# USARSim/ROS: A Combined Framework for Robotic Control and Simulation

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# Outline

# Advantages of Simulation

(simulation1-1.mov)

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1. Experimentation in a safe and low-cost environment
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3. Study a problem at several level of abstractions
   - Provide extensive testing opportunities
   - Simulate major components of the robotic architecture (e.g., advanced sensors)
   - Allow rapid prototyping

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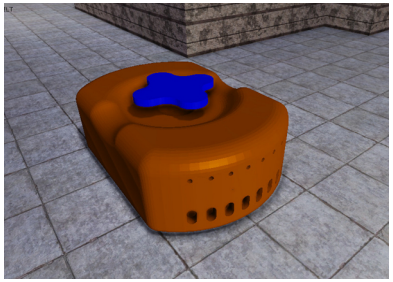
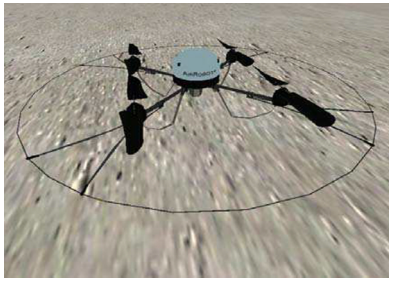
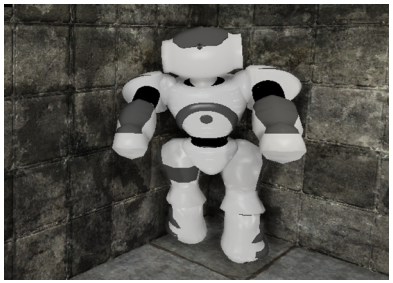
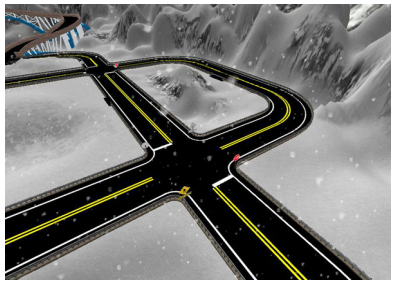
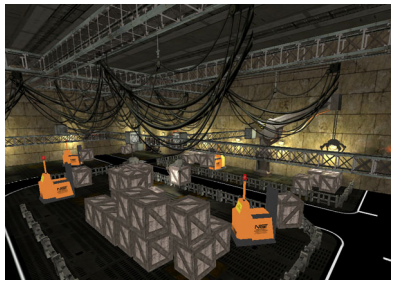
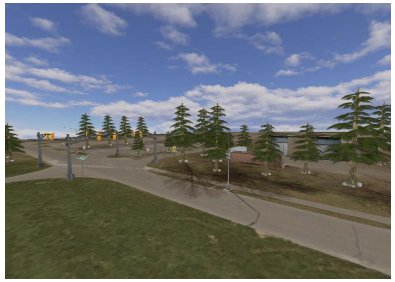
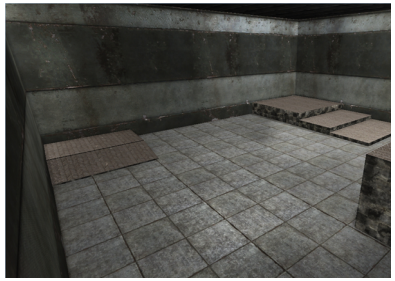
## Platforms

- High-fidelity physics-based simulation system based on the Unreal Development Kit (UDK)

## Environments

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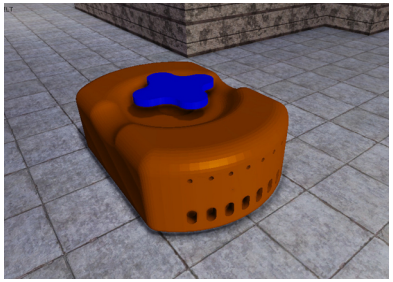
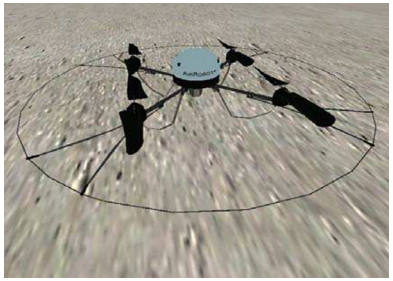
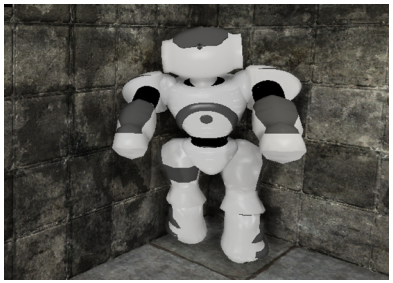

