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Coal Dust Controller on Indramayu Power Plants Conveyor Lane Based IoT

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Abstract

The coal is combustion fuel of power plant which is located in Indramayu West Java. Power plant has produce coal dust during combustion process. Moreover, the residu of coal dust has potentially self combustion which damage or could explosived arround the environment. To addressing this situation, detection and controlling combustion dust is needed. To avoid this situation, a prototype devices which able to control combustion dust is proposed. The prototype has comprises of processing signal which controlling by Arduino microcontroller and sensed by MQ2 sensor for flammable gas and MQ135 for CO_2 sensor, and Sharp GP2Y1010AU0F for dust sensor.These sensor are detected combustion dust, if the level more than set level then springkle will spray the water. The reading point value of sensors transmitted on to thingspeak IoT could server, which of sensor are consist of methane, gas, CO_2, and dust. These value has monitored and able to conduct for controlling the combustion dust. The evaluation shows that the value of sensors are able to delivered as well and the relay as able to activated whenever level of combustion is above.

Keywords: Self Combustion, Thingspeak Server, Wifi Module, Arduino, Relay

1. Introduction

Coal dust is a coal material powder formed from coal crushes during processing. The explosive dust of coal is when the dust is exposed in the air and then rub against each other which can cause sparks, then the explosion will happen and it can cause a fire.

If in the first process there is an explosion and a fire, the remaining dust of coal on the floor or on the ceiling of the conveyor lane will be blown into the air will occur a blast streak until it runs out all the coal dust. With the system to prevent and control coal dust, the explosion caused by self combustion coal dust can be prevented.

There are some previous studies related to the impact of dust controller and air quality, such as Asrofi Nuchrowi from Lampung University to create a microcontroller based vacuum cleaner. Not only Asrofi Nuchrowi but also Ilham Setiardi from Mercu Buana University Jakarta made arduino-based measurement tool and dust-based detector. Besides that, Yudhaniristo from Syarif Hidayatullah State Islamic University Jakarta developed a prototype of the online monitoring tools of air quality, weather and radioactivity environment. Also Anjar Rinaldi from Institute Pertanian Bogor designed a micro-environment parameter monitoring system on an internet-based greenhouse. The latter, Riza Mega Utami from the Islamic University of Maulana Malik Ibrahim Malang made smoke controller based on AT89S8252 microcontroller. The thing that differ this research with the previous studies is on coal dust monitoring has not been used by another researcher.

2. Research Method

2.1. Coal Dust Controlling

The problem is about how to reduce the potential of self-combustion of coal dust on the conveyor lane of PLTU Indramayu by controlling coal dust which can be monitored by IoT. The research of designing prototype of coal dust controller IoT-based needs flow chart as reference to make the prototype. The flow chart as below.

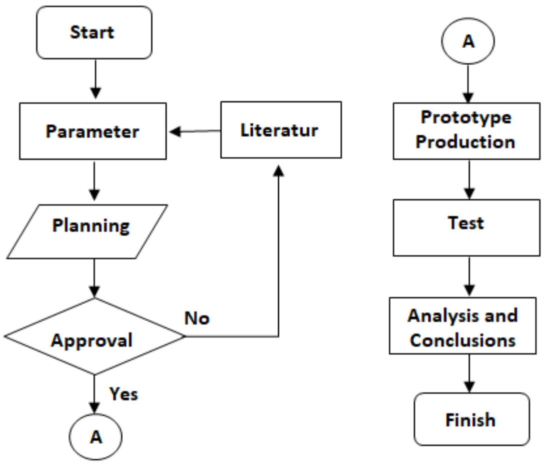


Figure 1. Flow Chart of Planning and Processing

2.2. Designing Architecture System

The outline process of the system in this research is described below.

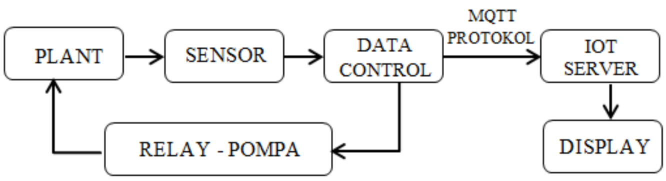


Figure 2. Architectural Design

Based on figure 2 it shows that the device process starts from the sensor readings at the plant then data control processes it which results are displayed to IoT media through MQTT protocol but it also turns on the relays and pumps to pump the water to the plant.

