Laboratory Challenge 2:

Grimaldi Riccardo, Krassowizkiy Michael, Peron Davide, Vitetta Emanuele;
Group: 7, Thursday shift

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1 Approach

To meet the design requirements, we designed a switching controller. It starts with a constant action and switches at the first sampling interval to a "slow" PI-Controller. This way we can ensure to have a slow sampling time while still matching the required settling time. The schematic of the control architecture is shown in fig. 1.

2 Design and Results

2.1 Controller Design

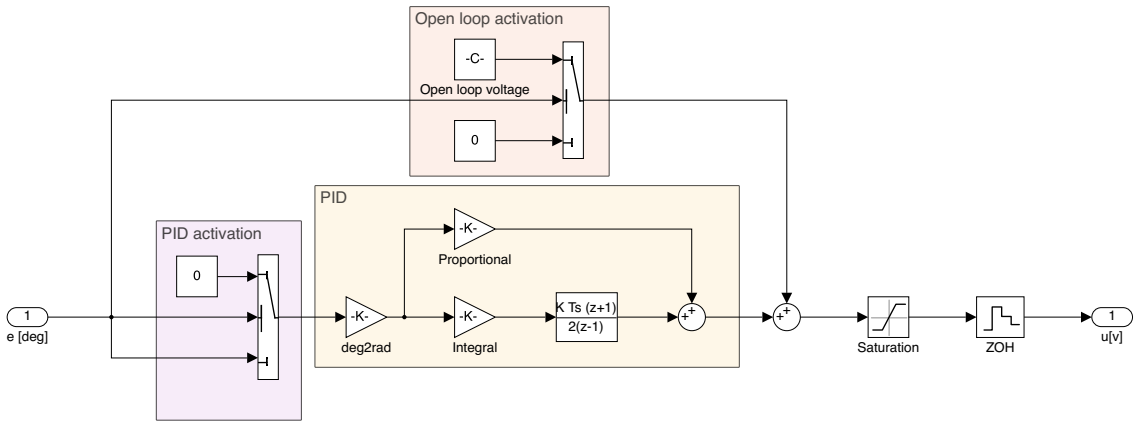


Figure 1: Controller Design using a combination of PI and constant input handled by two switches.

Our goal was to achieve the largest possible sampling time. When designing a PID-Controller for large sampling times, we could not achieve the required settling time. Therefore we introduced an open loop constant action, that drives the output to the 5%-band around the desired reference during the first sampling interval. Afterwards, we switch to a PI-Controller ensuring steady state tracking for any step reference. This way, we could achieve a sampling time that is exceeding the settling time.

The Simulink implementation approximates the logic described above, but the unique switching is ensured only for sufficiently small disturbances after tuning the initial control action. We start with the constant control action. To reproduce the desired switching, we check whether the tracking error is inside the 5%-band. If it is, the PI-Controller is chosen by the switches.

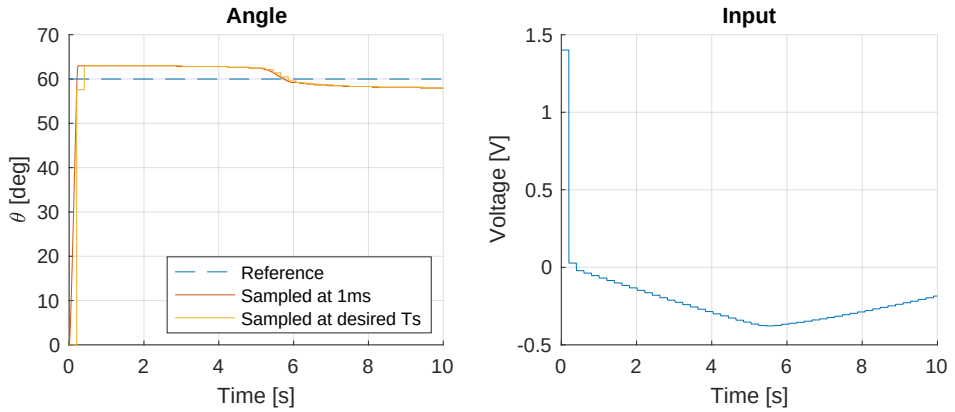
For the tuning, we initially chose a sampling time T_s close to the settling time. Consequently, we tuned the initial control action amplitude V_{init}, such that we reach the 5%-band after the first sampling interval. Then the PI gains, K_p and K_i, were chosen to give a satisfying behaviour after the switch.

K_p	K_i	V_{init}	T_s
0.5	1.5	1.4012	202ms

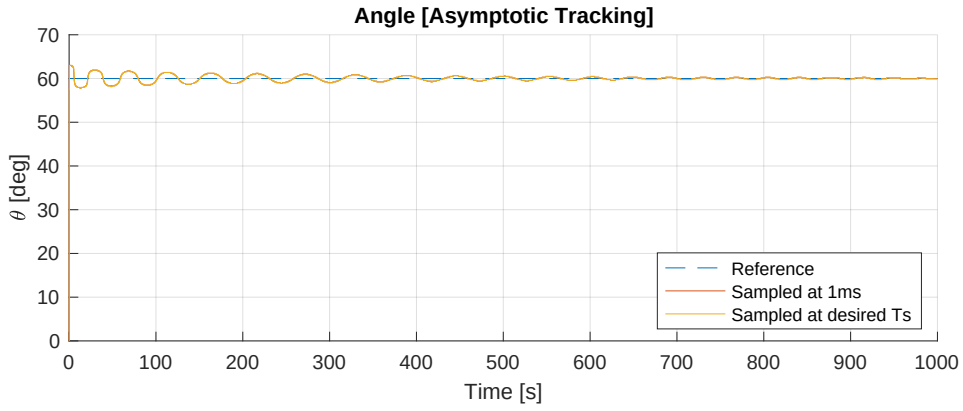
Table 1: Best parameter choice

2.2 Results

Simulation results on the black box model for a step reference of 60° at 0s, using parameters in table 1, are shown in fig. 2a,2b. The achieved performances are summarised in table 2.



(a) Step response on the left and control voltage on the right.



(b) Steady-state tracking of the reference.

Figure 2: Results for black-box for a step reference of 60°.

Settling time	Overshoot
0.200s	5%

Table 2: Achieved settling time and overshoot.