University of Ljubljana
Faculty of Electrical Engineering

COLLABORATIVE ROBOTICS CENTRE

robolab

Vodenje robotov – ROS
ROS CONTROL

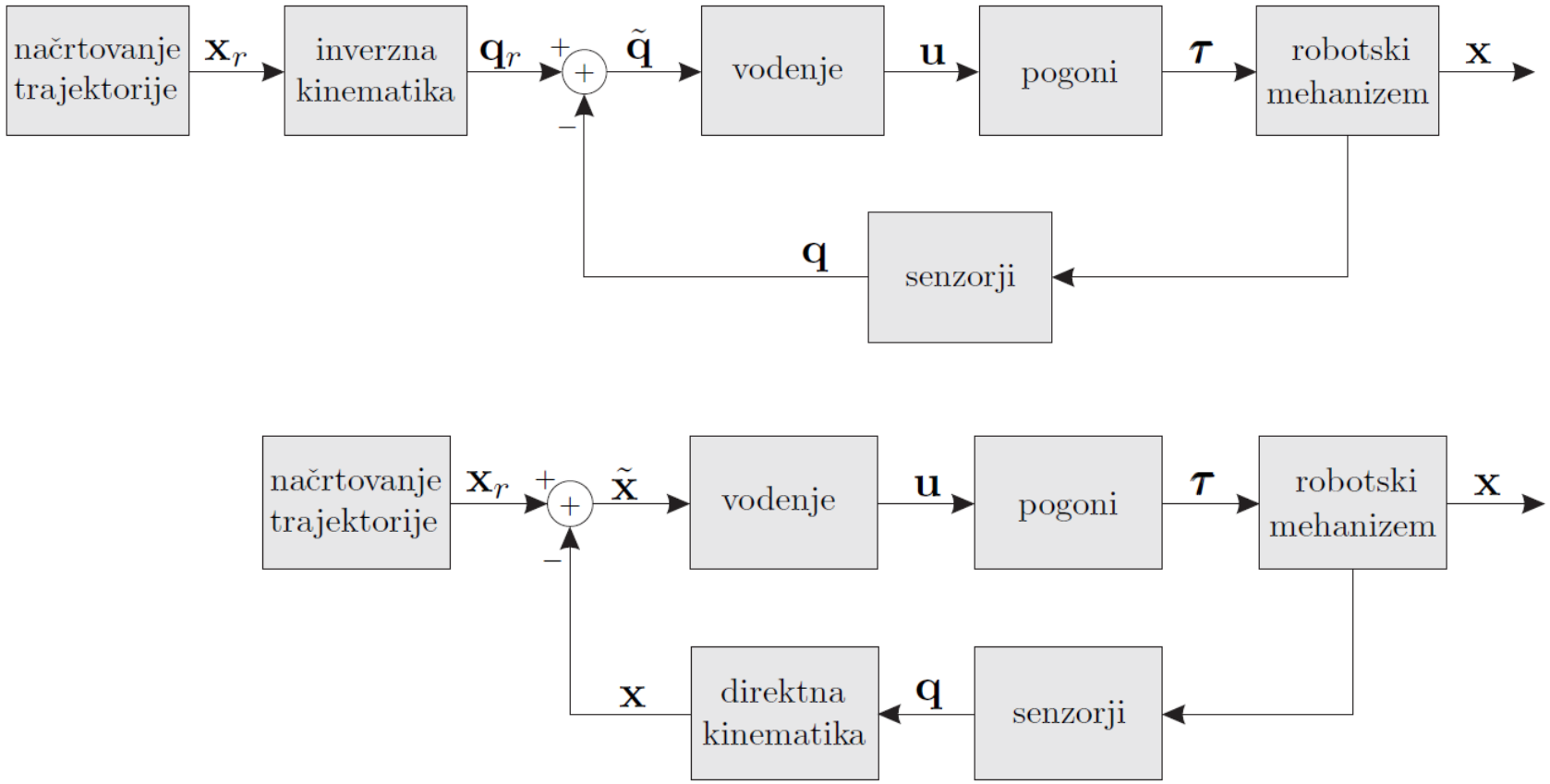
Sebastjan Šlajpah

Univerza v Ljubljani
Fakulteta za elektrotehniko
Laboratorij za robotiko

sebastjan.slajpah@fe.uni-lj.si

www.robolab.si
www.cobotic.si

Vodenje robotov



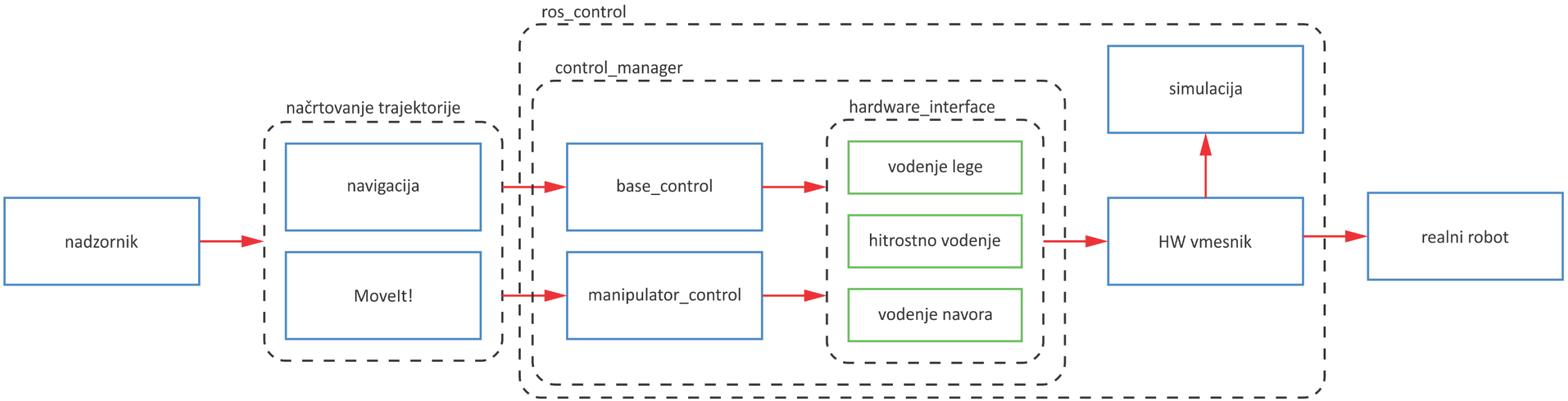
ros_control

- pošiljanje ukazov sklepom robota
- vodenje sklepov

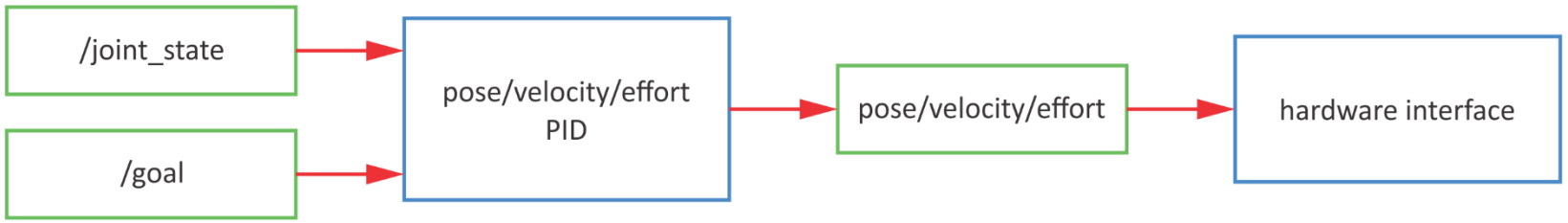
Paket `ros_control` zajema:

- controller interfaces
- controller managers
- transmissions
- hardware_interfaces
- control_toolbox

ros_control


ros_control
control_manager
načrtovanje trajektorije
hardware_interface
nadzornik
navigacija
MoveIt!
base_control
manipulator_control
vodenje lege
hitrostno vodenje
vodenje navora
simulacija
HW vmesnik
realni robot

ros_control


/joint_state
/goal
pose/velocity/effort
PID
pose/velocity/effort
hardware interface

ROS regulatorji

- **effort_controllers:**
  - joint_effort_controller
  - joint_position_controller
  - joint_velocity_controller
- **position_controllers:**
  - joint_position_controller
- **velocity_controllers:**
  - joint_velocity_controller