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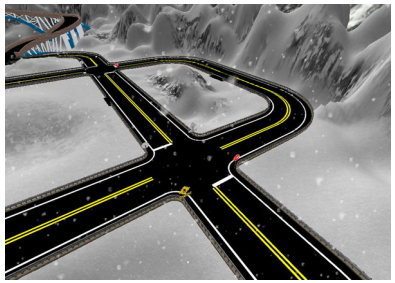
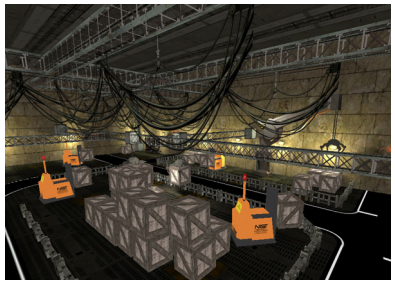
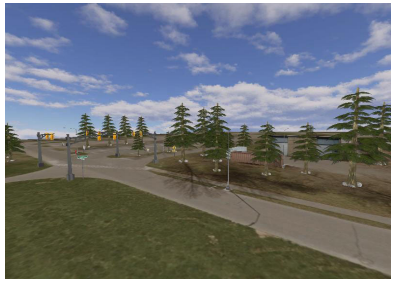
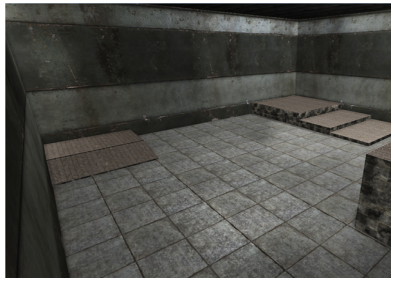

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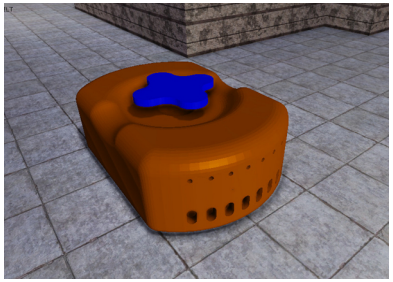
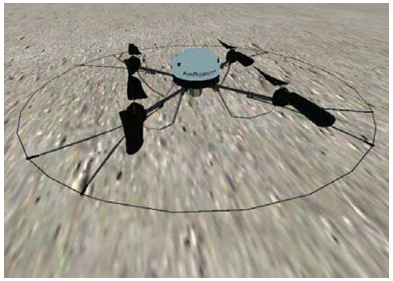
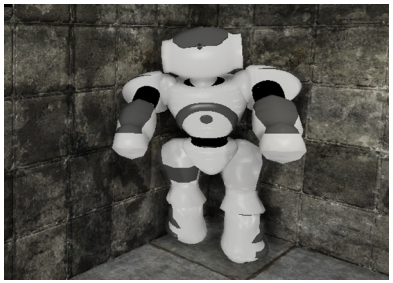

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- Through its usage of UDK, USARSim utilizes the physX physics engine and high-quality 3D rendering facilities
- Full user effort can be devoted to the robotics-specific tasks of:
  - modeling platforms
  - modeling environments
  - control systems
  - sensors
  - interface tools

