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by Faisal Irsan

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Design of control system expand valve on water heating process air jacket

F I Pasaribu* **and I Roza**

Department of Mechanical Engineering, Faculty of Engineering, Universitas Muhammadiyah Sumatera Utara, Medan, Indonesia

*Email: faisalirsan @umsu.ac.id

Abstract. Many automatic machines implemented in the processing of palm oil in the industry are less effective in working on a heating control process in the jacket water system. With the ATMega, 328 Arduino Uno microcontroller control system as an Arduino program input and output controller and "C" language, a servo motor as output (valve) is controlled, and LCD as a display device for LM35 temperature detection can make it easier for workers to control the process of controlling water temperature on the jacket and can avoid failure in the process of melting the palm oil from the previous processing so that the oil in the pipeline continues to flow. The method used in this research is the design method that consists of several stages, namely, (1) Requirement analysis, (2) Design, (3) Implementation of the circuit, (4) Testing Procedures and (5) Testing tools. The level of accuracy of the rotation degree of the servo motor (as a valve) qualifies 100% (>35 °C and ≤ 49 °C, the motor rotates 40°), the relationship between temperature and the rotation speed of the servo motor qualifies with 100% accuracy (>50 °C and ≤ 53 °C then the motor rotates 80 °C) The overall performance of this tool can work well and calibration of the detection temperature value between the LM35 sensor with a thermometer has a difference of 1 mV so that it can be implemented by adjusting devices in the industry.

1. Introduction

Companies or industries that are engaged in the oleochemical indeed booming, because community needs will be incessant oil. PT. Musim Mas is one company that has been the focus of the industry moving in the oleochemical or Palm oil processing industry into chemicals such as fatty acid (fatty acid) and Glycerin. The industry, in the process of doing the processing of palm oil, has equipment that supports the company's goals in order to produce a good product can be achieved. As for the equipment are a number of industrial machinery.

Along with the development of Science and Technology in particular automation system, PT. Season Mas has largely adopted the Mechatronics-based industrial machinery and automatic. However, the many automatic machines that are implemented on palm oil processing jobs in this industry are on the other side of which, according to researchers less effective in the workmanship of a process that is located on the process control of the heating system of the water jacket.

The water jacket is a system that functions as a water heater using the heat energy of the steam generated from combustion system where water is heated above that will be pumped to the outside pipes throughout the channel streamed palm oil that has processed previously in which case this is done to prevent freezing in the pipe oil its channels. On the process of this work still do manual work

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processes so less effective done because to do this job should still stand by in-room control and is monotone remains mindful of how the State monitors on display temperature of the water jacket that would do the process of opening or closing of the valve with the degree suggested by the needs of the system. In addition, the process of opening and closing a valve made by workers also spent a long time, while the needs of the heating systems should be immediately done. In addition, when arriving the distribution in the worker's room must be wary of the challenge of a steam explosion overpressure sound reason can lead to a heart attack for the workers concerned.

2. Review of literature

2.1. Control system

The system controls the degree of valve opening and closing the steam distribution system is a design tool that is composed of electronic components and software to control a system on the process of heating the water jacket in an industrial kitchen, where is the system that controlled the process of heating the water jacket is the capacity of the hot steam from the boiler flowing on the water jacket which is controlled manually by using human hands in the space distribution of steam temperature based on air jacket seems from your computer screen. With this tool, it will automatically do the work alone without human help more fully to set the degree of opening of the capacity of the hot steam that uses a servo motor based on information from a sensor water jacket temperature detector [1].

2.2. Arduino Uno

Arduino Uno is the Arduino ATmega328 microcontroller using the board. Arduino Uno has 14 digital pins (6 pins can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a connector voltage source, an ICSP header, and a reset button. Arduino Uno contains everything needed to support a microcontroller. By only connecting it to a computer via USB or DC voltage from the battery or the AC adapter to the DC was able to make it work. Arduino Uno using ATmega16U2 programmed as a USB-to-serial converter for serial communication to the computer via the USB port. Looked up from the Arduino Uno can be seen in Figure 1.



Figure 1: Arduino Uno

2.3. Sensors LM35

LM35 is a special IC used for temperature/temperature sensors that the results are quite linear. LM35 does not require external calibration or special timing. LM35 is the most widely used temperature sensor for practice because in addition to its fairly cheap price the linearity is also pretty good. This sensor can operate in the range of -55°C to + 150°C and has a linear characteristic at 10 mV/ °C.

This sensor is very simple but has fairly high precision. This sensor has only three legs. The first leg of the IC LM35 is connected to the power source, the second leg as the output and the third leg is connected to the ground. Figure 2 here is a picture of the physical shape and leg arrangement of the LM35 sensor.



