# Exercise Session 4

Theory

- ROS bag
- ROS time
- rqt_multiplot
- ROS launch
- RViz

Exercise

The goal of this exercise is to work with data that was recorded on a real robot. The recorded bag file contains sensor measurements from wheel odometry, inertial measurement unit (IMU) and laser scanner. Your task is to use this raw sensor data to localize the robot with a provided state estimation node that implements an extended Kalman filter (EKF). The same localization node is already running if you launch the SMB simulation. To see the results, plot the output of the localization node using rqt Multiplot and visualize the laser data in RViz.
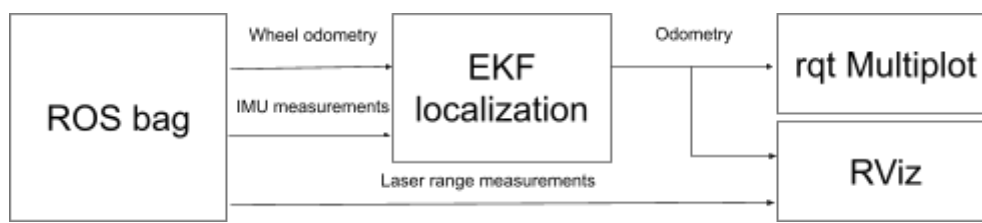

1. Start the launch file from the last exercise (or Ex2). Check what the node `/ekf_localization` is doing. What is it subscribing to and what is it publishing? Visit http://docs.ros.org/melodic/api/robot_localization/html/index.html for further information.

2. Launch your controller from the last exercise. Use *rqt_mulitplot* (Lecture 3, Slide 13) to plot the path of the simulated robot in the *x*/*y*-plane (Tip: use the topic `/odometry/filtered`).

3. Download the provided rosbag `smb_navigation.bag` from the course website and investigate the content with the command `rosbag info`.

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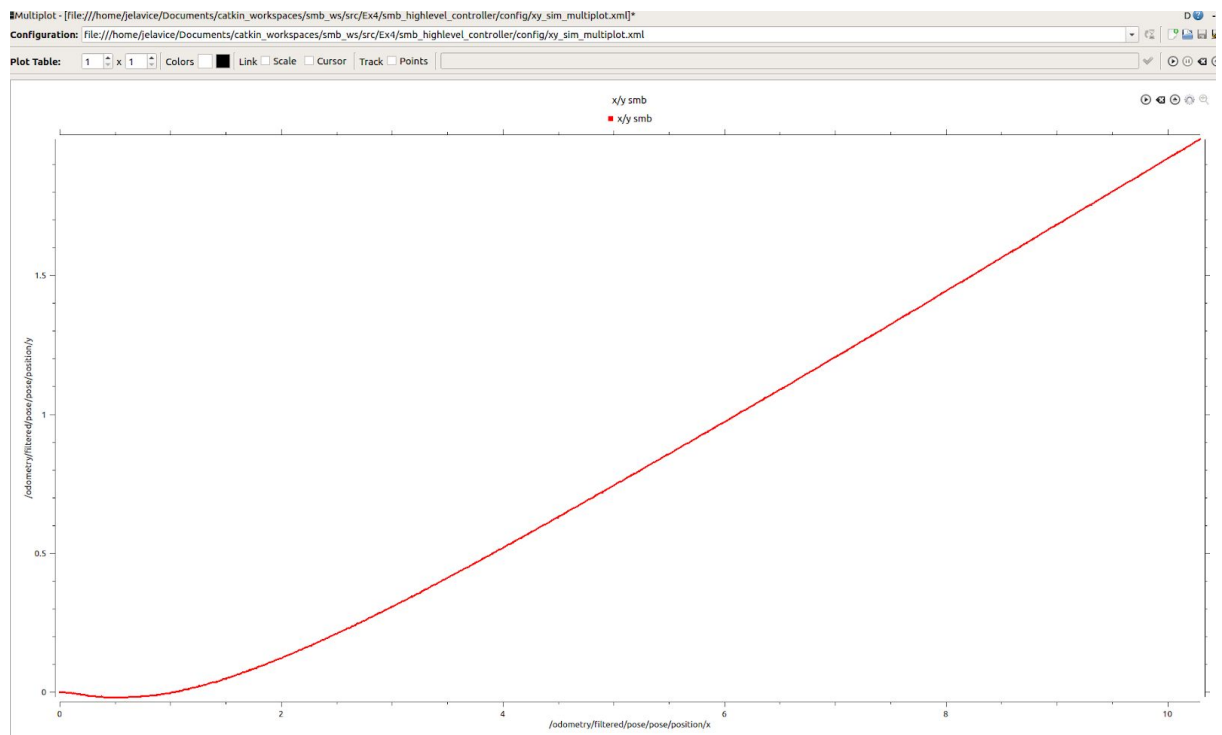
X-Y plot of path traversed when driving into the pillar.

