The Industrial Trajectory Generation and Python API of pilz_industrial_motion

https://wiki.ros.org/pilz_robots

MoveIt Workshop 2019
Macau, November 2nd 2019

Christian Henkel
Advanced Development

- **Two talks**

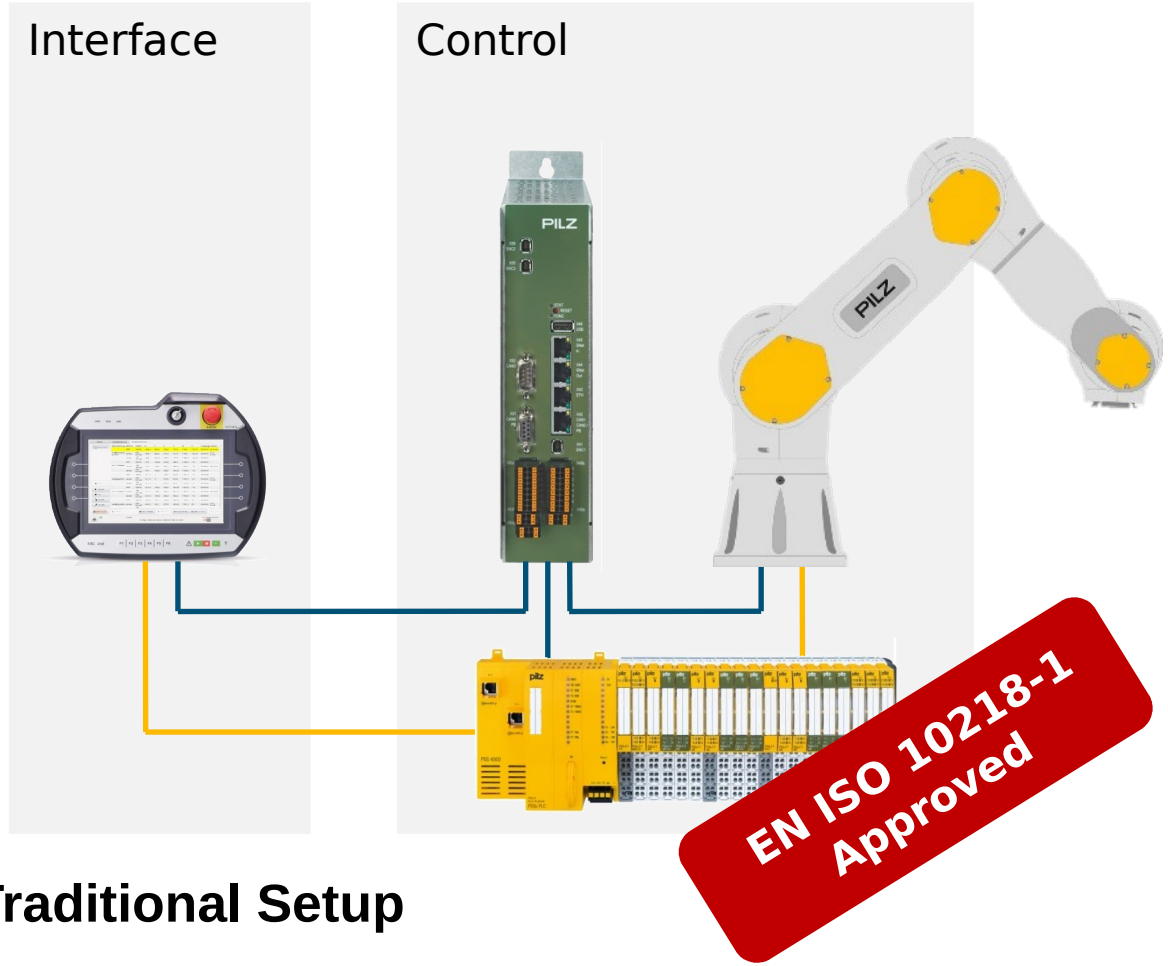
`pilz_robots`
  Drivers
  Hardware Support

