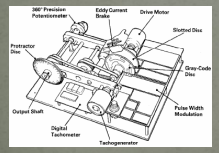
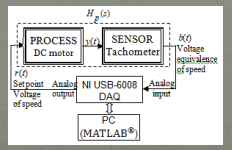
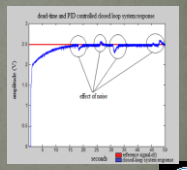
THE DETERMINATION OF PID COEFFICIENTS BEING AT DEAD-TIME SYSTEMS AT REAL-TIME

Mersin E., Sıtkı Ö., Erdil A.







INTRODUCTION

In this study, PID (Proportional Integral Derivative) control adjusting real time PID coefficients for DC motor speed control is performed. Required PID parameters are calculated using system delay in order to select control parameter suitable for system's properties.

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12th International Workshop on Research and Education in Mechatronics September 15th – 16th 2011, Kocaeli, Turkey

SURVEY

1) PID Control and Dead-time Systems
2) The Computation of PID Parameters
3) Realized DC Motor PI Control
4) Conclusions

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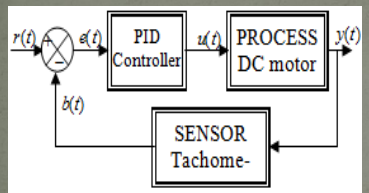
1. PID Control and Dead-time Systems



PID control block diagram.

PID control is realized using three parameters tuned; proportional , integral , and derivative . The application of these three parameters is changed for the systems and desired condition.

Controller's task is zero error level with short time period for disturbance effects. This condition is possible with the determination of convenient system control parameters.

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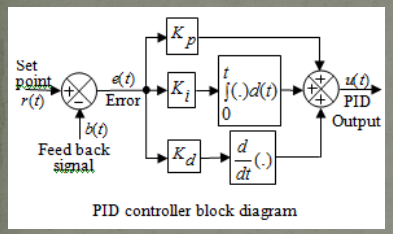


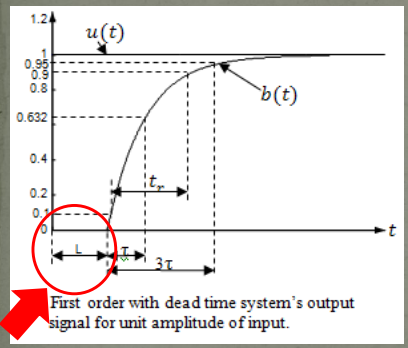
PID controller block diagram

The terms of is given depending on the error signal applied to the controller input

$$u(t) = K_p e(t) + K_i \int_0^t e(t)d(t) + K_d \frac{d}{dt} e(t)$$

Control signal is given for different forms

1. PID Control and Dead-time Systems



First order with dead time system's output signal for unit amplitude of input.

Here L is the dead-time and time between the signal applied to the system's input and displayed in the tachometer. The time constant τ is the 63.2% of the total respond of the system.

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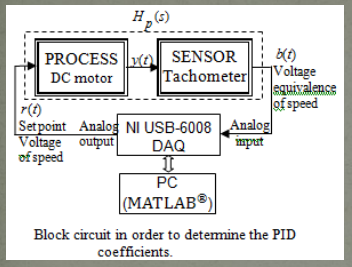
2. The Computation of PID Parameters



Block circuit in order to determine the PID coefficients.

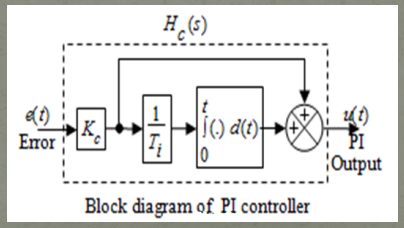
The computations of PID Parameters are realized with MATLAB using DAQ. It is needed to know the system's behaviour in order to determine the PID parameters. Thus, system is firstly started as open loop.

$$r(t) = 2.5\,u(t)$$

$$y(t) = 2(1 - e^{-\frac{t-L}{\tau}}).u(t-L)$$

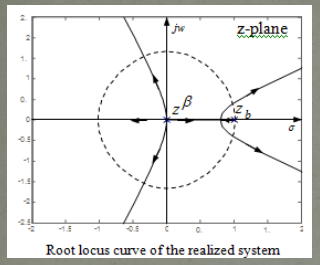
2. The Computation of PID Parameters

2,5V DC set point signal is applied to the system's input. System's behaviour is identified as a first order using this output signal. PI control is preferred instead of PID controller. The properties of this signal must be known more detailed to control the system.



Block diagram of PI controller

2. The Computation of PID Parameters



Root locus curve of the realized system

System's stability at discrete time is understood when the roots of system's characteristic equation is inside or outside of the unit circle in z plane. If the roots of the characteristic equation or system's pole are inside of the unit circle in z plane, system is asymptotically stable. The points of the deviation of real axis and the points of the approach of the real axis are obtained from using system's root locus curve. Root locus curve of the realized system and are assumed in the open loop transfer function.

