Proportional-Derivative (PD) Controller Implementation for Simulated Quadrocopters

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The dynamics for equation of motion of the quadrocopter is as follows:

$$\ddot{z} = \frac{x}{m} - g$$

The PD controller input, u is in the form of:

$$u = m(\ddot{z_{des}} + k_p e + k_v \dot{e} + g)$$

Input u corresponds to the motors thrust. Project goal is to design a PD controller that gives a commands of thrust as an input to the system to achieve 90 percent of rise time $t_r$and 5 percentage or less of overshoot m_p.

k_p is the proportional gain. The higher the number is the more spring like the system becomes. In other words, acts as an capacitor.

k_v is the derivative gain. By increasing the gain, the higher the system will be damped. Can also be viewed as adding resistance to an system. If the system is overdamped there won't be any overshoot.

1 Procedure

Values that can be measured are : $s = [z; v_z]$ and $s_{des} = [z_{des}, v_{zdes}]$. We can get m and g from 'params' struct. $\ddot{z_{des}} = 0$. e by definition is the error term and is defined as $z_{des} - z$ and $\dot{e} = \dot{z_{des}} - \dot{z}$. All the value needed for the control function u are known, need to tune the values of gain to get the desired step response.

Since there are only two gains need to be tuned, set $k_v = 5$ and adjust the values of k_p until we get close to 0.9 at 1s. By inspecting the step response and iterating the values settled with $k_v = 7$ and $k_p = 31$. Below is the step response of the simulation.

Figure 1 shows a reponse of $z = 1$ response. t_r reaches 0.9 in less than a second and m_p is 4.5 percent.

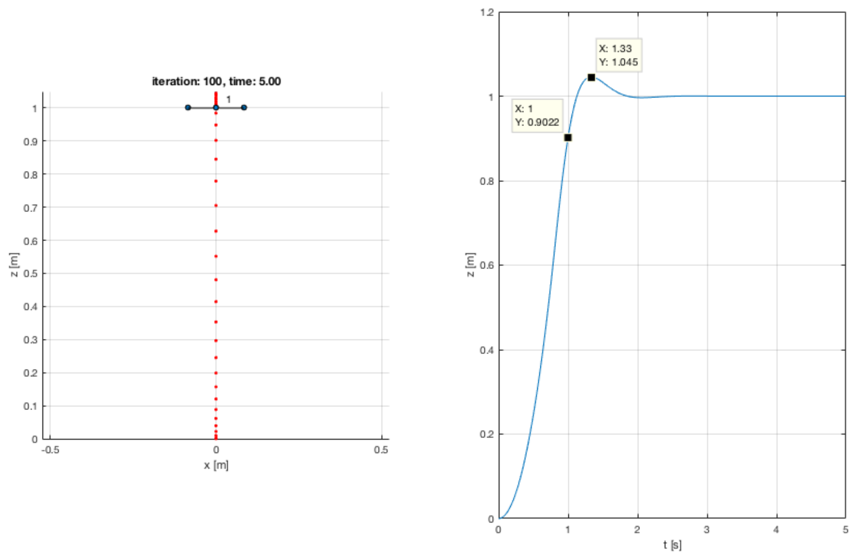

Figure 1: Step response.