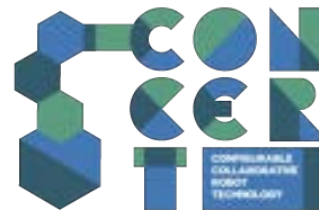




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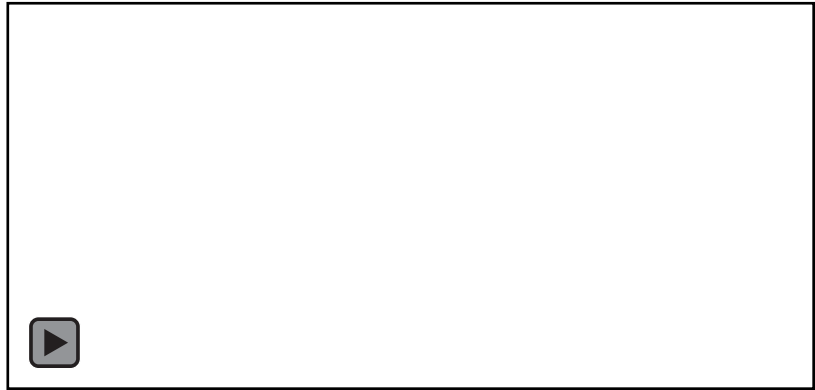
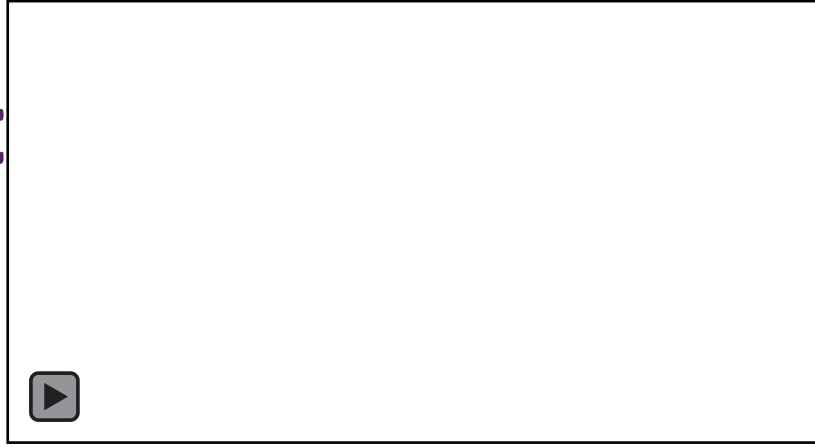
