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Controlling Of Water Temperature And Flow Rate

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Abstract

Nowadays, offices, restaurants, factories, etc. use liquid temperature control systems. Usually these systems are working according to a very simple logic. For example, water heaters are closed down after boiling water. There is no temperature control in those systems. Another water temperature system is electric water dispenser. In this system, water can be hot or cold without temperature controller. Therefore, water or liquid at the desired temperature can be obtained. There are hot and cold water tanks in the system. The temperatures of the tanks are kept constant. When users want water at a specific temperature, system calculate hot and cold water rates and mix them. In this way, the desired water temperature is obtained. This system can be use another liquid temperature control. The input values of temperature and flow rate of water is entered with the help of MATLAB GUI interface. The values are sent to STM32F4 controller card. The flow rate of the tank is controlled by the opening and closing of the solenoid valves. The flow rate of the water is measured by a flow meter and values sent to MATLAB in order to control flow rate of water.

Keywords: Liquid Temperature, Water Flow Rate, On/Off Control, Tank Level Control

INTRODUCTION

Nowadays, flow control systems are widely used in many fields. Liquid flows and gas flows controls with these systems. In addition, flow rate, pressure, temperature etc. features of water can be controlled.

In this study, it is aimed to control the water or fluid at the desired temperature. A simple On/Off control is used for this system. MATLAB/Simulink toolbox is used as control software. MATLAB/Simulink toolbox is advantageous to design the controller in simulation environment. Therefore, system problems can be found or system update can be set in this simulation environment. In this system MATLAB/Simulink Waijung block set is used. The system is controlled in real time. The system interface was done in MATLAB/GUI. Therefore, input and output parameters can be monitored easily. Thus, the system can achieve controlling of the temperature and flow rate of desired water by entering what the user wants. GUI interface is shown in the Figure 1 [1, 2].

System general design is shown in the Figure 2. Mechanical drawing system design is created in Solid Works environment. Mechanical drawing is shown in Figure 3. The system includes two tanks. First tank has temperature water and the other tank has fixed hot water. Second tank temperature control with thermostat. In this system On-Off control was done with solenoid valve. Control parameters are flow rate of water. The flow rate of water can control with help flowmeter. The value of the pulse from the sensor is converted to milliliters. flow rate and temperature of water requested by the user obtained two tanks. Given waters in the two tanks changes requested flow rate and temperatures of water. The flow rate is determined using the generated mathematical model. After the requested water pass the flowmeter sensor, sensor sent a signal to valve and valve closes. Then two different tanks water mixes and requested water obtain.

METHODOLOGY

Temperature Control

Temperature control is a very common application in industry and daily life [3]. It is used in significant various sectors such as industry, chemistry, petro-chemistry, food, and medication. There are many techniques for requirements and applications since temperature control is very necessary and important process. In some applications where the temperature is kept at sufficient certain intervals, open-close process which has low cost is used. However, in some applications where temperature level is desired to keep at a certain value, more developed methods such as PID control is used. If this control system is inefficient or works wrongly, this can cause financial damage. In order to prevent these damages, raise the awareness of user's education gains importance. Therefore, many company created their own temperature units to give education [4].

Temperature control is done with the help of thermostat sensor. Electric heaters resistance are used for hot water. Thermostat probe puts in the water and measures water temperature. Thermostat has upper and lower limit temperature. Resistance inputs connect the thermostat. If water is too hot thermostat sent a close signal, resistance stop giving heat to water. If water cold thermostat sent an open signal, resistance start giving heat to water. In this way water temperature can be constant. Necessary processes for temperature of water control are shown in the Figure 4.

Resistance system reference value is obtained with digital input block. Convert blocks allows the interconversion of different signals; X unit delay provides with Z-X blocks. When X= -1 used, the system sends a previous answer. Mathematical equations have been applied to system with MATLAB function block.

Flow Rate Control

The level of the liquid should be primarily control for the fluid processing system in industry. Usually liquids are used in process control systems. Controlling the status of the liquid in the tanks is extremely important. Therefore, it is a requirement application in many areas such as the fluid level in the nuclear tank and the water treatment plant, dry industry [5]. Because of the slight fluctuations in the liquid level control is the most common in PID method [6]. In addition, where PID is not enough for the level control, PID is used in combination with fuzzy logic [7]. In the fluid level control, there are studies and applications with neural network structure [8].

