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DESIGN OF A PID AUTO TUNING CONTROLLER USING LABVIEW

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ABSTRACT - *With the increased integration of information technology in our daily life, education and research we have entered into a new era of digitalization and this digitizer is replacing our traditional analog device gradually. This brings to us the necessity to improve the conventional instruments.*
In this paper the concept of virtual instrument and its merit against conventional instrument will be introduced. Here we will use the graphical programming concept of National Instrument's Lab VIEW. In this paper we will introduce the concept of a temperature control system which is a PC-based virtual instrument application. Taking these thoughts as principles, a temperature control system will be designed using LabVIEW dataflow visual programming language and environment to realize the data of the temperature of the objects. The sample input signals were analyzed and disposed to determine the size of the output signals by using the LabVIEW program.

KEY WORDS: Data acquisition, PID Controller, NI LabVIEW, Virtual instrument

1. INTRODUCTION

With the continuous development of information science, the issues that need to be addressed have become increasingly difficult, the requirements of control system have also been more and more demanding. Besides, as the multiple analytic methods require convenient operability, the traditional control system tends to be a bit powerless in implementing various functions. In the traditional control system the signal processing circuit design is very complicated and has great deal of difficulty in its updating process. The traditional instruments have no way to upgrade or update to the new calculating method or computing requirements that arises from time to time. Even cost of implementation is high.
Based on the rapid development of microelectronic technology, computer technology, software technology, network technology and modern measurement technology, a new kind of advanced instrument called the virtual instrument, has been a hot spot of current system research. As a combination of various technologies and computer technology, virtual instrument has opened up a new era of instrument technology. The idea behind the virtual instrument is to replace the traditional electronic instrument to implement some functions such as the collection, analysis, display and storage of data based on a software development platform. Virtual instrument integrates the computer hardware resources and instrument hardware. It also integrates the strong data processing capacity of computer, the measurements of instrument hardware and control capacity. The display, storage and analytic processing of data can be implemented through the software, and then the system control and the display of measurement data can be achieved by the interactive graphical interfaces that LabVIEW provides.
As LabVIEW is regarded as a language development platform, a temperature control system will be designed in this research piece. Based on the serial communication between computer serial port and the object, the real-time measurement and control of temperature can be attained.

1.1 GOAL

The goal of this thesis is to build a PID controller to control and tune any temperature as per user requirement. In order to achieve this goal, the controller is first simulated using LabView. The parameters are optimized prior to any implementation and a datasheet is produced.
For implanting this toolkit and GUI, which would be our next agenda, a data acquisition system(DAQ) is required to be developed in order to acquire the inputs from source into the toolkit and to generate the analyzed and manipulated output back again at the sunk. The sunk is a heating device for reference. It could be any plant system.

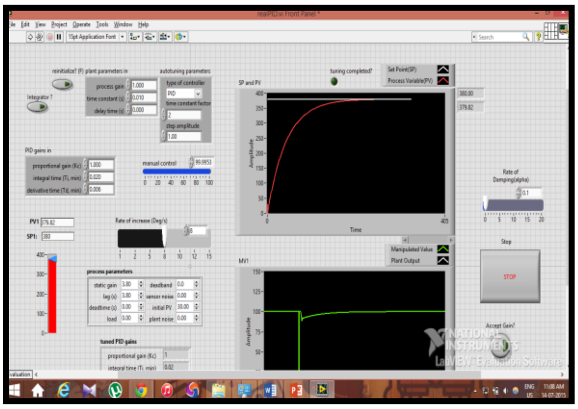
1.2 DESIGN

In the previous parts, the design analysis of virtual instrument module and the establishment of the virtual instrument have been briefly described. In this section, we will present the specific process of the design which is mainly about the designing aspects of software. We have designed the front panel and program chart of PID temperature control system. What's more, we have focused on the design of PID module program.

i. Front Panel Design

The front panel interface design is an important part of any virtual instrument. The functions of instrument parameters setting and test results displaying are realized by using the software, which requires a simple, direct and convenient software interface. The figure below shows the front panel of the temperature control system designed using LabVIEW.

