DEVELOPMENT OF IoT SYSTEMS FOR FIRE DETECTION TOOLS USING ESP 8266 AND TELEGRAM NOTIFICATIONS

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Abstrak

This research describes the process of making and developing a fire detection system using IoT technology. The background for making this tool is because the existing tool at the research site, namely at the Captive Power Plant of PT Indorama, is still a conventional device with an ordinary smoke sensor system and notifications only via a buzzer. This system combines telegram notification mode. Using three sensors namely temperature sensor, smoke sensor and fire sensor is a very effective combination as an early warning system. The test results show that the system provides notification via telegram when there is a significant increase in temperature above 31^{o} C. The smoke sensor is tested with three smoke conditions, namely thin, medium and thick with a value of 704-803 ppm. The sensor response is less than 2 seconds, notification instructions to telegrams are sent directly without any delay. In the fire sensor test, six test conditions were carried out with variations in distance ranging from 10-100 cm, the sensor response was under 2 seconds, immediately activated the buzzer and a telegram notification was sent. The results of this study contribute to the hope that with the three sensor combinations the security layer will be more optimal and in real terms it can be used in industrial buildings which are prone to fire.

Kata Kunci : *IoT, ESP8266, MQ-2 sensor, Flame Sensor, DHT Sensor, Fire Detection*

1. INTRODUCTION

One of the crucial aspects that must be an important concern in a building in an industrial area is the security system. Apart from being safe from theft, this security system is also safe from fires caused by various types of disturbances[1].

Studies on the design of fire detection systems are carried out using the Zegbee wireless sensor for forest fire systems[2]. Then other studies were also carried out to detect fire systems in IoT-based homes[3]. At the industrial implementation stage, further research is on the implementation of PLCs for building fire detection systems[4]. Furthermore, the role of the ATMEGA 8535 microcontroller is also quite effective as a medium for controlling and controlling fire detection systems such as this research[5] and also using GMS implementation assistance, including as a notification medium[6].

Recent research involving artificial intelligence network systems is the most interesting, including the early warning fire detection system using a probabilistic neural network [7]. This research is based on the needs of the building at Captive Power Plant (CPP) PT Indorama which refers to previous research so that in addition to developing an IoT-based system it is also integrated through a notification system so that fire detection can be handled quickly and appropriately.

The purpose of this research is to build a prototype IoT station to monitor fire information in industrial buildings, especially at CPP PT Indorama, Purwakarta, Indonesia.

2. RESEARCH METHOD

Currently, PT Indorama's captive power plant has a fire alarm system using a smoke detector with a controller using BrightSky JB-QB-5Li and Nohmi as shown in Figure 1.

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a b

***Figure 1a**. BrightSky JB-QB-5Li **1b**. Nohmi Controller*

Furthermore, this controller works based on input from the smoke detector and when a fire occurs or smoke appears, the sensor will trigger the controller to activate the alarm as shown in Figure 2. Apart from being activated by the controller, the alarm can also be operated manually.

a b

***Figure 2a**. Push Button Fire **2b**. Alarm & Smoke Detector*

From these existing conditions, this research proposes to develop into an integrated system by utilizing IoT technology and telegram applications, so that a fast and precise situation can be sent immediately if there is a disturbance either smoke or fire at the captive power plant. The block diagram description of the system to be developed can be seen in Figure 3.