4. Write a launch file that starts an `ekf_localization_node` subscribing to the topics provided in the rosbag file. Load the parameters from the same config file as it is done by the simulation (Tip: The config file `localization.yaml` can be found with `roscd smb_control/config`).

5. Use `rqt_mulitplot` to plot the path of the recorded robot in the *x/y*-plane.
   ○ Tip: Remember to set the parameter `/use_sim_time` to `true`: http://wiki.ros.org/Clock. (Lecture 4, Slide 16)
   ○ Tip: Play the bag-file with: `rosbag play mydata.bag --clock` which also publishes the time of the recorded data http://wiki.ros.org/rosbag/Commandline. (Lecture 4, Slide 16)

6. Visualize the motion of smb by using TF markers in RViz. Add a `robot_state_publisher` node to your launch file and load the smb robot description to the parameter server. Now you can visualize the smb model in RViz. (Tip: Use the `control.launch` file from the `smb_control` package as reference). Note: The wheels jump behind the robot body a bit, but that is okay.

7. The rosbag also contains laser data from a Velodyne LiDAR. Visualize the point cloud in RViz. It should be moving with the robot.

8. Add a frame that will hover 2 m above the SMB and move together with the robot. The frame should be named *smb_top_view* and it should be situated 2m above the *base_link* frame. Do this for the recorded SMB.

○ Tip: there are multiple ways of doing this. One easy way to do so is to use the `static_transform_publisher`. Start the static tf publisher from your launch file. (see http://wiki.ros.org/tf, section 6.3)

9. [OPTIONAL] Include rosbag playing into your launch file and play it at 50% of the nominal speed (slower than nominal).
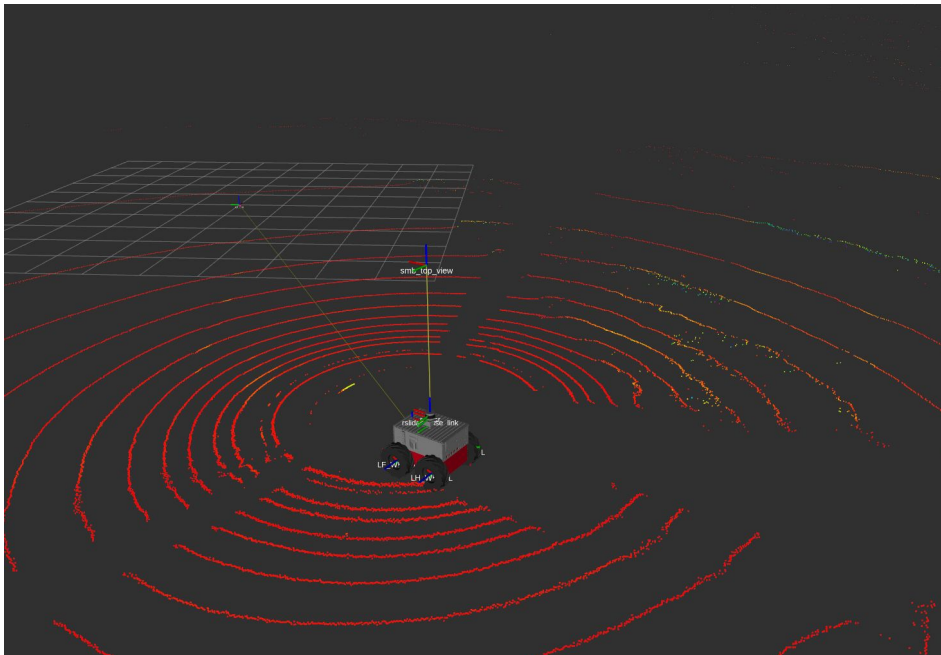
Smb Visualization with point cloud from Velodyne LiDAR. Note the frame *smb_top_view* hovering above the smb.

Evaluation

❏ Explain what the `ekf_localization_node` node is doing. [10%]
❏ Answer which topics and message types are recorded inside the rosbag smb_navigation.bag. How did you find that out? [10%]
❏ Plot the *x/y*-plane of the simulated SMB in `rqt_multiplot`. [20%]
❏ Plot the *x/y*-plane of the recorded SMB in `rqt_multiplot`. [30%]
❏ Visualize the 3D point cloud from Velodyne LiDAR in RViz.
   ❏ Visualize the point cloud [10%]
   ❏ Change the color transformer to AxisColor and Z axis. Set the point size to 0.05 m [10%]
❏ Is the frame *smb_top_view* above the robot? Is it moving together with the robot in rviz when the rosbag is played? [10%]
❏ Run the rosbag playing from the launch file. [Bonus 5%]
❏ Play it at 50% of the nominal speed. [Bonus 5%]

Note that all the functionally must be implemented inside the class and not in the main() function where the class is instantiated. You will lose 20% points if you don't adhere to this rule.