- **joint_state_controller:**
  - joint_state_controller (`/joint_states`)

- **joint_trajectory_controllers:**
  - position_controller
  - velocity_controller
  - effort_controller
  - position_velocity_controller
  - position_velocity_acceleration_controller

Hardware interface

programski vmesnik med regulatorjem in strojno opremo (Hardware Abstraction Layer – HAL)

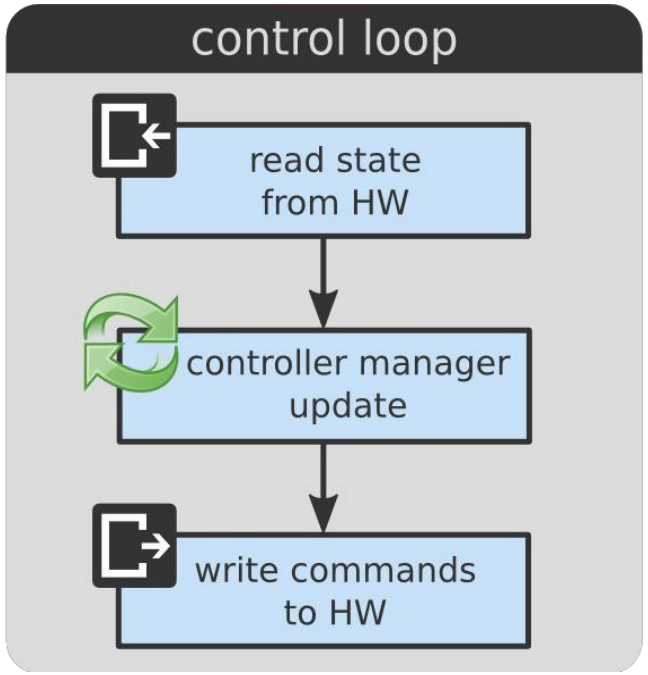
- **Joint Command Interface:**
  - omogoča pošiljanje regulirane veličine na aktuator
  - *Effort Joint Interface*
  - *Velocity Joint Interface*
  - *Position Joint Interface*

- **Joint State Interfaces:**
  - omogoča branje stanja sklepov (pozicija/hitrost/sile oz. navori)

ROS regulacijska zanka

```
main(){
    MyRobot robot;
    controller_manager::ControllerManager cm(&robot);

    while(true){
        robot.read();
        cm.update(robot.get_time(), robot.get_period());
        robot.write();
        sleep();
   }
}
```



URDF – Transmissions

povezava med sklepom in aktuatorjem

```
<transmission name="tran1">
   <type>transmission_interface/SimpleTransmission</type>
   <joint name="joint1">
      <hardwareInterface>EffortJointInterface</hardwareInterface>
   </joint>
   <actuator name="motor1">
      <hardwareInterface>EffortJointInterface</hardwareInterface>
      <mechanicalReduction>1</mechanicalReduction>
   </actuator>
</transmission>
```

Gazebo

```
<!-- ros_control plugin -->
<gazebo>
   <plugin name="gazebo_ros_control" filename="libgazebo_ros_control.so">
      <robotNamespace>/ime_robota</robotNamespace>
      <robotSimType>gazebo_ros_control/DefaultRobotHWSim</robotSimType>
   </plugin>
</gazebo>
```

`DefaultRobotHWSim` omogoča:

- JointStateInterface
- EffortJointInterface
- PositionJointInterface
- VelocityJointInterface

Konfiguracija regulatorjev

/config/my_robot_control.yaml

```
ime_robota:
   joint_state_controller:
      type: joint_state_controller/JointStateController
      publish_rate: 50

   joint1_position_controller:
      type: effort_controllers/JointPositionController
      joint: joint1
      pid: {p: 100.0, i: 0.01, d: 10.0}
```

