about the transform between two frames

```
> rosrun tf tf_echo  
source_frame target_frame
```

View Frames

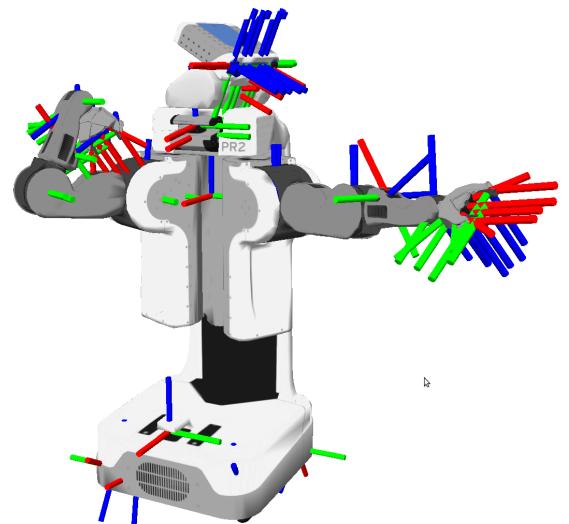
Creates a visual graph (PDF) of the transform tree

```
> rosrun tf view_frames
```



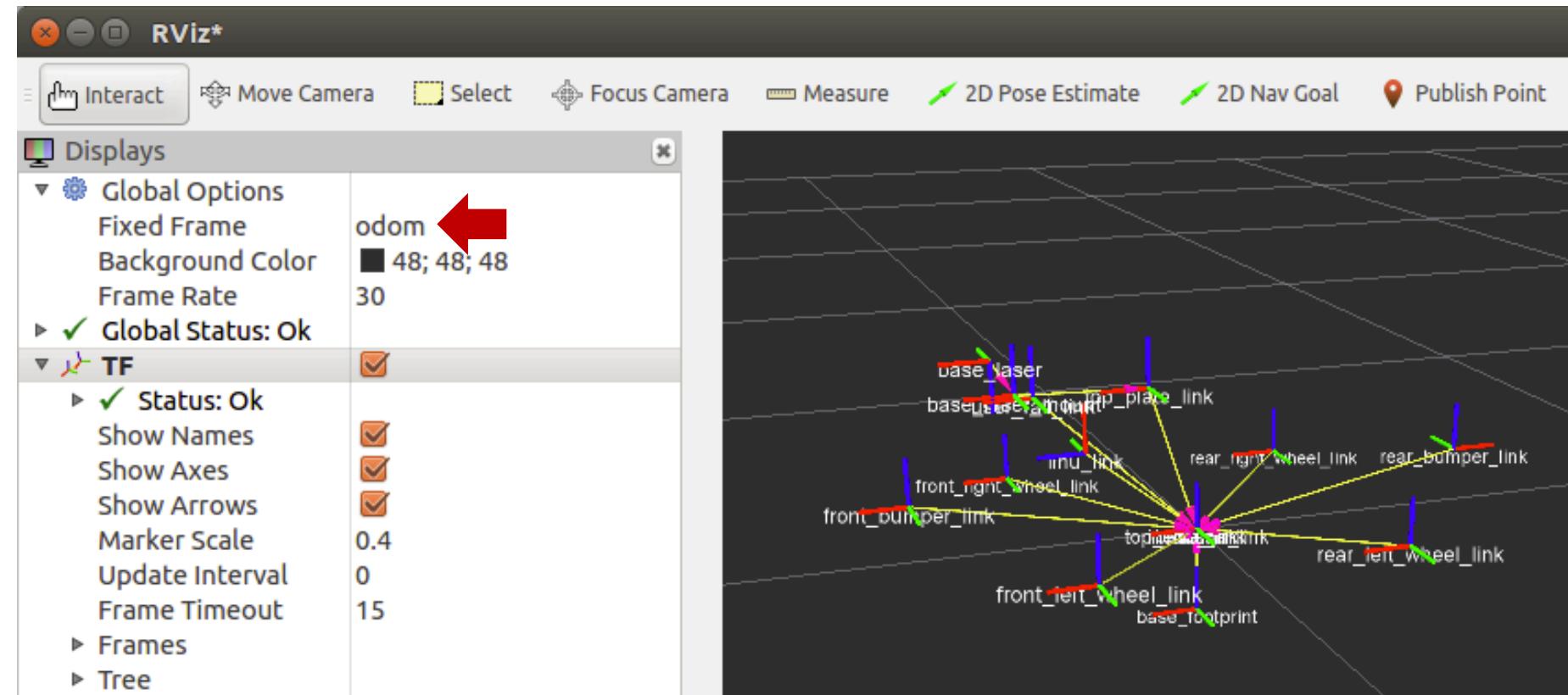