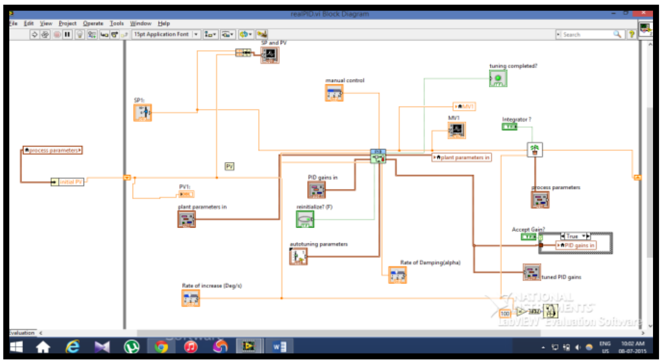
The main functional areas of the interface include parameter input area, data display controls and results display area.



(Front Panel: Temperature Control System)

ii. Back panel design

The figure below shows the chart of the back panel program of the VI design.



(Back Panel: Temperature Control System)

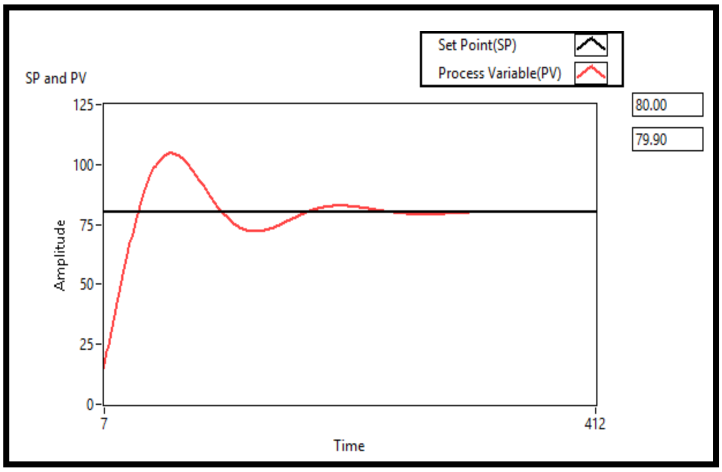
In the part, the process parameters and the PID parameter settings will be design. After that the real-time temperature and the target temperature will be collect by the system which will pass through the PID controller (with the control value).

PROCESS

The P.I.D Controller looks at the set point and compares it with the value of process variable (pv).Then the controller error at current time t is computed as set point minus measured process variable i.e. e(t)=SP-PV.The controller uses this e(t) in a control algorithm to compute a new controller output signal CO. This CO signal is sent to the final control element which causes a change in manipulated variable. This manipulated process variable cause's change in PV and it's wired to the sink. The sensor measures and transmits the current value of the process variable (pv) back to the controller.