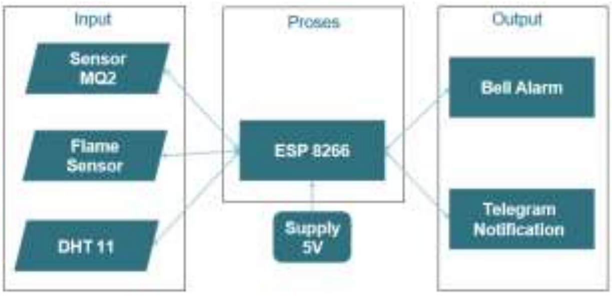
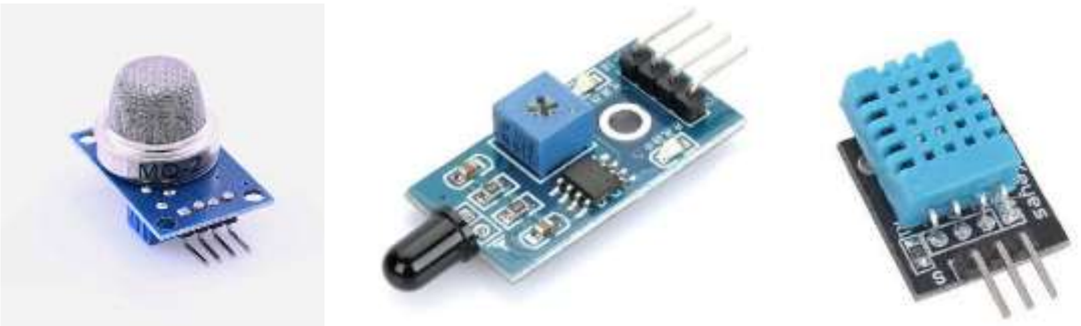


***Figure 3.** Block Diagram System*

From Figure 3 it can be explained that the methodology of this research is by first designing three important blocks, namely the input, process and output blocks. The input block consists of MQ2 sensors, Flame sensors and DHT 11. The process section uses ESP8266 and the output section is connected to a relay which activates the alarm bell and sends data via the internet to Telegram.

MQ-2 sensor [8] is a Metal Oxide Semiconductor (MOS) type gas sensor or also called Chemiresistors because its detection is based on changes in the resistance value of the material/material from the sensor when the material/material is in contact with gas. When a SnO_2 semiconductor layer is heated to a high temperature, oxygen is adsorbed on the surface. When the air is clean, electrons from the conduction band of tin dioxide are attracted to oxygen molecules. This creates an electron depletion layer just beneath the surface of the SnO_2 particles, forming a potential barrier. As a result, the SnO_2 film becomes highly resistive and prevents electric current flow. In the presence of reducing gasses, however, the surface density of adsorbed oxygen decreases as it reacts with the reducing gasses, lowering the potential barrier. As a result, electrons are released into the tin dioxide, allowing current to freely flow through the sensor. This sensor image can be seen in Figure 4a below.



a b c

***Figure 4a.**. MQ-2 sensor **4b**. Flame sensor **4c.** DHT 11 sensor*

Furthermore, still in the input section, a flame sensor is used. The way the flame detector works is able to work well to catch the flame for preventing fires[9], namely by identifying or detecting the detected flame by the presence of infrared and ultraviolet light spectrum by using the method optical then the results of the detection will be forwarded to the existing microprocessor the flame detector unit will work to distinguish the light spectrum contained in the fire detected with a delay system for 2-3 seconds on this detector so that it is capable detect the source of the fire earlier and prevent the source of false alarms from occurring. This sensor uses a transducer in the form of infrared (IR) as a sensing sensor. This transducer is used to detect the absorption of light at certain wavelengths specific, which allows this tool to distinguish between the spectrum of light on fire with other light spectrum such as light spectrum, lightning flash, welding arc, metal grinding, hot turbine, reactor, and many more.

The next sensor is DHT 11. This sensor is a sensor module that functions to sense temperature and humidity objects that have an analog voltage output that can be further processed using a microcontroller. The DHT11 sensor generally has a fairly accurate calibration feature for temperature and humidity readings. The calibration data is stored in the OTP program memory which is also known as the calibration coefficient. The following is the arrangement of the DHT11 sensor pins presented in Fig 4C. The DHT11 sensor has 2 versions, namely the 4 pin version and the 3 pin version. There is no characteristic difference between these 2 versions. On the 4 pin version. Pin 1 is the source voltage, ranging from 3V to 5V. Pin 2 is the output data (output). The 3rd pin is the NC pin (normally close) alias is not used and the 4th pin is Ground.

