Control of a Three-Tank Process System

Introduction

As a typical process control system, a three-tank system has been constructed and used for student project purpose in AAUE, as shown in Fig.1 This system can be viewed as a prototype of many industrial process applications, such as in the wastewater treatment plant, in the petro/chemical plant and Oil & Gas systems as well. The lab-scaled system plays a good platform to study process control systems with reasonable physical size and complexity level.

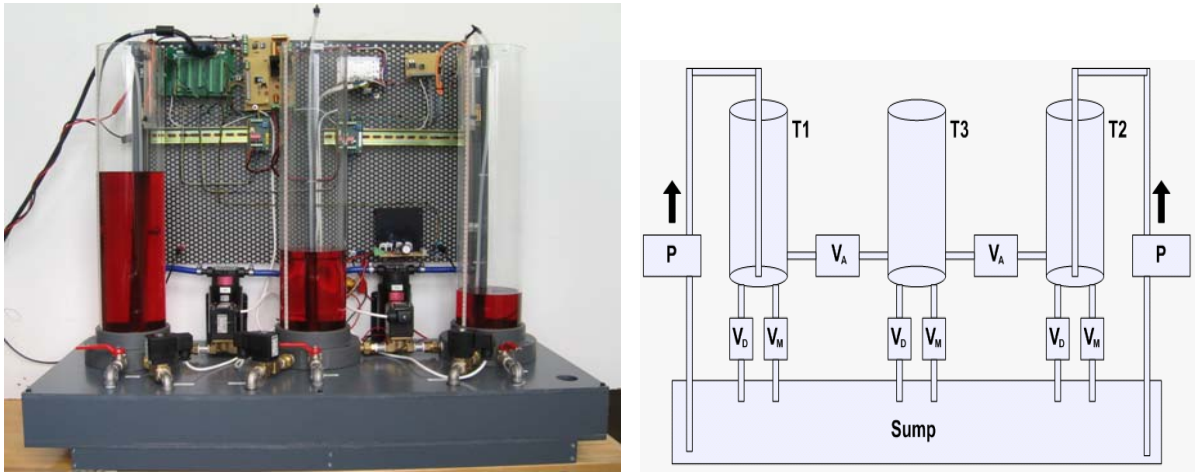

Fig.1 AUE Three Tank System (left) and its Schematic Diagram (right)

As shown in the schematic diagram of the physical setup, the system consists of four “tanks” - one large "sump", and three see-through tubes which are all interconnected through valves are named tanks. Two pumps are used to pump water into Tank 1 and Tank 2, respectively. The control objective is to control the water levels in these tanks by manipulating the pump(s) and/or adjustable valve(s).

Objectives

The objective of this project is to study the control of this process system. There could be different control objectives, such as

Topic One: Single-Tank Level Control

The aim is to control the water level in Tank 1 by manipulating the connected pump system, where the outlet valves connecting to Tank 1 are left open at some positions. The developed controller should be able to drive the water level to track the set-point with proper transient dynamic, and also be able to compensate possible deviations caused by changing the outlet valve position(s).

Topic Two: Two-Tank Level Control

The similar idea can also be used to control the water level in Tank 3. Within this configuration, two tanks (Tank 1 and 3) will be used. The outlet valves from Tank 1 except the intermittent valve between Tank 1 and Tank 3 will be closed. The system outlet will be the outlet valves connected to Tank 3. By manipulating the pump system connected to Tank 1, the water level in Tank 3 should be

able to track any given reasonable set-point, and also be able to compensate possible deviations caused by changing the outlet valve position(s).

In general, the project contents could include:

- Hardware development/improvements;
- Mathematical modeling and Matlab Simulation;
- Be familiar with Labview Software and programming, because the current system uses a Labview interface and data acquisition card, and the developed controller also can be implemented in PC-based Labview environment;
- System property analysis and Control design;
- Validation and comparison if more than one kind of controllers is developed.

Resources

- The main hardware system is available at AUE E-Laboratory;
- Some previous project reports.

Remarks

If the group has further ambitions, the developed control system could be extended into a Networked Control System (NCS), which means a control system wherein the control loops are closed through a real-time network. As shown in Fig.2 the feature of an NCS is that control and feedback signals are exchanged among the system's components in the form of information packages through a network. Then, what kind of network, how about communication protocols, real-time information collection and efficient processing of sensors data and so on, need to be explored and handled in the project, besides the development of standard feedback control system. Two typical challenging issues of NCS are: the additional time delays in control loops and possibility of packages loss.

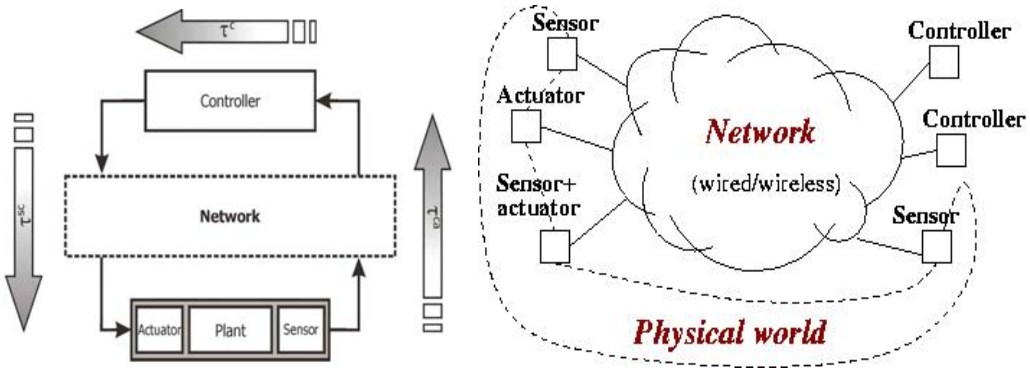

Fig.2 Schematic Diagram of Networked Control System

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