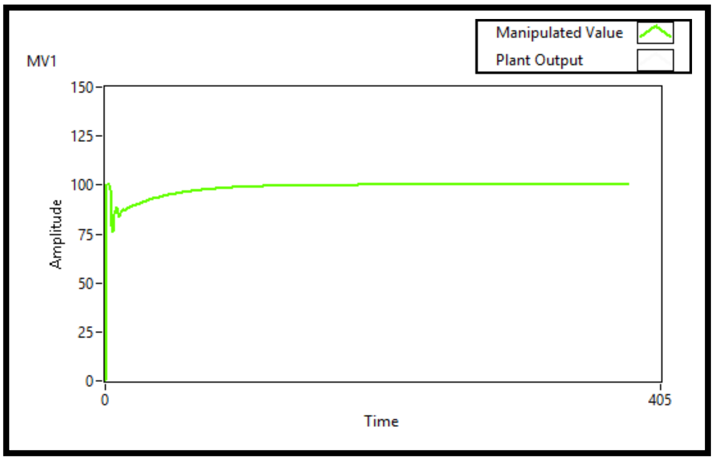
2. OUTPUT

Output prior to any adjustments



A significant scale of overshoot is observed in the above response

Manipulated Output

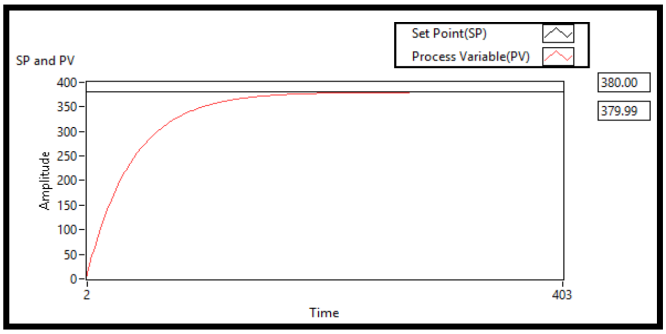


Requirement at Output

- The output should be under damped.
- The maximum overshoot should be negligible or zero.
- Very less amount of steady state error.
- Good increase of rise and peak time.
- The speed of the system & the fast response is required.
- Bump less increase of temperature.

For Obtaining an under damped output with zero MP

Static gain and lag(s) of process parameter are one of those crucial parameters upon which the under damped factor of the output curve PV is depended on. In order to obtain an acute under damped curve at output the aforesaid two parameters are to be tuned in the desired way.



To attend proper speed and fast response of the system

a) Speed of the system has a very important role to play in the controller phenomenon. The fast a system attains its SP the superior is the design of the PID.

b) To attain a proper value in such a way that the system attains SP in the fastest way possible without even giving any maximum overshoot is the duty of the designer.

Above requirements and change of parameters can be obtained by Tuning of PID.

Tuning

Tuning is the process of finding appropriate parameters for the PID controller. Tuning determine the overall performance of control loop which affects the quality of the product, cost etc.

A PID control system needs tuning if-

- Careful consideration was not given to the units of gains and other parameter.
- The process dynamics were not well-understood when the gains were first set, or the dynamics have changed.
- Some characteristics of the control system are direction dependent.

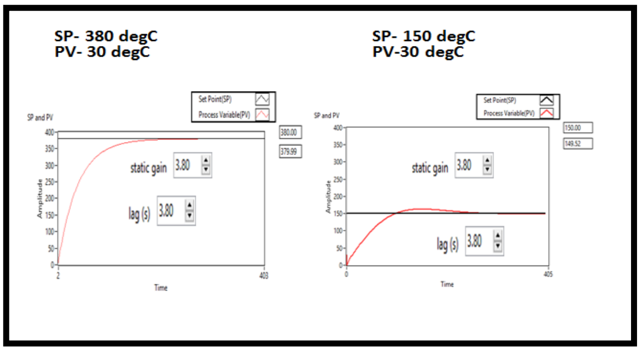
Factors associated with the response of the system

- Speed and proper response of a system mainly depends on the two things:

  a) Process Parameters : These are the "How far" variables. In a linear process, the ratio of the magnitudes of the measured process response to that of the manipulated variable. These parameters are in turn controlling the plant system.

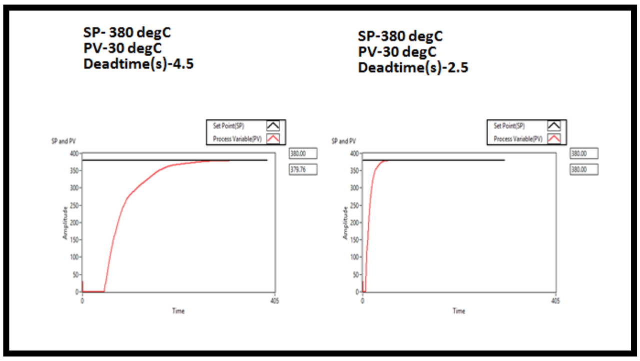
  b) PID Gain: proportional plus integral (reset) plus derivative (rate) control action. Changes in these parameters bring serial changes into the controller.

Observations at different set points



Here it's seen that at same static gain, lag, and process variable value but with different set point the response is different and at 150 deg. C (SP) there is significant overshoot.

