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Prototype of Fire Detection Tool Using Short Message Service (SMS) Notification as A Disaster Mitigation Effort Against Environmental Damage Due to Forest Fires

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Abstract

In relation to the threat of drought, it is necessary to do a drought analysis to evaluate the drought that has occurred. Another disaster caused by water drought is forest fires. The purpose of this study using the prototype of a Forest Fire Detection Tool (FFDT) are to early detection of forest fires and providing Short Message Service (SMS) notification of forest fires to the officer. The method of this study used a prototype of a FFDT with SMS Notification. This tool is controlled using the ATmega328 microcontroller or better known as Arduino Uno R3 and also the GSM 800L v2 module so that this tool will provide notification to forest guards in the form of sirens and SMS sounds when there are indications of smoke or fire that are identical to the event of a forest fire. Monitoring uses fire sensors, namely fire for the detection of flames that are often associated with forest fires and uses sensors as soon as possible, namely MQ2 and MQ9, all of which are equipped in one device, a forest fire detector using the Arduino Mega microcontroller. When there is a good sign that the flame or as soon as possible is read, the tool will send an SMS notification to the forest officer, the process of sending the SMS makes the fire process can detect even though it is still in a small condition or not widened.

Keywords: water drought; protect environmental damage; prototype of fire detection; short message service (SMS); notification

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INTRODUCTION

Drought is one of the natural disasters that threatens life and causes huge losses. The report of the Intergovernmental Panel on Climate Change (IPCC, 2007) states that the world has become increasingly vulnerable to drought in the last 25 years, and climate projections suggest that this will be more severe in the future (WHO, 2002). This will have a big impact, especially for developing countries. An important component of a national drought strategy is a comprehensive drought monitoring system that can warn of the onset and end of a drought, determine its severity, and disseminate information on various sectors, especially agriculture, clean water, energy, and health. Water resources management is an effort to plan, implement, monitor, and evaluate the implementation of water resources conservation, utilization of water resources, and control of water destructive power (WHO, 2003). In relation to the threat of drought, it is necessary to do a drought analysis to evaluate the drought that has occurred. Another disaster caused by water drought is forest fires (Prüss-Üstün & Corvalán, 2006).

Forest fires often occur in some Indonesian forest areas, for example forests under the supervision of PUSLITBANG forests. As happened in the Pasir Awi research forest, Leuwiliang in 2015, which was caused by forest honey hunters who used burning coals to cause smoke and sparks (Hamilton, 2005), then the sparks hit parts of the tree that contained flammable contents so the fire quickly burned one tree it was then that forest officials realized the fire when it was already large enough (Park et al., 2019). Fire is the flame both small and large in place, the situation, and when unwanted detrimental and generally difficult to control (Mahzan et al., 2018). The forest is a plant community that is dominated by trees or other woody plants, grows together and is quite dense (Khan et al., 2019). Forest fires have also occurred in the Dramaga research forest although the effects of the fire did not have a major impact because only a portion of the forest area was burned compared to events in the Pasir Awi research forest (Sathishkumar et al., 2019).

In the event of a fire that occurs often officers find out when a forest patrol consisting of 5 forest guards, so officers must return to the post to pick up fire poison (Alqourabah et al., 2021), it is time consuming and inefficient often the post distance with the location of the fire is far enough then the fire can be enlarged when the officer has returned to the scene of the fire (Bahrepour et al., 2007). Fire extinguishers using the feet and dry branches are also often used and this also takes a long time (Telagam et al., 2019). The purpose of this study using the prototype of a Forest Fire Detection Tool are to : 1. Early detection of forest fires. 2. Providing SMS notification of forest fires to the officer.

METHOD

The method used in this research can be seen in **Figure 1**. The location of the research was initially carried out at the Experimental Laboratory of the Computer Engineering Study Program, College of Vocation Studies, IPB University, Indonesia. The method of this study used a prototype of a Forest Fire Detection Tool with SMS Notification. This tool is controlled using the ATmega328 microcontroller or better known as Arduino Uno R3 and the GSM 800L v2 module so that this tool will provide notification to forest guards in the form of sirens and SMS sounds when there are indications of smoke or fire (the MQ-7 smoke sensor) that are identical to the event of a forest fire. However, at the time of application, it was carried out directly in the plantation area around IPB University. The following methods are used in the study, namely: observation, design, assembly, and testing as shown in **Figure 1**.