Whereas in the 3 leg version, pin 1 is VCC between 3V to 5V, pin 2 is output data and pin 3 is Ground.

In the process section, the microcontroller used is the ESP 8266. The use of this microcontroller is very popular in the IoT field [10], including for smart parking [11], wireless sensor [12] dan home automation [13]. Due to the wide use of this device, in this research this controller was chosen because it has been highly tested for its reliability.

In the output section, the devices connected are the buzzer and the telegram notification system. This Telegram notification system has also been widely implemented in the field of control and monitoring [14]–[16], because apart from being easy to use, the application is also reliable and powerful.

Of all the devices used in this study it can be explained how these devices are connected through the wiring diagram in Figure 5.

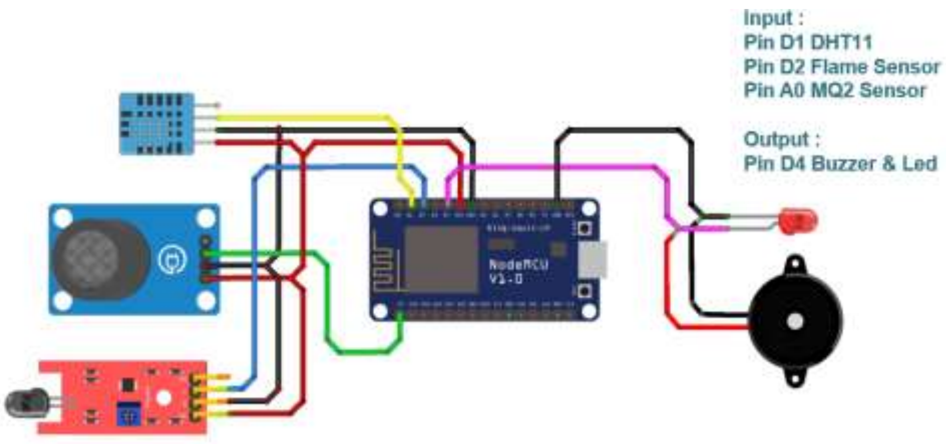


Figure 5. *Wiring diagram system*

From Figure 5 it can be explained that the pins used are pins D1, D2 and A0 for input devices, while pin D4 is for output devices, namely Buzzer and LED. To further explain the distribution of pins can be seen in Table 1.

Tabel 1. *PIN ESP 8266 Mapping*

Pin Number	Connect to	I/O
D1	DHT11	INPUT
D2	Flame Sensor	INPUT
A0	MQ-2 Sensor	INPUT
D4	Buzzer & LED	OUTPUT

The process sequence for how this system works can be seen in the flowchart in Figure 6.

From Figure 6 it can be explained as follows: At first the system is turned on, the initial initialization of the sensor is ON and reads the data. At the same time ESP8266 is ON and connected to WiFi as an internet delivery medium. The system works to detect three conditions: temperature, smoke and fire. If a high temperature is detected by DHT 11, then the system is processed by ESP8266 and sent to a telegram along with buzzer activation. The same thing is also processed when smoke or fire is detected by each flame sensor and MQ-2. Furthermore, how the data communication process in this system can be show in Figure 7.