Figure 2. (a) Physical form LM35; (b) Look at the bottom LM35

Besides its very simple physical shape, the LM35 sensor also has several advantages. The advantages of LM35 are as follows:

- It can be calibrated directly inside the Celsius scale.
- Linear scale factor + 10 mV / °C.
- The accuracy level of 0.5 °C when room temperature (25 °C).

The working principle of this sensor circuit is based on changes in temperature or heat that occurs in the vicinity. Where if the temperature around the sensor is higher, then the value of resistance in the sensor circuit that serves as a regulator of the current to input non-inverting will be greater and vice versa. So if the resistance value of the current regulator to the non-inverting is small then the current from the previously priories transistor will be grounded and non-inverted, so as the value of the current regulator's resistance causes the incoming voltage to the amplifier (A2) is getting bigger. Thus the transistor serves only as a large regulator of the auxiliary current (A1), and the symbol (i) is only a custody controller.

Although the voltage of this sensor can reach 30 volts, but given to the sensor is 5 volts, so it can be used with a single supply provided that the LM35 sensor requires only a current of 60 μA. This means that LM35 has the ability to generate heat (self-heating) of the sensor that can cause a low error reading that is less than 0.5 °C at 25 °C

The LM35 output voltage (VOUT) has a working range of 0 volts up to 1.5 Volts with an LM35 sensor operating voltage that can be used between 4 Volts to 30 Volts. LM35 sensor output will rise by 10 mV every degree Celcius so that Equation 2.4 as follows.

$$V_{LM35} = Temperature \; x \; 10\,mV \tag{1}$$

where Temperature is temperature changes that occur around the sensor.

In principle, the LM35 sensor will do the sensing at the temperature change every temperature 1°C will show a voltage of 10 mV. In the placement LM35 can be affixed with adhesive or can also be cemented on the surface but the temperature will slightly decrease about 0.01°C because it will be absorbed at the surface temperature [2].

2.4. Standard servo motor

Servo motor is a DC motor equipped with a control system. This control system will provide motor rotation position feedback from 0 to 180 degrees. Besides, this motor also has relatively strong enough torque. Figure 3 shows the cross-section and wiring of the servo motor. Servo motor cabling system consists of 3 parts, namely Vcc, Gnd, and Control (PWM = Pulse Width Modulation). Giving PWM to the servo motor will make the servo move to a certain position and then stop (position control).

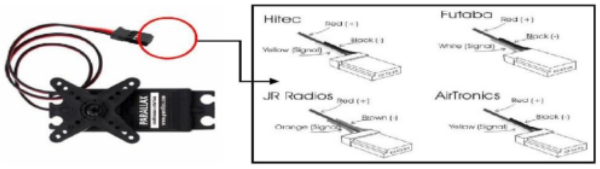


Figure 3. Motor servo and pin configuration

The main principle of servo motor control is the assignment of PWM value to its control. The PWM frequency used on the servo motor controller is always 50 Hz so that the pulses are generated every 20 ms. The pulse width will determine the desired servo position. Giving 1.5 ms pulse width will make the servo motor rotate to a neutral position (90 degrees), 1.75 ms pulse width will make servo motor rotate approach 180-degree position, and with pulse width 1.25 ms servo motor will move to the 0-degree position. Figure 4 shows the relationship between pulse width PWM with rotation direction servo motor.

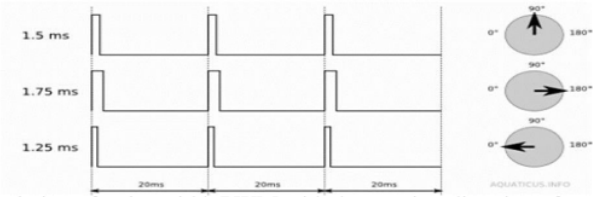


Figure 4. Relation of pulse width PWM with the rotation direction of servo motor

An industry primarily engaged in the processing of liquid, of course, has a piping system that serves as a place to flow liquid. Each pipe circuit must have a device used to adjust the amount of flow for the processing process that can run in accordance with the specified. The tool is called a valve or often also called a valve. Valve or valve is a device installed in the piping system, which functions to regulate, control and direct the flow rate of fluid by opening or closing part of the fluid flow (Figure 5).

The valve can be operated manually, either by using the handle, pedal lever and so on, besides manually operated valve can also be operated automatically by using the principle of change of flow, pressure and temperature. The changes will affect the diaphragm, spring or piston so that it will automatically move the valve with an open system close [3, 4].



Figure 5. Gate valve

The water jacket or water jacket is a process of heating the water in the normal temperature of the pam water, where the water is heated in a water bath, then the water in the bath is heated by steam [5]. The function of the jacket water is to heat the oil through a coated pipeline of cashing, aims to prevent the oil from freezing. Here is Figure 6 which shows the physical shape of the water jacket.