Figure 1. The process of study

Arduino Uno R3

Arduino Uno R3 is a microcontroller development board based on the ATmega328P chip. Arduino Uno has 14 digital input / output pins (or commonly written I/O, of which 14 pins can be used as PWM outputs including pins 0 to 13), 6 analog input pins, using a 16 MHz crystal, including pins A0 to A5, USB connection, power jack, ICSP header and reset button. This is all that is needed to support a microcontroller circuit. The specifications for Arduino Uno R3 can be seen in **Table 1** and Arduino Uno R3 can be seen in **Figure 2**.

Table 1. Arduino Uno R3 Specifications

Components	Specifications
Microcontroller	ATmega328
Operating Voltage	5 Volt
Input Voltage	7-12 Volt
Digital I/O Pins	14
Analog Pins	6
DC current per I/O pin	50 mA
DC current when 3.3V	50 mA
Flash memory	32 KB

SRAM	2 KB

(**Source :** Specification of tools in this study)

Figure 2. Arduino Uno R3 Specifications

RESULTS AND DISCUSSION

Based on the tests in **Table 2** it can be concluded that the Forest Fire Detection Device Prototype can operate properly and in accordance with the program that was created when the tool is at a height of 2 m and the distance of the fire from the tool's upright reaches 1 m, because that position creates an angle of 63 degrees. The calculation process can be seen in **Figure 3**.

Table 2. Detection of the range of fire sensor devices

Trial	Height	Distance	Status
1	1 m	2 m	The SMS is not sent and the siren does not sound
2	1.5 m	1 m	The SMS is not sent and the siren does not sound
3	2 m	1.5 m	The SMS is not sent and the siren does not sound
4	2 m	1 m	The SMS is not sent and the siren does not sound

(**Source :** Data of this study)

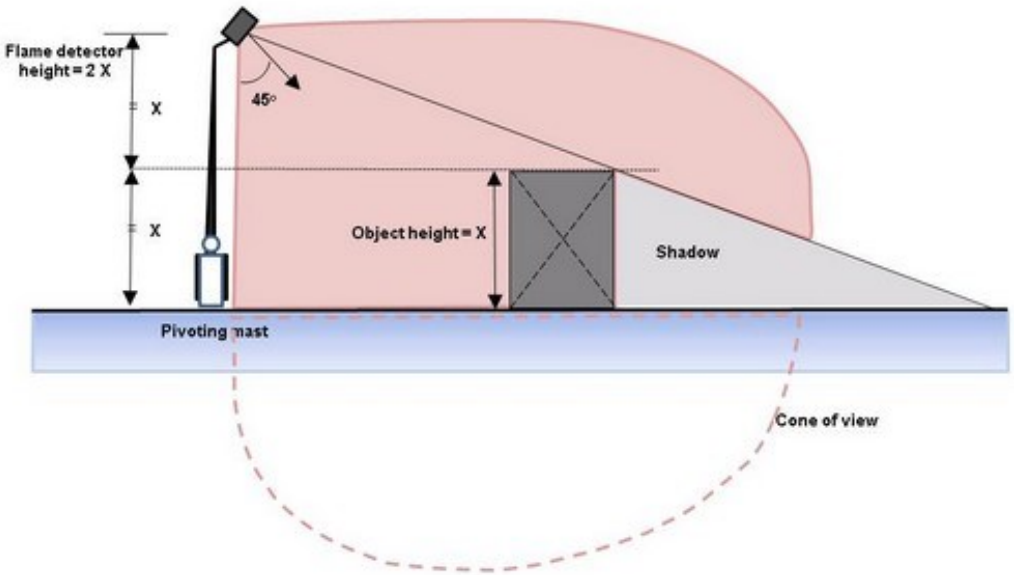

Figure 3. Calculation of the reading range of a fire sensor

Figure 4. Fire sensor testing process

In **Figure 4**, it is not visible to the tool that the author has made because the process of taking photos is not comprehensive (Bahrepour et al., 2007), so only visible picture of the indications. When the reading process has been completed by the fire sensor then the siren will sound and when the siren has reached the sound of the three devices will send an SMS as shown in **Figure 5**. This process occurs when there is a change in voltage on one of the sensors then it is forwarded to the Arduino which then appears an audio and visual warning through a flashing LED and a buzzer that sounds as long as the sensor detects signs of fire (Alqourabah et al., 2021). In addition, the LCD display which originally displayed the status of each sensor will change according to the signs of fire that have previously been categorized (Adjiski et al., 2017), which in the first frame will appear text as shown in **Figure 6**. In addition, the system also instructs the Arduino GSM Shield to send a notification message, if there are signs of fire to the mobile number that was previously programmed (Kharisma & Setiyansah, 2021).

