Part B, PD Controller Performance

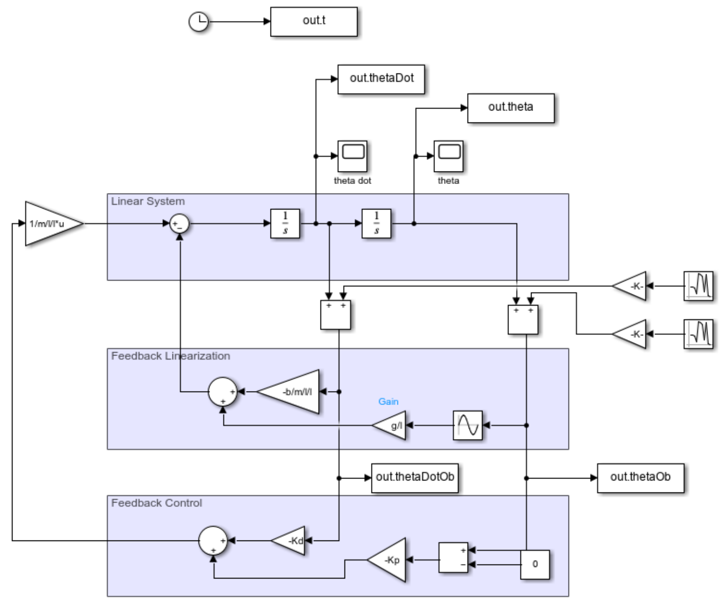

Figure 1 Simulink Design

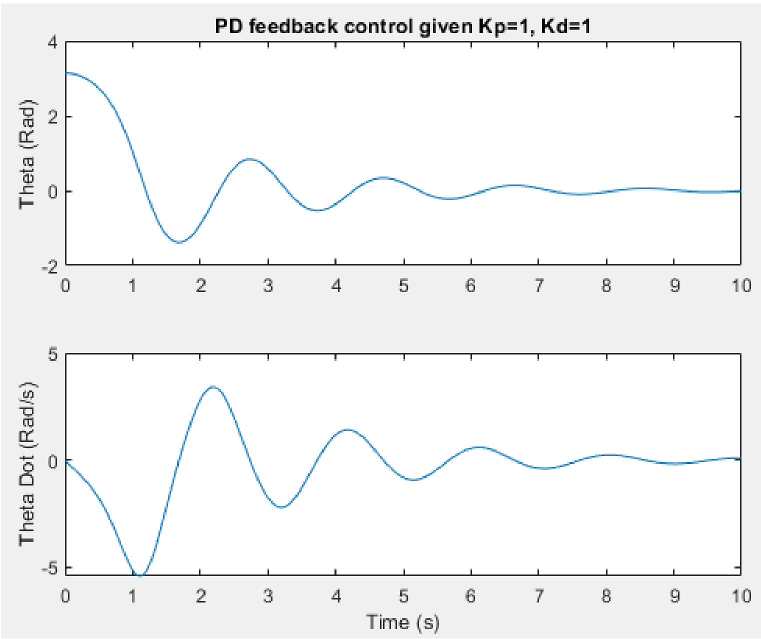

Figure 2 System response given theta=pi, Kp=Kd=1

The PD controller performance can be seen as in Figure 2, the system is Underdamped. It oscillated and gradually approached the zero position.

