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Fire Detection System At Labuhanbatu University Based On Internet Of Things (IoT)

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Abstract

Fire accidents are disasters that often occur compared to other fire disasters such as floods, landslides, earthquakes or tsunamis. Fires can occur at any time and no one knows for sure when a fire accident will occur. The impact of a fire disaster is not only material that can disappear human lives. The causative factors of fire disasters often occur due to human negligence and fires often occur in houses where the occupants have left them. Labuhanbatu University at night will be left by the owner and all lecturers and educational staff, only guarded by 2 security people with this condition it is very dangerous when a fire occurs in one of the buildings. The purpose of this research is to focus on making a fire detection system at Labuhanbatu University based on the internet of things to provide early warning on safety. The system uses three sensors namely temperature sensor, gas sensor, and fire sensor. This research is an R&D research using the ADDIE model with the following stages Analysis, Design, Development, Implementation, Evaluation. The results of the fire sensor test were 90% successful, the results of the sensor test as soon as possible were 90% successful and the temperature sensor test results were 90% successful. This fire detection system can minimize or minimize the occurrence of fire accidents and losses because it is based on the internet of things providing early information when a fire occurs to education staff and lecturers at Labuhanabtu University. Overall this fire warning system can function properly.

Keywords: arduino; internet of things; microcontrollers; android; fires; ADDIE

1. Introduction

Fire is one of the tragedies that cannot be predicted, besides being unwanted by the community, it is also often out of control when the fire is big. Fire events are very dangerous and disrupt the life and livelihood of the community. Fire is categorized as a form of disaster. According to the National Disaster Management Agency (BNPB)[1], disaster is an event or series of events that threatens and disrupts people's lives and livelihoods caused by natural factors, non-natural factors are covered by Kompas. Fires will be a threat to human and environmental safety. The rapid progress of development development, resulting in an increasing risk of fire occurrence. The population is getting denser, the construction of office buildings, residential areas, apartments, industries is growing rapidly, causing vulnerability.

With the increasing number of incidents that have recently occurred regarding house and building fires and also several other crowded places. According to BPBD DKI Jakarta, there have been 642 incidents of fires. Furthermore, covered by the Detik News media in Simandulang Village, North Labuhanbatu, 16 houses burned down on January 10, 2022 and in Rantauprapat Labuhanbatu, 8 houses burned on September 13, 2022, covered by the Jawa Pos media.

As for the causes of fires, there are several factors, such as: electrical installation short circuit [2], gas stove exploding[3], cigarette butts[4], candles when there is a power cut, fuel storage, insect repellent[5] and others. In general, a fire is known when the fire has started to grow or the smoke has started to turn black or has been billowing out of the building. There are still many incidents that have not been properly resolved which has resulted in many fire incidents occurring. A security system in buildings (buildings or housing) is needed because the fire hazard does not know the time, so that early prevention can reduce the occurrence of fires.

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Along with the rapid development of technology, new tools are created that help humans to be automatic, digital and connected to the internet in the fields of health, security, education, economics and other fields [6].

In order to facilitate and assist the public in quickly informing them of fire indications, it is necessary to have a tool capable of detecting and issuing fire warnings so that the public can monitor the condition of their residence, for this it is hoped that this tool can work effectively and reliably. The technology that can be used is the Internet of Things technology, which is a technology that allows physical objects to communicate with each other via the internet. IOT (internet of things) devices connect between other IOT devices or applications (cloud base) to convey information using the internet transfer protocol[7]. Previous research on IOT has been used for remote blood pressure monitoring[8] , monitoring of IOT-based electric power [9], IOT-based home security[10] , distribution of clean water with IOT [11] and others.

To create a system with the internet-of-things concept, many open source-based standard platforms have been developed, for example ThinkSpeak [12], Blynk [13] , Cayenne[14][15] and Thinger.io, DeviceHive [16], ThingsBoard.io[17] and others.

In this study, the prototype was built using the Blynk platform for internet-of-things implementation. Apart from being open source, the platform provides convenience in connecting with various hardware devices to support communication via Ethernet, WiFi, GSM, and others.

The microcontroller used in this study is Arduino. Arduino is a platform for physical computing that is open source. Called a Platform because, Arduino is not just a development tool, but it is a combination of hardware, programming languages and a sophisticated Integrated Development Environment (IDE).

There are many projects and tools developed by previous researchers using Arduino, for example door guards with fingerprints[18], line follower robots[19], food delivery devices[20], overcurrent protection[21] and others. From the results of research that has been carried out using Arduino and the internet of things by previous research that was successful and can help humans, research was carried out on an Arduino-based fire detection system at Labuhanbatu University to provide early notification to Labuhanbatu University safety education staff.

