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TUNING PID PARAMETERS IN LABVIEW

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Abstract: The purpose of this paper is to provide an overview of the PID controller and its implementation in LabVIEW with a focus on using LabVIEW's capabilities to tune the PID parameters to meet the criteria specified for the system. The system we examined is a two tank system where the liquid is pumped from the bottom tank to the top tank. The PID controller controls the voltage on the pump.
Keywords: LabVIEW, Control Systems, PID tuning

1. INTRODUCTION

Simulation is a key part of teaching control systems, however it is not the only one. While simulation is important it can only go so far before it becomes too complicated and we have to make simplifications or we omit some crucial aspect of our system. It is not a too difficult task to create a physical system to demonstrate different aspects of a simulated controller. An excellent example is teaching fuzzy and PID controllers. The simulations will decrease the setup time for the various aspects and the physical model will deepen the experience of the students (J. P. Keller 2000).

Figure 1. Festo EasyPort

2. MATERIALS AND METHODS

Materials

The instruments in use were the FESTO EasyPort (Fig 1.), FESTO process automation workstation (Fig. 2) and the LabVIEW software.

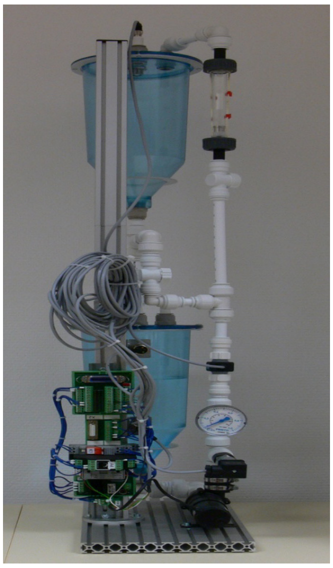

Figure 2. Festo process automation workstation

Methods

As we know the transfer function of the PID controller is:

$$W_r(s) = K_p(1 + \frac{1}{T_i s} + T_d s)$$

From this we can get the response of the PID controller u(t):

$$u(t) = K_p e(t) + \frac{K_p}{T_i}\int_0^t e(t)dt + K_p T_d \frac{de(t)}{dt}$$

u(t) - is the PID controller response as a function of time.

e(t) - is the difference between the set point and the current output as a function of time.

K_p, T_i, T_d - are the parameters that need to be tuned to a specific system to achieve desirable results. The specific function of each parameter can be seen in Table 1.

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Table 1. PID parameter descriptions

Parameter	Function	Value	Stability	Reaction time
K_p	Set proportional gain	Decrease	Better	Worse
		Increase	Worse	Better
T_i	Counter the offset caused by proportional gain	Decrease	Worse	Better
		Increase	Better	Worse
T_d	Decrease time to reach the set point	Optimal	Better	Better
		Not optimal	Worse	Worse if smaller

Tuning these parameters to a specific system can be done with any of the Ziegler-Nichols, Oppelt, Chien-Hrones-Reswick, Kessler or Samal methods. We can acquire the plant model by system identification. Once the plant transfer function is established the tuning can begin with any of these previously described methods. To begin we use the plant model of the pump given in zero-pole-gain form:

$$P(s) = \frac{2}{(s - 9{,}997)(s - 2{,}003)}$$

in a control and simulation loop. We add an integrator to model the top tank and model the leakage of the tank (Fig. 3) (National Instruments 2009).

