REAL-TIME DIGITAL SIMULATION OF CONTROL SYSTEM WITH LABVIEW SIMULATION INTERFACE TOOLKIT AND SIMULATION MODULE

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ABSTRACT

In this paper, the virtual instruments software Lab VIEW and its Simulation Interface Toolkit are introduced at first. With visualization technology, Lab VIEW can simulate an industry plant with better effect. The Lab VIEW Simulation Interface Toolkit (SIT) provides a seamless integration between MATLAB/ Simulink software and Lab VIEW. A method is presented to implement real-time digital simulation with no hardware-in-the-loop and a pure software real-time digital simulation example of a Performance comparision between Single loop and Cascade Control of Super Heated Steam Temperature System using analog Controllers using Lab VIEW Simulation Interface Toolkit is given. It can get better effect in teaching or training of industry process control system with minimal cost.

KEYWORDS: Lab VIEW Simulation Interface Toolkit, Real-Time, Digital Simulation, MATLAB

INTRODUCTION

With the development of computer technology, the drawbacks of traditional control system simulation system become more and more apparent. Putting virtual instruments software into control system simulation system will result in not only the cost reduction of the hardware, but also but also the enhancement of the teaching or training effect. NI LabVIEW is the graphical development environment for creating flexible and scalable test, measurement, and control applications rapidly and at minimal cost [4]. With LabVIEW, engineers and scientists interface with real-world signals, analyze data for meaningful information, and share results and applications.

Regardless of experience, LabVIEW makes development fast and easy for all users. LabVIEW programs are called virtua instruments, because their appearance and operation imitate physical instruments, such as oscilloscopes and multimeters. Every VI uses functions that manipulate input from the user interface or other sources and display that information or move it to other files or other computers. MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Simulink can easy analyze model and simulate control systems [7]. Simulink can work with the MathWorks Real-Time Workshop.

Real-Time Workshop generates and executes stand-alone C code for developing and testing algorithms modeled in Simulink. The resulting code can be used for many real-time and non-real-time applications, including simulation acceleration, rapid prototyping, and hardware-in-the-loop testing [5]. So Simulink is widely used in simulation of all kind of systems. But Simulink lack the imitation of physical instruments or equipment in appearance and operation.

It is a good idea to combine LabVIEW and MATLAB in simulation of control system. The LabVIEW Simulation Interface Toolkit [1] integrates LabVIEW with the software of The MathWorks, Inc. known as Simulink and Real-Time

Workshop in a way that allows us to develop, prototype, and test control systems using models developed in the Simulink simulation environment.

The Simulation Interface Toolkit automatically generates LabVIEW code to interface with a Simulink model resulting in a flexible and easy-to-use user interface. After configuring the Simulink model to communicate with LabVIEW, then we can create a LabVIEW host VI that automatically calls, runs, and interacts with the Simulink model [2].

Example in [1,3] teach us how to create LabVIEW user interfaces for simulink models on RT on NI RT Series Hardware. But our goal is to implement real-time digital simulation with no hardware-in-the loop. Same Simulation is performed using LabVIEW Simulation module.It is a pure software real-time digital simulation, so the cost will be low.

SUPER HEATED STEAM TEMPERATURE CONTROL SYSTEM

Conventional steam electric power plant converts fossil fuels - coal, gas or oil - into electric energy. Fuel burned in the boiler releases heat, which boils water and converts it into high-pressure superheated steam. The steam enters a turbine where it expands and pushes against blades to turn the generator shaft to create electric current. After the steam passes through the turbine, condensers convert it to water that is returned by pumps to the boiler to repeat the cycle. Combustion gases exit through the stack. This process is basically the same for all fossil fuels. Steam temperature control is carried out in all boilers to get a constant temperature within a range.

All boilers used for both process and power generation plants have to maintain steam parameters within a particular range. The pressure and temperature of steam at superheater is to be maintained to achieve an optimum plant efficiency. As with any superheated steam cycle, the temperature of the superheat needs to be controlled to ensure that it does not exceed the material limits of the steam turbine and boiler.

Temperature control is accomplished by use of an attemperator desuperheater that injects a controlled amount of cooling water into the superheated steam flow. Attemperator is a coil of pipe through which hot or cold water may be run for regulating temperature. An attemperator is controlled by the control valve which is controlled by the Controllers.

Since Steam is a mixture of hot vapour n pressure there are two types of disturbances acting on Control valve of an attemperator. So a Cascade Control System is used to control temperature of Super Heated Steam.