RViz

3D visualization of the transforms



TF Transformation System

RViz Plugin



rqt User Interface

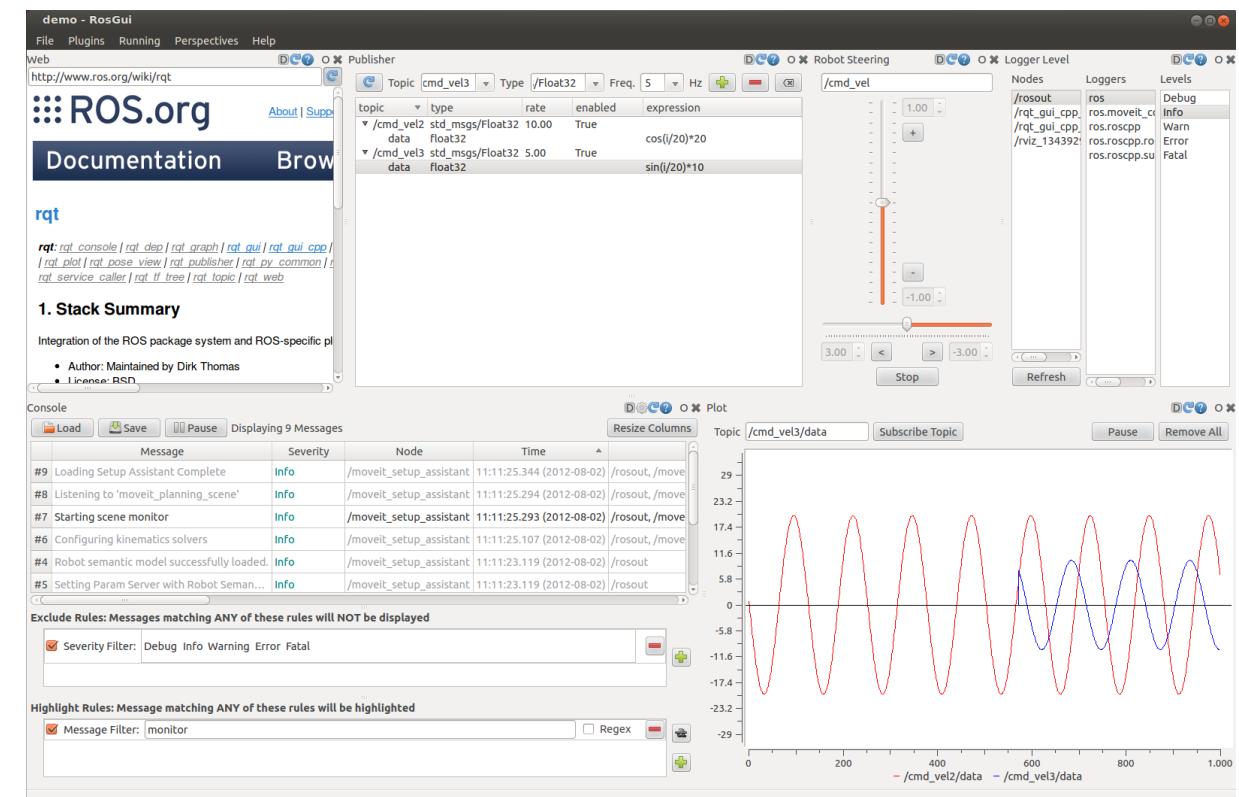
- User interface base on Qt
- Custom interfaces can be setup
- Lots of existing plugins exist
- Simple to write own plugins