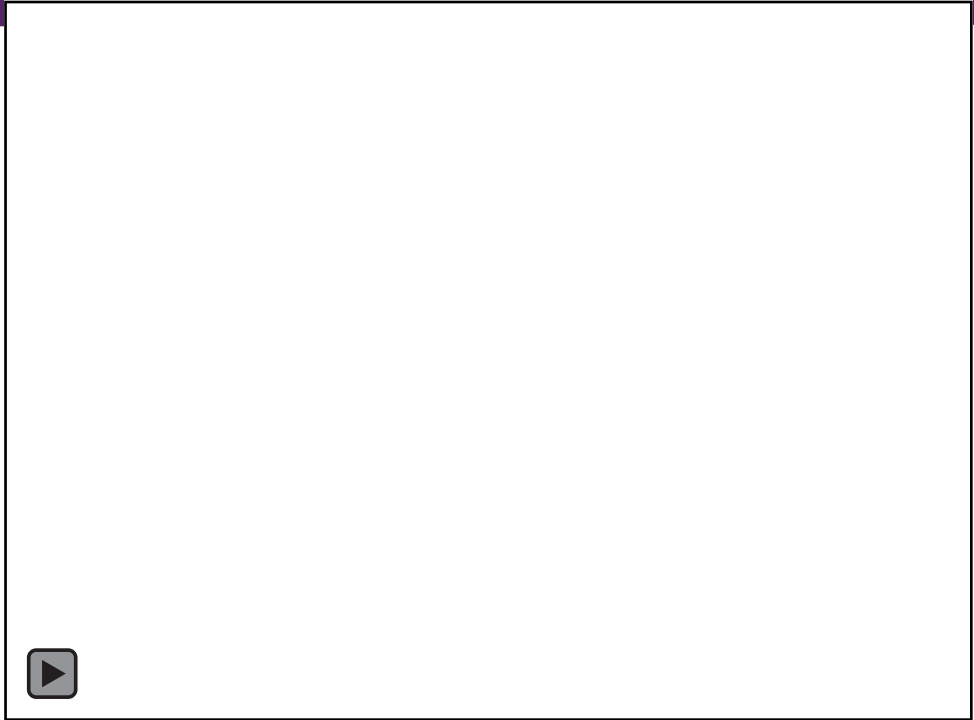
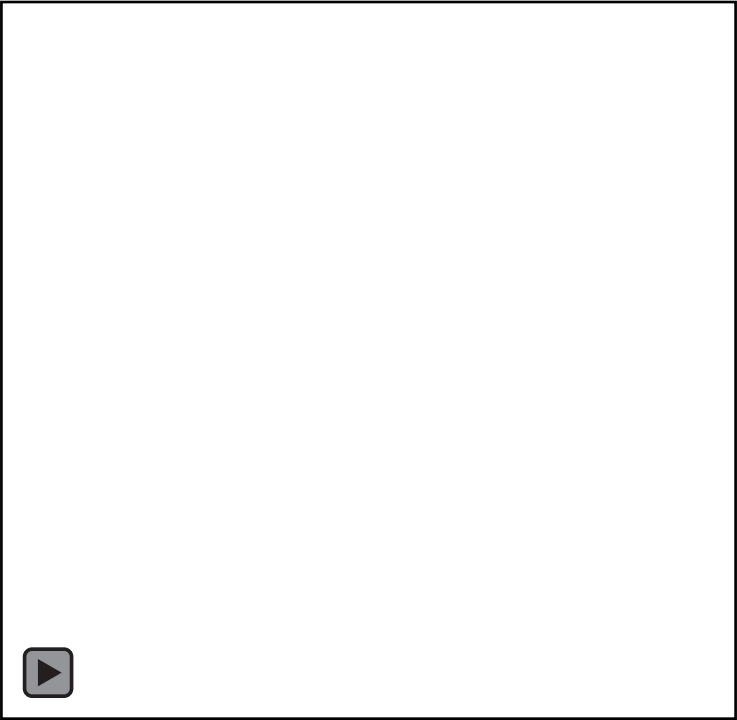
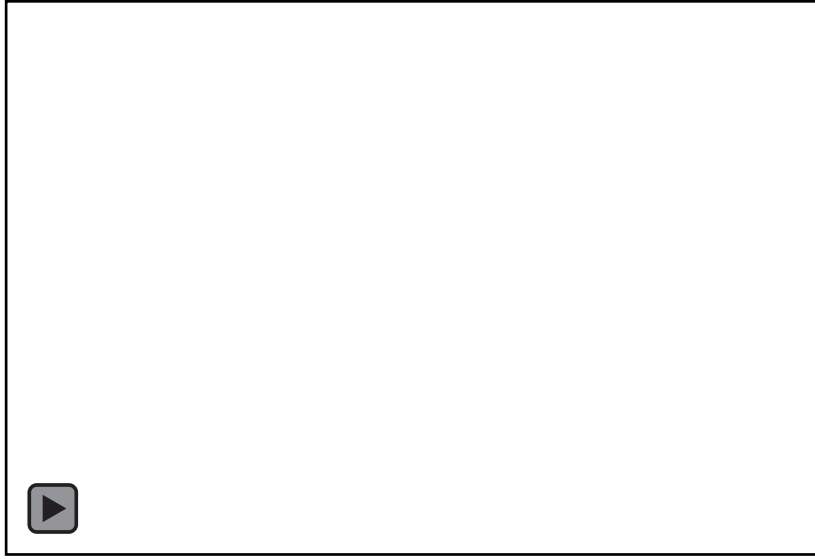
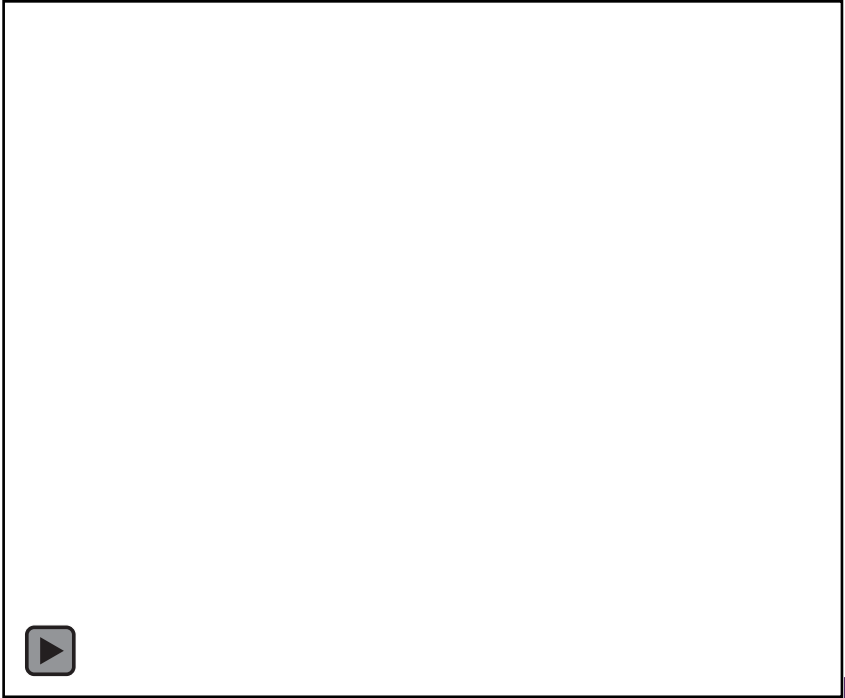