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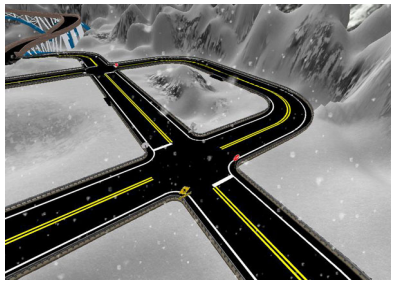
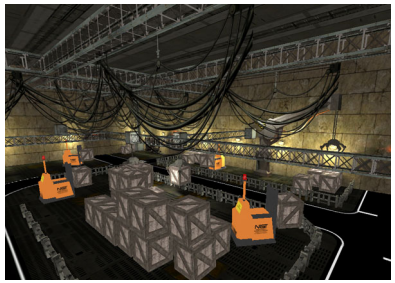
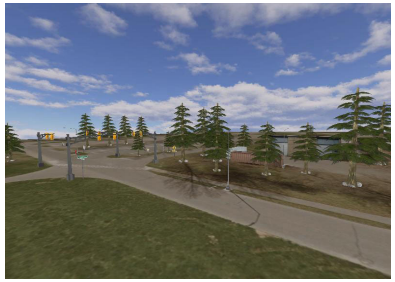
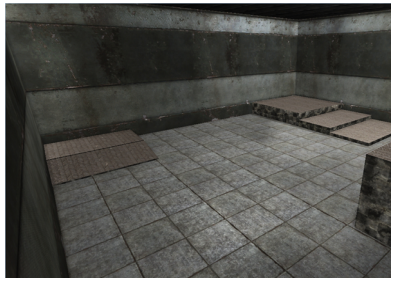

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## ROS Concepts

1. Stack: Packages in ROS are organized into ROS stacks which simplifies the process of code sharing
2. Package: A compilation of nodes that can easily be compiled and ported to other computers
3. Node: Executable file within a ROS package
4. Topic: A communication channel between two or more nodes
5. Message: A strictly typed data structure. A node sends a message by publishing it to a given topic

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  - Publishes a ROS transform tree (from the ROS tf package) – Figure 1

## tf Transform tree

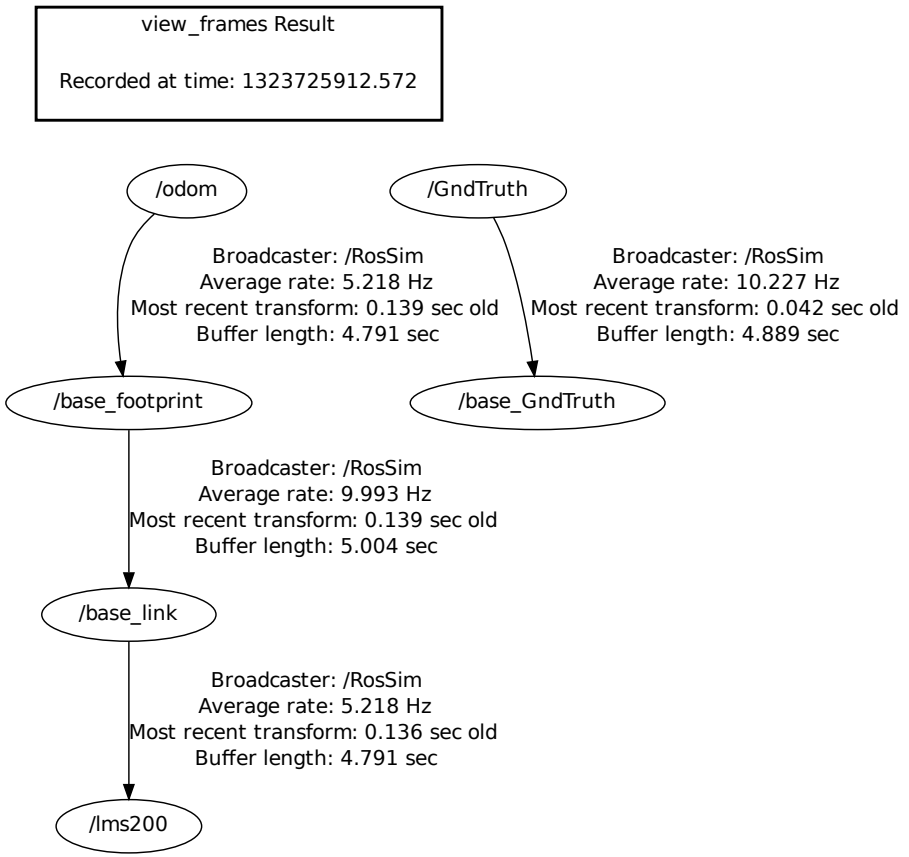


Figure 1: tf Transform tree for P3AT.

