Temperature Control Based on LabVIEW for Process Control Laboratory

Chananchai Wutthithanyawat[1] and Nawadee Srisiriwat[2]

[1]Department of Instrumentation and Control Engineering, Pathumwan Institute of Technology, Bangkok, Thailand.
[2]Department of Chemical Engineering, Pathumwan Institute of Technology, Bangkok, Thailand.

Abstract

Instrumentation and control engineering education concentrates on the measurement and control of temperature, level, pressure and flow processes in industry. As the experimental laboratory is very vital to make students more understand in the process control, the process control laboratory offered as an important part of the engineering curriculum is recognized as the opportunity to improve technical skill needed to solve the real work situations. It has been known that temperature control is widely used in industrial process. Therefore, the objective of experimental setup for temperature control in the heat transfer process based on LabVIEW software is to familiarize the students with the basic skills necessary to use equipment and software because the control systems in many industrial processes can be implemented on a computer which runs on LabVIEW.

Keywords - temperature control, LabVIEW, control education

1 Introduction

A process control laboratory course offers for the third-year undergraduate engineering students in the Instrumentation and Control Engineering, Pathumwan Institute of Technology, Thailand. Normally, the necessary background knowledge for the study of process control consists of basic mathematics, physics, electrical and electronic circuit, sensor/transducer and signal conditioning and programming. The course description of the process control laboratory course is following: introduction to process control, modeling and analyzing process dynamics, feedback and feedforward control, PID controller and tuning, model based control and introduction to multivariable control. The main objectives of this laboratory course are to make students understand process control design and computer–aided control design, to support learning by doing, to increase the interest of students between process control theory and practice, and to familiarize students with the implement and rapid control tools using LabVIEW software.

Nowadays, there are various process control laboratory based on LabVIEW for engineering teaching and practice [1-3] because LabVIEW provides a modern tool to easily perform the computer-based experiments, user friendly and low cost for implementation [4]. In addition, LabVIEW has module and toolkit for control engineering education, such as control design and simulation module, PID & Fuzzy logic toolkit, real-time module and other module and toolkit for engineering education. So far, there are many applications of control system designed by LabVIEW [5-8]. The tension control for digital picture kiosk by LabVIEW with FPGA module was introduced by Gomez and Goethert [5]. The LabVIEW with PID & Fuzzy logic toolkit was applied to temperature control by auto-tuning PID via Grey-predictor [6] and Fuzzy Logic controller and Neuro-Fuzzy controller based on LabVIEW were proposed in [7] and [8], respectively. Moreover, the real-time control by LabVIEW with real-time module was also presented [9-11]. As mentioned earlier, the process control laboratory based on LabVIEW will become an important way and method to experimental teaching. As a development of the lab equipment combined with computer–aided control design is remarkably needed and the temperature control is very useful in many industries, the heat flow process is created and used for the experimental teaching in the process control laboratory course. The objective of this paper is to present the experimental setup of temperature control based on LabVIEW for heat flow process. The results of control system response are shown in this paper as well.

2 Heat Flow Process

A model of heat flow process was designed as shown in Fig. 1. The atmospheric air forced by electrical fan flows across heaters to generate hot air in which the heat flow based on internal forced convection heat transfer was presented. The air velocity can be measured and adjusted via LabVIEW. To control temperature in the rectangular channel, the RTD sensors were used to measure temperature and the heater power supply can be adjusted. This process is widely used to perform the controller design represented by first order plus dead time (FOPDT) model [12, 13]. It is because of the reasonable cost of heat flow process that makes it suitable for experimental setup for the process control laboratory.

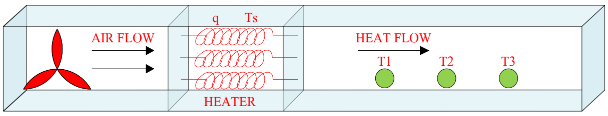

Fig. 1. Model of heat flow process.

3 Experimental Setup

The experimental apparatuses of heat flow process are composed of a set of heat flow process, DAQ card and LabVIEW software as depicted in Fig. 2.

