Design of Coal Handling System for Filling Bungker using PID Method in Coal PLTU

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Design of Coal Handling System for Filling Bungker using PID Method in Coal PLTU

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Abstract. The process of filling bunkers at PT PJB UBJ O&M PLTU 1 east java Pacitan is very dependent on coal handling system. In the existing system is still dependent on human resources as an operator, of course, very influential on human performance. The level of the bunker is a major problem for the continuity of the combustion process in the boiler. To support productivity, the authors make an innovative coal handling system design and monitor the level conditions in the bunker by using the PID (Proportional Integral Derivative) controller method to determine the level in the bunker. After that the condition is sent to the micro controller which then commands the conveyor and coal plough. The conveyor itself is driven by a stepper motor and the coal flow is driven using a servo motor. For combustion protection, there is a temperature sensor and a water pump in the bunker to extinguish. The level in the transmitted bunker serves as input to the PID and then the filling process is carried out by the conveyor to meet the demand for the bunker level. The accuracy rate in this system is 97.8% of the input data level of each bunker through an ultrasonic sensor. To make it more optimal all the information in the visual studio display.

Introduction

Steam Power Plant (Pembangkit Listrik Tenaga Uap: PLTU) is a power plant that uses coal as its main fuel, such as PLTU 1 Pacitan, East Java, with two generating units needing coal as fuel. In a power plant, coal handling systems have an important role in maintaining the availability of electrical resources to consumers. The many factors and facilities used in the coal handling system greatly affect the performance of each generating unit. One of them is the failure of supply to the bunker, causing the power plant unit to not get coal supply. Coal supply failures and errors cause fatal disruptions to the generating unit. Therefore, coal supply must be managed effectively and efficiently.

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The process of filling bunkers at the Pacitan Steam Power Plant is operated manually by the operator from the control room, so it is very prone to human error . The availability of coal in the bunker must be maintained in order to carry out the combustion process. In order to prevent errors and failures, there is a need for reliability in the coal handling system found in the Pacitan power plant. In the coal handling control system researchers used a close loop control type . Where there are inputs in the form of height level on each bunker, the temperature in the bunker and the output in the form of a fire extinguisher valve and three motors connected with coal flow which function as a coal holder which is channeled with a conveyor to fill each bunker. With these problems, in this research the author will use the PID method on the coal handling system to fill the bunker, which aims to improve the reliability and effectiveness of the performance of the coal handling system for charging and security protection on the bunker. Many research about controller method especially for adaptive nonlinear system can be used for comparison with PID method as conventional method but have powerful result. The simplify method used to get more cost benefit with effectiveness performance [1]-[8].

2 Methodology

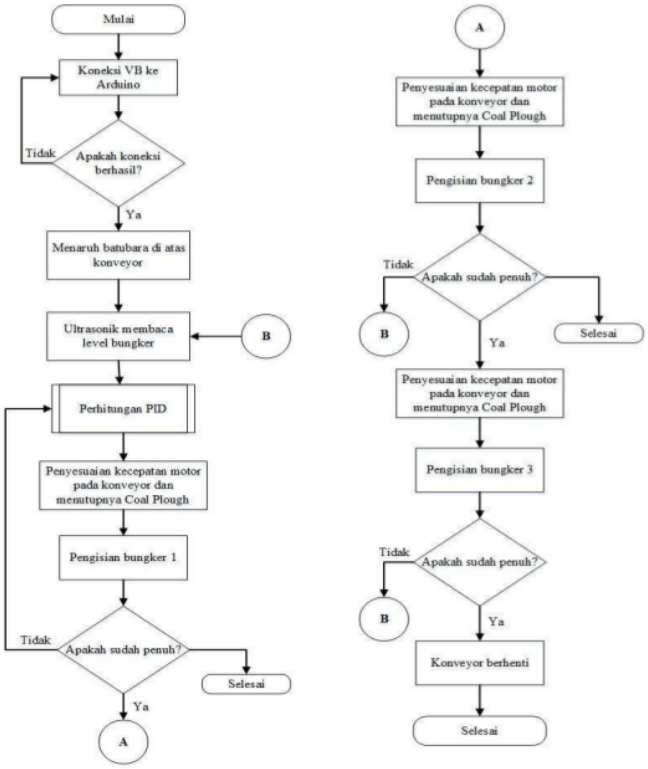


Fig 1. Flowchart

From the Fig 1 system flowchart, the working principle used is :

- VB communication to Arduino
- Coal that has been sent from the coal yard is passed on the conveyor and ready to be put into the bunker.
- The ultrasonic sensor reads the height level on the bunker
- PID calculation to determine conveyor speed

- Coal flow on unit one will be closed until filling meets the bunker
- If unit one bunker has been fulfilled, then coal unit one will open and close coal unit two to fill unit two bunker.
- If unit two bunker has been fulfilled, then coal unit two will open and close coal unit three to fill unit three bunker.
- After all bunker units are met, the conveyor will stop

2.1 *Ultrasonic* sensor

This ultrasonic sensor is a device that functions as a sender, receiver, and ultrasonic wave controller. This sensor works with the principle of reflection of a sound wave so that it can be used to see the distance of an object with a certain frequency. This sensor can be used to measure object distances from 2cm - 4m with an accuracy of 3mm. The author uses ultrasonic sensors to determine the height at the bunker level.