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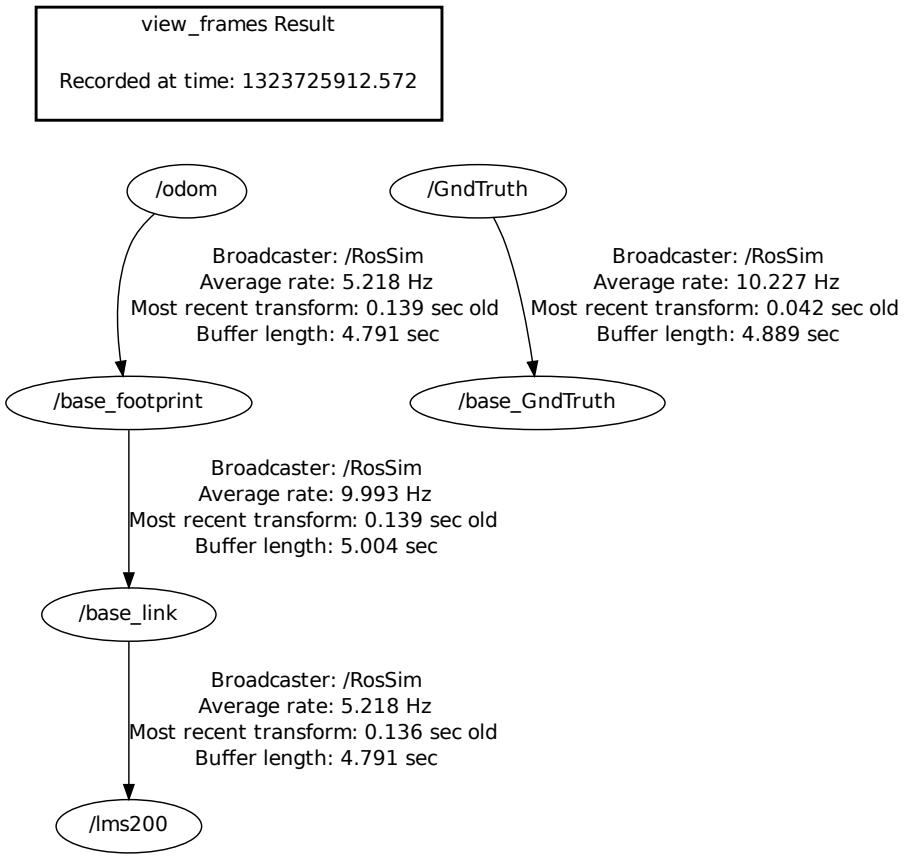


