AN APPLICATION FOR THE DEVELOPMENT OF PROCESS CONTROL TRAINING SET

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Abstract: In this study, a design, flexible and can work on many platforms, has been made for process control education. Design is an electronic board, communicated with equipment of proses control training set made by the Bytronic. Electronic card is capable of such these features; sensor reading (PT100), temperature control and fluid flow control etc. Software has been developed inside microcontroller located on the electronic board. This software can be achieved data transfer by connecting with the computer via USB. Thus, process control training set can be made from programs such as Matlab, .Net etc. This provide a great convenience and flexibility for students.
In this study will be described electronic cards and computerized control methods designed.
Keywords: Process control, Training set

Introduction

Chemical processing of the inspection and control procedures is called process control. Generally fluid such as liquid and gas are controlled in the chemical process (Stephanopoulos, 1984). Process control includes the following processes; transferring fluid, heating, mixing and cooling. All information on this transaction will be via sensors. Actuators are controlled by processing data received (Lipták, 2013). The sensors used in, detects information such as the liquid level, temperature and fluid velocity. As the output, heaters, fans, valves, pumps are controlled (Bequette, 2003).

This study design is made for effective training in process control. The design is composed of electronic cards and software interface. Studies have been applied to the Bytronic process control training set have been in the Mechatronics laboratory located Trakya University Faculty of Engineering. Hardware and sensors have been used of the current training set in practice. Electronic circuits are designed for reading the sensors and control of the actuators. Monitoring of all signals by the microcontroller. Similar studies have been published for effective control training (Gillet, Longchamp, Bonvin, & Franklin, 2014).

In the next section will be discuss designed electronic circuits, the applications and microcontroller software.

Material and Method

This paper studies will be discussed in two categories namely software and hardware. Hardware; It consists of electrical circuits which is designed and produced. Software is interface, developed on different platforms for process control function.

Figure 1: Process Control Training Set

Electronic Circuit

In this study developed electronic circuits for reading the sensor and controlling the actuator on the process control training set. The sensors contained in the system; PT100 temperature meter, analog liquid level meter, flowmeter, limit sensors. The output elements are mixer (DC motors), pump (DC15V), valves (DC 24V), heater (AC220V), radiator coolant -fan (DC24) and lamps. All signals are processed by microcontroller. In addition, the microcontroller communicates with the computer, providing data transfer. Designed circuit will be discussed below.

Temperature Measurement (PT100)

Pt100 is a sensor, a resistance varying with temperature ("PT100," 2015). 0-100 °C change in resistance is 100-138.51Ω. An operational amplifier (opamp) circuit is designed to read this small change (Ding, 2015). First circuit makes extraction, after than circuit increases signals. There are three PT100 temperature sensor for temperature measurement in training set. There are two of them in two separate tank. The other measures the coolant exit temperature.

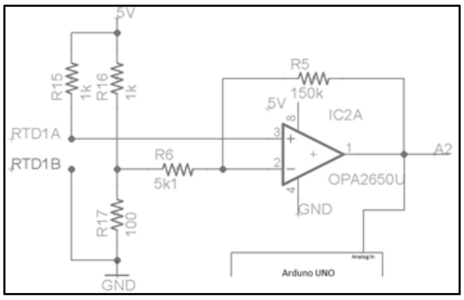

Figure 2: PT100 Reading Circuit

Liquid Level Meter

Liquid level is measured in the mixing tank. Exchange of the liquid level sensor value is changing linearly. This value is read analog (Jiang & Xiao, 2015). This value is connected to the microcontroller by filtration. It is also made filter in the software.

Heater Control

220V 2200W heater is used. Solid state relay used for heater control. Control is done by observing the AC phase transition. Heater will be controlled by changing the trigger angle. Optical isolators are used to protect the circuit (Booma, Reddy, & Pradeep, 2015).

Flowmeter

The flow rate measurement sensor has a rotary disc. As long as it revolves flow. Each rotation generates a pulse. The number of pulses counted flow rate was determined by the microcontroller. The pulses are read by the interrupt input. Multiplied by the number of rotations per unit time flow rate and ratio are provided.

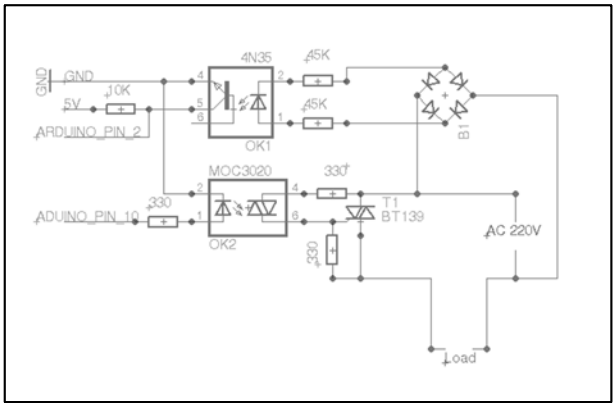

Figure 3: AC220V Heater Control Circuit

DC Motor (Pump, Fan) and Valves Control

Semiconductor elements is selected according to the voltage and current values to control pump, fan and valves. Microcontrollers Control signal is 5V. However, the motor and the valve voltages and currents are higher. This reasons, good-value MOSFETs are used for control. DC motors performance can be controlled gradually with PWM signal. Whereas the valves works on/off. Transistors is used for signal optimization.