ANALOG CONTROLLERS AND THERE TUNING

- A Proportional Controller (P) reduces error responses to disturbances, but still allows a steady-state error and offset. Offset decreases with increase in Kp, larger the value of Kp leads to instability and oscillations.

- A Integral Controller (I) when added to proportional error, then the steady state error to a constant input is eliminated, Offset is eliminated, since Integral values depends on previous values response will be slow.

- A Derivative controller (D) increases speed of response, when added with proportional controller reduces oscillations, but still offset is present.

PID CONTROLLER

In the *s*-domain, the PID controller may be represented as

U (s) = (Kp+Ki/S+Kd S) E (s)

CONTROLLER EFFECTS

So the combination of P+I+D eliminates

- Offset.

- Steady state Error.

- Oscillations.

- Output response will be fast.

Depending on the application the combination of different controllers are used. Tuning of the controllers is to be done in order to get good response, with any of the controlling techniques.

Tuning of Controllers with Ultimate Cycling Method

Create a Simulink Model as Shown in Figure

Create Simulink Model as shown in figure.

- Experimentally determine ultimate Gain Kc, Kcu is gain at which the sustained oscialltions are observed.

- Increase the value of Kc until sustained oscillations are observed in the system output

- Pu is the period of oscialltions at Kc

COMPARISION OF SINGLE LOOP AND CASCADE TEMPERATURE CONTROL SYSTEMS

Cascade Control Systems contain integrated sets of control loops

- **Primary Loop:** Monitors the control variable and uses deviation from its setpoint to provide an output to the secondary loop.

- **Secondary Loop:** Receives its setpoint from the primary loop and controls the reference variable accordingly.

CONFIGURING SIMULINK MODEL

To create a user interface in LabVIEW for a Simulink model, we first must have a Simulink model. Before using the Simulation Interface Toolkit, we must have the MathWorks MATLAB 6.0 or later, MathWorks Simulink 4.0 or later and National Instruments LabVIEW 7.0 or later installed on the host computer. We can complete the following steps to build a new control system model in Simulink.

- Installing the Simulation Interface Toolkit configures MATLAB to launch the SIT Server when we launch MATLAB. The SIT Server transfers data between LabVIEW and MATLAB. Launch MATLAB on the host computer. The MATLAB command window displays the following message. Starting the SIT Server on Port 6011 SIT Server started this message indicates that the SIT Server is running.

- Enter simulink in the MATLAB command window to launch the Simulink Library Browser window. In a new model, place a Transfer Fcn blocks, Constant blocks a Sum blocks, a Scope block and other blocks in the model window. The NI Toolkit Sinks library contains two blocks—the NISink block and the NIXY Graph block. These two blocks export the output of the model to LabVIEW so LabVIEW can display the data. At each point we want to monitor in the simulation model, add a NISink to allow LabVIEW to read the data at that point in the simulation model. Since we are going to compare cascade loop and single loop of steam temperature control

system we require two NISink blocks. After wiring the sources, functions, and sinks, the model looks like the diagram in Figure 1.

- Select Simulation»Simulation Parameters to open the Simulation Parameters dialog box to set the simulation parameters. Reference [7] gives a guide how to choose a Fixed-Step Solver and step size. On the Solver tab, type 2000 (which must at least be greater than the settling time of a control system, so we can see a full step response chart of control system.) in the Stop time text box. By Set the Type option to Fixed-step size (fundamental sample time) text box. Select two sliders controls and place them on the front panel. Label the sliders PI controller-kp and PI controller-Ti. Change the PI controller-kp scales to 0 to 10 and PI controller-Ti scales to 0 to 200.

CONCLUSIONS

Simulation Interface Toolkit provides a link between Simulink and LabVIEW. The Simulation Interface Toolkit and Simulation Module enables control design engineers to run Simulink models while using the power of a LabVIEW user interface to display results and modify parameters as the model runs. The method presented in this paper can implement real-time digital simulation with no hardware-in-the-loop. The cost is low because we only need MATLAB, Simulink, LabVIEW and LabVIEW SIT installed on computer.