A ROS 2 Package for Online Cobots Impedance Modulation

Liana Bertoni^{1,2}, Luca Muratore¹, and Nikos Tsagarakis¹

¹ Humanoids and Human Centered Mechatronics (HHCM), Istituto Italiano di Tecnologia, Genova, Italy

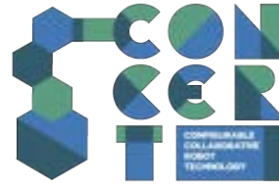
² Dipartimento di Ingegneria Informatica (DII), University of Pisa, Pisa, Italy



Flexibility Adaptation



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At this purpose:

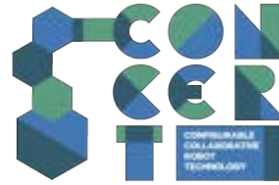
we propose a **ROS2** package aimed to unlock
flexibility and **adaptability** of robot behaviors and interactions
by exploiting a **variable impedance modulation** targeting
human-robot applications.

ROS2





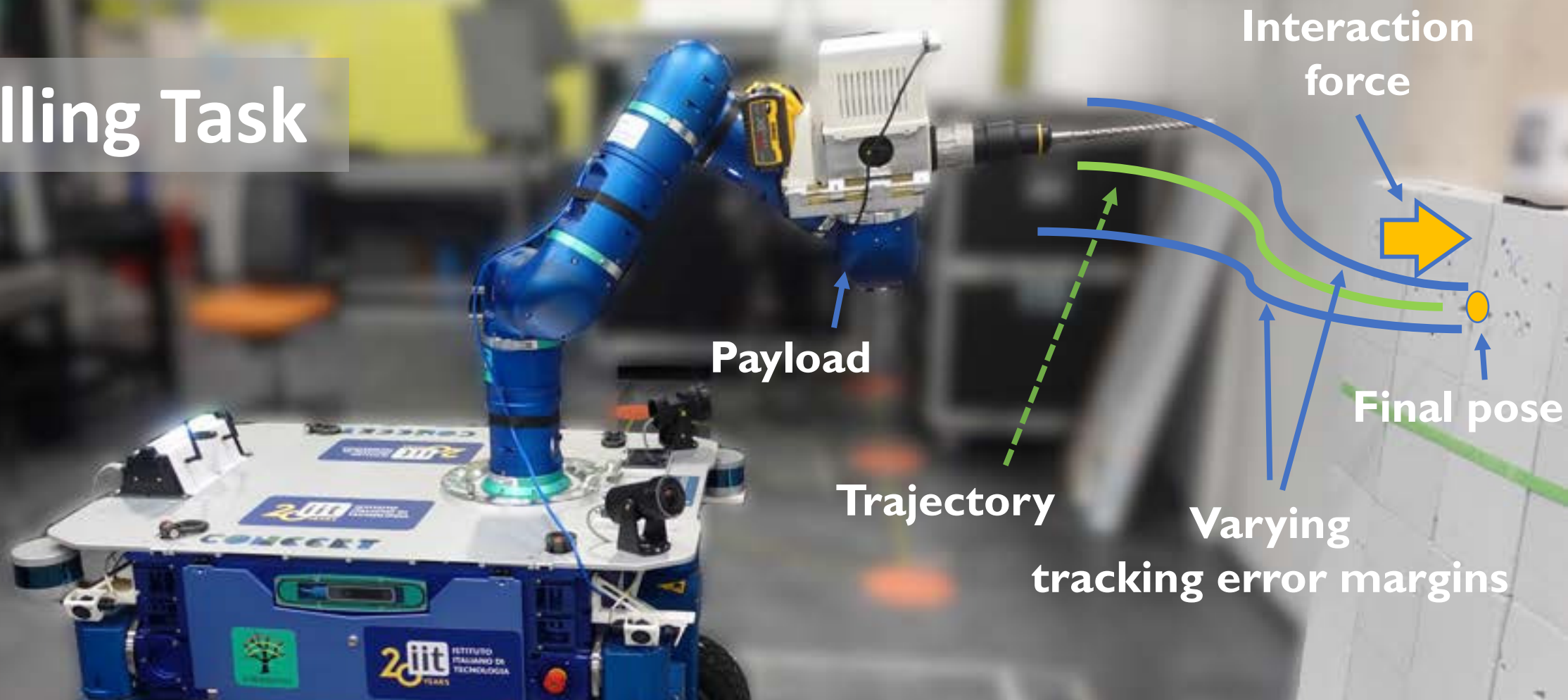
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Principle behind