  → ROScon

`pilz_industrial_motion`
  Planner
  API

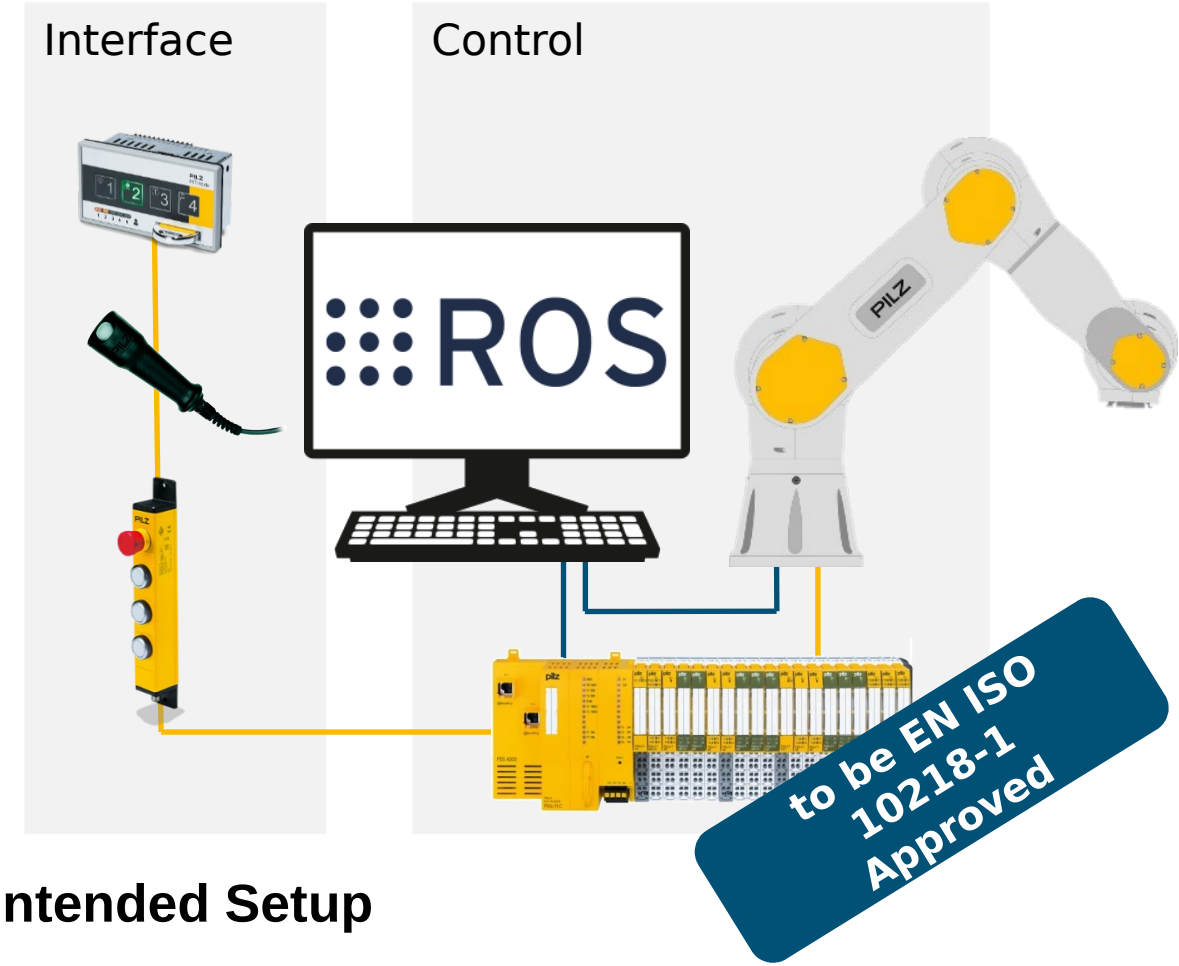
  → **NOW**

Recap of „Safety Certified ROS-native Industrial Manipulator“ @ ROSCon



Traditional Setup

ROS would be merely an afterthought



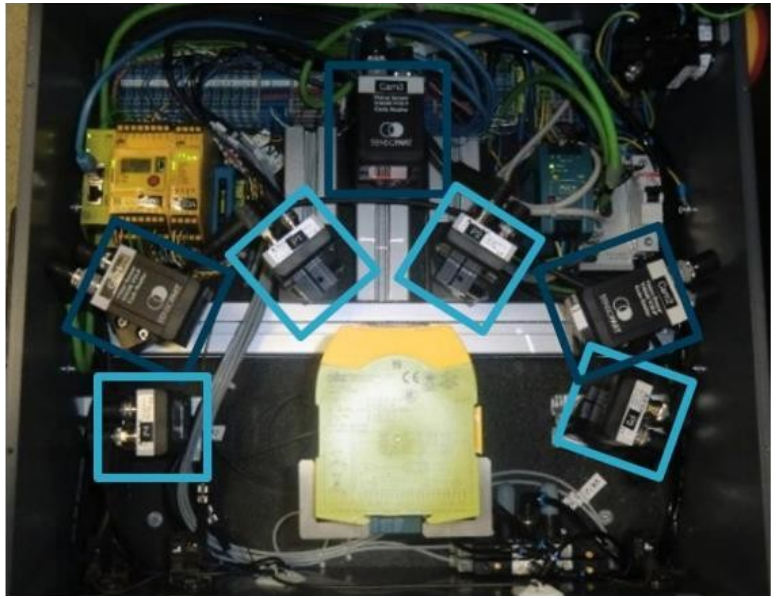
Intended Setup

ROS as core component

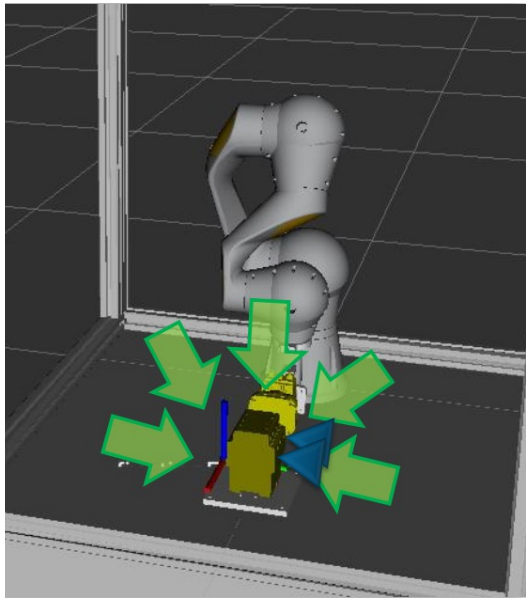
Example Application: Visual Inspection

- *Task:* Inspect part features for large number of product variants
- *Approach:* Robot on-board camera supported on database to lookup poses and save results
- Strengths of ROS:
  - High-level control based on the adaption of State-Machine packages
  - Interface with other software components
  - Use of workspace based (OMPL) and deterministic (pilz_industrial_motion) motion planners

