Simulation of Highly Dynamic Omnidirectional Robots in Isaac Sim
Marvin Wiedemann - Fraunhofer Institute of Material Flow and Logistics
From Highly Dynamic Omnidirectional Real-World Robots...
... to Highly Dynamic Omnidirectional Simulation Models!
Agenda

01 Actuators & Dynamics
How to model the robot in simulation?

02 Sensors
How to replicate the sensors of the robot?

03 Communication & Interfaces
How to replicate the robots’ interfaces?
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Video last GTC?
New images of Odyn?
The Demonstrator: O³dyn - a Next-Generation Logistics Robot

O³   = Omnidirectional, Outdoor, Open-Source
dyn = Dynamics
Actuators & Dynamics
Get The Robot Into Simulation

Import from CAD data

Import from URDF

```xml
<!-- Dimensions of the IMU -->
<macro property name="IMU_XDIMENSIONS_x" value="0.0031"/>
<macro property name="IMU_XDIMENSIONS_y" value="0.0035"/>
<macro property name="IMU_XDIMENSIONS_z" value="0.0039"/>

<!-- Dimensions of the Sick TL4 S1 -->
<macro property name="SICK_TL4_DIMENSIONS_x" value="0.01"/>
<macro property name="SICK_TL4_DIMENSIONS_y" value="0.01"/>
<macro property name="SICK_TL4_DIMENSIONS_z" value="0.01"/>

<!-- Dimensions of the URG Antenna -->
<macro property name="URG_ANTERIORITY_SENSOR_URG" value="0.01"/>
<macro property name="URG_ANTERIORITY_SENSOR_URG" value="0.01"/>
<macro property name="URG_ANTERIORITY_SENSOR_URG" value="0.01"/>

<!-- Dimensions of the RealSense camera -->
<macro property name="REALSENSE_DIMENSIONS_x" value="0.01"/>
<macro property name="REALSENSE_DIMENSIONS_y" value="0.01"/>
<macro property name="REALSENSE_DIMENSIONS_z" value="0.01"/>

<!-- Include thymio parts -->
<macro include file="parts/thymio.xacro"/>
<macro include file="parts/lowerparts.xacro"/>
<macro include file="parts/middleparts.xacro"/>
<macro include file="parts/particicules.xacro"/>
```
Smoothness is Key: The Roller Colliders

Auto-Generated Meshes
Convex Hull
Convex Decomposition

Spheric Colliders
6 spheres
11 spheres
Actuators & Dynamics

Entering the ROS Ecosystem

Isaac Sim

rviz
Actuators & Dynamics
The Robot Base Controller

OmniGraph based Controller
- Controller can be built in Isaac Sim
- Visual Scripting Language OmniGraph

Custom Controller
- Implementation via ROS or Python API
- Controller node allows to implement robot specific dynamics & behaviors (e.g., delay)
Sim2Real Comparison – Do They Behave Similarly?

Reality

- Given trajectories
- rosbag /cmd_vel
- Motion Capture

Simulation

- rosbag /pose
- Sim Ground Truth
- Msg Timing

Sim2Real Gap
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### Available Sensor Types

**Camera**
- RGB camera
- Depth camera
- Replicator for synthetic data generation

**LiDAR**
- PhysX-based LiDAR
- RTX-based LiDAR

**Others**
- PhysX-based range sensors (generic, ultrasonic)
- Force and contact sensors
- IMU
- Proximity
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## Communication & Interfaces

### Topics

<table>
<thead>
<tr>
<th>Category</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base Controller</strong></td>
<td>/cmd_vel, /odom</td>
</tr>
<tr>
<td><strong>Joints</strong></td>
<td>/joint_state, /joint_command</td>
</tr>
<tr>
<td><strong>TF</strong></td>
<td>/tf, /tf_static</td>
</tr>
<tr>
<td><strong>Sensors</strong></td>
<td>/laser, /point_cloud</td>
</tr>
<tr>
<td><strong>Custom Msgs</strong></td>
<td>/battery_soc, ...</td>
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</table>
Communication & Interfaces

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Communication & Interfaces
Actions and Services

Real O³dyn
- Actuators
- Sensors

Simulation Model
- Joints

ROBOT BASE NODE
- Action Server
  - /load
  - /control_lift
  - ...

PLC

vendor specific

/joint_states
/joint_command
Conclusion

Simulation of highly dynamic robots is challenging – but possible! Take care of the collider modeling and use real-world data.

Isaac Sim offers a lot for robotics and has its strength within the GPU usage mainly for sensor simulation and rendering.

ROS is the bridge between simulation tools and the reality.
Check Out the O³dyn Simulation Model at Home!

O³dyn on your Nucleus
omniverse://localhost/NVIDIA/Assets/Isaac/2023.1.0/Isaac/Robots/O3dyn

Open source @ Open Logistics Foundation
https://git.openlogisticsfoundation.org/silicon-economy/simulation-model/o3dynsimmodel/
Contact

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Thanks to:
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Steffen Daniel¹, Mrunal Hatwar¹, Jan Finke¹, and Sören Kerner¹

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