Run RQT with

```
> rosrun rqt_gui rqt_gui
```

or

```
> rqt
```



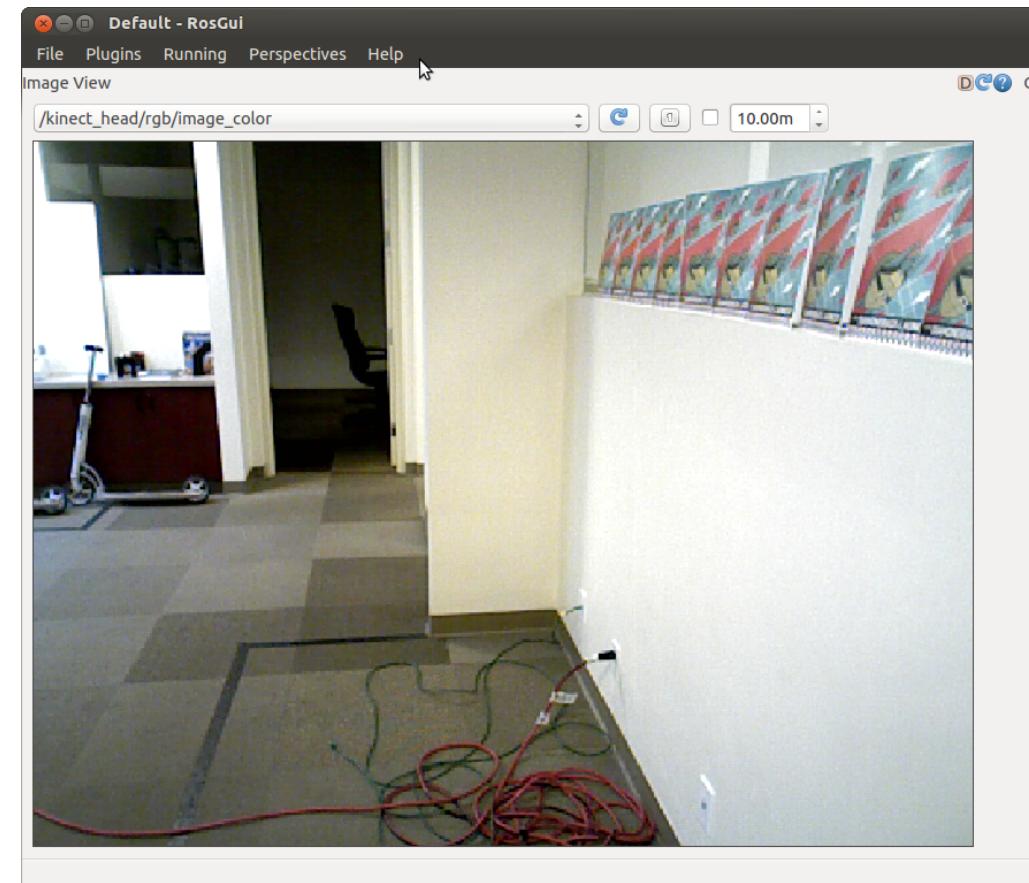
More info

<http://wiki.ros.org/rqt/Plugins>

rqt User Interface

rqt_image_view

- Visualizing images

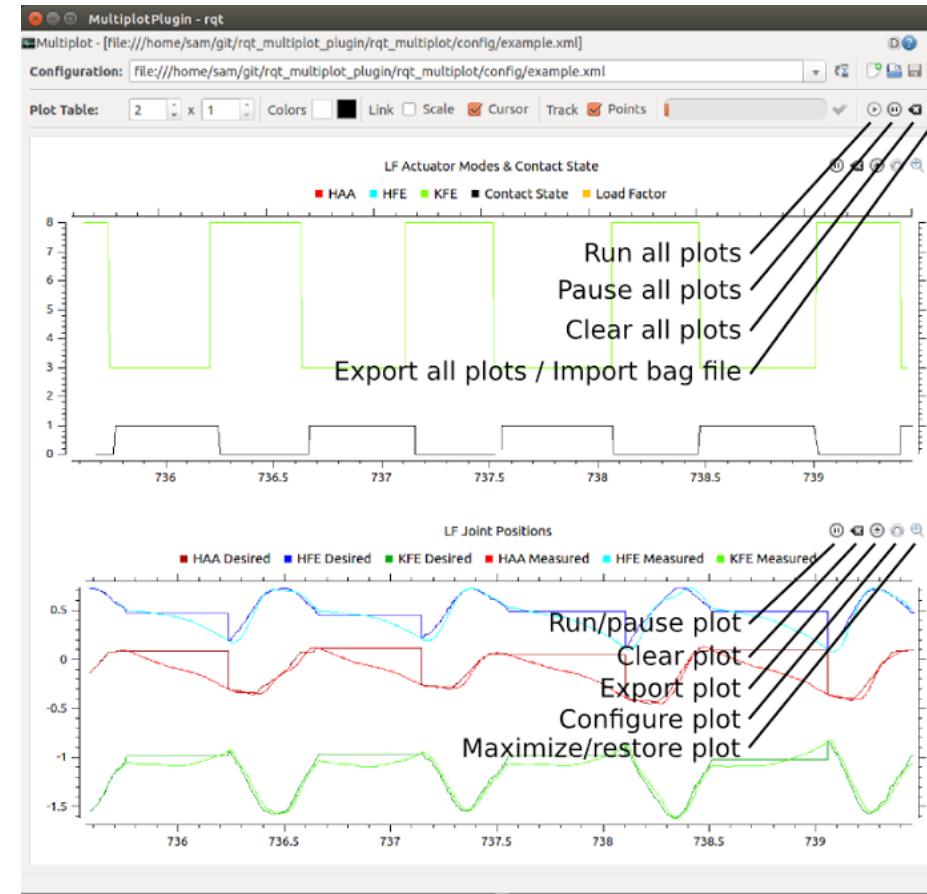


More info
http://wiki.ros.org/rqt_image_view

rqt User Interface

rqt_multiplot

- Visualizing numeric values in 2D plots



More info
http://wiki.ros.org/rqt_multiplot

rqt User Interface

rqt_graph

- Visualizing the ROS computation graph



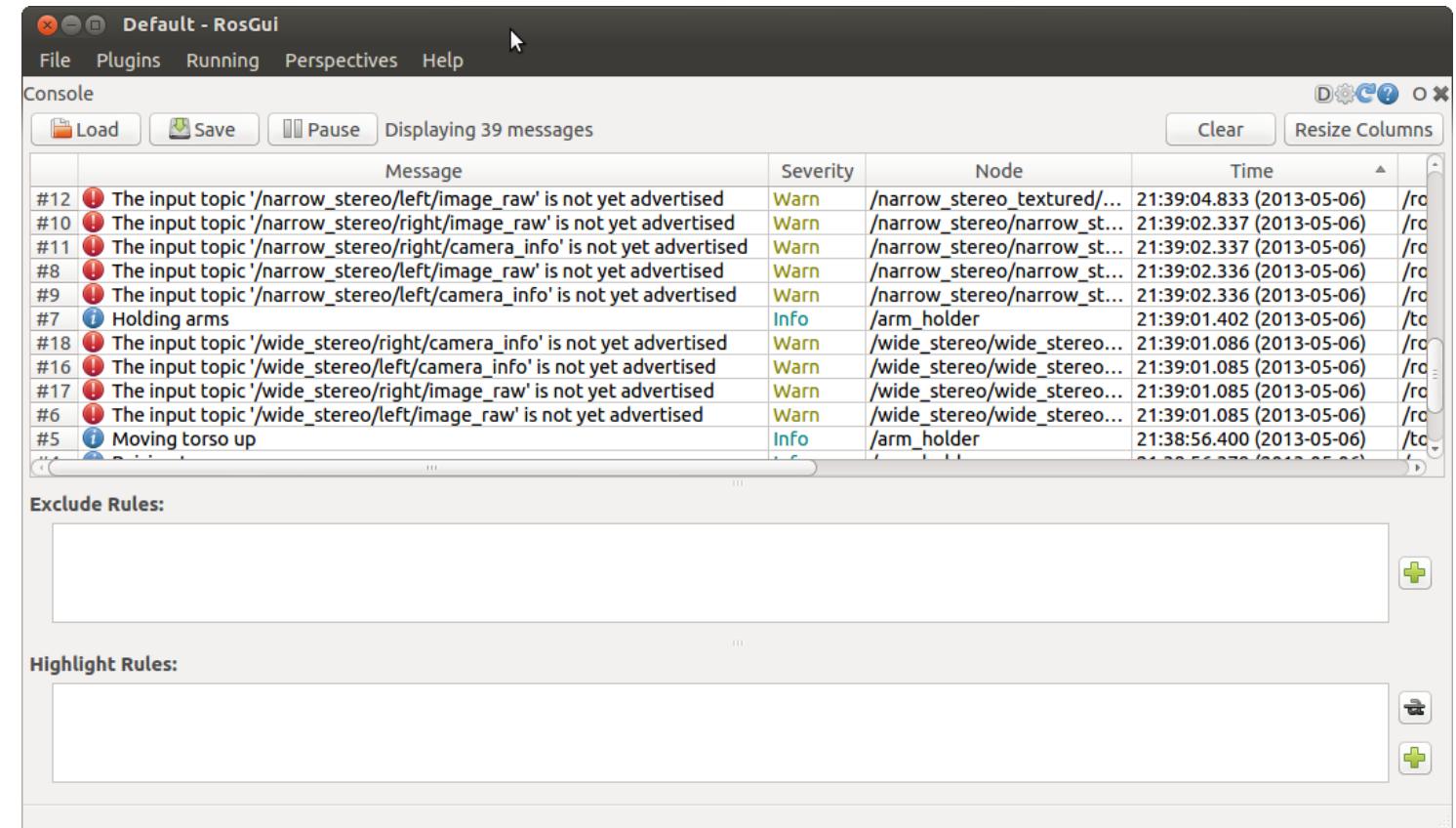
More info

http://wiki.ros.org/rqt_graph

rqt User Interface

rqt_console

- Displaying and filtering ROS messages



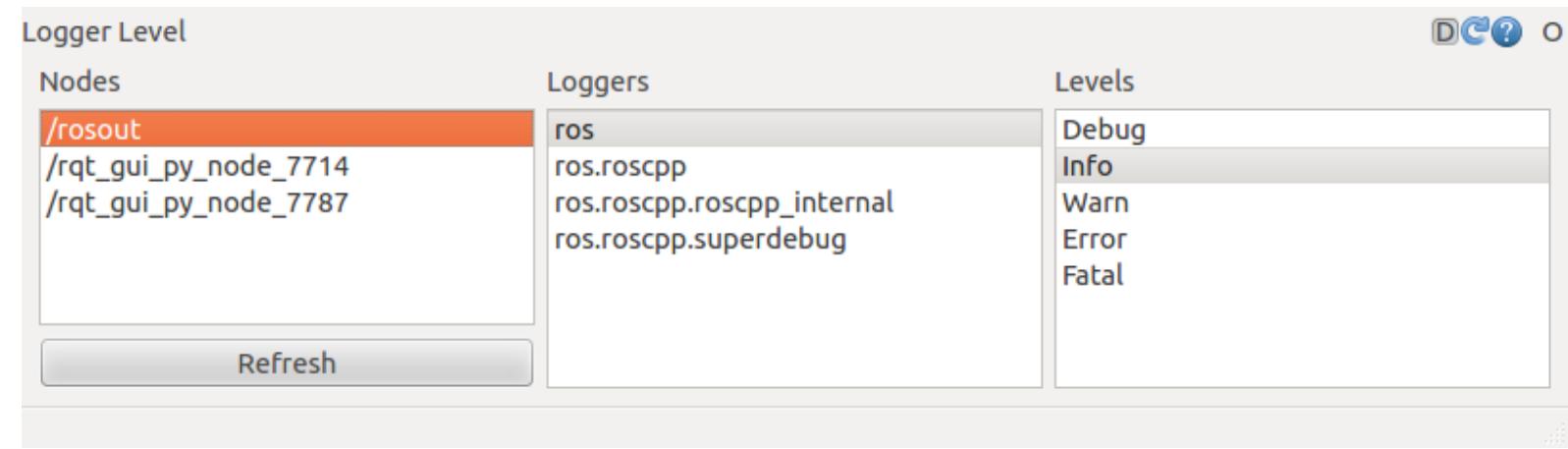
More info

http://wiki.ros.org/rqt_console

rqt User Interface

rqt_logger_level

- Configuring the logger level of ROS nodes



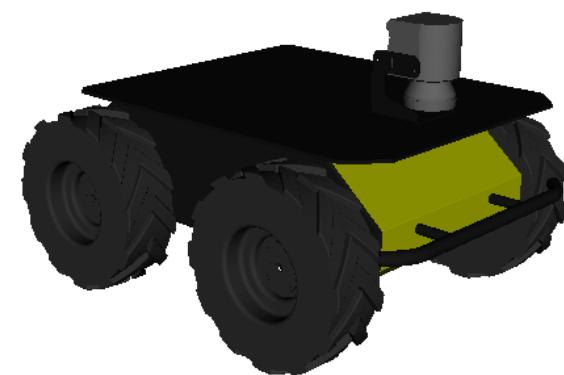