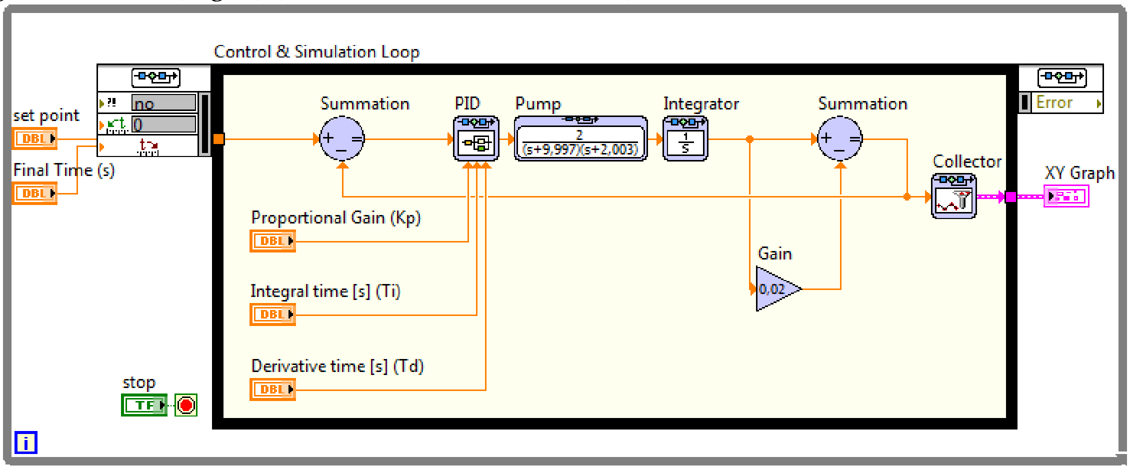

Figure 3. Implementation of plant in LabVIEW

The K_p, T_i, T_d parameters can be entered on the front panel and the result will be visible in real time (Fig. 5). There is also the opportunity to auto-tune the PID controller in LabVIEW. This is mostly used to fine tune the established parameters. This exercise is quite visual and offers a deepened learning experience especially with the Festo process automation workstation connected to LabVIEW (Fig. 5).

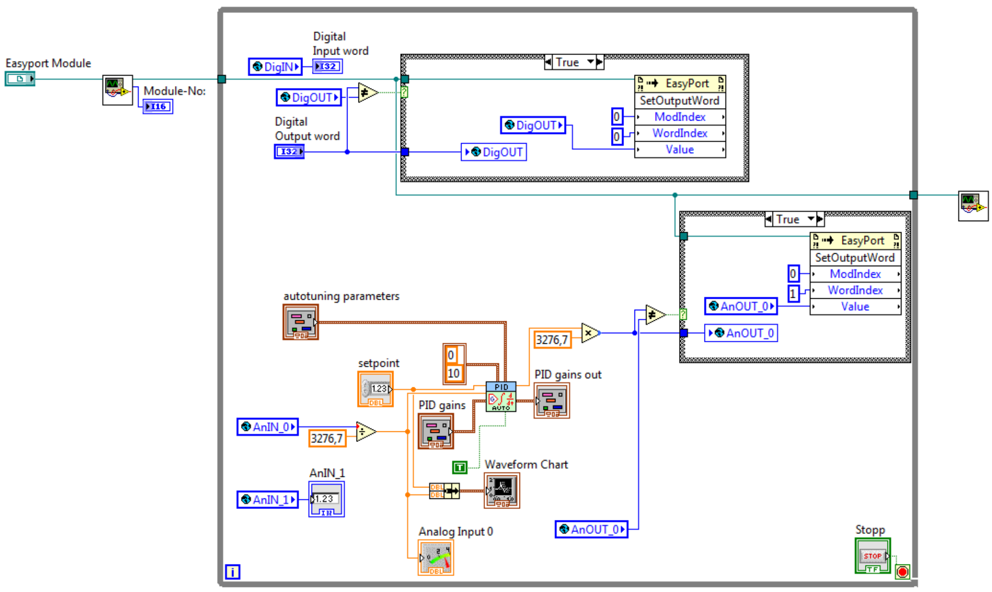

Figure 4. Connecting the Festo process automation workstation to LabVIEW

3. RESULTS

As depicted on (Fig. 5) we can achieve a versatile simulation platform for the teaching of control algorithms.

Using LabVIEW models (J. Sárosi 2012) can be tested without the need for the physical device to be in place. We can also test various controls on experimental test beds (P. Toman et al 2009) cost effectively.

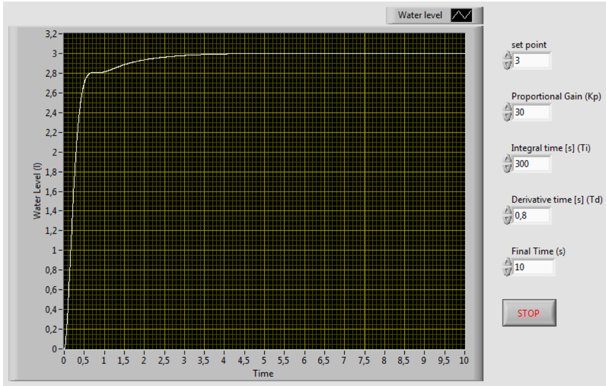

Figure 5. Front panel of simulation

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