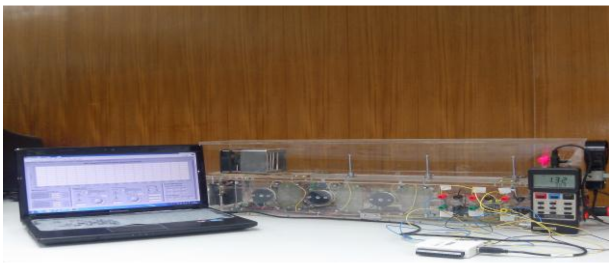
Fig. 2. Experimental apparatus of heat flow process.

The controlled and manipulated variables are displayed on the front panel of LabVIEW as shown in Fig. 3. Fig. 4 shows the model parameters displayed on the front panel of controller configuration. Fig. 5 illustrates the block diagram of LabVIEW.

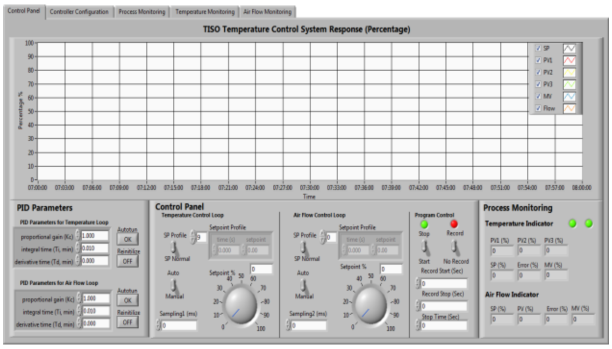

Fig. 3. Front panel for temperature control.

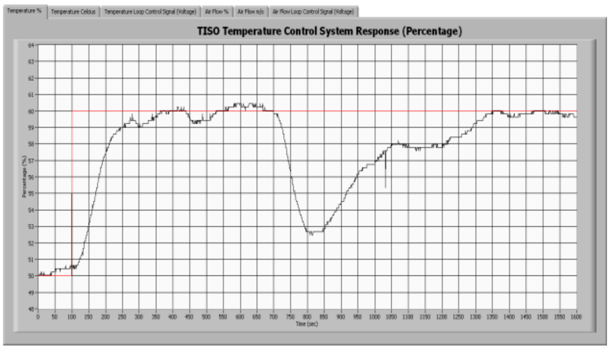

Fig. 6. Temperature control system response.

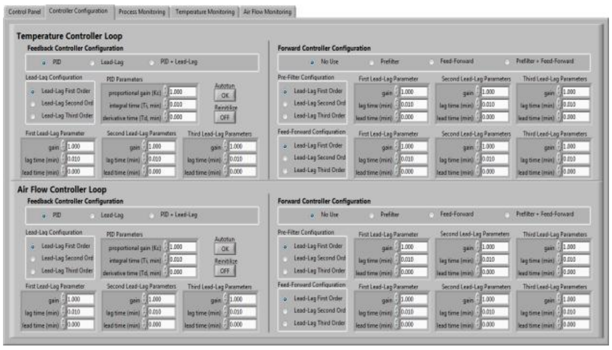

Fig. 4. Front panel for controller configuration.

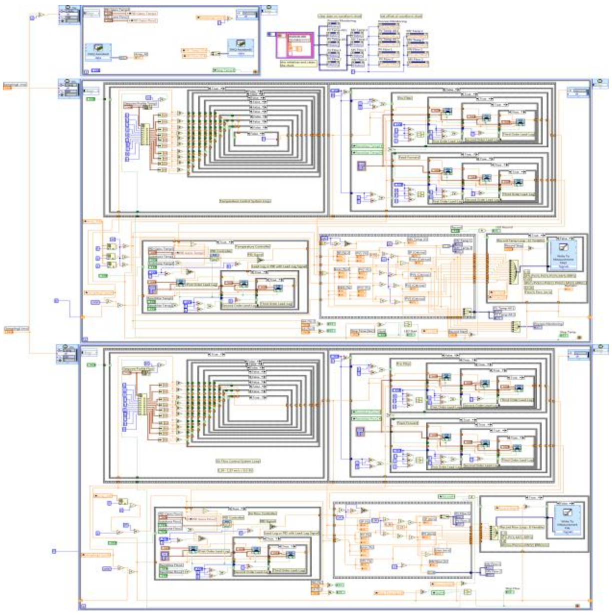

Fig. 5. Block diagram of LabVIEW.