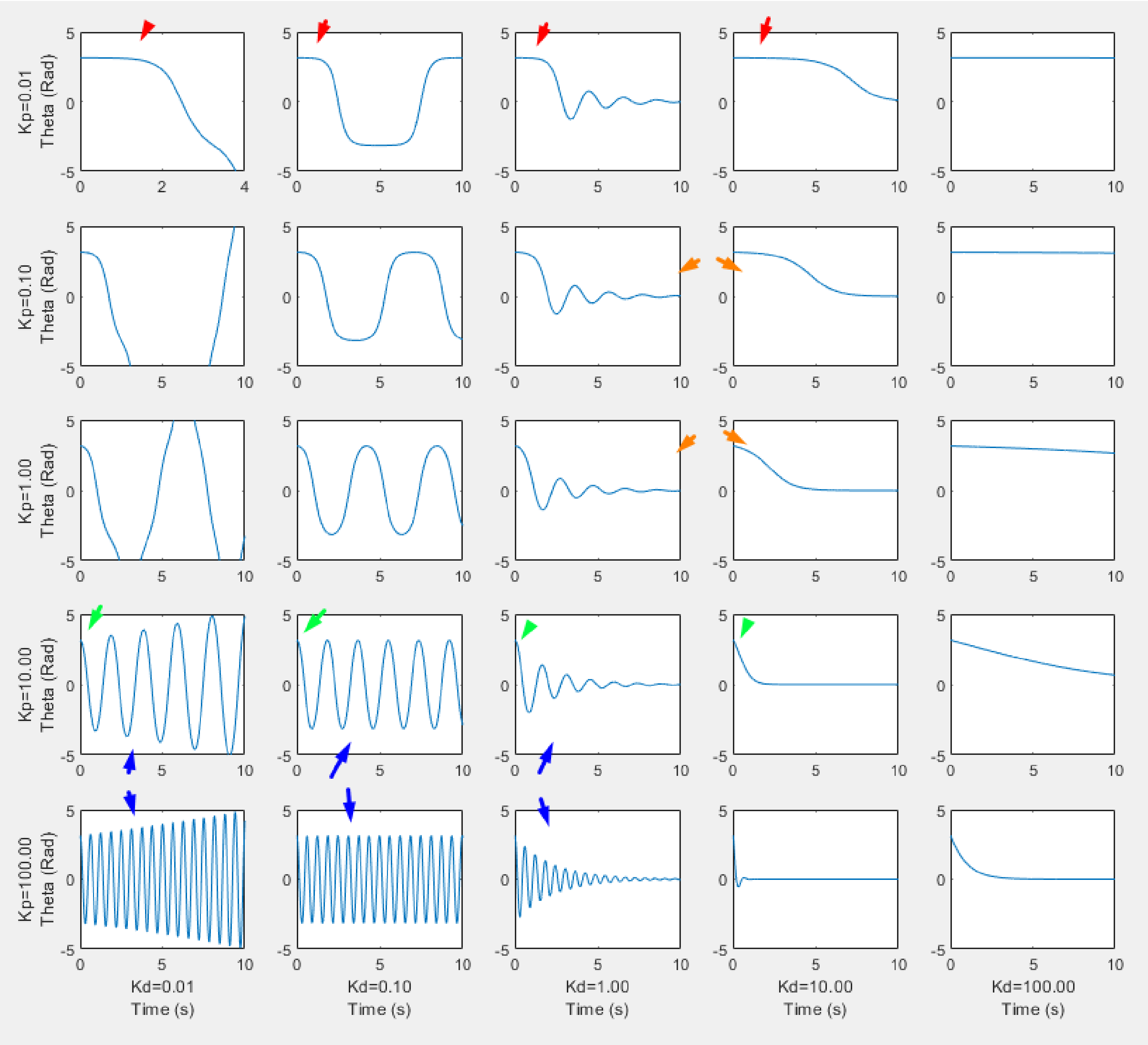

Figure 3 PD Controller Performance

The PD controller performance can be seen as in Figure 3:

1, when Kp is larger, the response of the system starts to move quicker (comparing the red arrows with green arrows)

2, when Kp is larger, the system resident frequency is higher (comparing the blue arrows)

3, when Kd is low, the system is under damped; when Kd is high, the system is over damped (comparing the orange arrows)

Part C Noise

Random noise was applied to both theta and dot theta with a fixed percentage ratio while keeping Kd=1 & Kp=1. The result is as follows:

