# TEK4030 - Assignment 3

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# Project 1 - Motion control

In this project the task was to simulate the CrustCrawler in Gazebo and implement joint space PD control with gravity compensation.
I used the attached packages to run a base Gazebo simulation of the CrustCrawler.

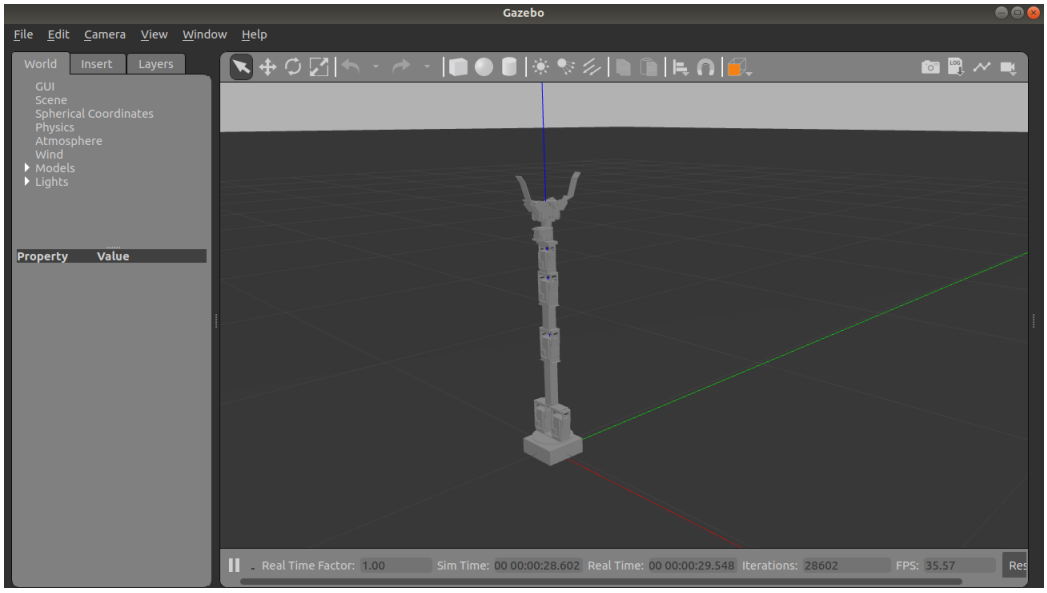


Figure 1: View of bare minimum CrustCrawler simulation

I have made a launch file that launches the base Gazebo simulation with the CrustCrawler gripper enabled and using effort control. Then it launches a setpoint node and a control node. Launch signature:

```
$ roslaunch motion_control pd_gravity_controller.launch
```

## Nodes

To control the robot I made two nodes; a setpoint node publishing desired joint-angles, called **setpoint_node**, and a control node, called **pd_gravity_controller** subscribing to the desired joint angle and publishing control commands to CrustCrawler joints.