2.2 DC Motor

DC motor is an electric motor that converts electrical energy into mechanical energy. DC motors are widely used in daily life, especially in industry, because they are easy to apply and efficient. The working principle of direct current is reversing the voltage phase of a wave that has a positive value by using a commutator, so that the current is reversed by a rotating anchor coil in a magnetic field. The simplest form of motor has a coil with a coil that rotates freely between the poles of a permanent magnet. A DC motor is applied to drive the conveyor to carry coal to the bunker.

The motor that can be used on the conveyor in the final project is a permanent magnet DC motor with the following specifications :

Supply voltage rating = 24 VDC
Current = 3 A
RPM maximal = 600 rpm
So :

Power = V x I = 24 V x 3 A = 72 W

Torque = $\frac{5252 \, x \, P}{}$

$= \frac{5252 \, x \, 0.0965}{600} = \frac{506.818}{600}$

= 0.845 Nm

Motor Speed is

$\omega = \frac{2\pi \, x \, 600}{60} = 2\pi \text{ x } 10 = 62.8 \text{ rad/s}$

Then the speed of the conveyor motor is

V = ω x r = 62.8 rad/s x 8mm
= 502.4 mm/s

2.3 DC Motor

DS18B20 is a temperature sensor that already has a digital output so it doesn't need an ADC circuit. The DS18B20 sensor has three feet of GND used for the ground, DQ is used for input or output data, while Vdd is used for sensor voltage. DS18B20 can be used for devices that use power from outside through the VDD foot. The required voltage ranges from 3.0Vdc to 5.5Vdc (Dwi Wahyu Suryawan, 2012). In this research, this sensor is an indication of the temperature used as protection against combustion or fire that occurs in each bunker.

2.4 PID Control

In this final project the design of the PID is used to determine the Kp Kd Kd used to set the set point in the tank bunker. The set point will adjust the speed of the conveyor motor as the drive of the conveyor in this thesis. The process of determining Kp Ki Kd on PID is:

2.4.1 Transfer Function

In PID there is the term Transfer Function, this TF is used to produce Kp Ki Kd. Transfer function is obtained from modelling the system at the plant. The results of the modelling will be entered into MATLAB as shown in Fig 2.

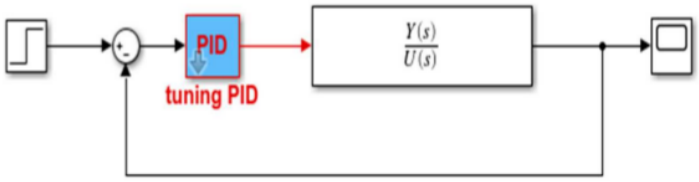


Fig 2. Input process in MATLAB

2.4.2 Determination of Curves S

Furthermore, after getting the results of TF input on MATLAB will get the S-shaped curve. The results of the s curve will be drawn tangents with the largest gradient on the graph that has been obtained. This tangent line is used to find out the value of dead time when the condition is not moving (L) and transition time (T). L and T values can then be used to determine the Kp Ki Kd value of the test system.

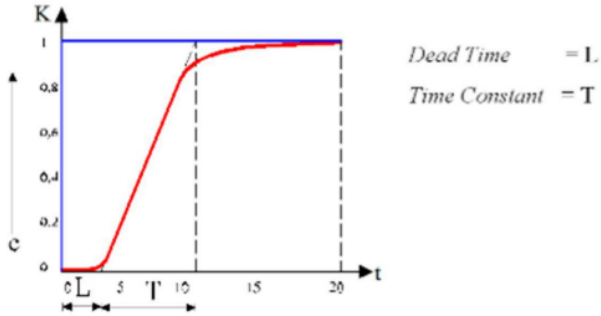


Fig 3. S curve on PID

2.4.3 Calculation of the PID Parameter Value

After getting the value of the dead time when the condition is not moving (L) and the transition time (T) then the value will be entered with the formula according to the PID parameter.

