



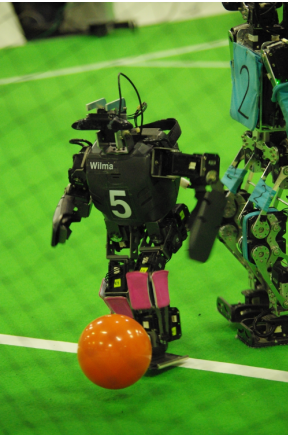
Pitfalls Using Simulation in Robotics

Seminar Intelligent Robotics



Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

Table of content



- Motivation
- Simulation in Robotics
- Problems with Simulation
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Intro

- Today there are Simulators for Robotics freely available
- Real robots are expensive
- Simulation is possible on most computers



Motivation for Simulation

- Expensive and failing Hardware
- Safe testing environment
- Reproducible tests

Motivation for Simulation

- Abstraction from currently not working parts
 - ▶ Vision
 - ▶ Localization
 - ▶ ...
- Partial Testing
- Testing 'at Home'



Motivation for Simulation: Machine Learning

- many trials
- Hardware damaging
- Reset to the beginning is easier
- faster than real time



Robocup

- The Goal of Robocup is to play soccer against humans around 2050
- Many different leagues
- Some of them are simulation leagues of the real Robots

Simulation

- Webots, Gazebo, ...
- 'Ready to use'

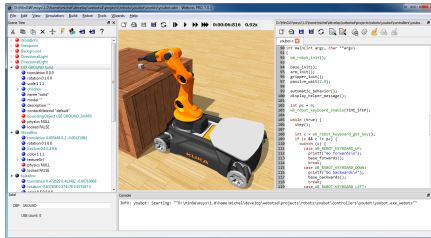


Image: <https://www.cyberbotics.com/overview>



Simulation in Robocup

- Algorithms from Simulation and real Robots are mostly not interchangeable
- Few teams doing both
- Many interesting learning approaches in Simulation
- Often 'We think it should work on real Robots'



Simple Problems

- Simplified models
- Sensor noise
- Computing power
- Hardware response delays



Noise

Video¹

¹<https://www.youtube.com/watch?v=rmqC0UnM-9A> and <https://youtu.be/Nq3ZQxUiVWA>

Delays

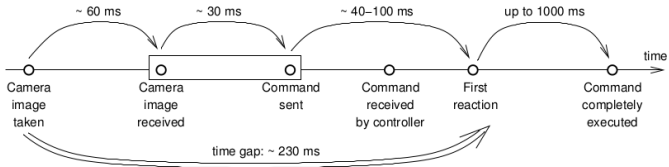


Image From: [Gabel et al., 2006]

Motor Responses

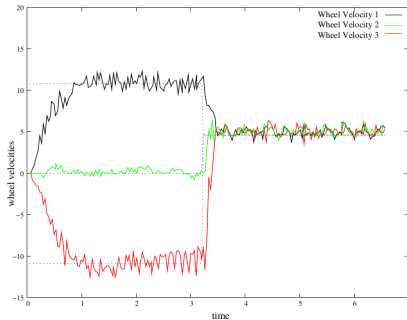


Image From: [Gabel et al., 2006]



Harder Problems

- Changing background distractors
- Dynamic Robot Parts
 - ▶ Cabel
 - ▶ Motor Load and inaccuracies
 - ▶ Mechanical tolerances
- Vision
- Physics

Background distractor



Image: Robocup-AG; Iranopen 2016

Images from Real Robot and Simulator



Images: Left: Robocup-AG; Iranopen 2016;
Right: The Virtual Nao (SimSpark)²

²<http://phys.org/news/2011-07-ut-austin-villa-world-robocup.html>

Physics

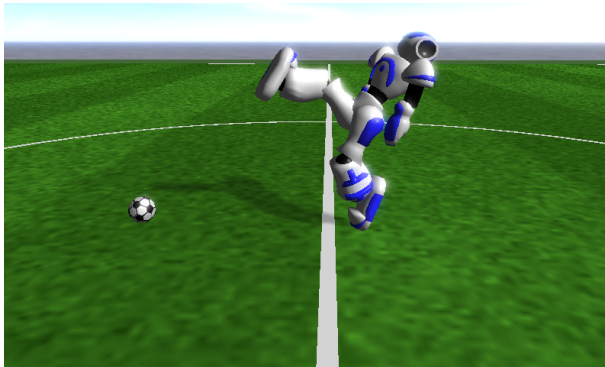


Image From: [Abdolmaleki et al., 2016]



Harder Problems (Vision)

- Reflections
- Motion Blur
- Lighting changes
- Color Changes

- Often even the lab surroundings are too sterile



Harder Problems (Physic)

- Friction
- Heating
- Corner cases

Machine learning

- Exploiting of Simulator corner cases
 - ▶ Shooting a Ball with INT_MAX as velocity
 - ▶ Putting the ball in your foot
- Mostly errors in the physics
- Game physic engines are used most of the time



Bridging the Gap

- Constant reevaluation with Real Robots
- Tuning the Simulator Parameters
 - ▶ Physics
 - ▶ Motor Controllers

Back to Reality building blocks

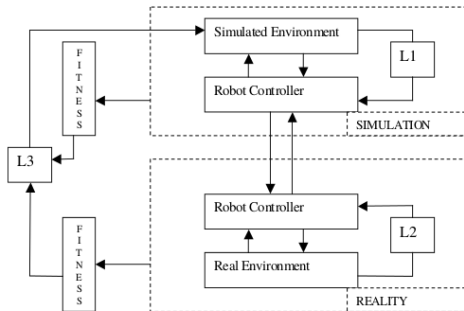


Image From: [Zagal and Ruiz-del Solar, 2004]

Back to Reality building blocks

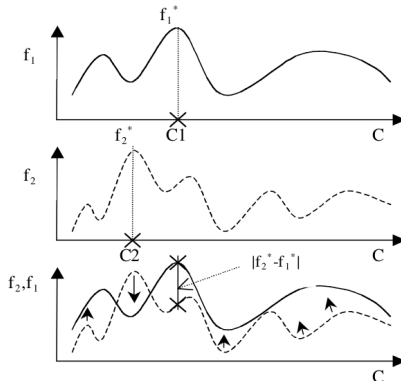


Image From: [Zagal et al., 2004]



Ros Bags


- Captured Ros Messages
- Easy to replay
- Potential Timing issues





Special Purpose Simulators


- Simulate only some aspects with more precision
 - ▶ Localization
 - ▶ Vision
 - ▶ Behavior

Sources

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Questions

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