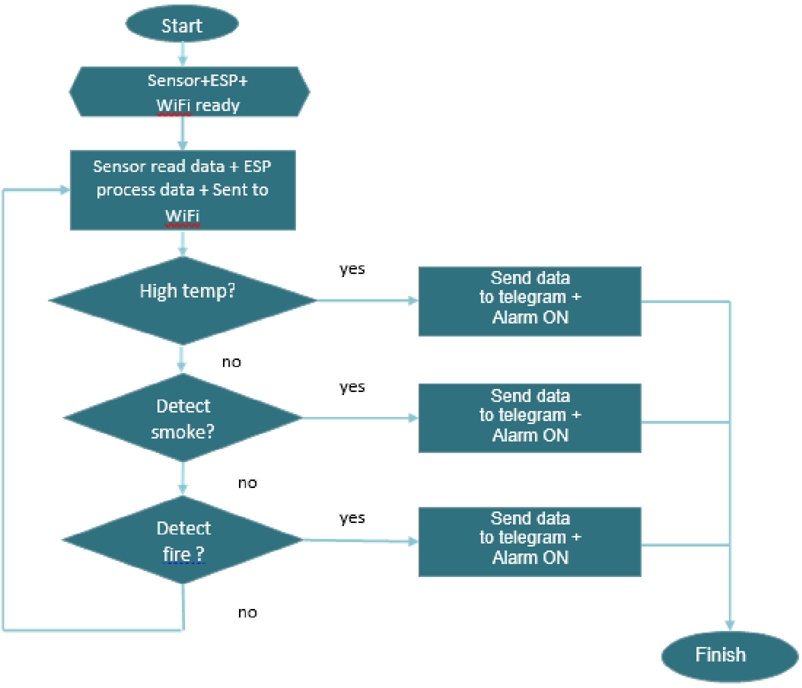


Figure 6. *Flowchart how this system works*

Figure 7. *Data communication process*

From Figure 7 it can be explained that all input signals are processed by ESP8266 and sent using the MQTT protocol [17], [18] via the test.mosquito.org server. ESP8266 published the topic to the Mosquitto broker. Furthermore, through the help of the nodered platform [19], [20]. This data is connected to a relay for alarm activation and push notifications to Telegram.

3. RESULT AND DISCUSSION

3.1. Product Prototype

Shown in Figure 8 is a product prototype that has been developed. Figure 8a shows the outside with a plastic casing measuring 10 x 8 cm and Figure 8b shows the inside following the wiring design in Figure 5.

Of the products that have been made, several things need to be discussed, including the selection of the selected casing material. It would be better if you use a material that is waterproof and more sturdy, so that it can withstand various weather conditions.