Signal Lamps

Output of the signal lights is taken from the control signal. 24V bulbs, located on the set of experiments were control. Also SMD LEDs are positioned on the design of electronic circuits.

Microcontroller and Control Board

Arduino UNO platform, which includes Atmel-based microcontroller has used. The Arduino is retrofitted to board designed. The Arduino Mega has the same pin structure can be used in the system. All control and signal is connected to Arduino Uno the pin by adapting the electronic circuit. Read the signals and control signals are sent to the definition pins. Also Arduino communicates with computer through the USB. Signals can be monitored easily by simple communication protocol from different platforms (MATLAB, LabVIEW, .NET etc.). PWM, digital and analog signal processing can be performed easily with the MATLAB applications.

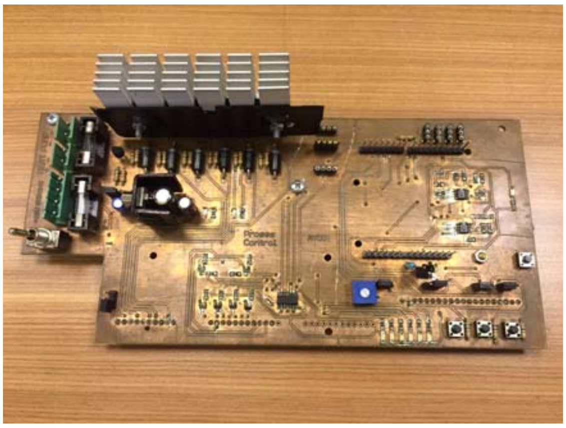

Figure 4: Designed Electronic Board

Software

The software consists of two stages. First of them is signal optimization software developed on the Arduino. The other is the control software can be developed on different platforms. Arduino is programmed differently for MATLAB and .NET programs.
Switching between these two platforms can be made by means of a jumper.

Arduino

The Arduino software includes within its scope the following; reading of analog signals, reading of digital signals and to be sent digital signals. It is also made in the mathematical transformation for convenience later, like these data; liquid level, temperature and flow rate. Processed and calculated signals are sent via USB in real-time to program will be used. Again, the signals coming from the program perceived in the Arduino side outputs are controlled.

Matlab (Simulink)

Software is developed to perform control operations. It allows to quickly control to process the available control blocks located in Matlab. Input and output signals can be taken directly to the Arduino. Also it can be achieved communication via the serial port with improved communication protocol. The same time is used at .NET. The figure below shows the routine for process control fluid level, developed in MATLAB environment.

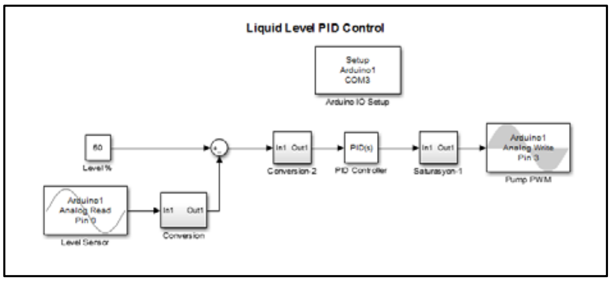

Figure 5: Matlab Simulink PID Level Control Interface

.Net (C #)

As in Matlab interface communication is provided via USB. The required equipment can be controlled by means of visual or console software. For this, there is no need for an additional library. The following figure shows an example for PID temperature control interface.

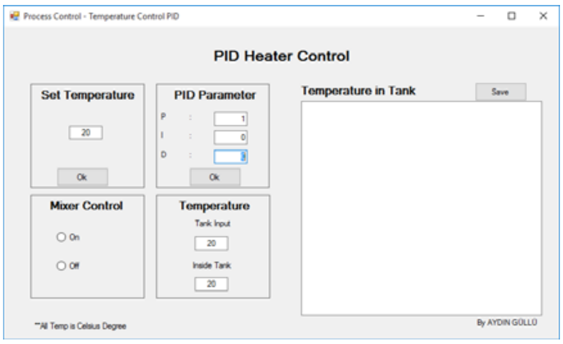

Figure 6: Heater control interface with C#

Conclusion

In this study, a new electronics and software are designed for Bytronic process control training set. Process control and education began to be more effective with this design. Students from different platforms via USB has been able to make process control. All equipment can be controlled with developed electronic circuits via USB. Control operation, such as temperature, level can be performed easily in real time with example designing interface. These designs can be implemented in a simple manner as a result of the different control methods will be provided with different platform. Both educational and experimental results-oriented work processes shortening is provided. In addition, using the infrastructure of software such as MATLAB, provides the implementation of different control methods. Likewise, a way of working compatible with other software such as .NET, C#, LabVIEW etc. provided.

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