

Labview Based PID controller Simulation for Multi input Multi output System

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ABSTRACT

This paper presents the National Instruments LabVIEW based simulation of design Proportional-Integral-Derivative (PID) for Level control of Four Tank System. The Four Tank System is one of the type of MIMO (Multi-Input Multi-Output) system. The objective of the paper is to give a brief on the working and controlling of a non-interacting four tank system which has been designed using LabVIEW and can be implemented in real time by interfacing with Hardware's. The issues in a MIMO system is it will non-linear and it will affect the Stability of the system. It can be solved using various controllers and we are using PID controllers with different Control techniques. The MIMO System consists of four tanks, two pumps and control valves. The Simulation result shows the efficient output of the different control techniques used in this paper

Keywords: MIMO System, PID, LabVIEW, Linearity.

I. INTRODUCTION

One of the most widely used educational experiments in control laboratories is the Four Tank System. The system applications range from simple One Tank to complex MIMO systems by minor modifications. Controlling of these systems in Real Time Applications is generally done with the help of PID controllers in case the system used is Linear. Using of Four Tanks facilitates the control of two or more tanks simultaneously. Thus this system or process is economical both in case of Time and Money. National Instruments LabVIEW can be used for monitoring of the process and for design of the simulated model of the MIMO system. MATLAB software can be used for finding the P, I and D values for the system with the help of the obtained Transfer Function. The output response of the system can be observed by using the MATLAB.

In process industries, control of liquid level in the process tank is important and also has been observed as a complicated issue. Since the process of level control is a non-linear one, the main idea is to modify the controller actions and settings to compensate the non-linearity of the process in any possible way. PID controllers along with other linear controllers are being used as a solution to the problem. But however the control of non-linear system using the linear control schemes doesn't give satisfactory performance at all operating points. The main reason for the failure being the varying of values with different operating conditions [1].

One of the main problem that occurs with a MIMO system is the decentralized control of the system. Another problem is the lack of stability of the system in the presence of Interactions. The problem can be solved through the use of Proportional-Integral-Derivative controllers by neglecting the interactions between the Input and Output Variables. Great care has to be taken during the choice of the controller gains so that the stability of the system can be preserved [2]

. The major issues in a multivariable process are that loop interaction can arise and causes difficulty in design of feedback controllers. It is not possible to determine all the parameters used in Multi variable systems. These problems can be solved by using various controllers like PID and FUZZY-PID. The PID controller is simple, reliable and accurate, hence can be used in industrial feedback control loops [3].

The main objective is to make the process easier and reduce the time to complete the process and get the desired output by using PLC and LabVIEW in Real Time Applications. It can be modified based on the process. The other objective is it is an automation process it can be controlled using our PC and Laptops. The output of the process can be stored and it can be reviewed.

II. MULTI INPUT MULTI OUTPUT SYSTEM

The Four tank process is a laboratory process with two pumps and four tanks (Tank 1, Tank 2, Tank 3, and Tank 4) which are interfaced to the system. x_1 and x_2 are the inputs and y_1 and y_2 are the output of the MIMO system. The input voltage to pumps is 230 volts. The objective of the controller is to control the level of Tank 1 and Tank 2.

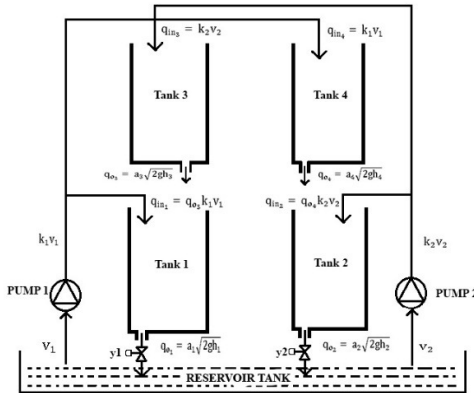


Fig 1. Schematic diagram of MIMO system

In the Fig 1, the pump is connected to tank 1, tank 2, tank 3 and tank 4. The purpose of pumps is to pull the water from the reservoir to the tanks. The pump 1 is connected to the tank 1 and tank 4 and the pump 2 is connected to tank 2 and tank 3. The output of the tank 3 is given as the input to the tank 1 and the output of the tank 4 is given as the input to the tank 2.

