ROS-I interface for COMAU robots

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• **Comau (COnsorzio MAcchine Utensili)** is an Italian multinational company

• Comau develops and produces process automation, manufacturing and service solutions and specializes in welding robots
INITIANG AUTONOMOUS SYSTEMS LAB

Initial COMAU control system

C4G Open realistic Robot Library

PDL2 Program (Moves, etc.)

C4G Open

RT UDP/IP

COMAU

Università degli Studi di Padova
Initial COMAU control system

C4G Open

- **C4G**: Robot Unit Control
- **Open**: it allows and easy and safe integration of the Robot Control Unit with an External Personal Computer. This helps
  - Programming automated robotic cells
  - Integrating external sensors to
  - Implementing complex manufacturing applications
ORL allows to perform the following operations:

- Initialization of a virtual robot on Linux (complete Comau robot family) starting from a real configuration file
- Computation of Direct and Inverse Kinematics, for each Comau robot
- Error management of position and joint ranges
- Integration of Comau Trajectory Generator and Interpolator
- Computation of the Dynamic Model and Jacobian

The operations are realistic: they describe what the robot would do if they were performed via PDL2 on the real robot
Challenge:

• Increase ease of use
• Flexibility
• Integrability

of the open controller

Solution:

Development of a ROS-I interface for Comau robots
The final system

- ROS

C4G Open realistic Robot Library

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ROS
The final system

C4G Open realistic Robot Library

ROS

ROS

ROS

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ROS

ROS

ROS

RT UDP/IP
The final system

INTELLIGENT AUTONOMOUS SYSTEMS LAB
The final system

- ROS
- TCP/IP
- RT UDP/IP

C4G Open realistic Robot Library

ROS

Gazebo

PDL2 Program (Moves, etc.)

ROS

Movelt!

ROS

ROS

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ROS
The final system

Simulation

- Contains the robot meshes
- Contains the URDF file

2 ‘hidden’ ROS packages have been developed:
- A virtual model of the robot
- A plugin integrating the controller in Gazebo
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- A virtual model of the robot
- A plugin integrating the controller in Gazebo

- Connects the robot controller to the simulator
- A wrapper for ORL has been developed
- The simulated robot performs the same movements as the real one
The final system
Real robot

Problems:
- Robot communication → hard real time (2 ms)
- ROS → not real time at all
The final system
Real robot

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Solution: a communication node including
- **REAL TIME THREAD** → real robot connection
- **NORMAL PRIORITY THREAD** → motion data
The final system is **independent** from:

- **Platform**
  - Both ROS and not ROS –compliant platforms can use the software

- **Environment**

- **Motors**
  - Both ORL and external libraries can provide robot movements
Experiments

- Developed using a Learning From Demonstration Framework
- Developed using a Learning From Demonstration Framework
- Motion commands sent using ROS
- Performed both in the real and in the simulated world
- Two scenarios
  1. Position controller → ORL
  2. Velocity controller → customized Motion Planning library
First scenario

Move a box along a linear path from the beginning to the end of a 45 cm long table.

Position controller → ORL

Results of 25 attempts:

<table>
<thead>
<tr>
<th>Simulation</th>
<th>Real world</th>
</tr>
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<tbody>
<tr>
<td>45.011 ± 0.402 cm</td>
<td>54.332 ± 0.755 cm</td>
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Second scenario

Stop an object in motion in front of the robot.

**Velocity controller → customized MP library**

Results of 20 attempts:

Every time the robot stops the object in motion
Now, the COMAU system
- Is ROS-compliant
- Can be used by non ROS-compliant platforms without integrations
- Lets the user to control both a real and a virtual robot using the same motion controller
- Allows the replacement of the COMAU MP library with any library of the same type
Thank you for your attention