Current Setup



Inspection Poses



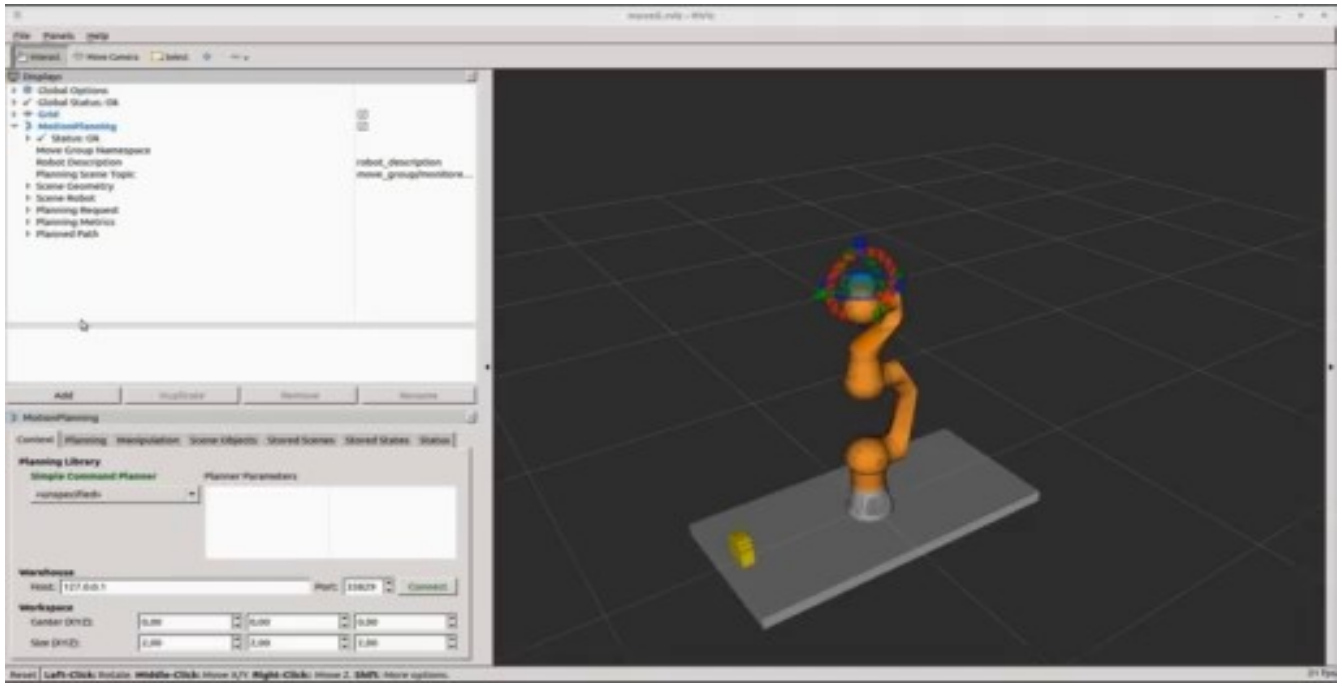
Demo Setup

Machine setup

FTP Industrial Trajectory Generation for MoveIt!

Goal:

- Reproducible trajectories (PTP, LIN, CIRC)
- Fast computation
- Easy-to-use interface
  - Motion from RViz
  - Programming with Python API
  - Tutorials



Working for every robot which has a moveit_config.

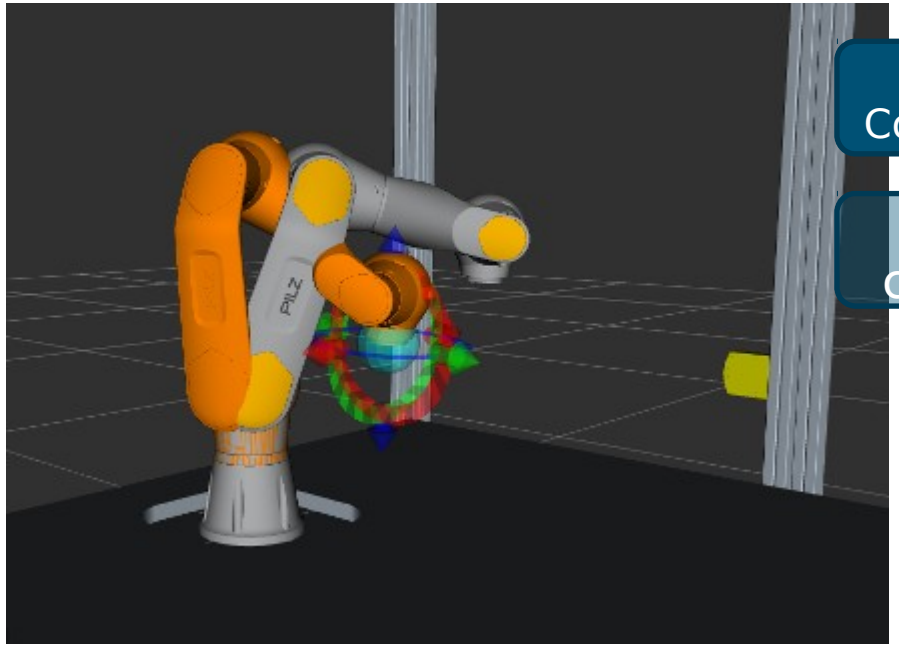
Supported by ROSIN - ROS-Industrial Quality-Assured Robot Software Components. More information: rosin-project.eu