Figure 5. The results of the process of sending an SMS indication of fire

Table 3. Detection of the range of smoke sensor devices

Distance	Smoke Conditions	Time Reading Sensor	Status
0,5 m	Thick	3 seconds	The siren sounds and an SMS is sent
1 m	Thick	6 seconds	The siren sounds and an SMS is sent
2 m	Thin	26 seconds	The siren sounds and an SMS is sent
3 m	Thin	37 seconds	The siren sounds and an SMS is sent

(**Source :** Data of this study)

Based on **Table 3** all tests show the status of the siren sounding and SMS sent. So the authors conclude that the smoke sensor can operate at a considerable distance (Listyorini & Rahim, 2018).

Figure 6. The smoke sensor testing process

When the reading process has been completed by the smoke sensor then the instrument sounds the siren when the siren sound has reached the third sound (Labellapansa et al., 2019), the tool will send an SMS as shown in **Figure 7**.

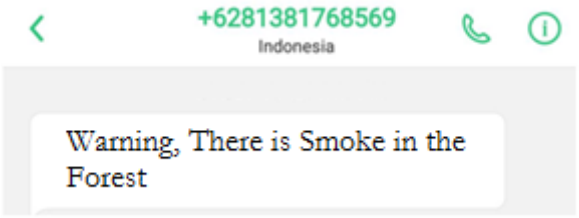

Figure 7. The results of the SMS sending process are indicative of smoke

From the test results of the MQ-7 smoke sensor, it can be concluded that smoke will be detected only when the wind direction is in the direction of the device, when the wind direction is different, the system is unable to detect even though there is smoke. When smoke is detected, it is displayed on the web as shown in **Figure 7**. There are 3 provisions on the MQ-7 smoke sensor:

1. If the smoke sensor detects smoke along with the fire sensor detects a flame, the status on the web changes to "NOT SAFE" with a red indicator and automatically sends an SMS.
2. If the smoke sensor detects smoke along with a temperature sensor with a temperature of >45°C, the status on the web changes to "WARNING" with a yellow indicator and automatically sends an SMS. If only the smoke sensor detects the presence of smoke then the status on the web remains at the "SAFE" status with a green indicator.

The design of this IoT-based fire detection system and SMS gateway is very helpful in providing fast information to find out fires that occur in the forest, by using the Internet of Things method, officers will be able to know conditions in real time, because this technology is able to monitor hardware using means of internet communication so that distance and location are not affected as long as the sensors used detect changes that occur. The results of the tests that have been carried out have yielded several information, including:

a) The fire sensor is capable of detecting the presence of fire, but the ability of this sensor is not sufficient to cover a large area, while the process of transferring data on the presence of fire from the sensor into an internet database that can be accessed by officers is very adequate, marked by the time obtained in just seconds.
b) On the smoke sensor, the presence of smoke is strongly influenced by the direction of the wind, if the wind blows towards the sensor when there is smoke, the sensor will be able to detect CO levels even though the changes are very small but if the wind blows in the opposite direction the sensor will not be able to detect CO levels. For the temperature sensor test, it is able to detect temperatures that are almost similar to real conditions in the field by comparison with a thermometer so that the level of data accuracy is very large.

c) There are no problems in testing the process of sending data from sensors via MQ-7 smoke sensor to the database using Internet of Things technology, so that the fire detection process is highly recommended to use this method.
d) The old system takes up to ±30 minutes to handle fires, while the new system that the author uses only takes a few minutes (≤5 minutes) to inform related parties and the state of the forest can be monitored at any time because it uses a real system time.
e) Completeness will die completely if it is engulfed in fire, therefore this equipment requires a fire-resistant coating so that the sensor can be fire-resistant and it is recommended not to use a 1-point flame sensor model because this sensor is not able to detect fire from a distance so it is not effective if there is a large fire, besides this 1 point fire sensor is less able to detect sunlight that is too hot, and fire so the accuracy level is very less.

CONCLUSION

Prototype Testing of Forest Fire Detection Devices has been carried out under various conditions and obtained results in the form of warning notifications to forest guards with sirens and SMS notifications so that these devices have been described as early detection of forest fires. The way this system works is when one of the sensors detects signs of fire, then it sends a signal to Arduino and from Arduino then orders the Arduino GSM Shield to send notification messages (notifications), if there are signs of fire to the user's cellphone or cellphone number that has been previously set. program, then a second notification of text on the LCD and LED that keeps flashing and the buzzer sounds continuously, the two notifications will continue to give notifications and will stop if the sensor does not detect any signs of fire.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest concerning the publication of this article. The authors also confirm that the data and the article are free of plagiarism.

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