Figure 6. Water jacket

How to warm-up jacket water at the company where researchers get the idea of this final title is to open and close valve steam manually, where high and low-temperature water jacket bias seen on the computer monitor screen. Below is Figure 7 which shows the window screen of the application:

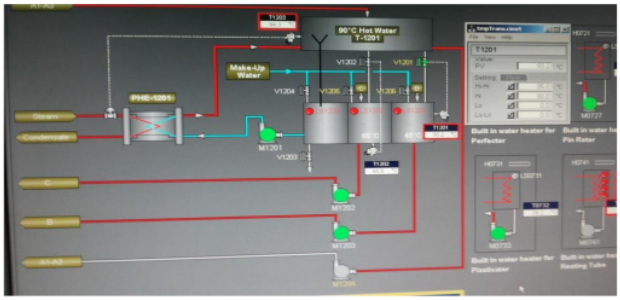


Figure 7. Window display application monitor temperature water jacket

3. System planning

The scheme of merging the entire installation of a tool-making system is a scheme that shows the layout of the connection of each tool-forming component in this study. The scheme can be seen in Figure 8 below.

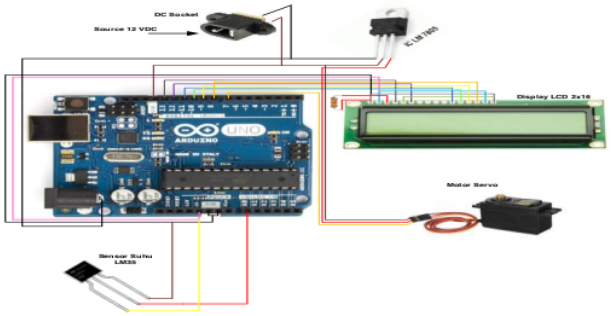


Figure 8. Scheme of the whole system

4. Methods

The test was carried out for 7 days by observing the temperature of the glass evaporator outside and also the temperature of the water and air in the evaporator by recording the clock. There are 6 thermocouples installed on each side that you want to observe the temperature.

4.1. Testing method

After all, components forming the system control degree opening and closing valve steam distribution system on the heating water jacket process is completed as in Figure 3 above, then the next to do the testing process. But before doing the test as a whole, in this research first tested is the function of the LM35 sensor with the aim of whether the sensor can work to detect the temperature well before it is connected with the minimum Arduino Uno system.

As a sensor that detects temperature, IC LM35 is one of the main components that must be tested condition and level of reliability. Because the work of LM35 will greatly affect the work of the system as a whole. This test is performed to test the response time of the LM35 sensor to the ambient temperature changes and compared with the ordinary (standard) thermometer.

This test is done through two stages, namely testing the LM35 sensor response to the surrounding temperature rise and testing the LM35 sensor response to the decrease in ambient temperature. Further, for each stage, three experiments were conducted to obtain cumulative data to obtain more accurate average results. The results of this experiment will be compared with the same experimental results performed on a regular thermometer.

In accordance with the characteristics of the LM35 sensor that every 1 °C temperature will show 10 mV voltage on its output, then the process of measuring the temperature change of the LM35 sensor is done by measuring any voltage changes at the sensor output. The measurement of the output voltage is performed using a measuring device by connecting the probe (+) Voltmeter with VOUT foot and probe (-) Voltmeter with Ground feet on the sensor. Figure 9 shows the scheme and form of LM 35 sensor testing:

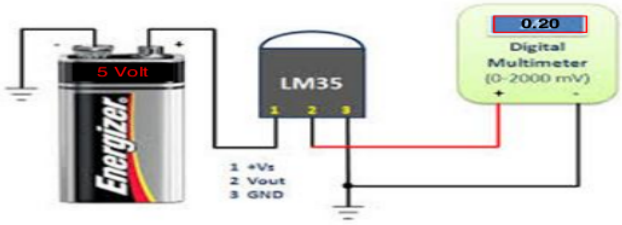


Figure 9. LM35 sensor testing scheme

As for how the overall test which is the goal in making this tool is:

- Distributing power source to all systems by means of power supply (AC to DC power supply) to source PLN 220 VAC.
- Then, heat the LM35 sensor by bringing the electric soldering temperature closer or closer to the fire temperature from various sources of fire (for example: from a fountain, match, or the like).
- Taking into account the temperature displayed by the display or LCD, then pay attention to the following parameters:
  a). If the temperature displayed on the LCD is ≤ 35 ^{o}C then the motor rotates 0^{o}
  b). If the temperature displayed on the LCD is > 35 ^{o}C and ≤ 49 °C then the motor rotates 40^{o}
  c). If the temperature displayed on the LCD is > 50 ^{o}C and ≤ 53 ^{o}C then the motor rotates 80^{o}

