EE402 Mini Project 3

M. Mert Ankarali*
Department of Electrical and Electronics Engineering
Middle East Technical University

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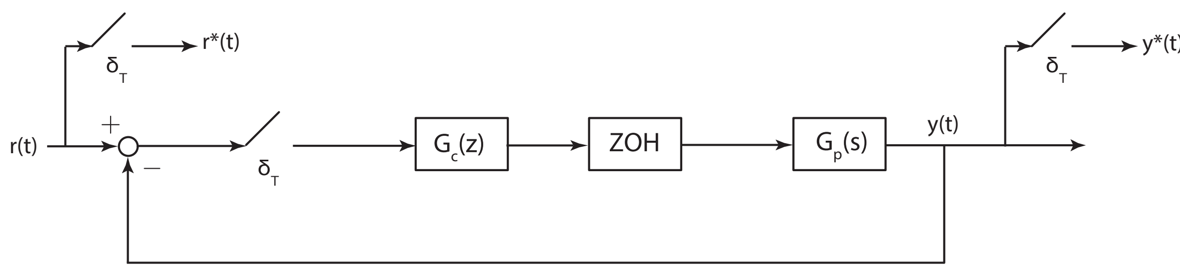
Important: In this mini project, you are supposed to perform some computations in MATLAB, perform simulations in Simulink, and plot some results both using MATLAB and Simulink. You should provide all of your source codes, Simulink models, and graphical results with your hard copy submission. For Simulink models a snapshot figure of the model is satisfactory.

1. Consider the fundamental discrete time control system block given in the Figure below. Let



$$G_P(s) = \frac{1}{s^2+s-2} \quad , \quad G_c(z) = K_P + K_D(1-z^{-1}) \quad , \quad T = 0.2s$$

Then

(a) Compute the Pulse Transfer Function $\frac{Y(z)}{R(z)}$.

(b) Let $K_D = 0$ (i.e., no D action), then find a range of K_P such that closed-loop pulse transfer function is stable. You can use any method.

(c) Choose a K_P value that can stabilize the system when $K_D = 0$, then find a closed form expression for the step response of the closed-loop discrete system, i.e. $y[k]$.

(d) For the same K_P value, using MATLAB find and plot the step-response of the closed loop discrete system. Compare this result with the one found in the previous part (e.g. you can plot both results on the same figure).

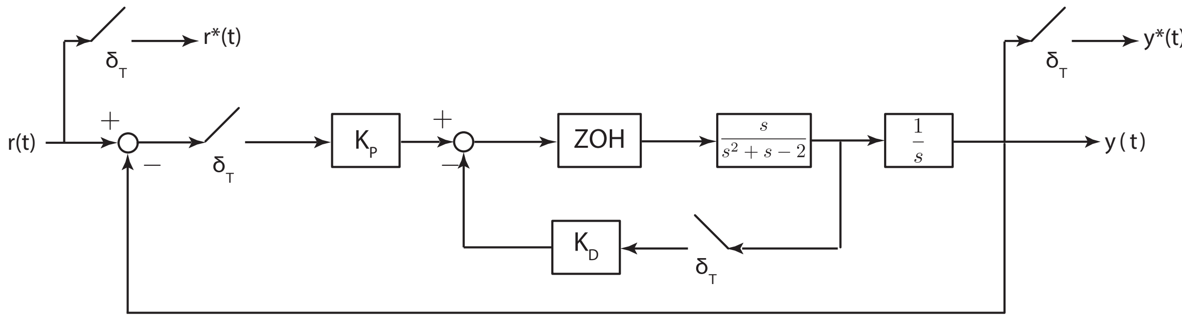
(e) Now, you will analyze the general PD action. Let $K_P = 15$, then find a range for the K_D values such that closed-loop PTF is stable.

(f) For $K_P = 15$, choose a K_D value that can can stabilize the system, then find a closed from expression for the step response of the closed-loop discrete system, i.e. $y[k]$.

(g) For the same (K_P, K_D) pair, using MATLAB find and plot the step-response of the closed loop discrete system. Compare this result with the one found in the previous part, (f).

(h) Realize the block diagram topology in Simulink, and simulate the system with the same (K_P, K_D) pair to find the unit-step response of the closed-loop system. Compare this result with the ones found in parts (f) and (g).

2. Now, let's consider a different discrete-time control system topology which is given in the Figure below.



Let again $T = 0.2s$, then

(a) Compute the Pulse Transfer Function $\frac{Y(z)}{R(z)}$. Compare this PTF with the one found computed in Problem 1(a).

(b) Let $K_P = 15$, then find a range for the K_D values such that closed-loop PTF is stable. Compare this result with the one found in Problem 1(e).

(c) Now choose the same (K_P, K_D) values that you picked in Problem 1(f). For this (K_P, K_D) pair, find a closed form expression for the step response of the closed-loop discrete system, i.e. $y[k]$.

(d) For the same (K_P, K_D) pair, using MATLAB find and plot the step-response of the closed loop discrete system. Compare this result with the one found in Problem 1(g).

(e) Realize the block diagram topology in Simulink, and simulate the system with the same (K_P, K_D) pair to find the unit-step response of the closed-loop system. Compare this result with the one found in Problem 1(h).