a *b*

Figure 8. *IoT Station for fire detection system*

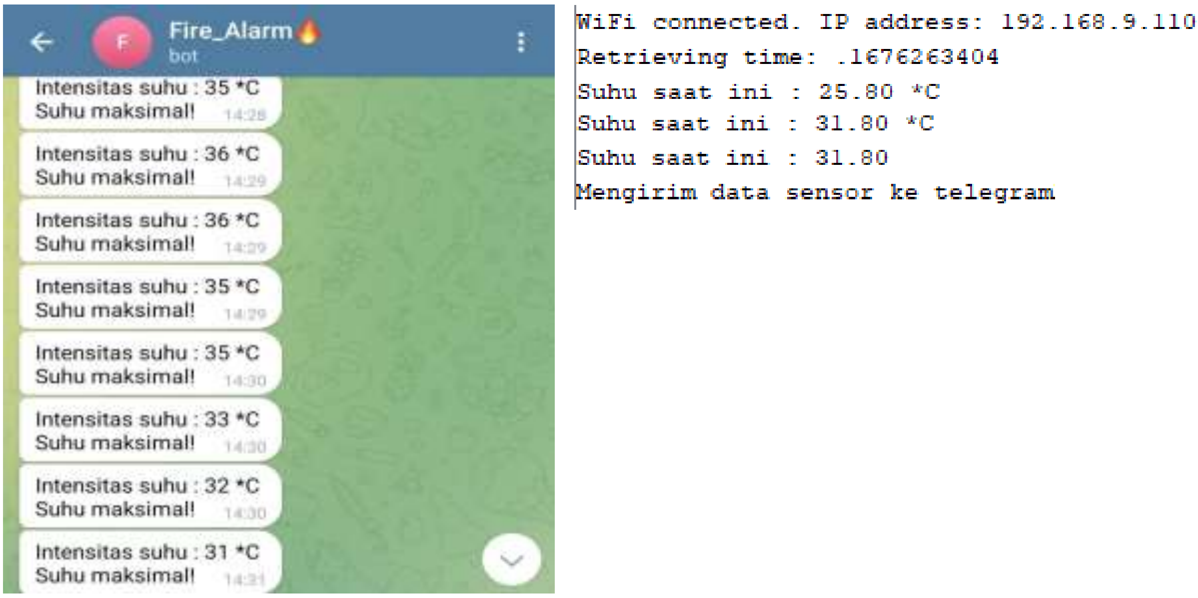
3.2. Wifi Connectivity Test

Wifi connectivity test aims to determine whether the ESP8266 is connected to WiFi or not with the username and password that have been set in the program code. If it is already connected, the serial monitor will display "WiFi connected" which means that the ESP8266 is already connected to WiFi. The results of the ESP8266 test can be seen in Tabel 2.

Tabel 2. *WiFi connectivity test result*

No	Temp	Message	Serial monitor	Action
1	31	Sent	Read	Buzzer On
2	32	Sent	Read	Buzzer On
3	33	Sent	Read	Buzzer On
4	35	Sent	Read	Buzzer On

Data display via telegram notifications can be seen in Figure 9a and serial data read on the serial monitor can be seen in Figure 9b.



a *b*

Figure 9a. *Telegram notification* ***9b.*** *Serial data notification*

From Figure 9 it can be seen that every change in temperature, apart from being displayed on the serial monitor, data is also sent via telegram in real time. When the temperature shows the numbers 31 to 35, the buzzer is automatically activated as a notification that there is a significant increase in temperature and you are asked to be alert.

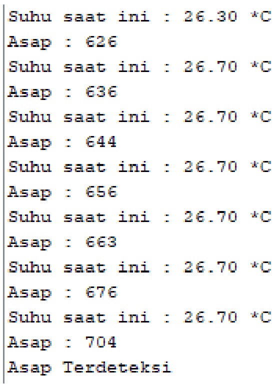
3.3. Sensor MQ-2 Test

Testing the MQ2 sensor circuit aims to determine whether the circuit can function according to the program made and can be connected to the ESP8266 when the sensor detects smoke or gas. In this test, smoke from an electric cigarette is used and the MQ2 sensor is set to activate and then give a signal to ESP8266 when the smoke thickness is above 700 ppm. In this condition the buzzer will sound as a hazard alarm.

Tabel 3. *MQ-2 sensor test result*

No	Smoke intensity	Smoke source distance	ppm	Sensor feedback	Serial Monitor	Telegram message	Action
1	light	50cm	704	<2 second	Read	Sent	Buzzer On
2	medium	50cm	755	<2 second	Read	Sent	Buzzer On
3	thick	50cm	803	<3 second	Read	Sent	Buzzer On

Table 3 provides an explanation in the form of data for us that in the test we are given three conditions of smoke thickness namely thin, medium and thick with a value range of 104-803. The results show that if the smoke starts to touch 700 ppm and above, the buzzer is on and the notification is active as shown in Figures 10a and 10b.



a b

Figure 10a. *Telegram notification* ***10b.*** *Serial data notification*

Furthermore, Figure 11 is a test display with three different types of thickness as described in Table 3.

a b c

Figure 11a. *light smoke* ***11b.*** *medium smoke* ***11c.*** *thick smoke*

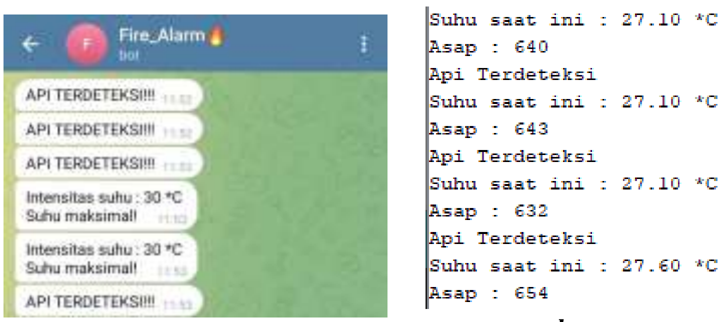
3.4. Flame Sensor Test

Flame sensor testing aims to determine the ability of the sensor to detect the presence of fire. This test is carried out with a portable stove as a source of fire which will be detected by the flame sensor. When a fire is detected, the buzzer will sound and send a telegram notification to the mobile user. Table 4 describes six variations of the distance between the fire source and the sensor.

