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Robust Control Design for Dispenser Table using Proportional Integral Derivative (PID) Controller

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Abstract

Proportional Integral Derivative (PID) control has been an active research topic for many years. Sciences many process plants controlled by PID controllers have similar dynamics it has been found possible to set satisfactory controller parameters from less plant information than a complete mathematical model. This paper describes one of Proportional Integral Derivative PID controller applications it is dispenser table.

Keywords: *PID Controller, Dispenser Table.*

1. Introduction

Many of the early applications of control engineering were involved with position control due to the requirement for accurate position control of guns and other devices during the 1940's

Dispensing consistent, controllable, and accurate amounts of fluid of varying viscosities remains an issue for product manufacturers and suppliers.

Most methods of controller design require the use of a mathematical model for the process. In practice this model, which may be called the nominal model, is always approximation of the real situation. The effect of inaccuracies in model on the system performance has therefore always been a concern of the design engineer.

PID controllers are used in plants with integration term to eliminate steady state errors caused by a consistent disturbance.

2. Dispenser Table

The location of the dot or bead being dispensed on the work piece relies on positioning equipment that controls the X-Y position of a work piece or manual abilities with dispensing gun.

Figure (1) below show illustration of dispenser table:

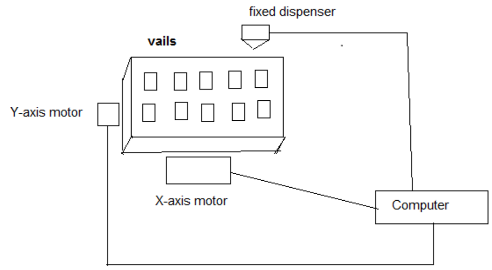

Fig.(1) Dispenser Table

A table is used to position vails under a dispenser head as shown in figure (1), also two motors are used to position X-Y position of work piece.

The position control system is shown in block diagram figure (2)

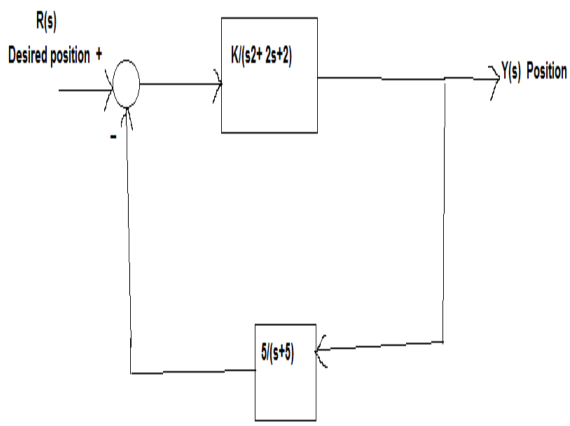

Fig. (2) Control System Block Diagram

3. Results

Science small over shoot for step input and yet desire a short setting time is required , so limit 20 logMpw to 3dB for T(jw).
Plot the bode diagram for a gain K that will result in stable system.

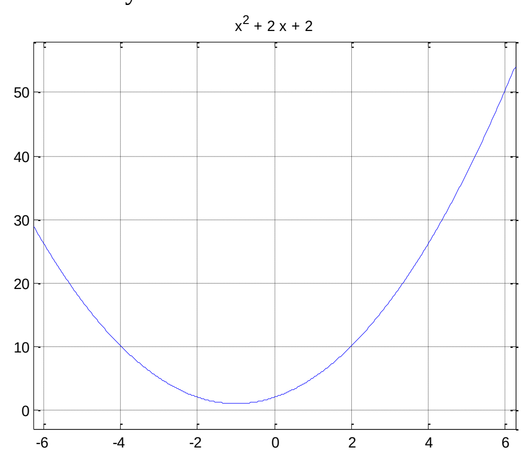

Fig.(3) Plotting Gain

Then K adjusted until 20 logMpw =3dB, and the closed loop system band width determined.

The steady state error determined for the system for the gain K selected to meet required Mpw.

Open loop Transfer function

$$G(s) = K * \frac{5}{(s^2+2s+2)(s+5)} \quad (1)$$

Close – loop Transfer function

$$\frac{Y(s)}{R(s)} = \frac{K(s+5)}{(s+5)(s^2+2*s+2)+5s} = \frac{K(s+5)}{s^3+7s^2+12s+10+5K} \quad (2)$$

Require that 20logMpw = 3dB

$M_{pw} = 10^{3/20} = 1.4125$

$$M_{pw} = [G(W_r)] = \frac{1}{2\zeta\sqrt{1-\zeta}} \; ; \zeta < 0.707 \quad (3)$$