2.3. Hardware Designing

Based on the steps of research process, the next step is the hardware designing. The following design is a block system diagram which uses arduino uno as its main component and utilizes IoT in controlling coal dust.

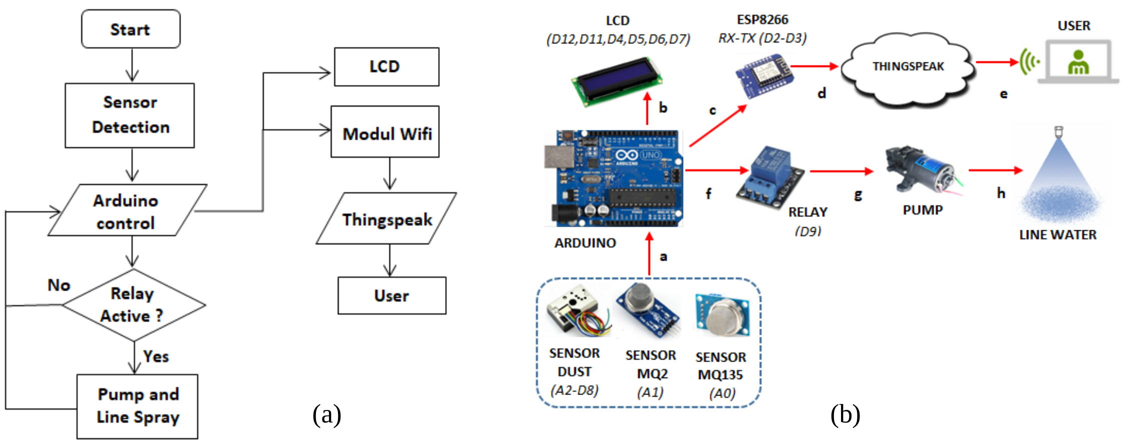


Figure 3. Flow Chart (a) and Block Diagram of Hardware Designing (b)

From Figure 3 it shows that the device working system starts from reading dust sensor, MQ2 sensor, and MQ135 sensor then all of them are processed in arduino which will be displayed on the LCD and IoT media which is called thingspeak. The result of arduino process which is suitable with predefined score will activate relay water pump.

2.4. Software Designing

Controller coal dust device which uses IoT that has been designed well needs a program to run that device system. It needs a flow chart to design the program which will be put into the device.

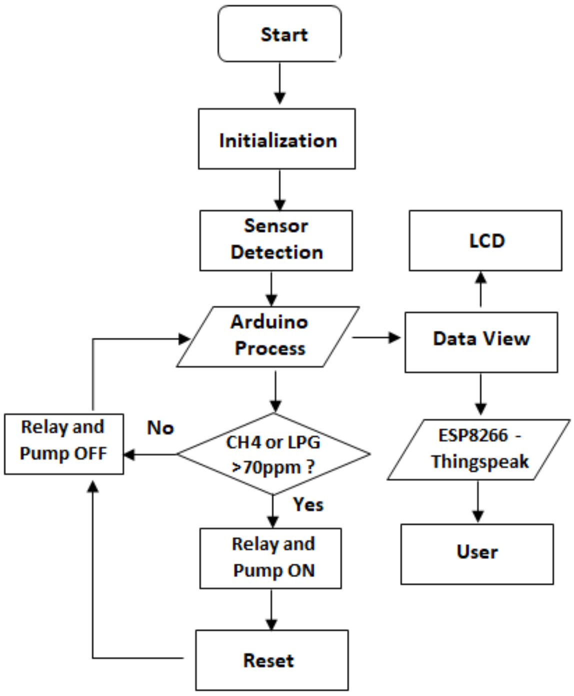


Figure 4. Flow Chart of Software Designing

Figure 4 shows how the system works which is an open loop control system. It is an open loop control system because the output amount which is an ON pump does not give effect to the input amount. The initiation starts on the arduino board. The flammable gas sensor (MQ2) informs the arduino board and forwards the information to the ESP8266 module to be displayed with IoT through the Thingspeak cloud server. In addition, the information on the arduino board will also determine the relay and the pump are active or not according to the limit parameter CH4 or LPG.