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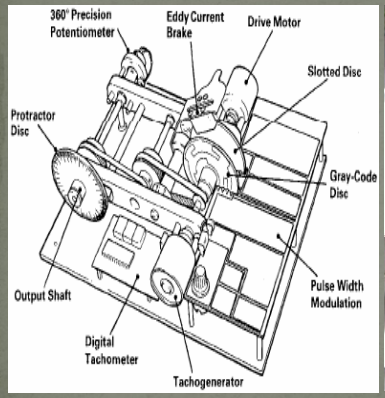
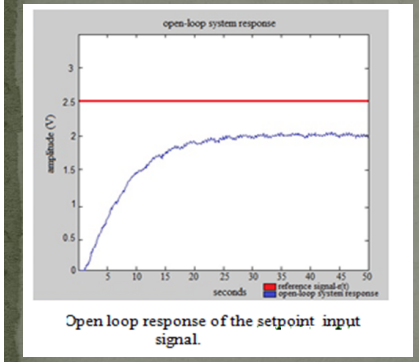
3. Realized DC Motor PI Control



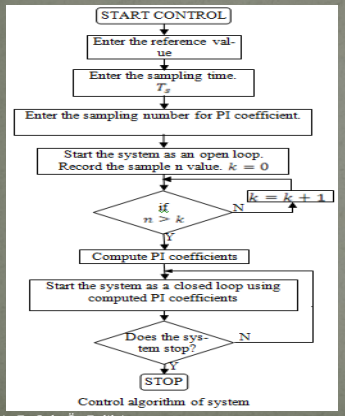
3. Realized DC Motor PI Control



Open loop response of the setpoint input signal.

Here, the speed of the DC motor under different loads wants stationary. Speed knowledge is measured as a voltage. Therefore, setpoint signal applied to the system is used as a voltage.

3. Realized DC Motor PI Control

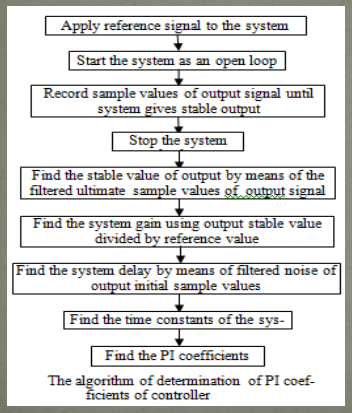


Control algorithm of system

At first, dead time L value and time constant τ value are computed. Stable value of the system output must be known in order to find the system gain K.

Received output signal must be filtered in order to find reaction time when the setpoint signal is applied to the system's input. For this purpose, time value of 10% of output signal's maximum value is assumed as the first value of output. The difference between the found value and first signal time applied to the input is assumed as time constant of system.

3. Realized DC Motor PI Control



The algorithm of determination of PI coefficients of controller

The difference between the appearing time of output signal and 63.2% of the stable value of output give us the time constant of system. b, K_c and T_i values are found using these values.

System works using control algorithm of system. This algorithm works firstly determination algorithm of PI coefficient. Then, the system is controlled using obtained coefficients.

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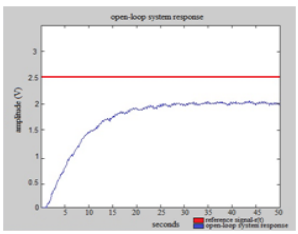


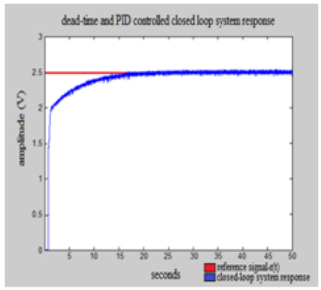
Open loop response of the setpoint , input signal.

In this study, real time speed control of DC motor is performed using an algorithm of dead time PI control with MATLAB software and NI USB6008 DAQ.

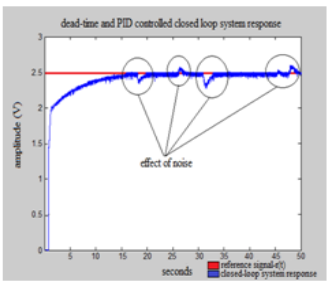
system gives quick response of setpoint differences and noise effects. The algorithm finds PI parameters depend on the dead time. In this algorithm, dead time is selected as 10% of the system response. In other words, dead time is determined as the system delay. Therefore, algorithm can also be applied to the no dead time systems.

Since the system starts each time, controller's parameters can be determined again. There no need to expert person the determination of control parameters.

4. Conclusions



The response of PI controller.



The response of controller with different loads

4. Conclusions

System responses for different setpoint values (2.0, 2.5, 3.0 V) applied to the system. As it is seen from the figure, controller follows desired setpoint values for different setpoint values. But, 0-5 VDC motor feeding is caused to the overshooting of setpoint signal of 3 VDC.

System gain, K	0.789200774912764 V
Stable value of output	1.973001937281909 V
Initial value	0.129680962342637 V
Ultimate value	2.102682899624446 V
Dead time, L	1.000000000000000 sc
Time constant, τ	6.400000000000000 sc
Proportional gain, K_c	5.864583209444620 sc
Integral constant, T_i	6.450130207803538 sc
Sampling time, T_s	0.1 sc

The values of controller parameters

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THANKS!
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