So approximate damping ratio = 0.35 and approximate phase margin = 35 degrees

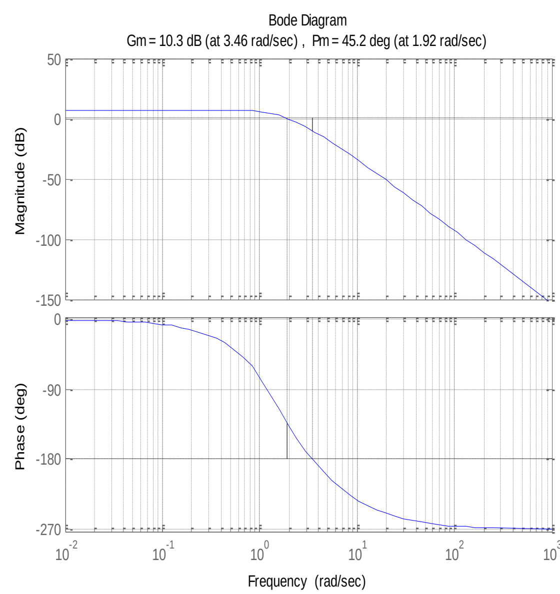

Fig.(4) Bode Diagram, Phase Margin=35 Degrees

Closed loop frequency response shown in Figure(5).

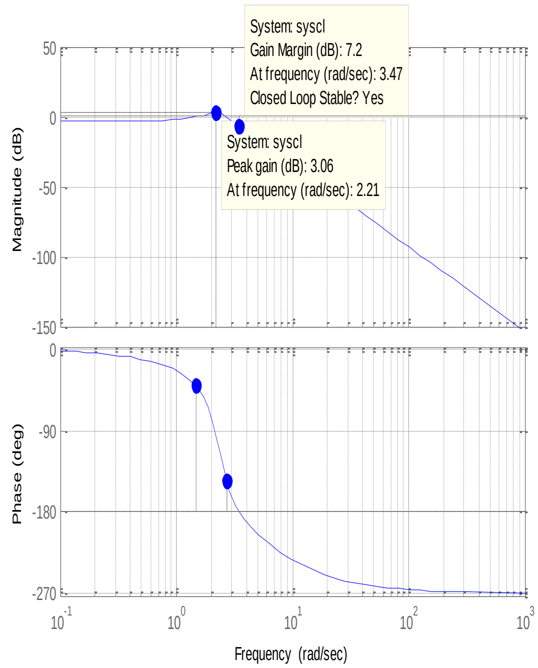

Fig.(5) Closed loop Frequency response

So, K =4.5

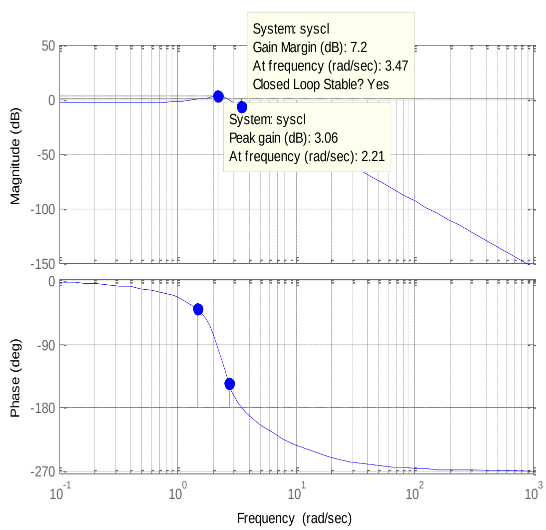

Fig.(6)

Bandwidth is approximately equal to 3 rad/sec
Steady error

$$Y_{ss} = (x+a)^n = \lim_{s-0} s \frac{k(s+5)}{s^3+7s^2+12s+5k}\frac{1}{s} = \frac{5k}{10+5k}$$

$$= 0.6923 \quad (4)$$

Ess= 1-yss = 1-0.69 = 0.31

From the open- loop Bode plot

G(0) =7.04 or G(0) =2.491

$$\text{ess} = 1 - \text{yss} = \frac{1}{1+G(0)} = \frac{1}{1+2.491} = 0.308 \quad (5)$$

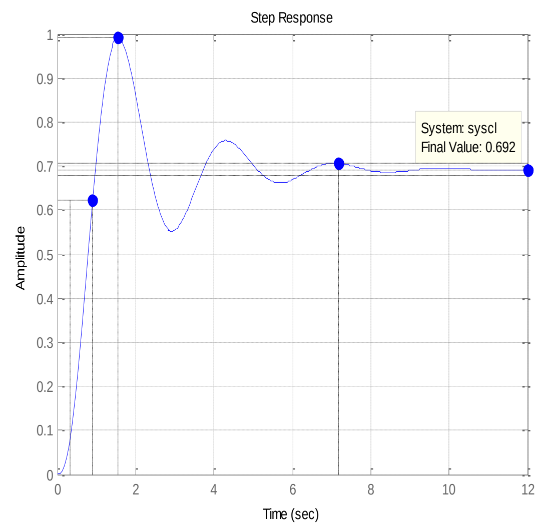

Fig (7) Step Response

4. Conclusions

PID controllers are used in plants or processes with integration term to eliminate steady state errors caused by a consistent disturbance. Many of the early applications of control engineering were involve with position control, this paper discussed one of these applications, it was Dispenser table control.

The results reported for designing dispenser table using PID controller are significant from both theoretical and practical perspective.

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