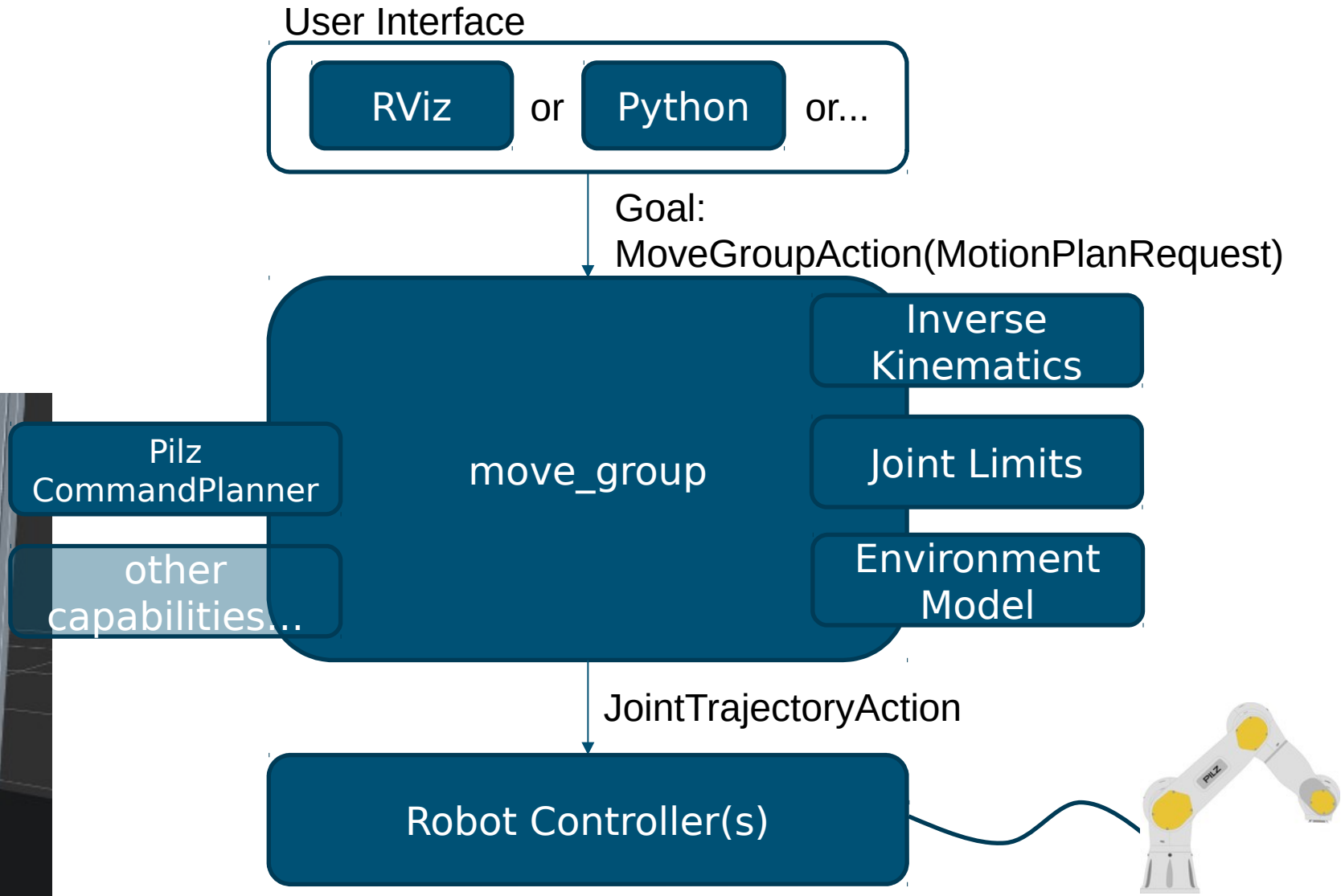
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 732287.