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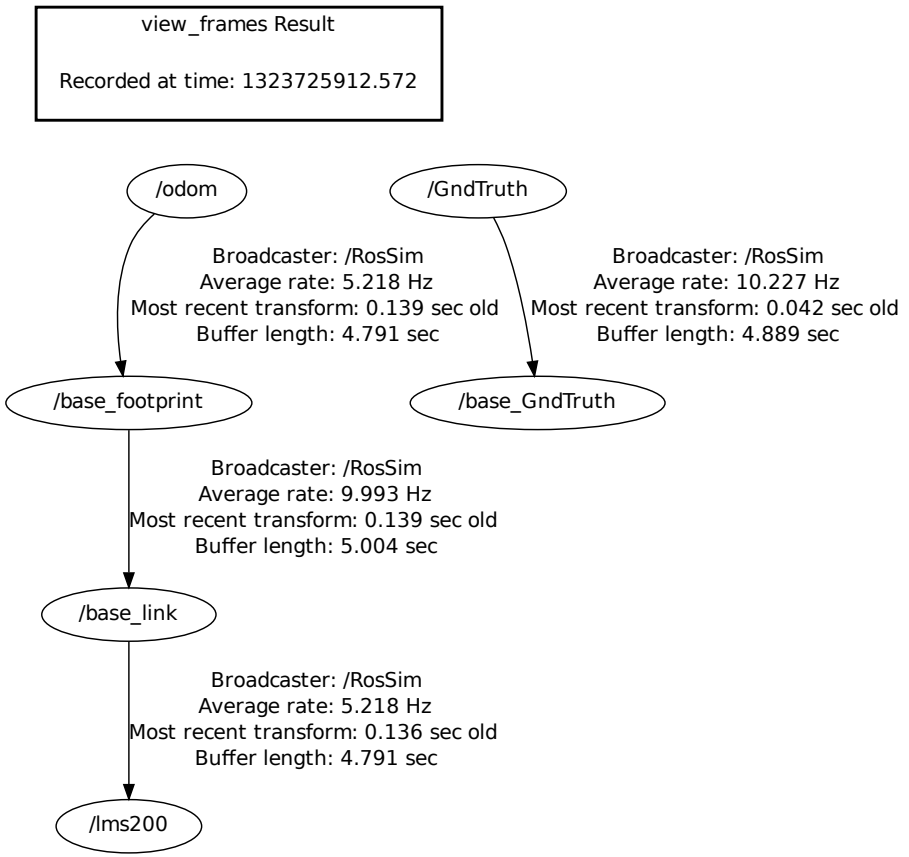


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  - Provides a mechanism for
    - Spawning a robot in USARSim
    - Auto-discovering the robot's sensors, actuators, and drive configuration

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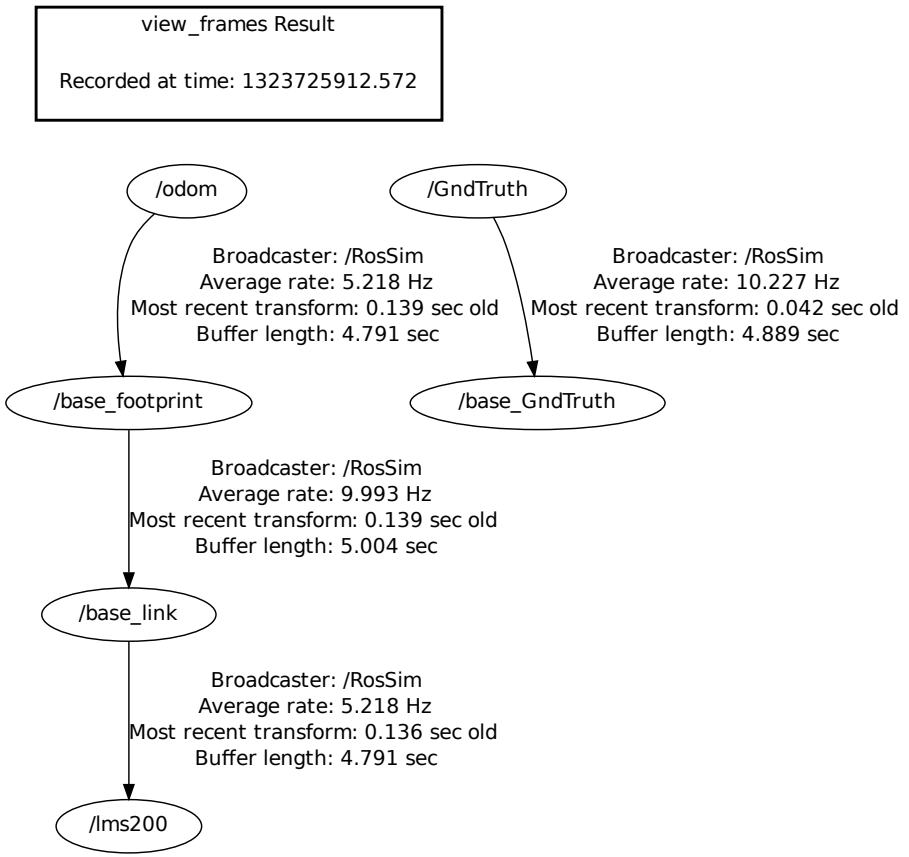


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    - Send information over standard ROS topics