Drilling Task



Robot impedance is **online** modulated based on

- task trajectory
- task force
- task precision

Task to Execute



drilling



pushing



assistance



- Task trajectory

- Task force

- Task precision

Task to Execute



drilling



pushing

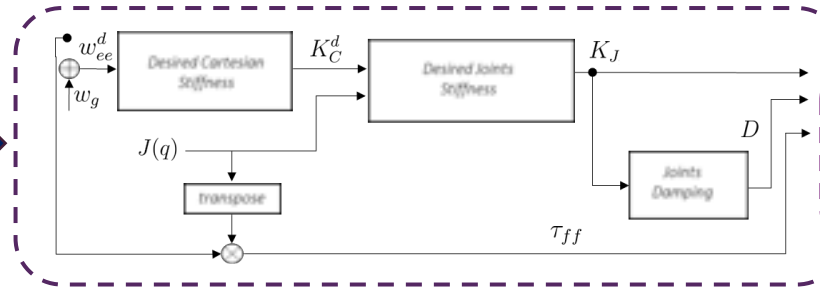


assistance

ROS2 Package Inputs

- Task trajectory
- Task force
- Task precision

Variable Impedance Modulation



ROS2 Package Outputs

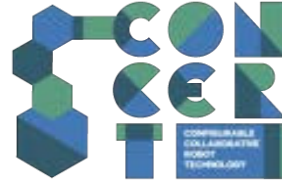
- stiffness
- damping

Robot Control





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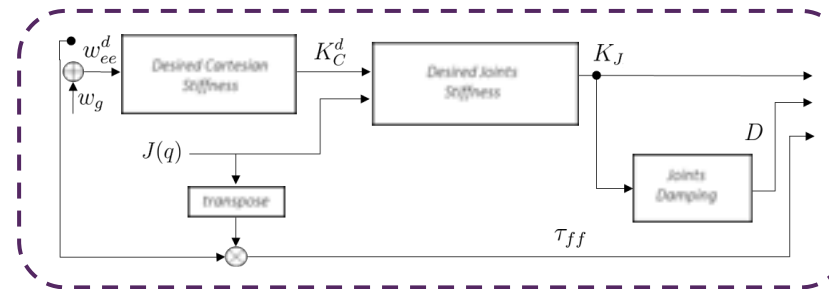
**How to use the package
By using ROS2 topics!**

Node_Settings.yaml

```
stiffness_preset  
stiffness_constant  
stiffness_maximum  
damping_preset  
damping_maximum  
robot_initial_config  
wrench_initial  
precision_initial  
transition_time  
robot_urdf_model_path  
robot_base_frame_name  
robot_tip_frame_name  
topic_subscriber_name  
topic_publisher_name  
rate  
log_path  
verbose
```

0. Configuration

Variable Impedance Modulation



ROS2



Params

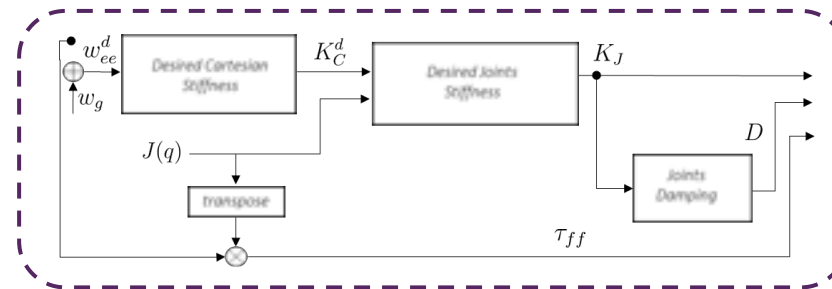
Node_Settings.yaml

```

stiffness_preset
stiffness_constant
stiffness_maximum
damping_preset
damping_maximum
robot_initial_config
wrench_initial
precision_initial
transition_time
robot_urdf_model_path
robot_base_frame_name
robot_tip_frame_name
topic_subscriber_name
topic_publisher_name
rate
log_path
verbose
  
```

0. Configuration

Variable Impedance Modulation



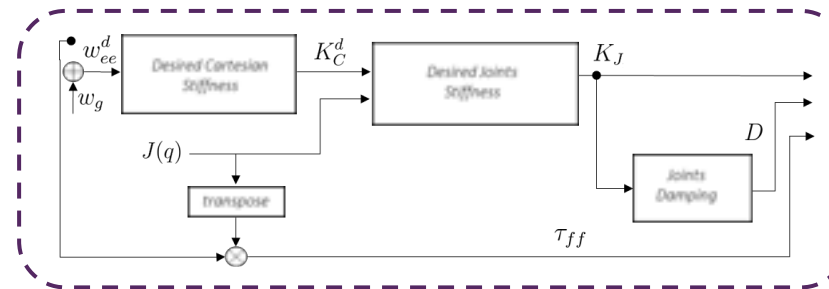
Params

Node_Settings.yaml

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stiffness_maximum
damping_preset
damping_maximum
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0. Configuration