Strengths of MoveIt!

The framework combines

- Kinematics module(s)
- Collision checking with the environment model
- Trajectory execution





Motion Types

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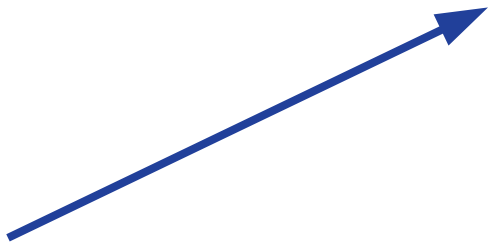
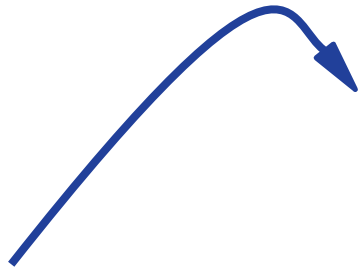
LIN

Linear intrapolation
in cartesian space



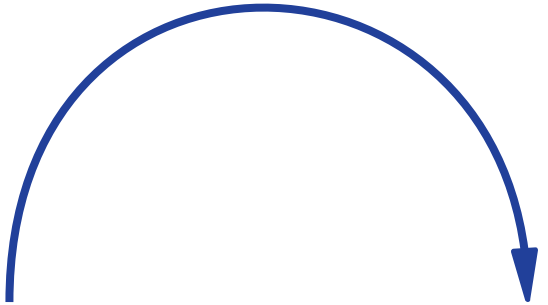
PTP

Linear intrapolation
in joint space



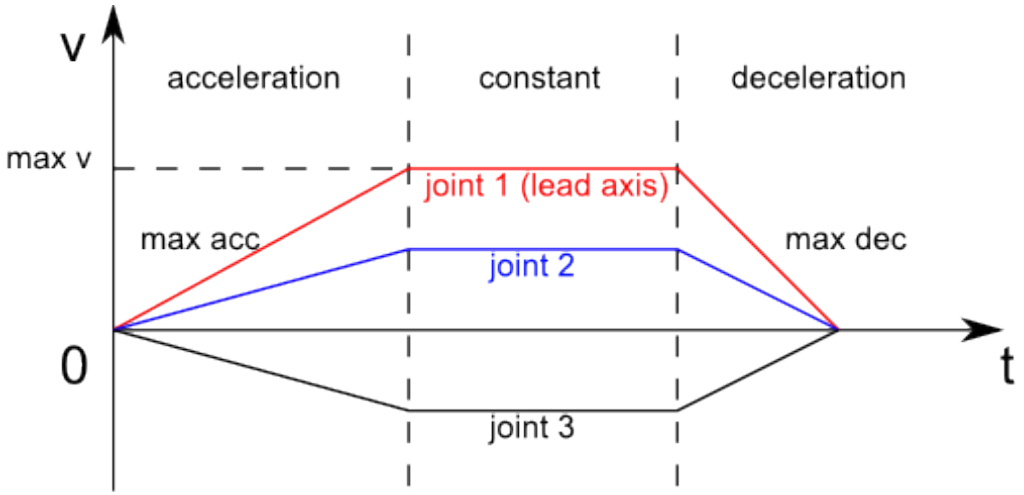
CIRC

Circular intrapolation
in cartesian space



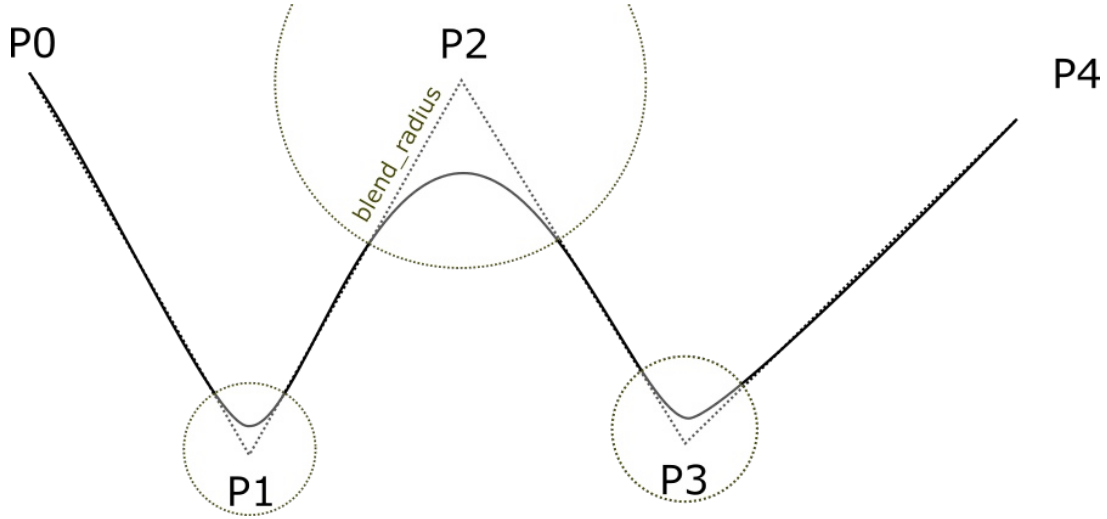
Pilz CommandPlanner

- Trapezoidal velocity profiles



- Collision checking (no avoidance)

- Blend combines a sequence of commands:
  e.g. LIN-LIN



User-Interface: Python-API

- Easy-to-use
- Versioning
- Move Command
- Reference Poses or Joint Values
- Relative Motions
- Sequences with Blending

```
r = Robot(__REQUIRED_API_VERSION__)

# Simple ptp movement
r.move(Ptp(goal=[0, 0.5, 0.5, 0, 0, 0], vel_scale=0.4))

start_joint_values = r.get_current_joint_states()

# Relative ptp movement
r.move(Ptp(goal=[0.1, 0, 0, 0, 0, 0], relative=True, vel_scale=0.2))
r.move(Ptp(goal=Pose(position=Point(0, 0, -0.1)), relative=True))
r.move(Ptp(goal=[-0.2, 0, 0, 0, 0, 0], relative=True, acc_scale=0.2))
```

```
sequence = Sequence()
sequence.append(Lin(goal=Pose(position=Point(0.2, 0, 0.8)), vel_scale=0.1, acc_scale=0.1))
sequence.append(Circ(goal=Pose(position=Point(0.2, -0.2, 0.8)), center=Point(0.1, -0.1, 0.8), acc_scale=0.4))
sequence.append(Ptp(goal=pose_after_relative, vel_scale=0.2))
```

https://github.com/PilzDE/pilz_industrial_motion/blob/melodic-devel/pilz_robot_programming/examples/demo_program.py

