Sheet 3
Robot Control

Group 4
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Exercise 1

a) Specify the control law of a PID controller

$$u(t) = K_P \; e(t) + K_D \; \dot{e}(t) + K_I \int_{-\infty}^{t} e(t)\, dt$$

with $e(t) = x_{desired} - x_{actual}$.

b) Define how the error integral can be computed in the discrete case

$$\begin{aligned} e_{I,t} &= e_{I,t-1} + e_t \Delta t. \\ \text{with} & \\ e_{I,0} &= 0. \end{aligned}$$

c) Define a formula for the discrete error derivative

$$e_{D,t} = \frac{e_t - e_{t-1}}{\Delta t}$$

d) Specify the discrete PID control law

$$u_t = K_P \; e_t + K_D \; e_{D,t} + K_I \; e_{I,t}$$

f) Specify how the error signals for each of these controllers can be computed from the current pose and the goal pose

$$\vec{e} = \begin{pmatrix} x_e \\ y_e \\ \psi_e \end{pmatrix}, \vec{x} = \begin{pmatrix} x_x \\ y_x \\ \psi_x \end{pmatrix}, \vec{g} = \begin{pmatrix} x_g \\ y_g \\ \psi_g \end{pmatrix}$$

$$\vec{e} = \vec{g} - \vec{x}$$

$$\begin{pmatrix} x_e \\ y_e \\ \psi_e \end{pmatrix} = \begin{pmatrix} x_g - x_x \\ y_g - y_x \\ \psi_g - \psi_x \end{pmatrix}$$

h) Screenshot of RVIZ

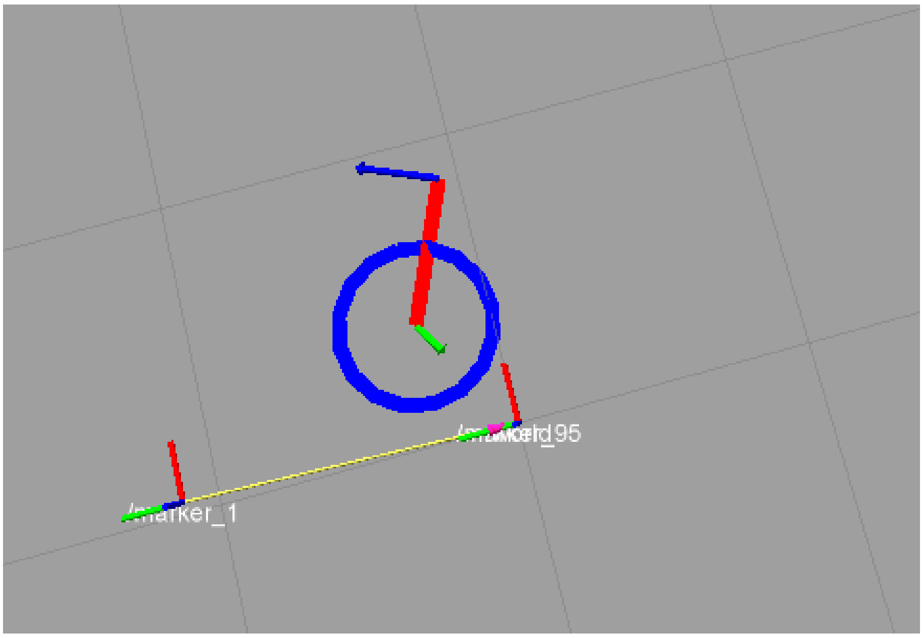

Figure 1: screenshot from RVIZ to indicate the x,y,yaw control command

i) Screenshot of RXPlot

j) Screenshot of RXPlot

Numerical differentiation is very susceptible to measurement errors, making the derivative very noisy.

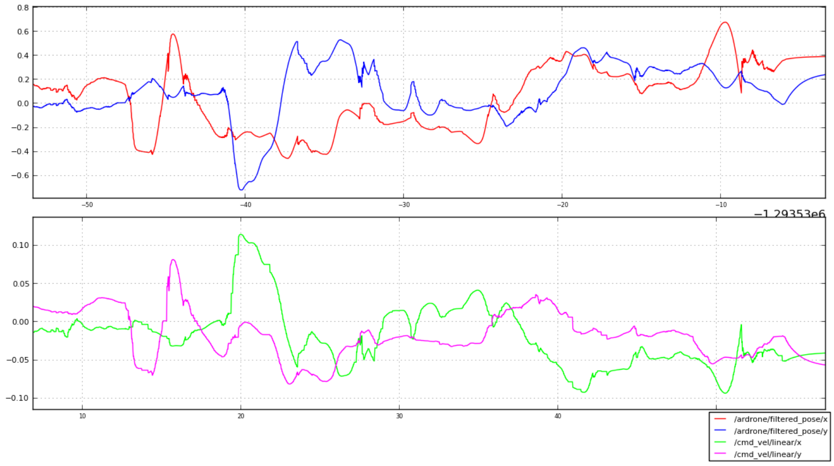

Figure 2: screenshot from RXPlot using the numerical derivative

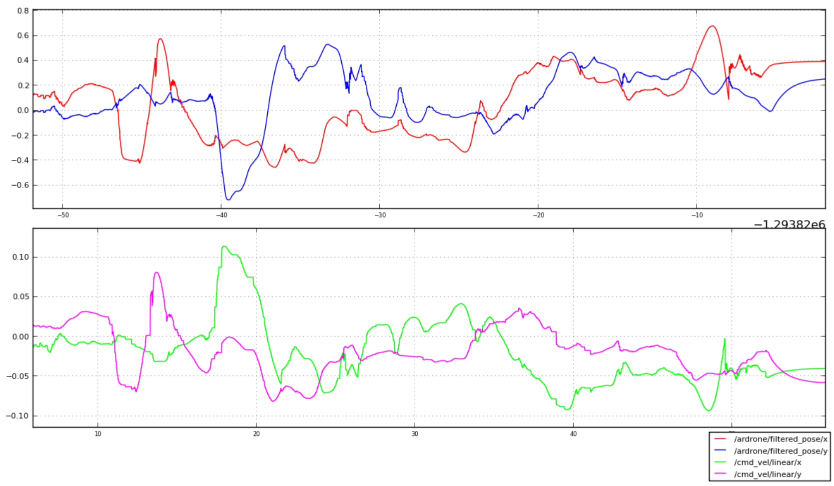

Figure 3: screenshot from RXPlot using the negative velocity

Exercise 2

b) Final PID gains

	P-Gain	I-Gain	D-Gain
x	0.15	0	0.2
y	0.15	0	0.2
ϕ	0.1	0	0.1