Variable Impedance Modulation



ROS2



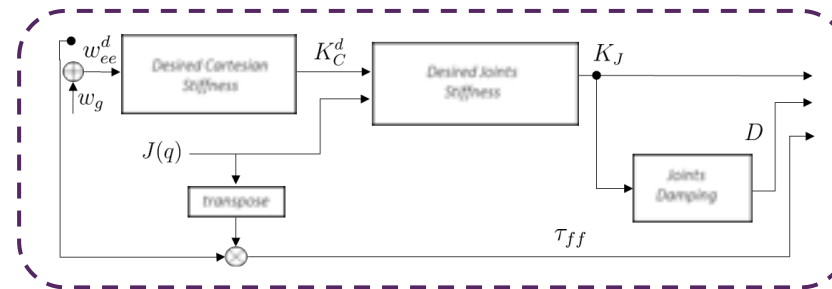
Params

Node_Settings.yaml

stiffness_preset
 stiffness_constant
 stiffness_maximum
 damping_preset
 damping_maximum
 robot_initial_config
 wrench_initial
 precision_initial
 transition_time
 robot_urdf_model_path
 robot_base_frame_name
 robot_tip_frame_name
 topic_subscriber_name
 topic_publisher_name
 rate
 log_path
 verbose

0. Configuration

Variable Impedance Modulation



ROS2



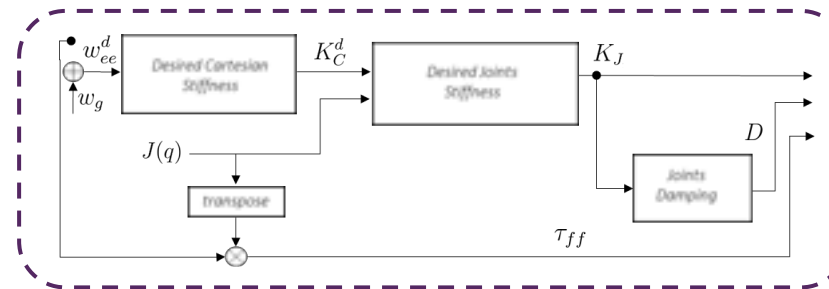
Params

Node_Settings.yaml

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stiffness_maximum
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robot_initial_config
wrench_initial
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transition_time
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robot_base_frame_name
robot_tip_frame_name
topic_subscriber_name
topic_publisher_name
rate
log_path
verbose

0. Configuration

Variable Impedance Modulation



ROS2



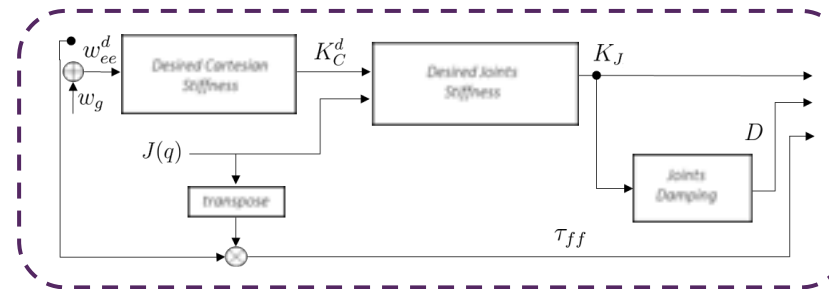
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Node_Settings.yaml

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robot_tip_frame_name
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0. Configuration