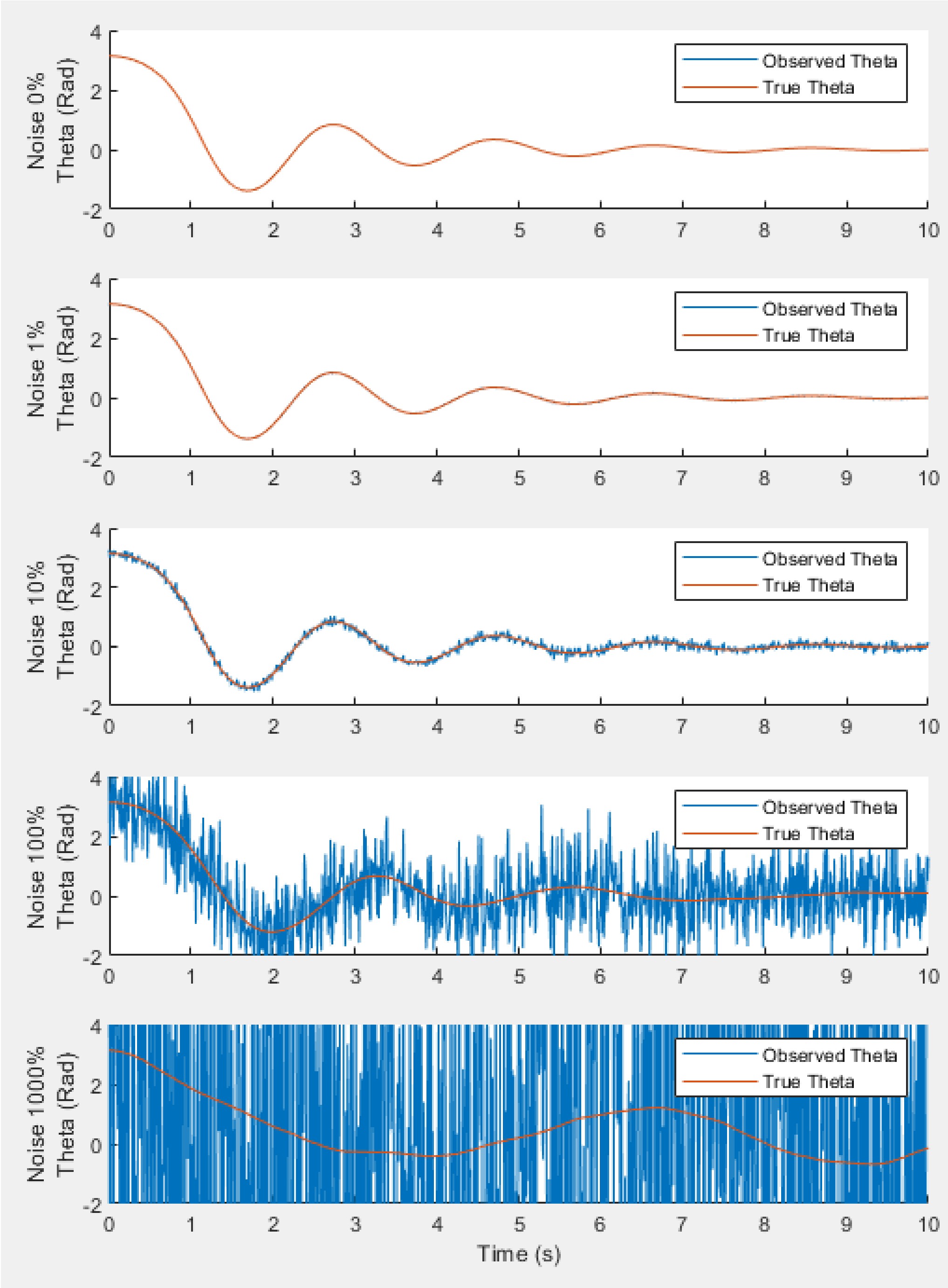

Figure 4 System angle and observed angle under difference noise conditions.

The system performance dropped when noise increased. But it is amazing that it can somehow handle a very noisy input up to 100%.

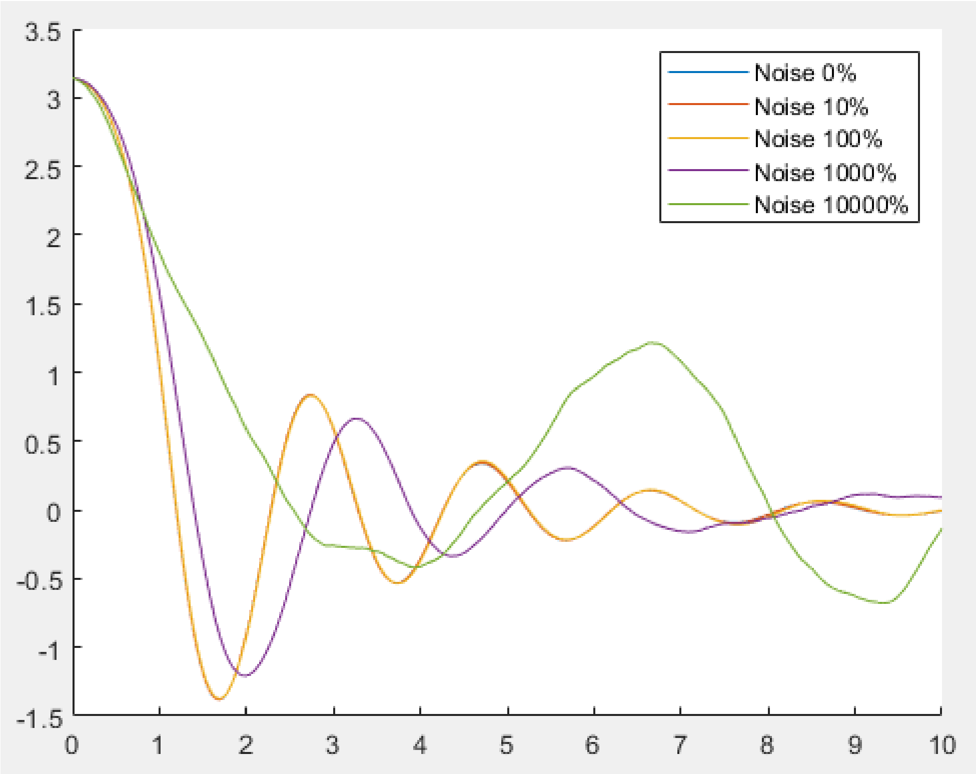

Figure 5 Comparing system angle under difference noise conditions

When the performance of the controller is compared under difference noise level, the result is impressive that, even under 100% noise, the system run as well as no noise. The performance deterioration started to be revealed when the noise was 10 times larger than system variables.