A control tank is often used in the experimental setup in the liquid level control applications as seen in the products of Festo and Bystronic companies. With the aim of realizing closest test as same in some industrial applications, the experimental set with three tanks is used [9].

Flow control is measured by the flow meter sensor. There is a system inside the flowmeter sensor which is working like watermill. Flow gives the output as a pulse by turning the mill inside the sensor. Output is obtained as milliliter by applying the necessary equations [10].

Flow rate that is passing from the mill is read as a pulse with the help of PWM capture block from the sensor output. Reading pulse values are converted to milliliters multiplied by coefficients in the gain blocks. Coefficients varies according to the flow of the fluid. The system fluid flow is constant and flow rate of output by coefficients that is set are arranged as milliliter. Hot water and cold water flow are controlled by two different flowmeter sensor. Processes of the hot water flow and cold water flow are shown in Figure 5 and Figure 6.

Different equations have been created according to the UART RX and PWM capture block in Matlab function. Hot water and cold water pwm capture Matlab function code in Figure 7, the hot water and cold water uart-rx Matlab function code in Figure 7 and temperature matlab function code is shown in Figure 7.

Solenoid Valve Control

Solenoid valves have two different forms which are normally closed and normally open. When voltage is applied to the coil on the valve, position-changing valve allows fluid to pass through or stop the passage. Solenoid valves work in a certain pressure range, some valves that need to have zero pressure work as on off. In general, there are the solenoid valves which are opened when the flow at appropriate pressure after the coil is triggered. In our system, it used two solenoid valves; normally closed and zero pressure. When desired flow rate of water passes through the flowmeter, the energy of the coil was interrupted by sending information to related valve and flow stopped. This procedure was carried out as a separate to the cold water and hot water flows.

RESULTS and DISCUSSIONS

The desired flow rate and temperature of flow control system had been controlled by the on off control methods. According to the total flow rate and temperature, that user wants coming from the system the flow rate of hot water and cold water flow rate values are shown in Figures 8 and 9. Output parameter refers to logic 1 and logic 0 situations. A large coefficient was used for it can be seen in the chart. The flow rate entered is that determined by the flow rate that the user wants hot water and cold water flow rate.

CONCLUSIONS

In this study, desired temperature and flow rate of water is obtained from two tanks at different temperatures. The system has been controlled at MATLAB / Simulink environment. The solenoid valves are controlled by using STM32F4 controller card. Finally, desired temperature and flow rate of water is obtained by using On/Off control of solenoid valves.

ACKNOWLEDGEMENT

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REFERENCES

[1] Z.BİNGUL, “Matlab ve Simulinkle Modelleme/ Kontrol”,İstanbul,Birsen Yayınevi, 2011.

[2] A.Singh, N.Aphiratsakun, “AU Solar Tracking System”, Assumption University Thailand, 2015.

[3] Jing, Li-Xia, and Cheng Zhao. “A fuzzy auto-tuning PID temperature controller.”IT in Medicine & Education, 2009. ITIME’09. IEEE International Symposium on. Vol. 1. IEEE, 2009.

[4] http://www.feedback-instruments.com/products/education/.

[5] Yongsheng, Qiu, Wang Yong, and Sun Nan. “Design of liquid level control system of nuclear power plant.” Electronic Measurement & Instruments (ICEMI), 2013 IEEE 11th International Conference on. Vol. 2. IEEE, 2013.

[6] Isa, I. S., et al. “Comparative study of PID controlled modes on automatic water level measurement system.” Signal Processing and its Applications (CSPA), 2011 IEEE 7th International Colloquium on. IEEE, 2011.

[7] Xiao, Qianhua, Deqiong Zou, and Ping Wei. “Fuzzy adaptive PID control tank level.” Multimedia Communications (Mediacom), 2010 International Conference on. IEEE, 2010.