Each tank has output valve in the bottom. The output from tank 3 fed to tank 1 while output of tank 4 goes to tank 2. These interactions make a between the tanks makes the system into a multivariable control system. The Four tank system can be used as three tank system by switch off the any of the pump and it turns to three tank system.

III. MODELLING OF MIMO SYSTEM

Mathematical Modelling is the most Important stages for the design of a control system. The theoretical and experimental values are used. To study the behaviour of the system we need the representation of the process variable is required. The representation can be a transfer function or a mathematical equation which is formed using the behaviour of the system.

The Bernoulli's theorem are used to form the mathematical model for each and every tank in the system

In MIMO system various multivariable control systems can be designed

The mathematical modelling of the four tank system is given below. Mass balance equation states that,

$$A_i \frac{dh_i}{dt} = q_{in_i} - q_{out_i} \quad (1)$$

Where

i = Input of the tank = 1, 2, 3, 4

A_i = Area of the tank

q_{in_i}, q_{out_i} = Input and output of the tank

h_i = Height of the tank

Hence

$$q_{in_1} = q_{o_3} k_1 v_1 \quad (2)$$

$$q_{in_2} = q_{o_4} k_2 v_2 \quad (3)$$

$$q_{in_3} = k_2 v_2 \quad (4)$$

$$q_{in_4} = k_1 v_1 \quad (5)$$

Where k_1, k_2 are the pump 1 and pump 2, v_1, v_2 are the velocity of the water flow through the pumps and q_{o_3}, q_{o_4} are the output of the tank 3 and tank 4.

$$q_{o_1} = a_1 \sqrt{2gh_1} \quad (6)$$

$$q_{o_2} = a_2 \sqrt{2gh_2} \quad (7)$$

$$q_{o_3} = a_3 \sqrt{2gh_3} \quad (8)$$

$$q_{o_4} = a_4 \sqrt{2gh_4} \quad (9)$$

The equation (6), (7), (8) and (9) are the output of the four tank system.

IV. LABVIEW

The LABVIEW (Laboratory Virtual Engineering Workbench) is a system-design platform for visual programming language developed by National Instruments. LabVIEW. This paper is proposed the simulation of the three tank system and four tank system. The programming has been done in the block diagram of the VI. The Front panel is used to monitor and control the process. Indicators are outputs: they indicate, or display, the results based on the inputs given to the VI. The back panel, which is a block diagram,

contains the graphical source code or program. All of the objects placed on the front panel will appear on the back panel as terminals. The back panel also contains structures and functions. Industries are using the LabVIEW for controlling and monitoring. It is a user interface and easy to understand the coding.

V. PROPOSED MODEL

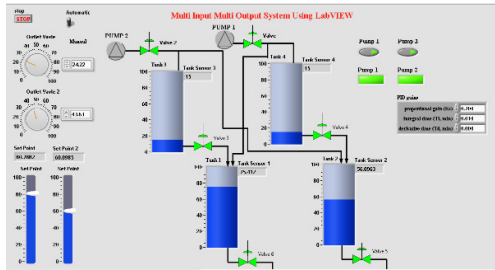


Fig 2. Simulation of Four Tank System (Front Panel)

The fig 2 shows the simulation of four tank system. This is the front panel of the four tank system which consists of set point 1 and 2 of the tank 1 and tank 2 which to be maintain the level of the tank. It has a changeover switch which will make the process in manual mode or automatic mode. It also has the PID gain parameter and the controlled output indicators and it shows the level of the tank in level sensor indicators. The pump1 is given as the input to the tank 4 and tank 1. And the pump2 is given as the input to the tank 3 and tank 2. The output of the tank 3 is given as the input to the tank 1 and the output of the tank 4 is given as the input to the tank 2. This will act as a four tank system. The tank 1 gets 2 inputs one from the pump 1 and another input from the output of the tank 3 and the tank 2 also gets 2 inputs one from the pump 2 and another from the output of the tank 4. The PID controller is used to control the level of the tank 1 and tank 2. The system is set in automatic mode and the set point is given to both the tank and if we give the values to the Proportional, Integral and Derivative the PID controller gives the controlled output and using the controlled output the control valve position will change that open or close using this valve position the level of the tank 1 and tank 2 is maintained at the desired set points. The proportional gain stands for the present value of the process, integral gain stands for the past values of the process and derivative gain stands for the future values of the process. The Proportional and integral can be used individually and it can be combined as PI controller or PD controller but the derivative can't be used individually because it is future values. This is the front panel working of the four tank system.

