



Course #: 804465 – Automatic Control Lab #7

EXPERIMENTS ON LINEAR POSITION CONTROLLER

Objective To derive the transfer function of a linear position control unit and simulate it's response to a unit step input. To demonstrate the effect of different control parameters on the behavior of the position controller.

Introduction

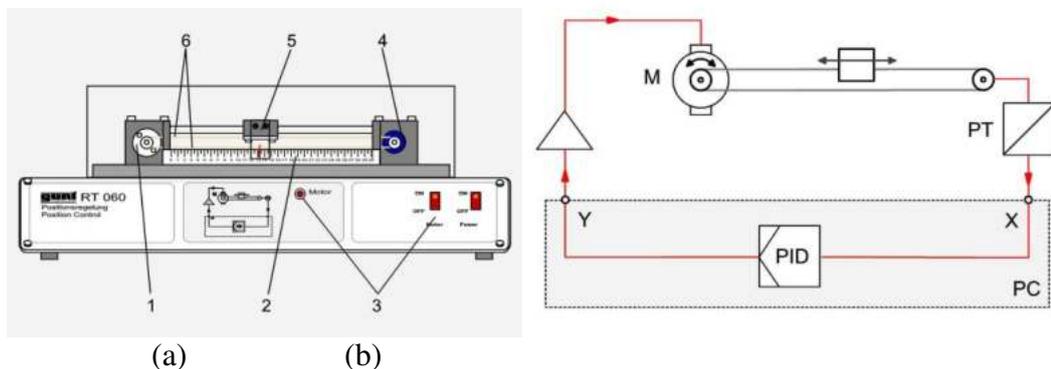


Figure 1: (a) Position control apparatus; (b) schematic diagram of position control apparatus. 1- motor (M), 2- scale, 3-displays and controls, 4-rotary encoder (PT), 5-carriage, 6-toothed belt.

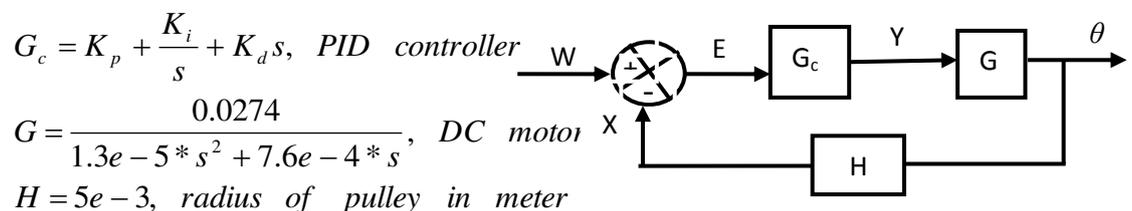


Fig. 2: Block diagram of the unit

Fig. 1 shows the linear position controller unit, which consists of a dc motor and a carriage. The carriage consists of a belt drive and a rotary encoder, which converts rotational motion to linear motion. The transfer function G of the dc motor was derived during lab #4. Fig. 2 shows the block diagram of the linear position controller unit with H representing the sensor (PT) that converts rotational motion to linear motion.

Lab Assignments

- a. Obtain the closed-loop transfer function of the linear position controller unit represented in Fig. 2. For easy simplification, let $a = 0.0274$, $b = 1.3e-5$, $c = 7.6e-4$ and $d = 5e-3$, such that:

$$G = \frac{0.0274}{1.3e-5 * s^2 + 7.6e-4 * s} = \frac{a}{bs^2 + cs}; \text{ and } H = d$$

- b. Write MATLAB m-file to simulate the response of the linear position



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controller unit for different values of K_p , K_i and K_d .

Hints:

```
clear all
close all
% Parameters. Change the values of Kd, Kp and Ki
% and observe the effect on the response.
Kd = 0;
Kp = 10;
Ki = 0;
a = 0.0274;
b = 1.3e-5;
c = 7.6e-4;
d = 5e-3;
%
num = [ ]; % write in terms of a, b, c and d.
den = [ ]; % write in terms of a, b, c and d.

tf(num,den)
step(num,den)
```

c. Experiments with the linear position controller unit.

- (i) **Open-loop operation:** Open the RT0X0 software on the PC, click on the selection button and select the position control unit, select manual mode, set manual regulation ratio $Y = 40 \%$, click on charts, switch on the power and motor of the unit and observe the carriage movement until it reaches the stopper. Switch off the motor.
- (ii) **Continuous control operation:** Select continuous control operating mode, set proportional control constant $K_p = 30$, the integral control constant $T_n = 0$, and derivative control constant $T_v = 0$, the reference $W = 25$ cm, click on charts, clear the graphs, switch on the motor of the control unit and observe the carriage movement. Switch off the motor and set $K_p = 30$, $T_n = 2$, $T_v = 0$, and then $K_p = 30$, $T_n = 2$, $T_v = 0.3$. Observe and comment on the responses for different controller parameters.

- d. Comment on the results of MATLAB simulations and experimental observations.