Tabel 4. *Flame sensor test result*

No	Fire source distance	Room Light	Respon Sensor	Serial Monitor	Telegram message	Result
1	10cm	Bright	<2 sec	Read	Sent	Buzzer On
2	30cm	Bright	<2 sec	Read	Sent	Buzzer On
3	50cm	Bright	<2 sec	Read	Sent	Buzzer On
4	70cm	Bright	<2 sec	Read	Sent	Buzzer On
5	90cm	Bright	<2 sec	Read	Sent	Buzzer On
6	100cm	Bright	<2 sec	Read	Sent	Buzzer On

The results of the experiment can be seen that the sensor works quite accurately from the closest distance of 10cm to the farthest distance of 100cm. The sensor response is less than 2 seconds and the notification is sent via telegram accompanied by the activation of the buzzer on.



a ***b***

Figure 12a. *Telegram notification* ***12b.*** *Serial data notification*

Visualization of the trial with variations in the distance between the sensor and the fire source can be seen in Figure 13.

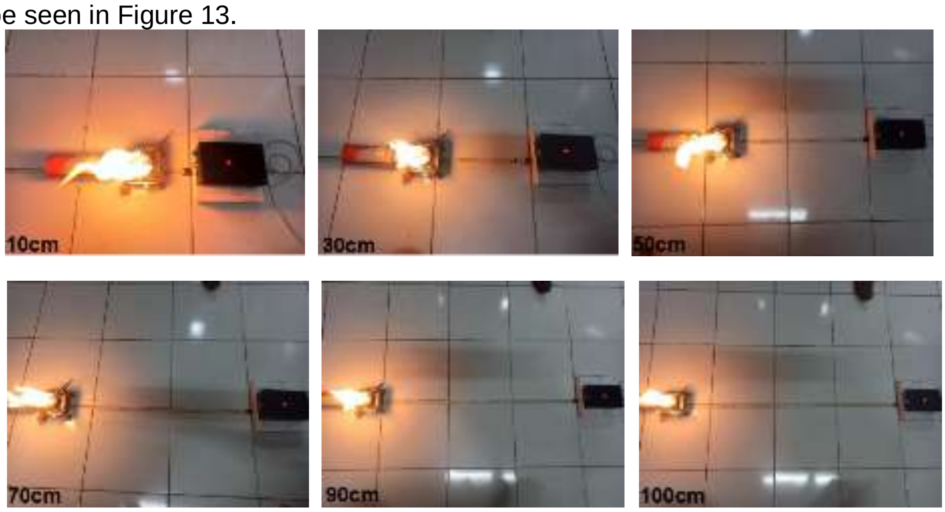


Figure 13. *variation of flame sensor tightening distance*

4. CONCLUSION

The fire detection system with IoT technology uses ESP 8266 which is connected to 3 main sensors, namely temperature sensors, smoke and fire sensors which aim to be 3 layers of detection so that there is an early warning if there is an abnormal increase in temperature. So before smoke or fire appears, the early warning system is already working. The use of ESP 8266 as a media controller for communication with IoT-based output devices is very reliable and there has never been a failure during testing. This system can be developed into a system that is ready to be implemented in industry, not only in the industry where this research is conducted, namely in the captive power plant of PT Indorama Purwakarta. The combination of the Telegram notification system in the IoT system is very effective, because apart from being fast, data is also sent quite accurately with the condition that the internet connection must be good and stable. The system can be developed into a ready-to-use system in various fire-prone buildings.

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