

Short Survey of Simulators for RoboCup@Work

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Outline

- ▶ Motivation
- ▶ Usecase and evaluation criteria
- ▶ Selection of simulators
- ▶ Short summary

Motivation I

- ▶ Speedup of development process
 - ▶ Hardware not ordered or purchased
 - ▶ Exactly needed parts aren't clear or specified
 - ▶ Delivery and assembly might be quite time consuming
- ▶ Sharing resources
 - ▶ Normally more students (projects) than robots are present
 - ▶ Who has a higher priority, esp. near due dates and deadlines?
 - ▶ What if a robot is broken?

Motivation II

- ▶ Battery problem
 - ▶ Executing time between one and a few hours
 - ▶ Charging time two to four times longer
 - ▶ In the meantime no autonomous tests are possible
- ▶ Safety and security
 - ▶ Important when dealing with fast or heavy equipment and/or objects, etc.
 - ▶ Programming mistakes may damage robots, objects, the environment, or humans.

Motivation III

- ▶ Increasing thoroughness of tests
 - ▶ Tests for unreachable environments (moon, mars, seefloor, etc.)
 - ▶ Tests with special perspectives (i.e. in potentially dangerous viewpoints for tester)
- ▶ Learning
 - ▶ Speed up of learning
 - ▶ Producing training data for offline learning
 - ▶ Enabling online learning

Usecase

- ▶ An application, that calculates/sends velocities to
- ▶ Ros node (e.g. Youbot API)
- ▶ Robot movement should be visualized in simulation

Evaluation criteria

<i>Criteria</i>	<i>Availability</i>	<i>Description</i>
<i>ROS</i>	—	
<i>YouBot model</i>	x	
<i>Examples/ Tutorials</i>	—	
<i>Support of sensors</i>	x	
<i>More</i>	—	
<i>License</i>	x	
<i>Several OS</i>	—	
<i>Graphics</i>		
<i>Engine</i>	x	

Selection of simulators

- ▶ Matlab/Simulink
- ▶ OpenRave
- ▶ Gazebo
- ▶ Webots
- ▶ V-Rep

Matlab/Simulink

Criteria	Availability	Description
ROS	x	Via IPC-Bridge (needed because of incompatible dependencies)
YouBot model	x	
Examples/Tutorials	x	Example and installation guide
Support of sensors	x	kinect, etc.
More	x	- High precision - No support of ROS services and param server
License	x	
Several OS	x	Windows, Linux, Mac Os
Graphics		All

<i>Criteria</i>	<i>Availability</i>	<i>Description</i>
<i>ROS</i>	x	<i>ROS Packages available</i>
<i>YouBot model</i>	x	<i>Model available as collada(.dae) file</i>
<i>Examples/ Tutorials</i>	x	<i>Wiki entries and more</i>
<i>Support of sensors</i>	x	
<i>More</i>	x	<i>Designed for evaluation of robot manipulator path planning algorithms</i>
<i>License</i>	—	
<i>SeveralOS</i>	x	<i>Windows, Linux, Mac Os</i>

Gazebo

<i>Criteria</i>	<i>Availability</i>	<i>Description</i>
<i>ROS</i>	<i>x</i>	<i>Fully integrated</i>
<i>YouBot model</i>	<i>x</i>	<i>With spheres instead of sweedish wheels</i>
<i>Examples/ Tutorials</i>	<i>x</i>	<i>Examples, Tutorial, wikis, etc.</i>
<i>Support of sensors</i>	<i>x</i>	<i>Kinect, hokuyo, etc.</i>
<i>More</i>	<i>x</i>	<i>Can be used headless</i>
<i>License</i>	<i>—</i>	
<i>SeveralOS</i>	<i>—</i>	<i>Only Linux</i>
<i>Graphics</i>		<i>Definitely for nVidia.</i>
<i>Engine</i>	<i>x</i>	<i>ODE (open dynamic engine)</i>

Webots

<i>Criteria</i>	<i>Availability</i>	<i>Description</i>
<i>ROS</i>	x	<i>ROS package webots</i>
<i>YouBot model</i>	x	<i>Integrated</i>
<i>Examples/ Tutorials</i>	x	<i>Tutorials and youBot example available</i>
<i>Support of sensors</i>	x	<i>Lots of common sensors, such as kinect, compass, etc.</i>
<i>More</i>	x	<i>Integrated world and robot editor, stored as VRML file</i>
<i>License</i>	x	<i>Pro : 1800 euro, Edu : 260 euro</i>
<i>SeveralOS</i>	x	<i>Windows, Linux, MacOS</i>
<i>Graphics</i>		<i>All</i>
<i>Engine</i>	x	<i>ODE</i>

V-Rep (Virtual Robot Experimentation Platform)

<i>Criteria</i>	<i>Availability</i>	<i>Description</i>
<i>ROS</i>	x	<i>No package yet, BUT possible (cpp or roslua)</i>
<i>YouBot model</i>	x	<i>Via drag&drop</i>
<i>Examples/ Tutorials</i>	x	<i>Demonstration already within V – Rep</i>
<i>Support of sensors</i>	x	<i>Also lots of common sensors</i>
<i>More</i>	x	<i>– No plugins for linux beta version – Arm joint angles are different for real robot and simulation</i>
<i>License</i>	x	
<i>SeveralOS</i>	x	<i>Windows, Linux, MacOS</i>
<i>Graphics</i>		<i>Recent nVidia and ATI graphics adapters</i>
<i>Engine</i>	x	<i>ODE or bullet engine</i>

And many more

- ▶ For fast learning purposes
 - ▶ UCHILSIM
 - ▶ YARS
- ▶ To learn team behaviors
 - ▶ Mason
 - ▶ BREVE
 - ▶ MuRoSimF

Summary

<i>Criteria</i>	<i>Matlab</i>	<i>OpenRave</i>	<i>Gazebo</i>	<i>Webots</i>	<i>VRP</i>
<i>ROS</i>	x	x	x	x	(-)
<i>YouBot model</i>	x	x	x	x	x
<i>Examples</i>	x	x	x	x	x
<i>Sensors</i>	x	x	x	x	x
<i>License</i>	x	-	-	x	x
<i>SeveralOS</i>	x	x	L	x	x
<i>Graphics</i>	x		nV	x	nV/ATI