Control of A Process System using Lab View

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Abstract— We have proposed here a novel method which overcomes the drawbacks in the existing process control technology efficiently. In the current scenario of process control, the choosing of controller to any particular system and development of its algorithm possess a major constraint to the system, further the adaptability of the developed controller to other constant or variable in the system is minimal. So, here in this project we have designed a new virtually platform using LabVIEW which is able to build, predict the parameters and PID values for the given system on its own and could efficiently overcome the problem of adaptability to new variables of the given system. The proposal entitled as Autonomous Tuning of controller. The idea is focused on development of PID controller without human interference. For the proposed method we are using MyRIO "1900" which can be connected to any given system and monitored wireless with a computer interfaced through LabVIEW, where our virtual platform is developed.

Key words: PID controller, MyRIO"1900" Labview, PID parameters, Tuning of controller, virtual platform

I. Introduction

In the modern trend set the field of instrumental and industrial set up has a wide range of advancement in along with the evolution of control design. Controllers play the complete role in maintaining the process for the given/desired set point. This is shown along with the various control tuning techniques that are performed along with the system identification and model validation. This section is dealt with the level process by the QUADRAPULE TANK (multi-variable) system where the experimentation is done in non-interacting process. The main objective of this work is to enforce PID controller in a real time process and to find out the best and suitable controller which provides efficient control action.

II. Need for PID Control

A PID controller is majorly used in industry where heating and cooling processes are controlled like fluid level monitoring and control, flow control etc. Defining Set point and process variable is considered to be the primary parameter for control. A process variable is the one which needs to be controlled and set point is the desired value for the parameter, you are controlling .Designing a PID controller is an essential process in any closed loop process which needs to be adaptive for the process thus determining the controller gain values for proportional(kp), integral(kI), and derivative (kd) is an effective part in controlling a process[5].

III. Quadrauple Tank

The experimental setup is designed to understand the advanced control methods used for complex processes in the industries. The system description deals with the MULTI VARIABLE CONTROL TRAINER 327A which could also be named as QUADRAPULE TANK. It is a basic kit that deals with the interacting and non-interacting process system. This system therefore deals with the separate process such as interacting and non-interacting and also deals with the combination of these processes with the help of the valve system. It also comprises of four transmitters for the respective tanks, two pumps and four outlet valves along with the ADAM controller for performing the interfacing mechanism with the software. The control valve is used to adjust the flow. [1]The non-interacting process in this system is done either in tank T4 and T2 or in tank T3 and T1 by their respective valve connections. This experimentation of non-interacting process is done through value V1 in the valve position is placed in such a way that liquid entirely flows to the tank T4.By opening the non-interacting valve to the respective tank the non-interacting process is carried out which is considered for this control mechanism.

Fig. 1: Multivariable Trainer kit

IV. Block diagram multivariable trainer kit

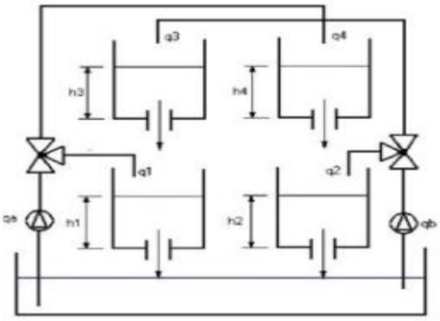

Fig. 2: Block Diagram of Multivariable Trainer Kit

V. SPECIFICATION

Specifications

Product	Multi variable level control trainer
Product code	327A
Type of control	SCADA
Control unit	ADAM-4022T Serial based dual loop PID controller; Analog input 4, Analog output 2, Digital input 2, Digital output 2. with RS485 communication.
Communication	USB port using RS485-USB converter
Level transmitter	Type Electronic, two wire, Range 0–250 mm, Output 4–20mA (4 Nos)
Diaphram pump	Positive displacement diaphram pump with adjustable stroke (2Nos)
VFD	Programmable, input 1 ph. 200VAC, 1.1A, output 3 ph AC, 0-230V, 0.3kVA
Process tank	Transparent, Acrylic, with 0-100% graduated scale (4 Nos)
Supply tank	SS304
Overall dimensions	600Wx1000Dx1800H mm
Optional	SCADA software package