[8] Zhou, Keliang, et al. “Double-tank liquid level control based on genetic algorithm.” Intelligent Human-Machine Systems and Cybernetics (IHMSC), 2012 4th International Conference on. Vol. 2. IEEE, 2012.

[9] Jatoth, Ravi Kumar, Anubhav K. Jain, and T. Phanindra. “Liquid level control of three tank system using hybrid GA-PSO algorithm.” Engineering (NUiCONE), 2013 Nirma University International Conference on. IEEE, 2013.

[10] M. PAPAGEORGIOUT, A.MESSMER, “Flow Control Of A Long River Stretch”, 2003, p. 177-183.

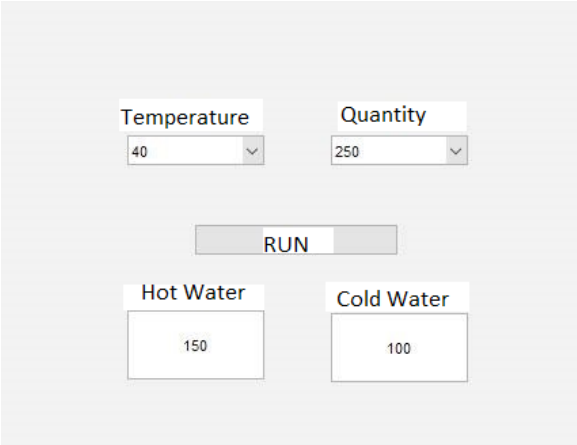

Figure 1. The Matlab/GUI Interface of The System

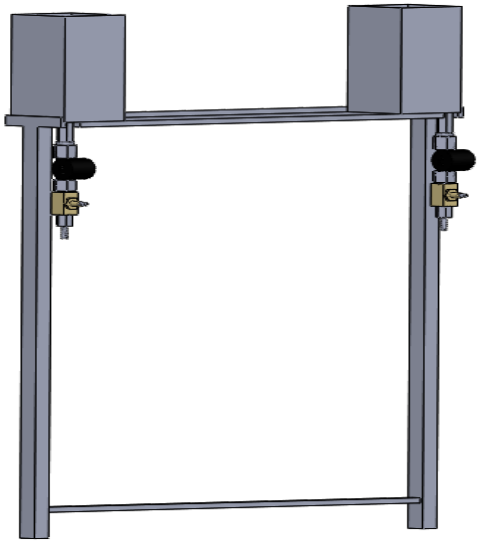

Figure 2. The Experimental System Design

Figure 3. Assemblyed Flow Control System

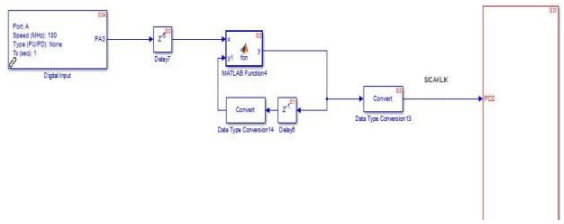