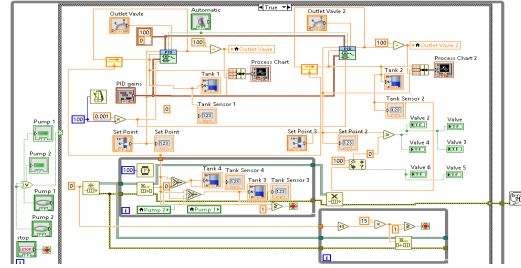


Fig 3. Simulation of Four Tank System (Block Diagram)

The fig 3 shows the block diagram of the four tank system. The PID controller is the controller which is used to maintain the level of the tanks. The set points are given to the PID controller and PID gain values are most important to calculate the controlled output. The level sensor is used to sense the level of the tank and it is the process variable of the system so the output sensor value is given as the feedback value to the PID controller. The producer consumer architecture is used for tank 3 and tank 4 because the tank 3 and tank 4 gets the input from the pump and gives the output to the tanks simultaneously. There are 2 PID controllers used to control the level of the 2 tanks tank 1 and tank 2. The controlled output from the PID controller is given to the control valves v1 and v2. The control valve changes its position open or close according to the controlled output which is given from the PID controller.

VI. SIMULATION OUTPUT

Simulation for Four Tank system level control in tanks is performed by using PID controller in LabVIEW is given below. The set point given to the controller, controller output, and the actual process variable (liquid level in tank) which are the important variables that are involved in the level control process can be observed using the output graphs. X axis in the graph denotes the Time, Y axis in the graph denotes the Process variable. The outputs are as follows

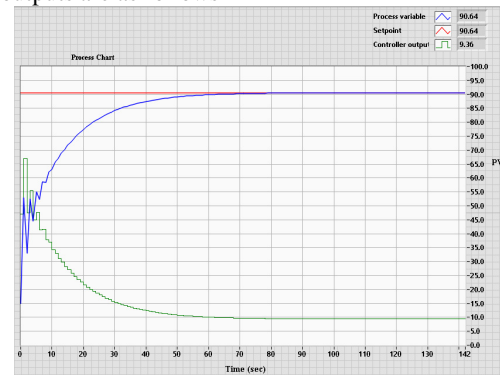


Fig 4. Output Response for Tank 1

The Fig 4 show the output of the controlled tank 1. The set point given to the tank 1 is 90 and the red line shows the set point, the blue line show the process variable or tank level and the green line show the controlled output which get from the PID controller.

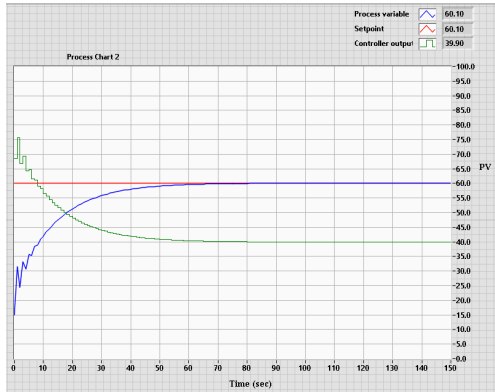


Fig 5. Output Response for Tank 2

The Fig 5 show the output of the controlled tank2. The set point given to the tank 1 is 60 and the red line shows the set point, the blue line show the process variable or tank level and the green line show the controlled output which get from the PID controller.

VII. CONCLUSION

The main problem with a Four Tank Setup is the designing and control of the system. Here LabVIEW is preferred for designing the simulated model of the setup due to its wide range of controlling abilities and easily understandable user interface. It is observed that the four tank setup is highly non-linear hence the controlling of the system is done by using Proportional-Integral-Derivative controller by giving the obtained gain values. The response of the process can be observed by using the graphs which shows the curves of the all the variables involved in the process. Thus with the help of developed simulated model the understanding of the process of four tank system can be done.

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