Utilities Required

Electric supply	**Support table**
230 +/- 10 VAC, 50 Hz, 1 phase	Size: 800Wx800Dx750H in mm
Computer	**Water supply**
IBM compatible with standard Configuration	Distilled water @16 liters

Fig. 2:

VI. WORKING OF THE SYSTEM

Open loop response is done in the real time environment without the use of controller and feedback. NI MY-RIO is used to interface the real time system(multivariable trainer kit) to the PC using RS232 cable. The open loop response are fetched into LabVIEW software using acquiring operation with the help of NI MY-RIO respective level for the Respective time is obtained. Control operation is performed using labVIEW simulation process and the controller gain values KP,KI,KD values are generated from LabVIEW loops and through generation process the gain values are fed into the ADAM controller through RS232 cable and thus the desired level control is done.

VII. INTRODUCTION TO LABVIEW

LabVIEW is a Laboratory Virtual Instrumentation Engineering Workbench. This software is ideal for any measurement or control system, and the heart of the NI design platform. LabVIEW is a graphical programming environment .The power of LabVIEW is in its ability to interface with thousands of devices and instruments using hundreds of built-in libraries and prebuilt VIs to help you accelerate development time and quickly acquire, analyze, and present data. Applications in LabVIEW mimic the appearance of real instruments (like multimeters, signal generators, or oscilloscopes), so they are called virtual instruments or VIs. Every LabVIEW application has a front panel, an icon/connector pane, and a block diagram. The front panel serves as the imitation of the real-world user interface of the device that the VI is defining. The icon/connector pane is analogous to terminals or plugs on a real-world instrument that allow it to be connected to other devices. Therefore, VIs can contain other VIs (called subVIs) . LabVIEW uses icons instead of lines of text to create applications. Due to this key difference, execution control is handled by a set of rules for data flow rather than sequentially. Wires connecting the nodes and VIs on the block diagram determine code execution order In summary, LabVIEW VIs are graphical, driven by dataflow and event-based programming, and are multitarget and multiplatform capable. They also have object-oriented flexibility and multithreading and parallelism features. LabVIEW VIs can be deployed to real-time and FPGA targets.

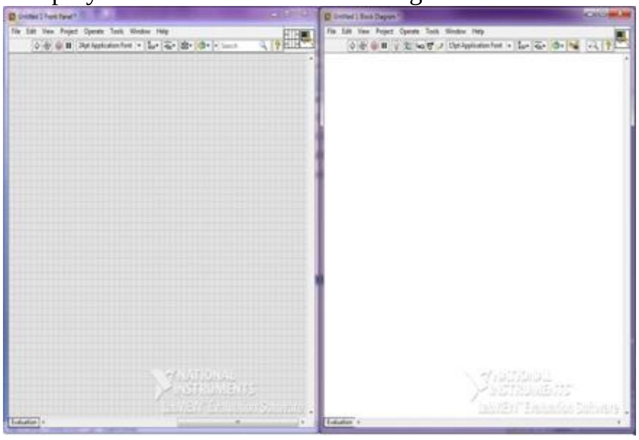

Fig. 3: Labview Window

VIII. NI MY-RIO

NI my-RIO is a National Instruments Reconfigurable Input Output , which is primarily designed for students and Engineers to have hands- on experience on engineering curriculum. It is considered to be the educational deign and prototyping platform based on NI LabVIEW. The NI my-RIO embedded student design device was created for students to “do real-world engineering” It features a 667MHz dual-core ARM Cortex-A9 programmable processor and a customizable Xilinx field-programmable gate array (FPGA).The NI my-RIO device features the Zynq-7010 All Programmable system on a chip (SoC) to unleash the power of NI LabVIEW system design software both in a real-time (RT) application and on the FPGA level. NI my-RIO is a reconfigurable and reusable teaching tool. The RT and FPGA capabilities along with onboard memory and built-in WiFi allow students to deploy applications remotely and run them “headlessly” (without a remote computer connection). Three connectors (two NI my-RIO expansion ports [MXP] and one NI miniSystems port [MSP] that is identical to the NI myDAQ connector) send and receive signals from sensors and circuitry. Forty digital I/O lines overall with support for SPI, PWM out, quadrature encoder input, UART, and I2C, eight single-ended analog inputs, two differential analog inputs, four single-ended analog outputs, and two ground-referenced analog outputs allow for connectivity to countless sensors and devices and programmatic control of systems. All of this functionality is built in and preconfigured in the default FPGA functionality.