Observation at different Dead times(s)



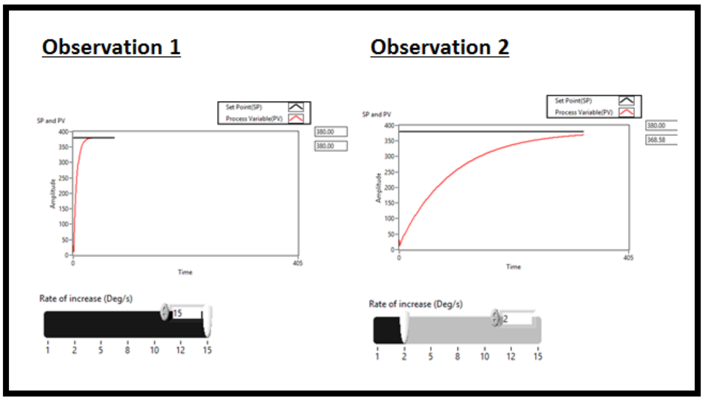
For different dead time different response were seen.

Introduction of the rate concept

- In order to define the rate of increase of response with respect to time a scaling system is introduced
- User can manually fix the rate at which the heating element should be heated.

The scale is tuned such that all graded rate would give the correct and stable output at any set point

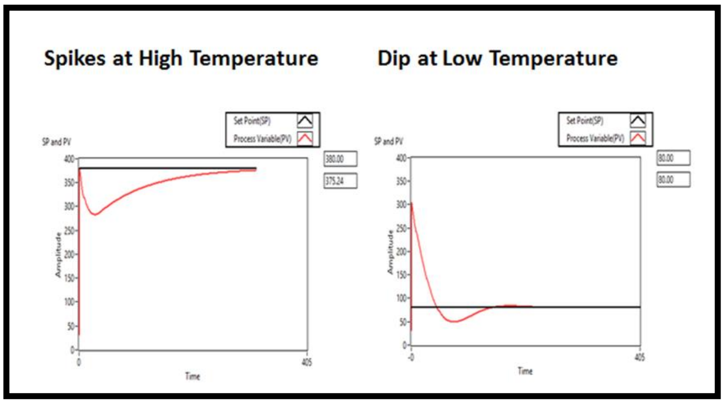
Scaling observations



3. DRAW BACK FACED DURING SIMULATION ARE

- Spikes during abrupt data change.
- Tuning is complex.
- At some set points, maximum over shoots may violate the permeable limit.

4. FAULT IN OPERATION



These malfunctions might be the problem of improper data functions of the system. But by vigorous tunings and making proper defaulting these spikes at high and dips at comparatively low temperatures can be get ridden away. For the record, response of the output is optimized well at a slow sampling rate. Giving the sampling rate unnecessary faster action can be proved into noises and improper simulation of outputs.

As for the convenience of users the rate of scaling has been fixed here with respect to seconds; users can change this scaling into minutes or any other units according to their wishes.

5. IMPLEMENTATIONS

- Apart from some abnormalities faced during simulation, this PID can certainly be implemented into hardware.
- An acute hardware implementation can generally and universally be applied into any device.
- The hardware casing (DAQ) concept is very unique and it brings sophistication in instrumentation and automatic mechanisms.
- This PID based design is an easy way of measuring various electrical and electronics components.
- The simulation can be further constructed as per user basis.
- A stable and manipulated output is very much convenient for application.

6. CONCLUSION

Simulation of a PID Controller for process heat auto regulation using graphical programming language of LabVIEW is accomplished.

If the PID controller parameters are chosen incorrectly then the controlled process input can be unstable i.e. its output diverges, with or without oscillation, and is limited only by saturation or mechanical breakage. Instability is caused by excess gain and particularly in the presence of significant lag. In general, stabilization of response is required and the process must not oscillate for any combination of process conditions and set points, though sometimes marginal stability is acceptable or desired.

As we can see by fixing the static gain value and varying the lag (time) amount we conclude that when lag (time) is decreased a steady and fast rise of the system is obtained. The tuning was done such that maximum overshoots and percentages of maximum overshoots are very less and when the lag (time) is increased a steady but slow rise of the curve is obtained. Percentages of maximum overshoot being negligible. And by fixing lag (time) and varying static gain we can come to the following conclusions:

a) When the static gain is increased the output shows a fast response. With negligible maximum overshoots .

b) When it is increased sloppiness overcomes into the output.

c) When lag (time) and static gain when both are just fixed. It shows a medium amount of growth and the response consists of a fair amount of maximum overshoots. The steady state response hence obtained can be displayed.

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BIOGRAPHIES

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