More info

http://wiki.ros.org/rqt_logger_level

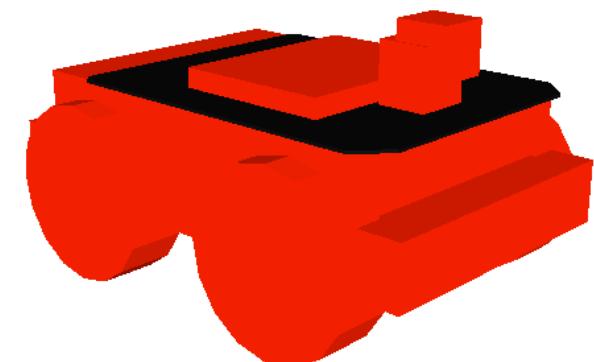
Robot Models

Unified Robot Description Format (URDF)

- Defines an XML format for representing a robot model
 - Kinematic and dynamic description
 - Visual representation
 - Collision model
- URDF generation can be scripted with XACRO



Mesh for visuals



Primitives for collision

More info

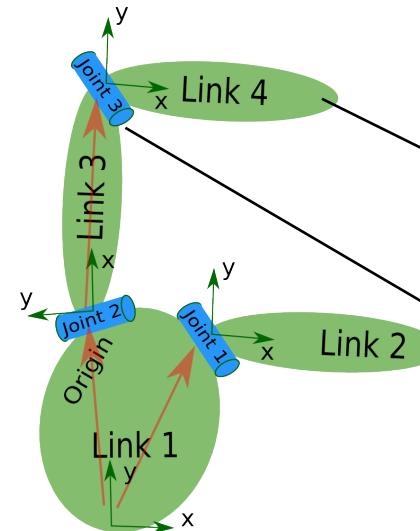
<http://wiki.ros.org/urdf>
<http://wiki.ros.org/xacro>

The *RobotModel* plugin visualizes a robot in RViz

Robot Models

Unified Robot Description Format (URDF)

- Description consists of a set of *link* elements and a set of *joint* elements
- Joints connect the links together



robot.urdf

```
<robot name="robot">
  <link> ... </link>
  <link> ... </link>
  <link> ... </link>

  <joint> .... </joint>
  <joint> .... </joint>