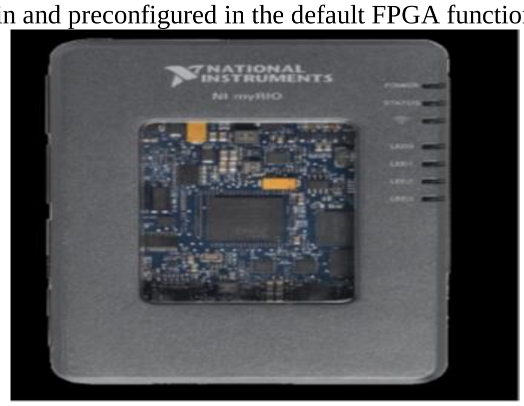

Fig. 4: NI my-RIO

IX. Control of a Process System

A. Identification of transfer function

System identification is the first step in controlling a process which deals with deriving the transfer function form the open loop response which includes deriving the three main parameters like system Gain (k), Time constant (tou) and Dead time(td) these three parameters are essential in deriving the transfer function for the system from the open loop response.

System identification can be done from methods like

1) *Tangential Method*

This method is also known as slop method from the open loop response obtained in labview the gain and tou values are determined which is dislayed below in [Fig 5] depicting the front panel image.

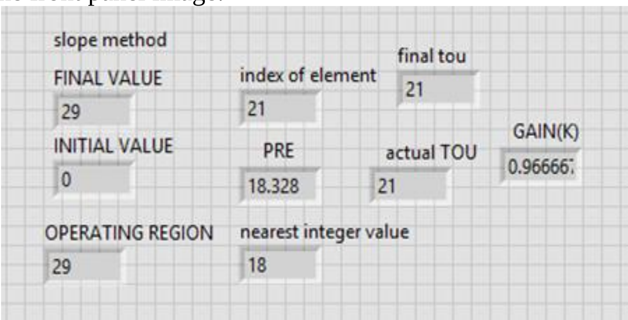

Fig. 5: Tangential Method Front Panel

2) *Two-Point Method*

In this method the transfer function is calculated by using the formulae given below and from the open loop response which is done in labview software and the response is shown below in the front panel depiction.

t_d = t63.2 – t28.3

τ_p = 1.5 (t63.2 – t28.3)

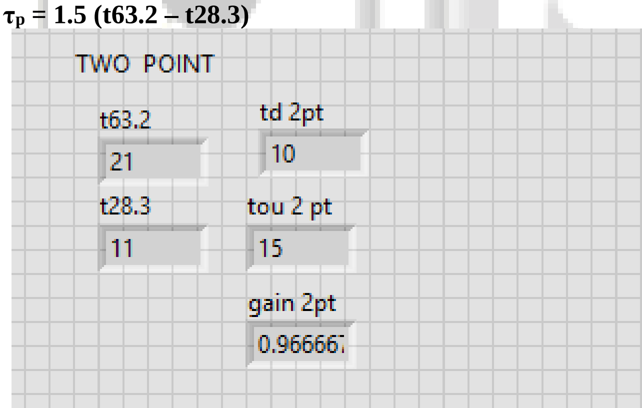

Fig. 6: Two-Point Method Front Panel

Sundaresan and Krishnaswamy use the normalized response $\frac{y}{KM}$ of the model to a step-forcing function: $U(s) = M/s$ at two different times, t_1 and t_2. These times are selected such that the normalized response reaches 35.3% at t_1 and 85.3% at t_2. The recipe gives the estimated values of the time constant and delay time given below

td = 1.3 (t35.3) – 0.29 (t85.3)

τp = 0.67 (t85.3 – t35.3)

from the above formulae the system identification is done using s-k method in fact the way to determine the transfer function from the open loop response is done with the help of above formulae in calculating the dead time and time constant from which the coding is proceeded in LabVIEW. Similar procedure is done for all the system identification methods using the corresponding formulae for the respective system and the coading is developed in LabVIEW.[fig.7] depicts the front panel image of the generated Gain(sk1),Dead time(td(sk)), and Time constant(sk tou).