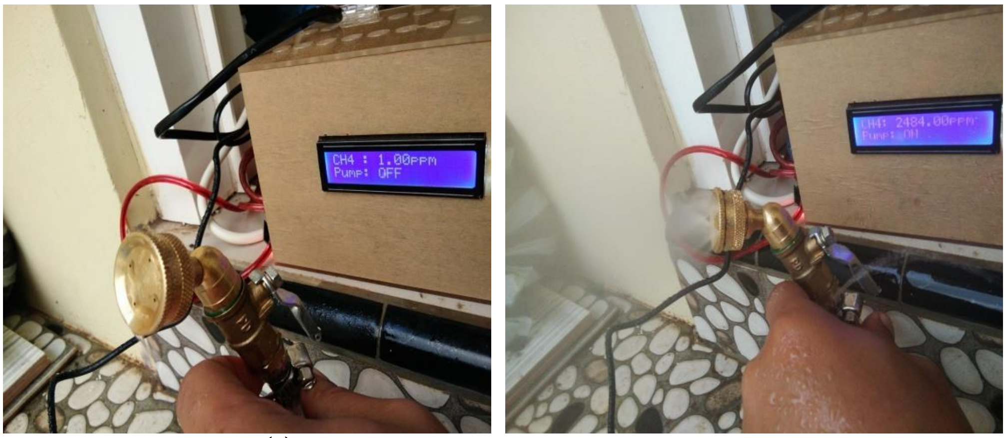
3. Analysis and Result

Testing process from some parts which have been designed is used to know the condition of the equipments runs well and appropriates to the target. The tests are :

a. Control system test
b. Data transmission to IoT test

3.1 Control System Test

Control system test is conducted from the sensor detection process until relay response. This test is performed to know the system which consists of sensors, arduino, and relays which have been assembled and programs that have been made work well.



(a) (b)

Figure 5. Standby Condition (a) and Active Condition (b)

In Figure 5 it is known that the standby condition (a) is the condition when the MQ2 and MQ135 sensors have not detected the methane gas and LPG so that the relay has not worked which is caused the pump and water spray are still inactive. While the active condition (b) is the condition when the MQ2 and MQ135 sensors detect methane gas and LPG, the relay will ON if methane gas and LPG above 70 ppm but the pump and water spray are inactive.

3.2. Data transmission to IoT Test

Thingspeak is an IoT media which plays as remote monitoring in this research. It needs a trial to send data sensor value that has been processed by arduino and sent to internet network.

Figure 6. Display of Tihngspeak on smartphoe result

Figure 6 is the result of sensor scores that has been sent to the thingspeak server which will be displayed on the website and thingspeak smartphone application. On the thingspeak display when methane gas and lpg standby, the sensor score is 0 ppm. While methane gas and lpg detected, thingspeak will display score above 500 ppm because air will always contain methane gas and lpg from coal dust.

Measuring the quality of the network connection to the thingspeak server uses wireshark which is a network analyzer tool. The parameter to check the network quality is RTT (Round Trip Time). RTT is a time which is needed by user to send data to server and then the data will be returned by server to the user.