Variable Impedance Modulation



ROS2



Params

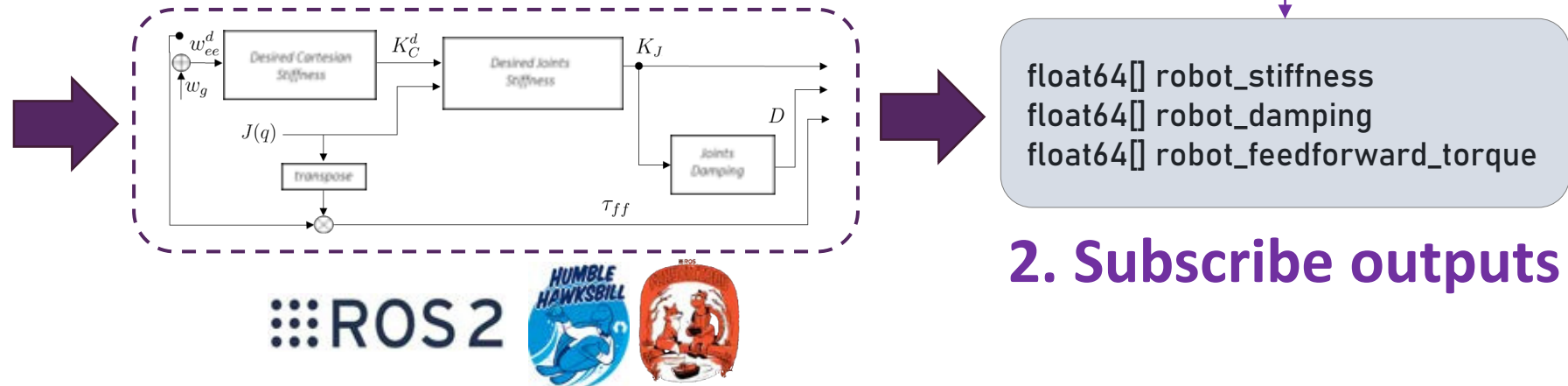


user

```
bool cartesian_space
float64[] joints_position
float64[] joints_position_reference
float64[] task_pose_reference
float64[] task_wrench
float64[] task_precision
```

1. Publish inputs

Variable Impedance Modulation



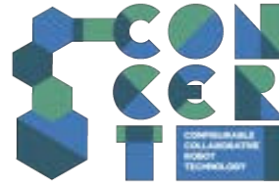
```
float64[] robot_stiffness
float64[] robot_damping
float64[] robot_feedforward_torque
```

2. Subscribe outputs

Every Iteration!



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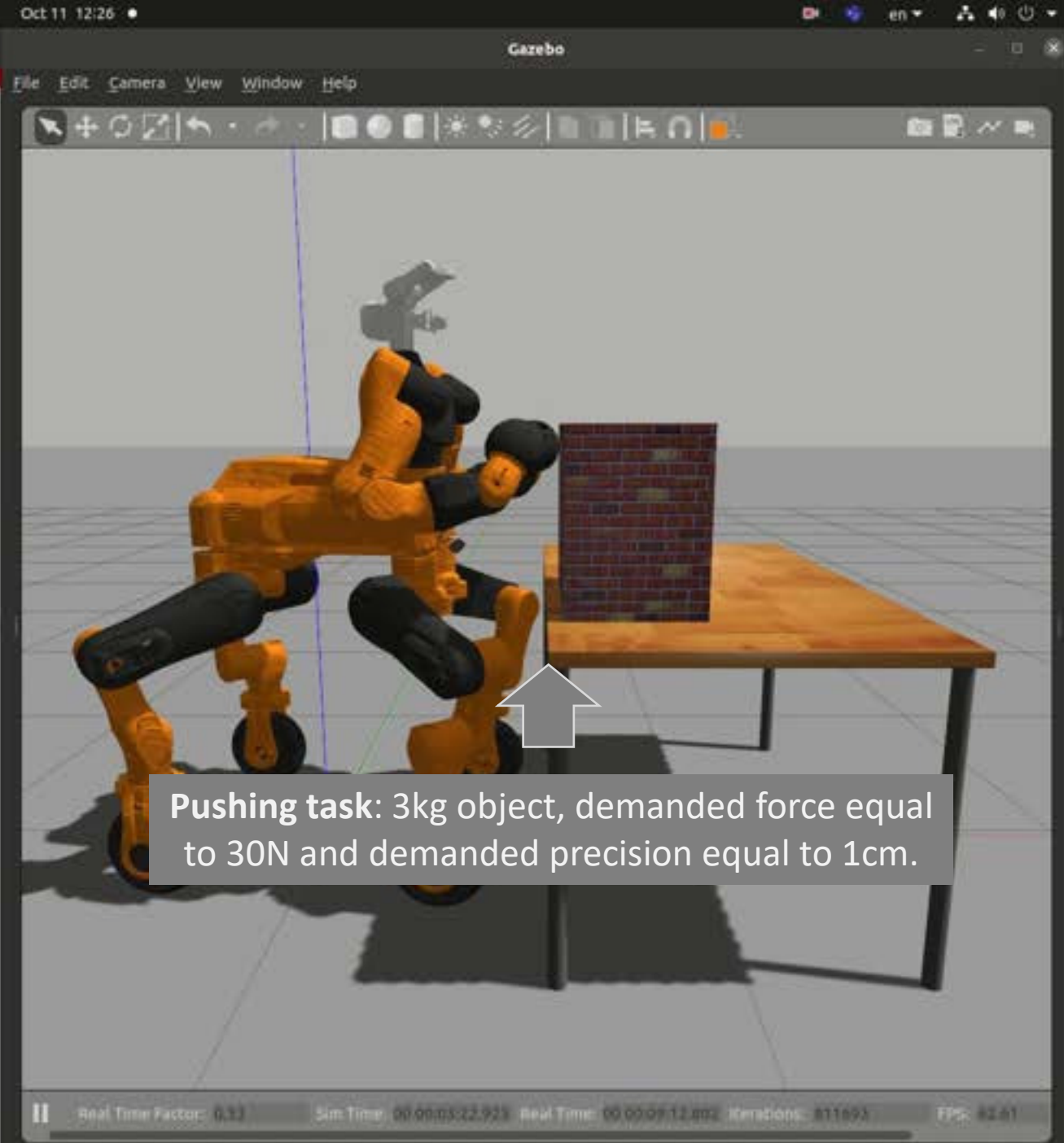
How the package works

```
lliana@lliana-M5-7820: ~/catkin_ws
lliana@lliana-M5-7820: ~/ros2_ws 94x27
lliana@lliana-M5-7820: ~/ros2_ws $ ros2 launch rim impedance_modulation_centauro.launch.py
```