By tuning the PD controller under the condition that 30% of noise applied to both theta and theta dot, the result is as follows:

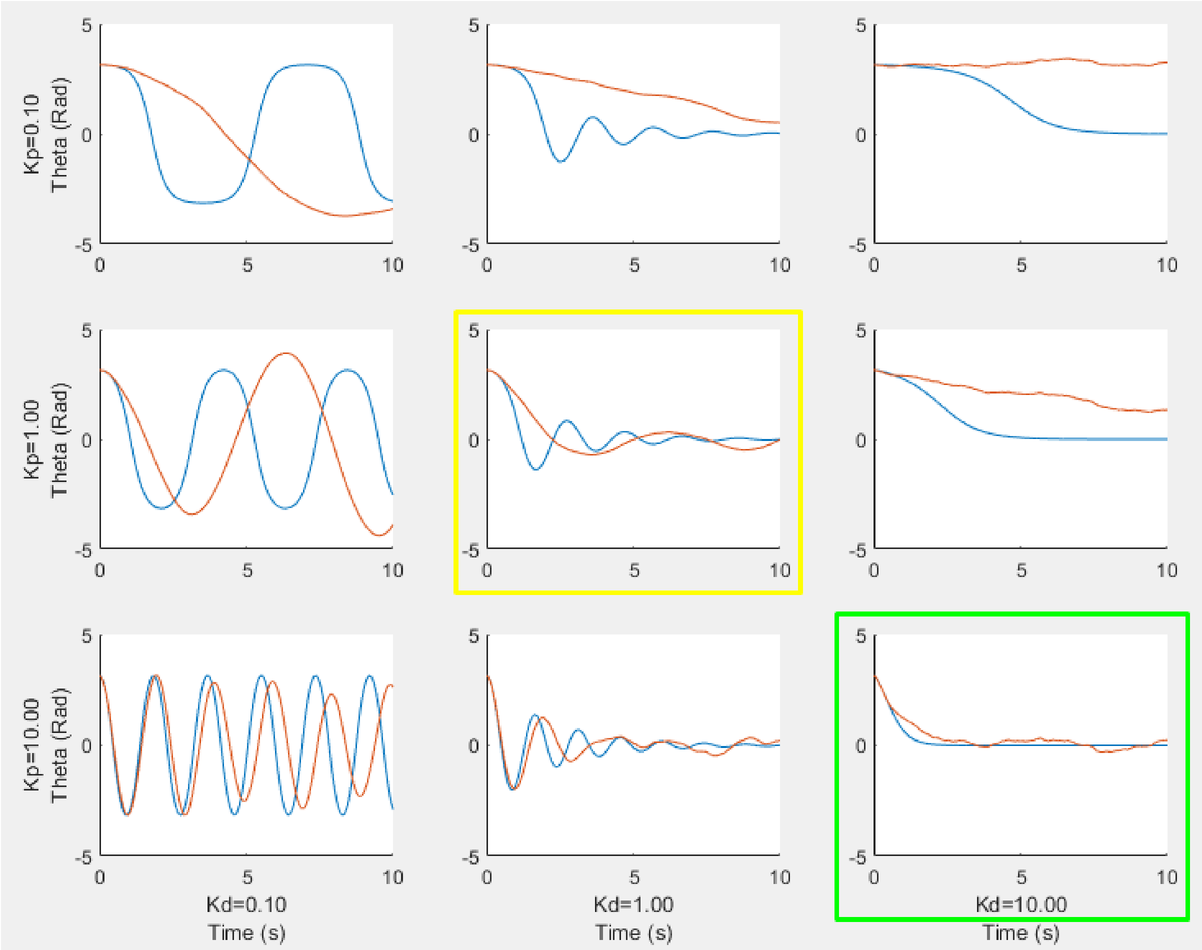

Figure 6 Difference PD controller performance under

It can be seen that the Kd=1, Kp=1 controller is marginally capable of driving the system (yellow box). Yet the strongly under damped system where Kd=10, Kp=10 performed better than other system parameters (green box).