Figure 4. Simulink Blocks for Desired Fixed Temperature Value

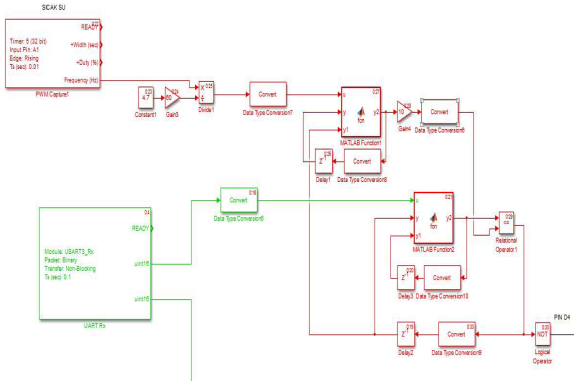

Figure 5. Hot Water Flow Rate Control and Conversion of Millimeter Process

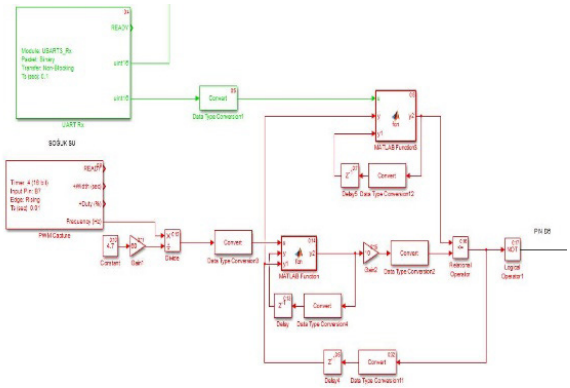

Figure 6. Cold Water Flow Rate Control and Conversion of Millimeter Process

```
function y2 = fcn(u,y,y1)
if y1==1
 y=0;
 u=0;
 y2=0;
end
y2=u+y;

end
```

```
function y2 = fcn(u,y,y1)
if y==1;
  y2=u;
else
   y2=y1;
end

end
```

```
function y = fcn(x,y1)
y=y1;
if y1 == 0
   if x == 0
      y = 1;
   end
else
   if x == 1
      y = 0;
   end
end
   y=y;
end
```

Figure 7. Matlab Function Codes

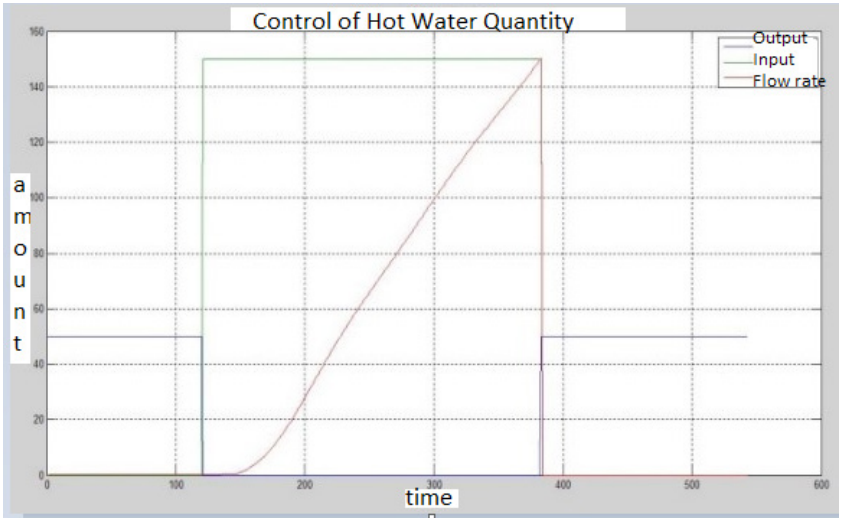

Figure 8. Hot Water Flow Rate

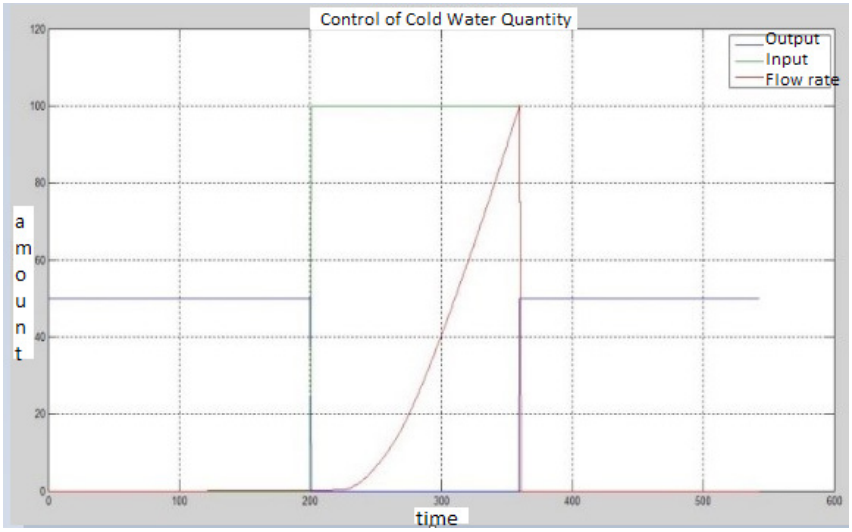

Figure 9. Cold Water Flow Rate