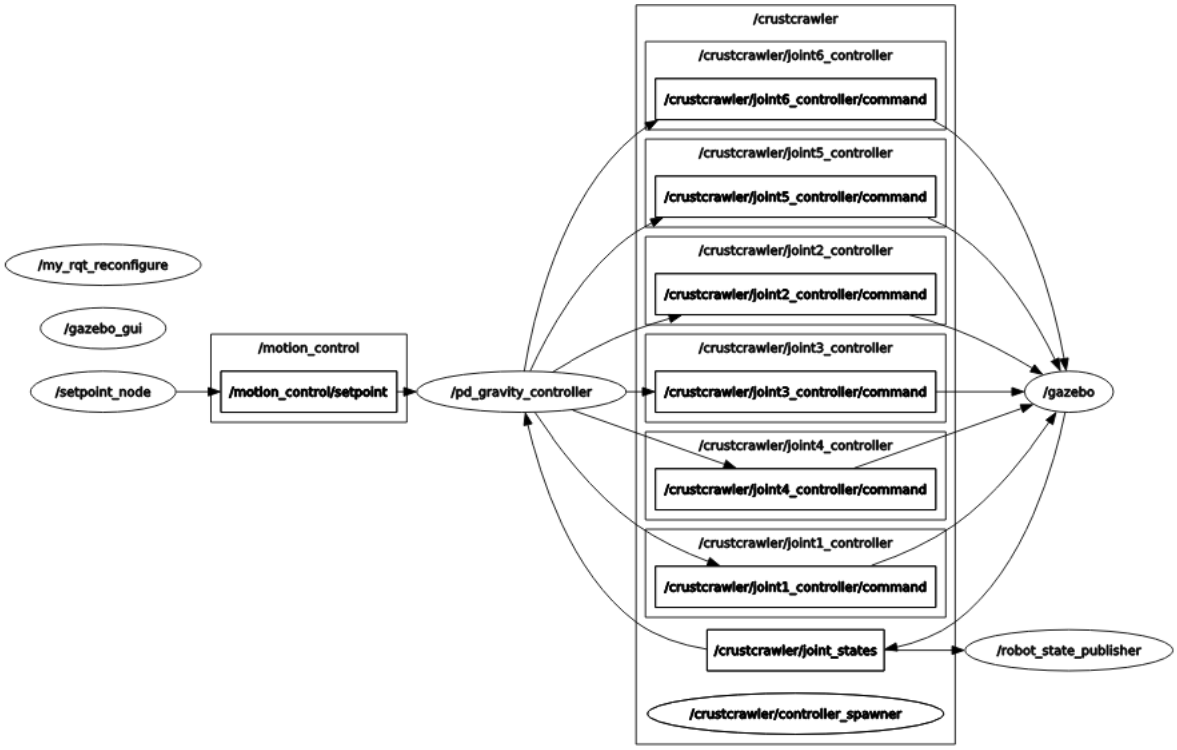


Figure 2: rqt_graph view of nodes and topics

## Control law

The control law for joint space PD control with gravity compensation is as follows

$$u = g(q) + K_P\tilde{q} - K_D\dot{q}$$

This is implemented in **pd_gravity_control** node, updating the control input when it receives updated joint-states ($q$ and $\dot{q}$) from Gazebo-simulator. The gravity term is calculated using the *crustcrawler_lib* package, and the $K_P$ and $K_D$ terms are provided by the **pd_gravity_control** node.

## Dynamic reconfiguration of control parameters and desired joint angle

The controller and setpoint node supports dynamic reconfiguration of $K_P$, $K_D$ and desired joint angle of joint-2. Using the controllers launch-file it will launch a rqt_reconfigure window where one can reconfigure control parameters and joint-angle.

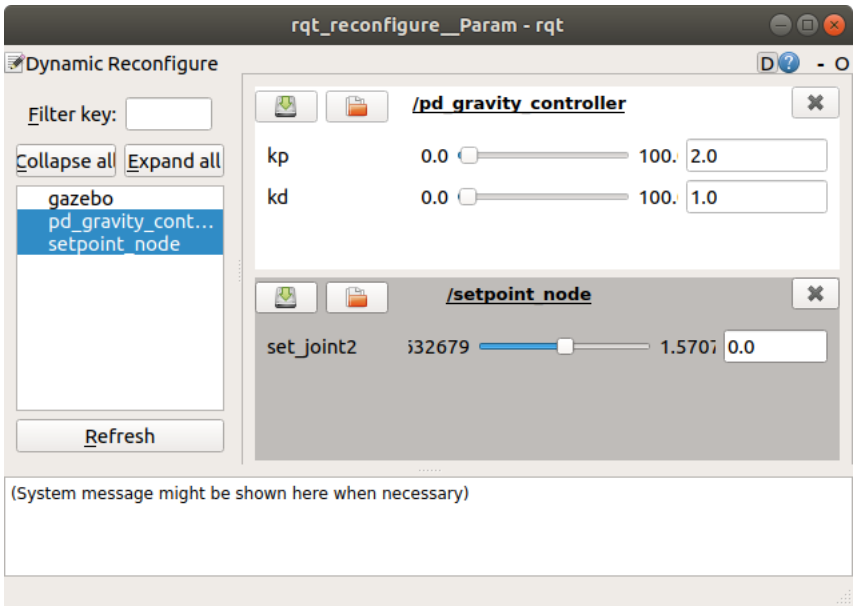


Figure 3: Reconfiguration of parameters

## Testing control parameters

In my implementation it is only desired angle of joint 2 that is changed, while all the other joints have set desired joint angle to 0.
Some good values of the control parameters was $K_P = 100$ and $K_D = 40$

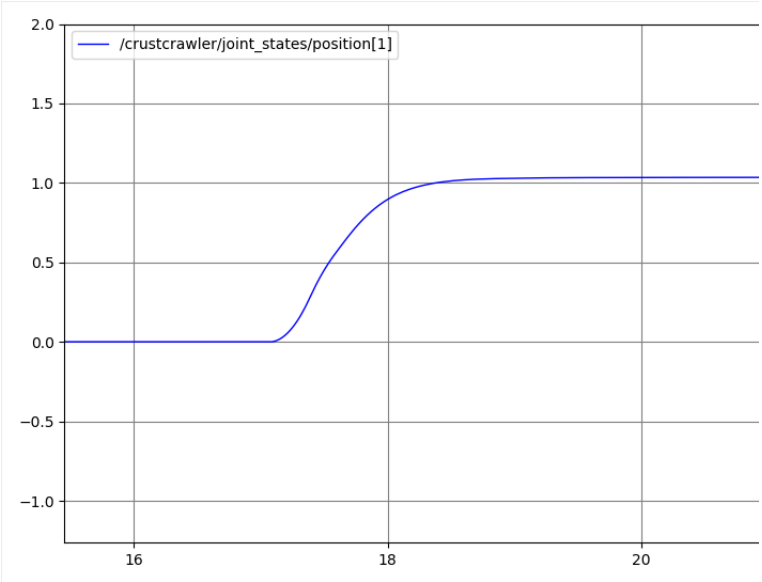


Figure 4: Step response from $\theta_{d_2} = 0$ to $\theta_{d_2} = 1$