5. Results and discussion

5.1. Tool design results

After the whole process of designing all components forming the control device the degree of opening and closing valve steam distribution system on the jacket water heating process using microcontroller controller Atmega 328 is done then the following in Figure 10 which shows the results of the design tool:

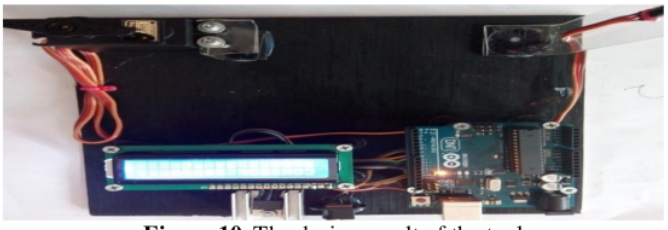


Figure 10. The design result of the tool

5.2. Overall test results

In the case raised in this study is how to control the degree of opening and closing of the steam distribution valve in the case of jacket water heating, wherein this jacket water in the industrial process is as a medium to keep oil production ingredients melt in the jacket pipe along the channel the process of printing oil until the oil is finished in print in solid form.

Since the oil in the pipeline of the production process must be kept at a temperature, the jacket water must have a hot temperature so that the oil in the pipes does not freeze and can still flow along the pipeline of the production process for the final printing. It is important that the temperature of the oil be kept hot along the pipe is the main focus in the process of setting the degree of valve opening and closing, since the heated water medium uses steam from the boiler and the manual arrangement is from the vapor distribution chamber manually. After understanding the workflow of the control process about the explanation of the problem in Chapter I is the background of the research problem, it departs from the problem that is done an automatic valve regulation process. Answering the question above has been designed the automatic tool and has been tested with results as in Table 1 below:

Table 1. The results of testing the system as a whole

No.	Display temperature (^{o}C) on the LCD	Degree of servo motor rotation	Temperature (^{o}C) on thermometer	Explanation
1	33^{o}C	0^o	32^{o}C	True
2	34^{o}C	0^o	33^{o}C	True
3	35^{o}C	0^o	34.5^{o}C	True
4	36^{o}C	40^o	35^{o}C	True
5	37^{o}C	40^o	36^{o}C	True
6	38^{o}C	40^o	37.5^{o}C	True
7	39^{o}C	40^o	38^{o}C	True
8	40^{o}C	40^o	39^{o}C	True
9	41^{o}C	40^o	40^{o}C	True
10	42^{o}C	40^o	41^{o}C	True
11	43^{o}C	40^o	42.5^{o}C	True
12	44^{o}C	40^o	43^{o}C	True
13	45 ^{o}C	40^o	44^{o}C	True
14	46 ^{o}C	40^o	45.5^{o}C	True
15	47 ^{o}C	40^o	46.5^{o}C	True
16	48 ^{o}C	40^o	47.5^{o}C	True
17	49 ^{o}C	40^o	48^{o}C	True
18	50 ^{o}C	80^o	49.5^{o}C	True
19	51 ^{o}C	80^o	50.5^{o}C	True
20	52 ^{o}C	80^o	51.5^{o}C	True

6. Conclusions and recommendations

6.1. Conclusions

From the results of the research conducted it can be concluded as follows. First, the system of rotation control motor servo degree (as a valve) able to fulfil the requirement of research purpose with an indicator of circle arc as a calibration value of rotation degree of the motor. Second, the degree of accuracy of motor rotation servo degrees (as a valve) meets 100% requirement. Third, the relationship between the temperature with the rotation degree of the servo motor is eligible with 100% accuracy. The last, calibration of detection temperature value between the LM35 sensors with an ordinary thermometer only has a difference value of 1 mV.

6.2. Recommendation

Some advice on this research is, first, for the perfection of this tool in the future it would be a nice tool design system that can be implemented directly in the industry. Finally, If you want to change the dimensions of servo motors used both in terms of physical size and input voltage values, then adjust it with the power used on this Arduino with a record no more than 5 Volt DC.

References

[1] Emerson Automation Solutions Edition F (N D) Control Valve 2019 *Fisher Controls International Llc* D101881x012/ Jun19.

[2] Pasaribu FI, Roza I and Efendi Y 2019 Memanfaatkan panas exhaust sepeda motor sebagai sumber energi listrik memakai thermoelectric. www.ojs.umsu.ac.id/index.php/jesce/article/view/2787

[3]. Stations G 2015 Draft Guide for motor-operated valve (mov) motor application protection.

[4]. Power N 2014 Draft guide for motor-operated valve (mov) motor application, protection control, and testing in nuclear power generating stations *Committee E & Society E*.

[5]. Chemical Processing. Jacketed Heating. (N.D.).www.Pickheaters.Com

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