.launch datoteka

/launch/my_robot_launch.launch

```
<launch>
  <rosparam file="$(find ime_paketa)
/config/my_robot_control.yamI"
            command="load"/>
  <node name="controller_spawner"
        pkg="controller_manager"
        type="spawner"
        respawn="false"
        output="screen"
        ns="/ime_robota"
        args="joint1_position_controller
              joint2_position_controller
              joint_state_controller"/>
  <node name="robot_state_publisher"
        pkg="robot_state_publisher"
        type="robot_state_publisher"
        respawn="false"
        output="screen">
    <remap from="/joint_states„
           to="/ime_robota/joint_states"/>
  </node>
</launch>
```

controller_spawner

- zažene dva *joint position* regulatorja s *service* klicem na *ros_control controller manager*
- zažene tudi *joint state* regulator, ki pošilja na topic `/joint_states` trenutno stanje sklepov

```
>> rostopic list
    /ime_robota/joint1_position_controller/command
    /ime_robota/joint1_position_controller/pid/parameter_descriptions
    /ime_robota/joint1_position_controller/pid/parameter_updates
    /ime_robota/joint1_position_controller/state
    /ime_robota/joint_states
```

rqt

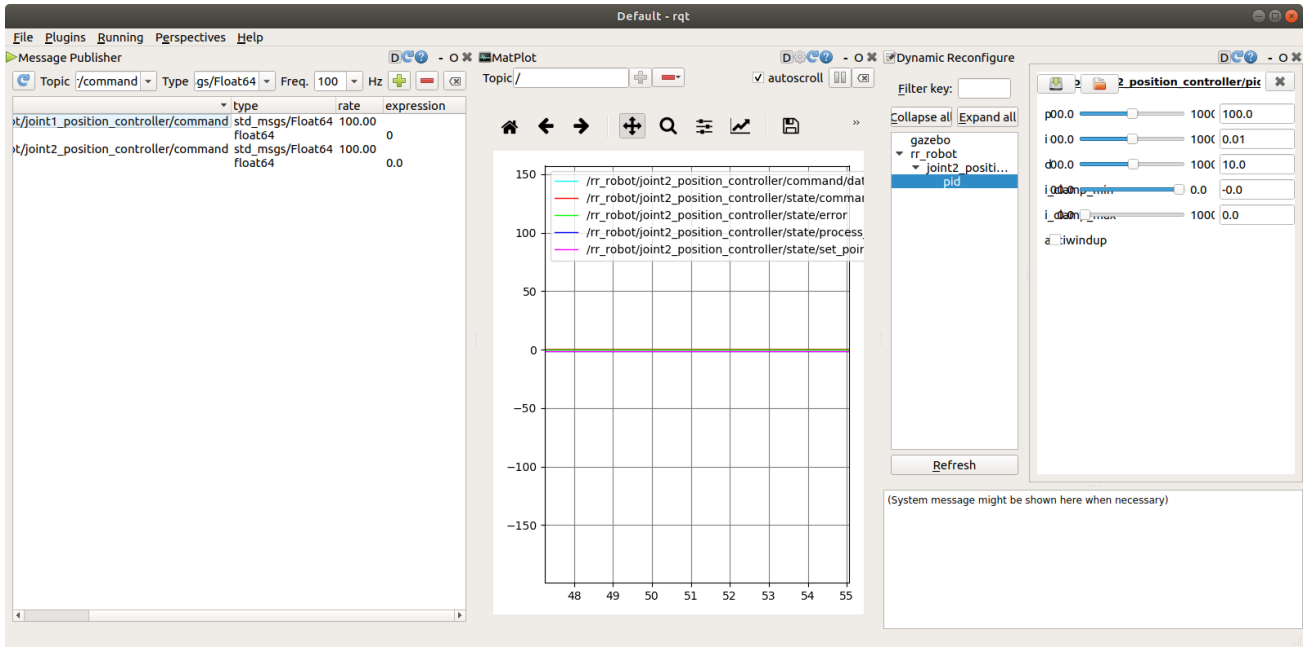
- Plugins > Topics > Message Publisher

- Plugins > Visualisation > Plot
  - Referenca:

    `controller/command`
  - Dejanska vrednost:

    `controller/state/process_value`
  - Regulirana veličina:

    `controller/state/command`



- Plugins > Configuration > Dynamic Reconfigure

joint_trajectory_controller

/config/trajectory_controller.yaml

/urdf/rr2_robot.urdf

/launch/rr_trajectory_launch.launch

rqt > Robot Tools > Joint Trajectory Controller