2. Research Methods

This study used the research method of R&D (Research and Development). The R&D method is a research method used to produce certain products and test the effectiveness of these products. Such that stated by Sugiyono [24] that "Research and development research is research methods used for produce a specific product and test the effectiveness of the product. Research and development (R&D) methods using the ADDIE development model. This model consists of five steps, namely : (1) analyze, (2) design (3) development (development), (4) implementation, and (5) evaluation[22] can be seen in Figure 1. Process Flow Chart in the System can be seen Figure 2.

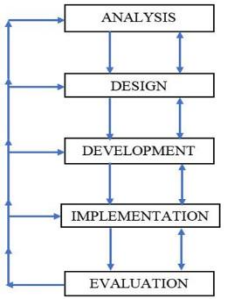

Figure 1. ADDIE Model Stages [23]

The details of the research stages are:

Analysis: In this process the author collects data and information needed in making this fire detection system. The process carried out here uses a method similar to a literature study which aims to examine matters related to relevant theories that support system planning and design.

Design: At this stage the author begins to design a series of system designs. This design stage begins with determining the materials and tools that will be used to manufacture a fire detection device

Development: The result at this development stage is a Fire Detection System product at Labuhanbatu University Based on the Internet of things (IOT)

Implementation: At this stage trials of fire sensors, temperature sensors, gas sensors are carried out to ensure that the sensors needed for fire detection function properly.

Evaluation: The final stage is evaluation, this stage is carried out to find out product weaknesses. Weaknesses of this product are known from several stages that have been done before. After the weaknesses are known, the next researcher improves the product according to the suggestions that have been given.

3. Results and Discussions

3.1 Analysis

The results of the needs analysis have revealed the necessity for esp8266, bylink applications, solder, light, fire, temperature, and smoke sensors. At Labuhanbatu University in North Sumatra, the study was carried out.

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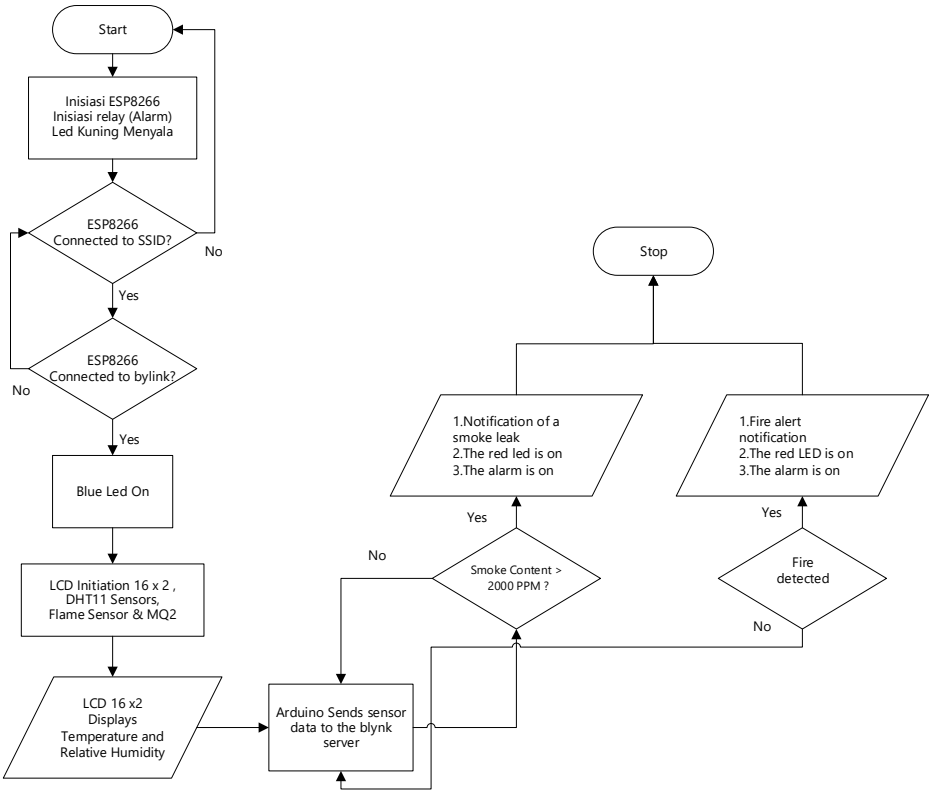

Figure 2. Process Flow Chart in the System

3.2 Design

The product design phase is the following stage. Fire detection equipment goods and user manuals were the two products created in this study. Designing the components and machinery that will be used to create fire detection devices is the first step in this design phase. The design of the tool's user handbook is the next step.

3.3 Development

The tool will now be verified by a number of validators who are professionals in their respective industries. Manual validation as well as tool validation for fire detection. The implementation of the tool products at Labuhanbatu University will follow expert validation of the fire detection tools and manuals.

3.4 Implementation

The product trials at this stage were conducted at Labuhanbatu University, and these trials provide insight into the implementation phase.