Ros2 node: variable impedance modulation

```
lliana@lliana-M5-7820: ~/ros2_ws 94x27
lliana@lliana-M5-7820: ~/ros2_ws $ ros2 launch utility_nodes task_planner_centauro.launch.py
```

Ros2 node: task planner



Pushing task: 3kg object, demanded force equal to 30N and demanded precision equal to 1cm.



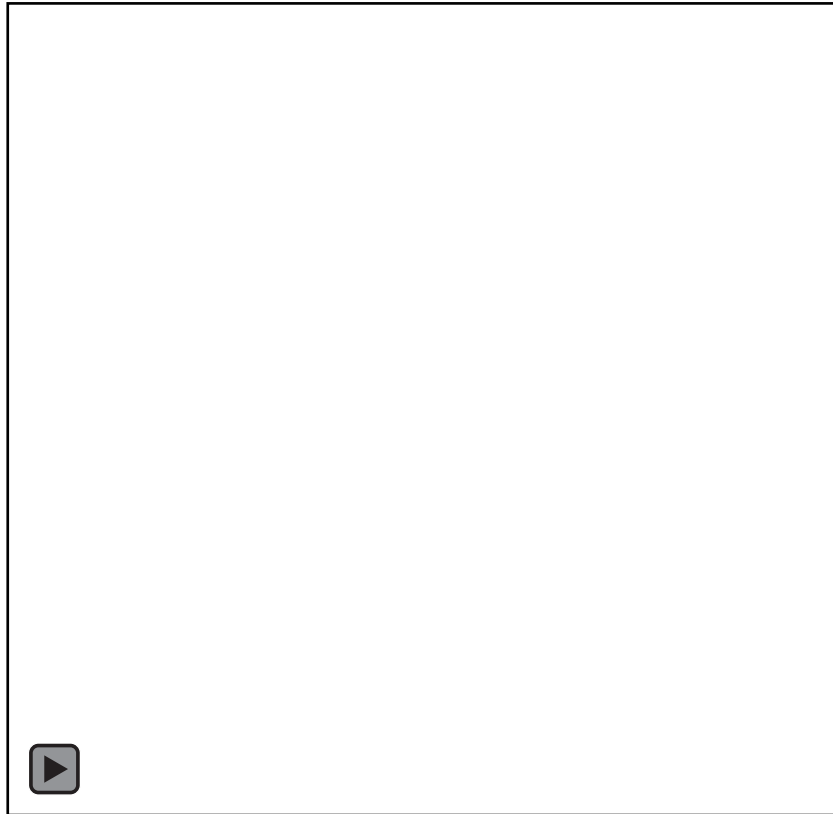


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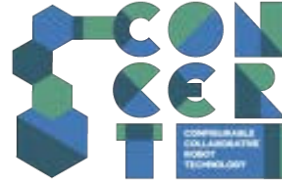
Centauro