4 Experimental Results and Conclusion

Because of the growing interest of the development of modern experiment for process control laboratory in Instrumentation and Control Engineering, the experimental setup of heat flow process for temperature control based on LabVIEW has been performed to give students a hands-on experience and view for process control design and computer-based laboratory that LabVIEW environment is accepted for implementation of local instrument control that a result of the response of temperature control system can be demonstrated by LabVIEW as shown in Fig. 6. Using these equipment and software, students can attain their experience to learn by the modern technology in the process control. Students have deeper understanding of the instrumentation and control engineering principles and their applications.

Acknowledgements

Authors gratefully acknowledge Pathumwan Institute of Technology for financial support.

References

[1] S.J. du Preez, S. Sinha and M. Hutton, A LabVIEW courseware customized for pre-college learners, Proc. AFRICON, Namibia, pp. 1-5, 2007.

[2] Mark A. Yoder, Bruce A. Black, Teaching DSP First with LabVIEW, Proc. Digital Signal Processing Workshop 12th – Signal Processing Education Workshop 4th, USA, pp. 278-280, 2006.

[3] Perez E. and Shearman S., LabVIEW DSP – A Hands-on DSP Educational Platform, Proc. Digital Signal Processing Workshop and 5th IEEE Signal Processing Education Workshop DSP/SPE, USA, pp. 232-237, 2009.

[4] Witoon Prommeel, Nitipong Somchaiwong and Suchitra Jeenawong, The low-cost instrument with LabVIEW And DB25, Proc. SICE-ICASE International Joint Conference, Korea, pp. 1996-1999, 2006.

[5] A. Gomez and E. Goethert, Control System Design using LabVIEW FPGA for a Digital Picture Kiosk, Proc. American Control Conference ACC, USA, pp. 1406-1409, 2006.

[6] Chien-Ming Lee, Yao-Lun Liu, Hong-Wei Shieh and Chia-Chang Tong, LabVIEW Implementation of an Auto-tuning PID Regulator via Grey-predictor, Proc. Cybernetics and Intelligent Systems, Thailand, pp. 1-5, 2006.

[7] P. Thepsatorn, A. Numsomran, V. Tipsuwanporn and T. Teanthong, DC Motor Speed Control using Fuzzy Logic based on LabVIEW, Proc. SICE-ICASE International Joint Conference, Korea, pp. 3617-3620, 2006.

[8] Pedro Ponce, Fernando Ramirex and Veronica Medina, A Novel Neuro-Fuzzy Controller Genetically Enhanced Using LabVIEW, Proc. Industrial Electronics IECON, USA, pp. 1559-1565, 2008.

[9] Dietrich Beck, Holger Brand, Christos Karagiannis and Christian Rauth, The First Approach to Object Oriented Programming for LabVIEW Real-Time Targets, IEEE Transactions on Nuclear Science, Vol. 53, No.3, June 2006.

[10] Xiang Xuejun, Xia Ping, Yang Sheng and Liu Ping, Real-time Digital Simulation of Control System with LabVIEW Simulation Interface Toolkit, Proc. Chinese Control Conference 26th CCC, China, 318-322, 2007.

[11] V. Peddigari, N. Kehtarnavaz and P. Loizou, Real-Time LabVIEW Implementation of Cochlear Implant Signal Processing on PDA Platforms, Proc. Acoustics, Speech and Signal Processing ICASSP, USA, pp.II357-II360, 2007.

[12] Kou Yamada, Takaaki Hagiwara and Yosuke Shimizu, A Design Method for Modified PID Controllers for Time-Delay Plants And Their Application, Proc. Electrical Engineering / Electronics, Computer, Telecommunications and Information Technology (ECTI), Thailand, pp. 225-228, 2007.

[13] Hyo-Sung Ahn, Varsha Bhambhani and YangQuan Chen, Fractional-order integral and derivative controller design for temperature profile control, Proc.Control and Decision Conference CCDC, China, pp.4766-4771, 2008.