Fire Sensor Testing: Testing the fire sensor perpendicularly using a candle as a source of fire. Measurements are running as expected. The sensor is able to read at a distance of 100 cm with a large source of fire, 50 cm on medium heat and 10 cm on low heat. The characteristics of the fire sensor can be seen where the voltage value is inversely proportional to the measuring distance of the fire center. And also the ability to read from the fire sensor which is more sensitive to large fires. From the results of the fire rate reached 90%. The results of the fire sensor test are shown in table 1. Sensor test, only 1 out of 10 trials failed, so the success

Table 1 Testing of Fire Sensors

No	Jarak	Buzzer	Blynk Notifications
1.	10	On	Yes
2.	20	On	Yes
3.	30	On	Yes
4.	40	On	Yes
5.	50	On	Yes
6.	60	On	Yes
7.	70	On	Yes
8.	80	On	Yes
9.	90	On	Yes
10.	100	Off	No

Temperature Sensor Testing (see Figure 3): In table 2, data in number 10 shows a temperature value of 48.7, then the system will send a warning message to the Blynk application as shown in figure 3.

Table 2. Temperature Sensor Testing

No	Temperature	Buzzer	Blynk Notifications
1.	34.2	Off	No
2.	36.9	Off	No
3.	39.5	Off	No
4.	42.0	Off	No
5.	42.5	Off	No
6.	43	Off	No
7.	44.4	Off	No

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No	Temperature	Buzzer	Blynk Notifications
8.	48.7	On	Yes
9.	49.8	On	Yes
10.	53.8	On	Yes

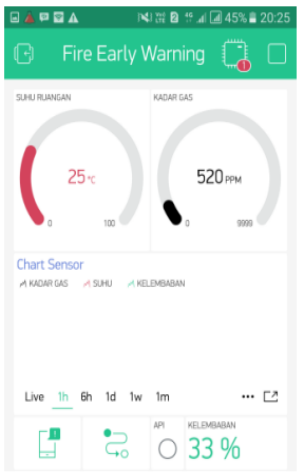

Figure 3. Temperature Sensor Testing

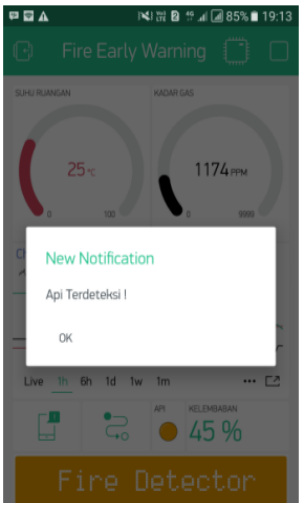

Figure 4. Notification of a Fire Occurrence

3.4.3 Smoke Sensor Testing

In table 3 the sensor data obtained has reached the research target. If the sensor detects more than 450 ppm it will send a notification to the Labuhanbatu University Blynk Tendik application can be seen in Figure 5.

Table 3. Testing of Smoke Sensors

No	Ppm	Buzzer	Blynk Notifications
1.	236	On	Yes
2.	513	On	Yes
3.	429	Off	No
4.	508	On	Yes
5.	601	On	Yes
6.	615	On	Yes
7.	739	On	Yes
8.	768	On	Yes
9.	732	On	Yes
10.	718	On	Yes

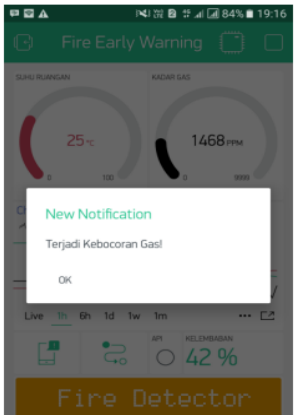

Figure 5. Gas Leak Notification

3.4.4 Blynk application testing

The Blynk application on this system is used to display information regarding temperature, humidity, gas levels and provide notifications on Android-based cellular phones when gas or fire is detected. The programming code that is installed into the microcontroller to activate this application is shown in Figure 5.

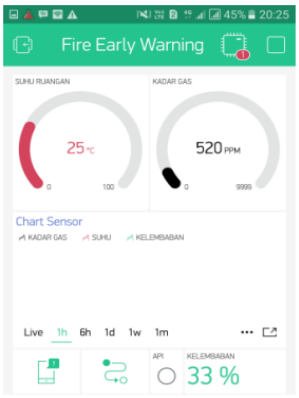

Figure 5. Sensor Monitoring Display on Android Smartphone

3.5 Evaluation

The final stage is evaluation, this stage is carried out to find out product weaknesses. Weaknesses of this product are known from several stages that have been done before. After the weaknesses are known, the next researcher improves the product according to the suggestions that have been given.

4. Conclusion

From the test results on the fire detection system at Labuhanbatu University based on the internet of things, the following conclusions are obtained. From the results of the fire sensor test, it was found that only 1 failure out of 10 attempts was made, so the success rate reached 90%,The results of the smoke sensor test obtained only 1 failure out of 10 trials, so the success rate reached 90% and The results of the temperature sensor test did not

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fail out of 10 trials, so the success rate reached 100%.

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