pushing

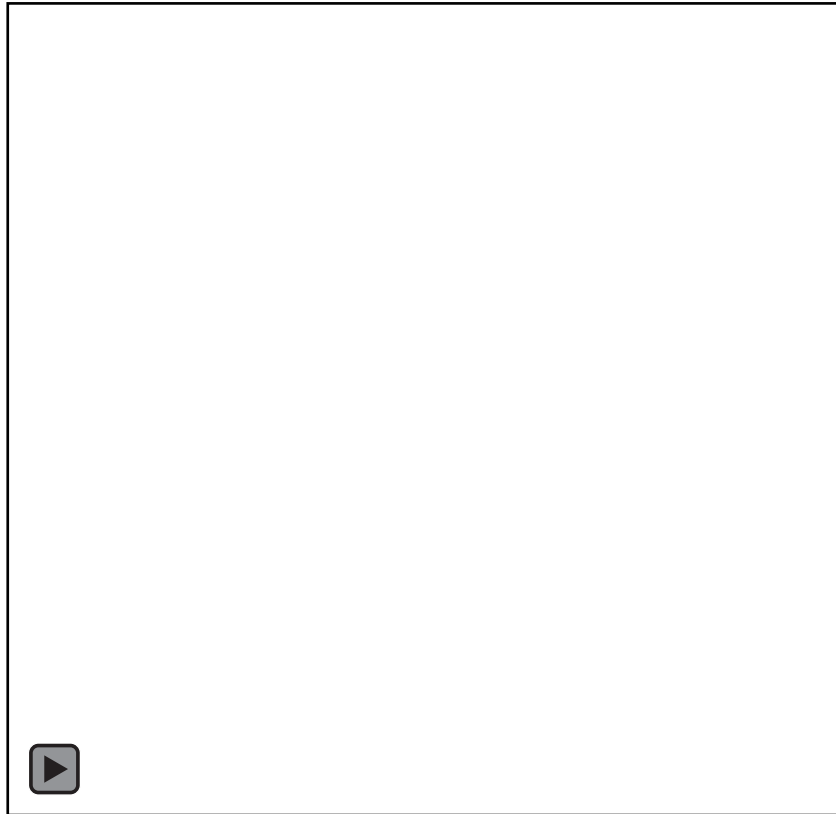


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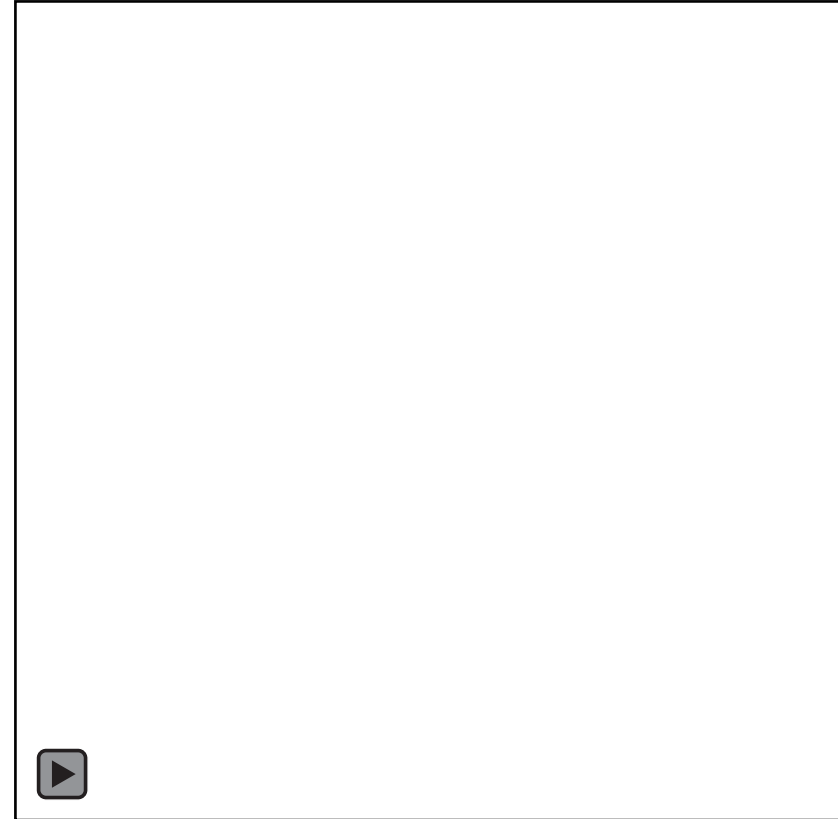
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Centauro

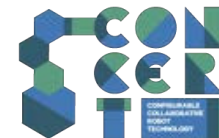


pushing

Concert

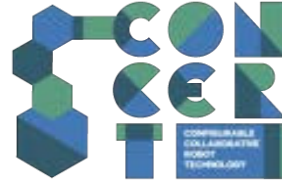


drilling





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Inail 2 arm

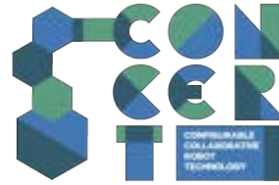


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ROS2



readme

- **Source code**

<https://github.com/ADVRHumanoids/RobotImpedanceModulation>

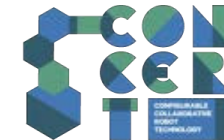
- **Documentation/Instructions**

<https://github.com/ADVRHumanoids/RobotImpedanceModulation>

- **Projects**

CONCERT: <https://concertproject.eu/>

HARIA: <http://haria-project.eu/>



- **Publications**

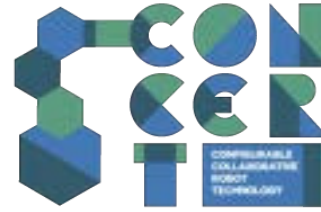
“Bertoni, Liana, et al. "Task Driven Online Impedance Modulation." *2022 IEEE-RAS 21st International Conference on Humanoid Robots (Humanoids)*. IEEE,2022”
<https://ieeexplore.ieee.org/abstract/document/10000215>

“An Assistive Human-Robot Bi-Manual Co-Manipulation System for Subjects with Upper Limb Motion Deficiencies” (ICRA submitted)





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THANK YOU FOR YOUR ATTENTION!

ANY QUESTIONS?

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