# USARSim Object Recognition Sensor

(ObjectSensor0001.mov)

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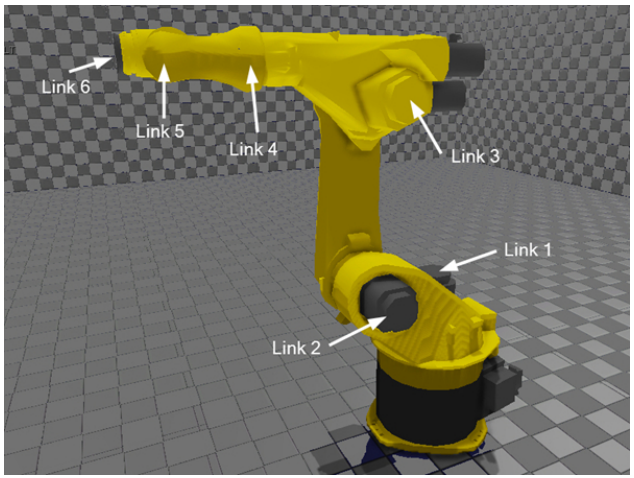


Figure 2: Joint axes in USARSim.

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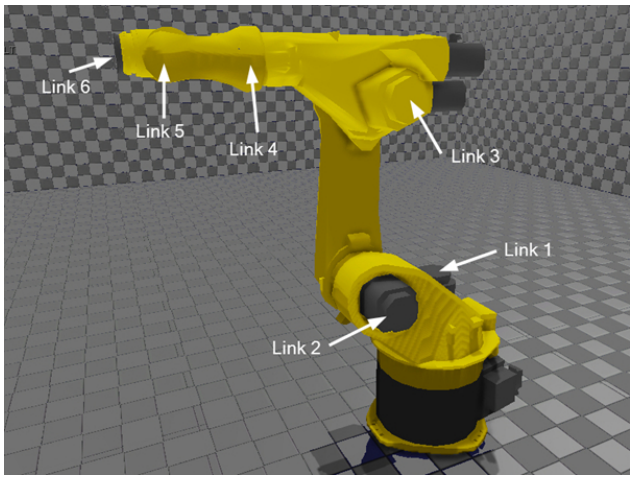
- RosSim node automatically builds the transform tree (Figure 4) for the various actuator coordinate frames by reading the USARSim Conf and Geo messages

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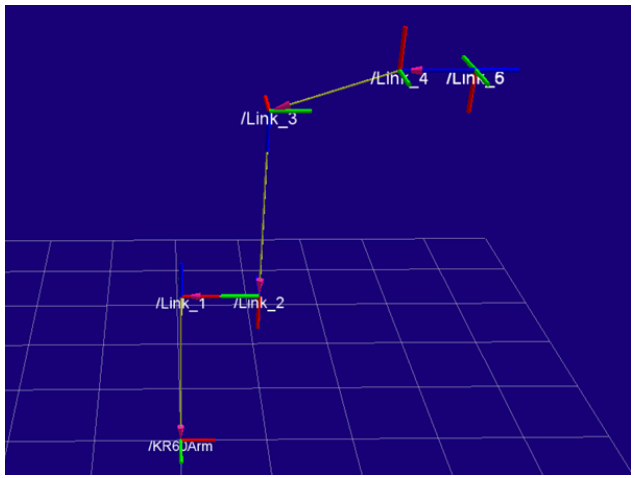


Figure 3: Joint axes from ROS tf topic.

# Robotic Arm in Action

## Tile Grasping

(vacuum.mov)

## Tool Changing

(toolchanger.mov)

# Conclusion and Future Work

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- Future Work
  - Additional sensors interfaces in USARSim to be supported in the ROS environment
  - Source code for public domain (Sourceforge) (July 2012)
  - Implementation of tooltip and global coordinates for robotic arms (July 2012)

# For Further Reading I



Willow Garage
ROS Wiki
*http://www.ros.org/wiki*, 2012.


USARSim
USARSim Web
*http://www.usarsim.sourceforge.net*, 2012.


Epic Games
Unreal Development Kit
*http://udk.com*, 2012.

THANK YOU!