Adjust the values of the setpoint slider or PI controller parameter sliders while the Simulink model is running for SIT and Adjust the values while LabVIEW is running for Simulation Module. We can see the real-time response effect of the temperature thermometers. As said above We can expand the VI to any other industry process control system. So the real-time digital simulation method presented in this paper is a good choice for engineers and teachers of control systems teaching or training. The responses of the Super Heated temperature system for single loop control and cascade control are shown in Figure.
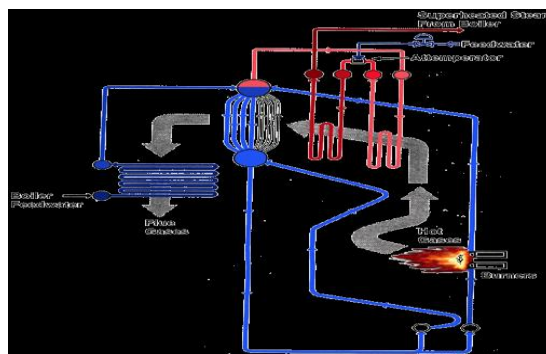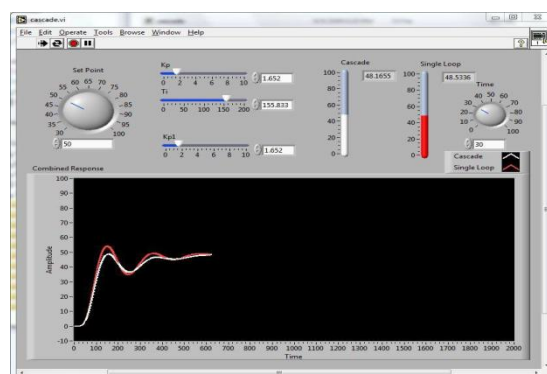

Figure 1: Simulation Results SHB

Figure 2: SHMSM VI Running

Table 1

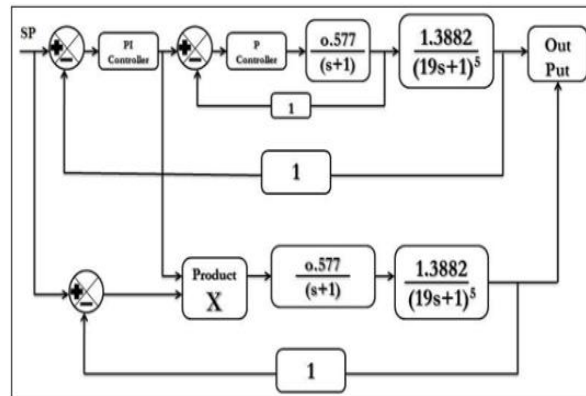| Parameters	Single Loop Control Kc=1.652, Ti=155.83s	Cascade Control Kc=Kc1=1.652, Ti=155.83s,
Set Point	60	60
Maximum Overshoot Mp	64.89	58.59
Rise Time tr(s)	75.372	119.14
Settling Time ts	871.60	648.5
Delay Time td(s)	80.196	75.372
Peak Time tp(s)	139.57	145.04

Figure 3: Combined Block Dig

Table 1 shows the performance of SHS temperature system for single loop control and cascade control to constant step change in set point. Hence out of single loop control and cascade control, cascade control is the best mode of control for SHS temperature system.

REFERENCES

1. National Instruments Corp. LabVIEW Simulation Interface Toolkit User Guide," October-2003[Online]. Available:http://digital.ni.com

2. National Instruments Corp.Building a LabVIEW User Interface for a Simulink Model with the LabVIEW Simulation Interface Toolkit-[Online]. Available:http://zone.ni.com/devzone

3. National Instruments Corp. Using CAN with the LabVIEW Simulation Interface Toolkit [Online]. Available: http://zone.ni.com/devzone

4. National Instruments Corp. Getting Started with LabVIEW,"April 2003 [Online]. Available: http://digital.ni.com

5. A. A. Rodriguez et al. Description of a Modeling, Simulation, Animation, and Real-Time Control (MoSART) Environment for a Class of Electromechanical Systemsresources [J]. IEEE Trans. Educ., 2005,48(3): 359-374.

6. Ogata K. Modern Control Engineering, 4th ed. Englewood Cliffs, NJ: Prentice-Hall, 2002.

7. MathWorks, Inc. Using Simulink [Online]. Available: http://www.mathworks.com/

8. The Bharath Heavy Electricals Limited, Hyderabad: Transfer function of a superheated steam temperature system of 500MW boiler, R&D technical information sheet.
Transfer Function of Control Valve: (0.577)/(s+1)
Transfer Function of SHS Temperature System: (1.3882)/(19s+1)Transfer Function of Measuring Device: 1