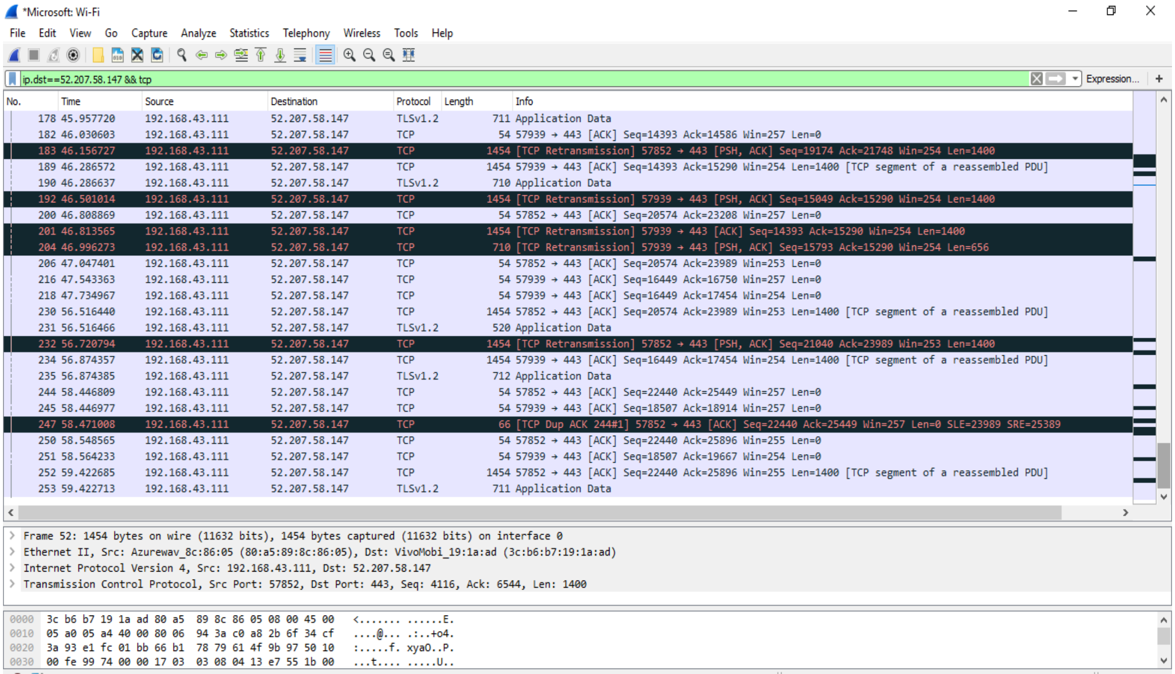
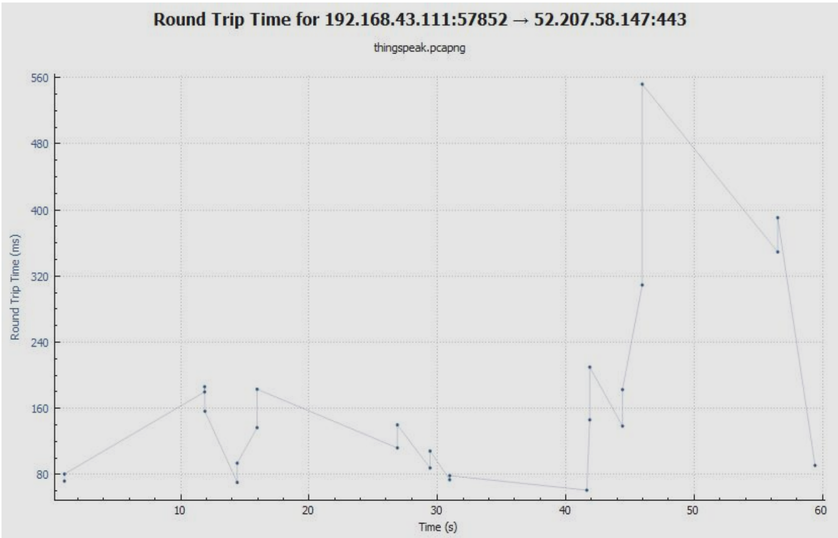


Figure 7. Second Measurement Thingspeak Server Network

In Figure 7 it appears that data retrieval on the network is done for 60 seconds. The next step is selects only the ip thingspeak IP address which will be used. After that on the wireshark toolbar selects statistics - TCP stream Graphs - Round Trip Time then will appear graphic related to RTT.



NO	RTT (m/s)	NO	RTT (m/s)
1	60	13	110
2	80	14	75
3	180	15	70
4	160	16	20
5	150	17	140
6	60	18	210
7	100	19	130
8	130	20	180
9	180	21	310
10	120	22	550
11	140	23	360
12	90	24	380
		25	100
AVERAGE RTT		163 m/s	

(a) (b)

Figure 8. Graph (a) and RTT Measurement Table (b)

Based on Figure 8 we can see the RTT graphic (a) from network connection data collection to thingspeak server. However, in Figure 4.13 we still haven't seen average of RTTscore. That's why the RTT graphic score is moved to the table so that it will be easier to count RTT average score. In table (b) it shows that the lowest RTT score is 20 m/s and the highest is

550 m/s, where the RTT average score is 163 m/s, this indicates that the connection to the thingspeak server is quite fluently.

4. Conclusion

1. The prototype circuit of the dust control system that has been created can work well. The prove is when the MQ2 and MQ135 sensors detect the presence of methane gas and lpg is above 70 ppm then the relay will be active and the lamp is on. Otherwise in standby condition, the relay does not work the lamp is off.
2. Data transmission to the thingspeak server depends on the quality of the internet network. Based on thingspeak server connection test it is known that data transmission to the server thingspeak is good with an average RTT score is 163 m/s.

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