With a focus on quality

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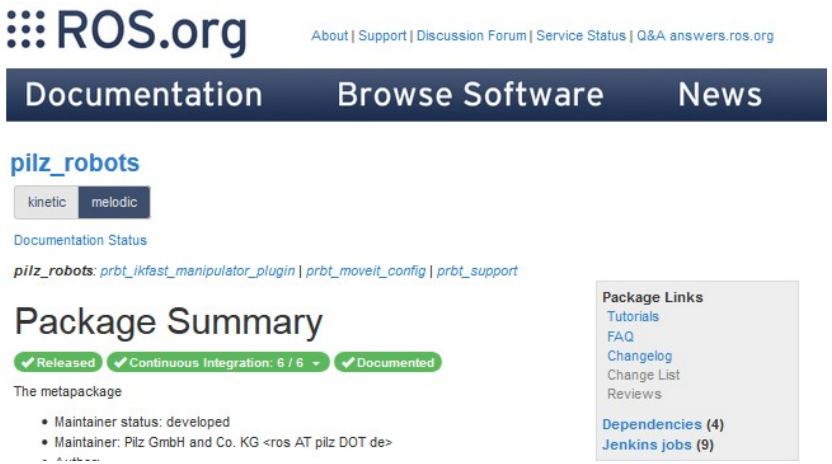
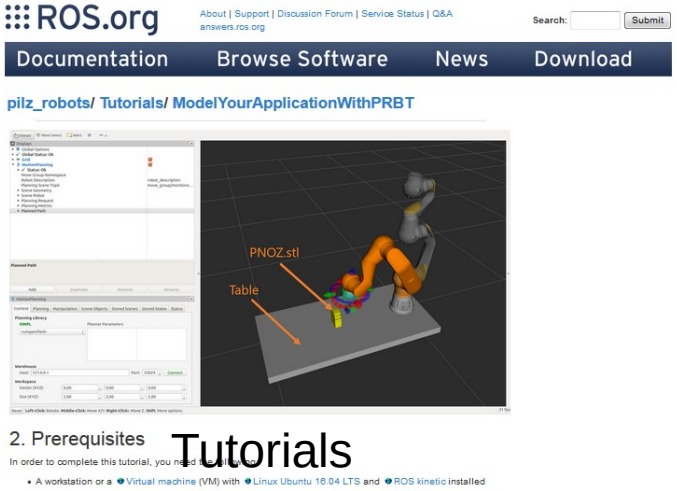
Documentation

- Overview on wiki.ros.org/pilz_robots
- Tutorials
- API-Documentation

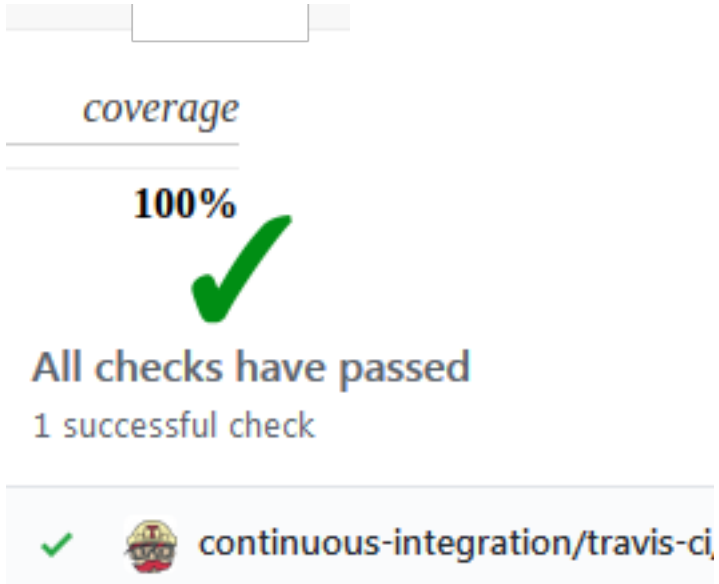
Tests

- Unit- and Integration tests (Travis-CI-Integration)
- ~100% code coverage





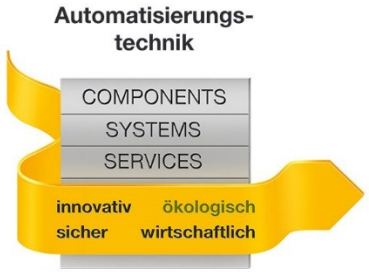
Tutorials



Summary / Outlook

- Industrial Trajectory Generation
  - LIN, PTP, CIRC
  - Blending
- Python API
  - Easy to use
  - Versatile

- Example using two planners
  - ompl + Pilz
  - LIN to approach
  - ompl in free space
- MoveIt 2.0 !
- World MoveIt Day



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Please visit
https://github.com/pilzde/pilz_robots
https://github.com/pilzde/pilz_industrial_motion

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