  <joint> .... </joint>
</robot>
```

```
<link name="Link_name">
  <visual>
    <geometry>
      <mesh filename="mesh.dae"/>
    </geometry>
  </visual>
  <collision>
    <geometry>
      <cylinder length="0.6" radius="0.2"/>
    </geometry>
  </collision>
  <inertial>
    <mass value="10"/>
    <inertia ixx="0.4" ixy="0.0" .../>
  </inertial>
</link>
```

```
<joint name="joint_name" type="revolute">
  <axis xyz="0 0 1"/>
  <limit effort="1000.0" upper="0.548" ... />
  <origin rpy="0 0 0" xyz="0.2 0.01 0"/>
  <parent link="parent_Link_name/>
  <child link="child_Link_name/>
</joint>
```

More info

<http://wiki.ros.org/urdf/XML/model>

Simulation Descriptions

Simulation Description Format (SDF)

- Defines an XML format to describe
 - Environments (lighting, gravity etc.)
 - Objects (static and dynamic)
 - Sensors
 - Robots
- SDF is the standard format for Gazebo
- Gazebo converts a URDF to SDF automatically



More info

<http://sdformat.org>

Further References

- **ROS Wiki**
 - <http://wiki.ros.org/>
- **Installation**
 - <http://wiki.ros.org/ROS/Installation>
- **Tutorials**
 - <http://wiki.ros.org/ROS/Tutorials>
- **Available packages**
 - <http://www.ros.org/browse/>
- **ROS Cheat Sheet** (partly outdated)
 - <http://www.tedusar.eu/files/summerschool2013/ROScheatsheet.pdf>
- **ROS Best Practices**
 - https://github.com/ethz-asl/ros_best_practices/wiki
- **ROS Package Template**
 - https://github.com/ethz-asl/ros_best_practices/tree/master/ros_package_template

Contact Information

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Course website:

[http://www.rsl.ethz.ch/education-
students/lectures/ros.html](http://www.rsl.ethz.ch/education-students/lectures/ros.html)