Type of Controller	K_p	T_i	T_d
P	$\frac{T}{L}$	∞	0
PI	$0.9\frac{T}{L}$	$\frac{L}{0.3}$	0
PID	$1.2\frac{T}{L}$	2L	0.5L

Fig 4. Parameter PID

2.5 Emergency System Design

Fig 5. Flowchart emergency system

From Fig 5 flowchart system, the working principle of this final project emergency system is :

1. In the initial condition the connection from VB to Arduino.
2. The temperature sensor at each bunker detects the temperature conditions inside the bunker.
3. If the temperature at one of the bunkers reaches 80 ° C, the conveyor will stop and the Coal flow rise (open).

The emergency system aims to maintain the condition of each bunker in the event of a combustion (fire) in the bunker, as well as minimize the events that result in enormous losses

2.6 Mechanical Design

Conveyor mechanics are designed with a length of 100 cm and a height of 10cm bunker tank with a diameter of 10cm. Conveyor building uses 3 mm iron plate on the frame and 2 mm plate. As for the tank frame using 0.5 cm aluminium size. Fig 1 is a mechanical building that has been created.

3 Result and Discussion

3.1 Ultrasonic sensor testing

Direct sensor testing is placed on system that has been made previously in order to know the ability to read sensors in real situations. The results of the test are in table (1)

Table 1. Ultrasonic sensor status data

No	Testing	Sensor (Cm)	Ruler (Cm)	*Error* %
1	1	3.05	3	1.63
2	2	4	4	0
3	3	5.12	5	2.34
4	4	6.03	6	0.49
5	5	7.01	7	0.14
6	6	8	8	0
7	7	9.07	9	0.77
8	8	10.01	10	0.1
9	9	11	11	0
10	10	12.05	12	0.41
Average error				0.588

Analysis of ultrasonic sensor testing using Arduino as shown in table 4.4 The sensor is able to read the level conditions in the tank with an average error of 0.588% in testing the level using a ruler as a reference for measuring tank level heights. From this test shows that the sensor has a good ability with a very low error.

3.2 Temperature sensor testing

Temperature sensor testing is done in order to see the resulting temperature.

Table 2. Temperature sensor status data

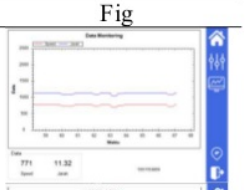
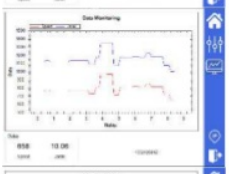
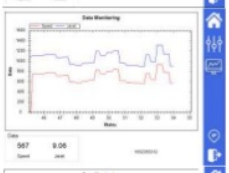
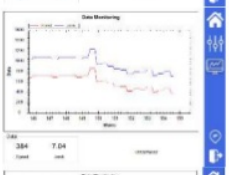
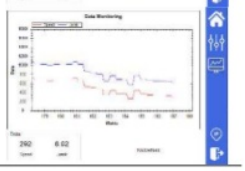
No	Testing	Sensor (Celsius)	Termometer (Celsius)	*Error* %
1	1	31,5	31,5	0
2	2	33,2	33,2	0
3	3	34,6	34,0	1,76
4	4	37,5	37,2	0,8
5	5	58,2	58,0	0,34
6	6	62,5	62,2	0,48
7	7	78,2	78,0	0,25
8	8	81,6	81,5	0,12
9	9	90,5	90,0	0,56
10	10	98	98	0
		Error rata-rata		0,43

Analysis of temperature sensor testing using Arduino as shown in table 2, the sensor is able to read the temperature conditions in the tank with an average error of 0.43% in temperature testing using a thermometer as a reference for measuring tank level heights. From this test shows that the sensor has a good ability with a very low error.

3.3 System testing

The system that has been made in this thesis has been running and tested by running the whole system on the tank and the results obtained in table 3.

Table 3. System Testing Data

Range	PWM	Fig
11.32 cm	771	
10.06 cm	658	
09.06 cm	567	
08.09 cm	479	
07.04 cm	384	
06.02 cm	292	

3.4 System Emergency Testing

Emergency system testing aims if there is a fire in the bunker by turning off all system conditions.

Table 4. Emergency system Testing Design

Sensor in the To-tank	Temp (Celcius)	System condition
1	30.25 °C	On
	>60 °C	Off
2	29.31 °C	On
	>60 °C	Off
3	29.81 °C	On
	>60 °C	Off

Emergency system testing functions properly and works when conditions exceed a specified safety limit.

4 Conclusion

Based on the design and measurement, the sensor reading process has an error range of 0.588% of the ultrasonic sensor used to measure tank height and 0.43% of the temperature sensor error used to measure the temperature in the tank. Whereas servo actuators have an average error of 1.15%. The application of PID control is done by trial error and gets a stable output with the constant values of Kp, Ki, and Kd which are most suitable for use are KP = 90, Ki = 5, and Kd = 1. HMI software can run well by using a wifi connection but has a delay in sending data, so changes in sensor values are less accurate.

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