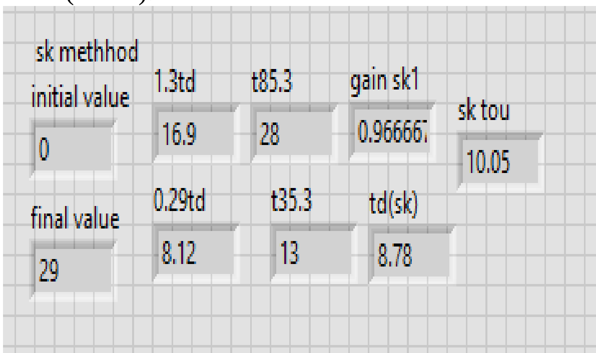

Fig. 7: S-K Method Front Panel

3) *Model Validation*

The best method is chosen from the above methods with the reduced time constant which is found to be s-k method. Thus the transfer function obtained from s-k method is chosen as the suitable for the process. Which is considered for the tuning process in the next stage.

4) *Tuning Process*

[3]Tuning is done to determine the controller gain values (kp,kI,kd) which is done using the common methods in labview like

Ziegler nicholes method

Choen coon method

X. Overall Response of the Process

This display the overall controlled process from system identification, model validation, and manipulating the controller gain values . The image in Fig 8 displays the block diagram consisting of global variables for the required values obtained through the main manipulation process.[4]

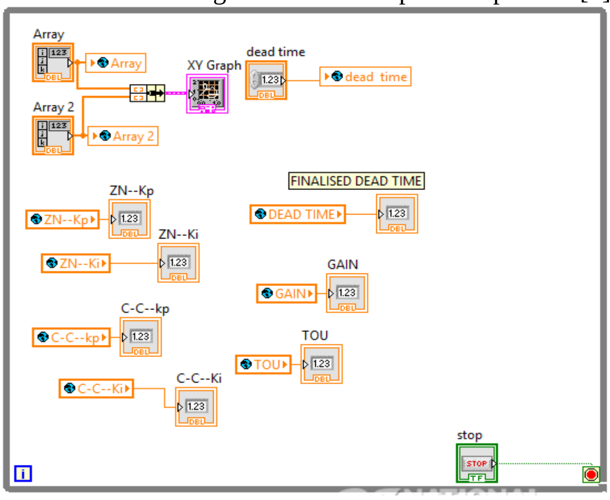

Fig. 8: Block Diagram For Overall Process

The front panel[Fig.9] depicts the values contained in the global variable of the block diagram displaying the open loop response for time and level obtained in the form of array. The best suited transfer function from S-k method with its Gain, Dead time, Tou values and finally the tuned controller gain values using Z-N method and C-C method.

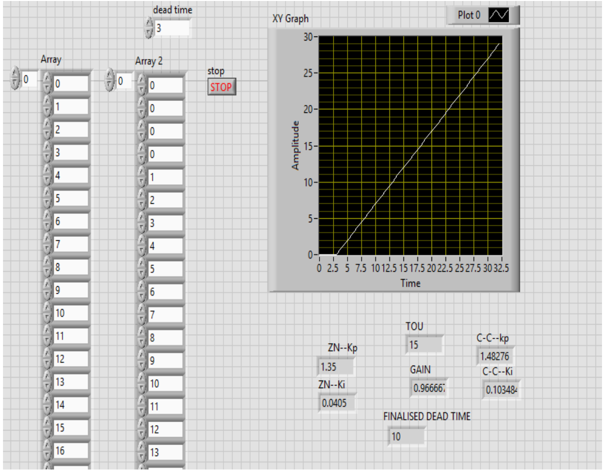

Fig. 9: Front Panel For Overall Process

Based on the tuned values generated, through RS232 cable which is connected with myRIO and the multivariable trainer kit the values are transferred to the ADAM controller in the kit which performs the necessary control action.

XI. CONCLUSION

[2]Based on the attained graphs & readings for level (NON-INTERACTING) process controlling we have established that the modal validation deals best with the SK METHOD and TYREUS AND LUYBEN is suitable tuning methods that provide enhanced performance than any other tuning techniques for the non-interacting process. Thus this concludes with simulation of non-interacting process in LabVIEW which created the control action for the non-interacting process.

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