ROSCon FR&DE 2025 WORKSHOPS

„Building Articulated Digital Twins and High-Fidelity Simulations with ROS 2 and NVIDIA Isaac Sim“

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Abstract:

Advance your robotics development workflows using digital twins. In this joint workshop, Proximity Robotics & Automation GmbH and the Fraunhofer Institute for Material Flow and Logistics (IML) present ROS 2 workflows and modeling techniques using Isaac Sim from the NVIDIA Omniverse. Participants will learn how to create digital twins of custom (mobile) robots from scratch, simulate complex kinematic structures, and integrate high-fidelity sensors and controllers with ROS 2. The workshop covers hardware/software setup, robot import using advanced URDF workflows, modeling techniques, and Sim2Real validation and optimization. Live demos and interactive sessions covering real robots and their digital twins illustrate both academic and industrial use cases. Afterwards you should be ready to build your own virtual robot.

Maximum of participants: *30*

Agenda (tentative)

1. Welcome & Introduction (20 min)

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2. Omniverse Isaac Sim & ROS 2 Overview (20 min)

- What is NVIDIA Omniverse Isaac Sim?
- Key concepts: USD, PhysX, RTX, AI workflows
- ROS 2 integration (topics, nodes, bridges)

- Application landscape (Digital Twins, Robotics R&D)

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3. Use Case Showcases (40 min) *(Includes short videos and demos)*

- **Fraunhofer IML**
    - O^3dyn simulation for highly dynamic omnidirectional robots
    - Mesh-based vs spherical collider modeling
    - Sim2Real workflows with real-world comparison metrics
- **Proximity Robotics**
    - Omni-RobotLab @HKA
    - Mobile robots in Omniverse, controller by ROS 2
    - Custom sensor simulation (SensorRTX, LiDAR modeling)

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4. Getting Started Hands-On (30 min)

- Hardware & software requirements
- Docker setup basics
- (Installing Isaac Sim + ROS 2 bridge)
- Best practices for project structure & dependencies

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5. Robot Creation & Modeling (40 min) – Proximity Robotics

- URDF, Xacro & STL workflows (“From CAD model to robot_description” from Andreas)
- PX Isaac Sim URDF Importer
- Custom tags for sensors (LiDAR, IMU)

- Get the simulation with PX Isaac Sim URDF Importer running

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6. Deep Dive: Mobility & Kinematics (30 min) – Fraunhofer IML

- Modeling differential and omnidirectional bases
- Wheel modeling challenges (colliders, friction, etc.)
- Integration of controllers via OmniGraph & ROS 2 nodes
- Joint state and command flow

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7. Sensor Modeling & Integration (20 min)

- Sensor types: LiDAR, RGB-D, IMU
- SensorRTX, PhysX-based vs RTX-based
- (Use in replicator and perception pipelines)

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8. ROS 2 Interface & Sim2Real (30 min)

- Base controller, TF tree, Nav2, Behavior Trees
- Interfaces: `/cmd_vel`, `/joint_states`, `/laser`, `/tf`, custom msgs
- Real-world validation: rosbag tools, trajectory overlays

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9. Optional: Robot Model Optimization (10 min)

- Mesh simplification
- Physics fidelity tuning
- Performance benchmarking on RTX hardware

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10. Live Demos & Open QA (30 min)

- Participants interact with live Isaac Sim instances and/or real robot
- Group discussion and feedback