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Pathfinding Augmented Reality for Fire Early Warning IoT Escape Purpose

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***Abstract* -** *Fire is an unpredictable disaster. Various things have been done, such as automatic alarms and making emergency calls. This problem can be solved with the help of the Internet of Things (IoT). The real problem is when it fires, everyone panics, not knowing what to do once the alarm goes off. In this study, the tool can combine fire early warning alarms with augmented reality (AR) gamification to find escape destinations called Pathfinding Augmented Reality. The tool that will be made uses the prototype method with a microcontroller on the ESP32. As well as using mild steel that is not easily melted by fire. The results of the study, in a tool using a questionnaire and BlackBox testing. The tool received a good response according to the results of the questionnaire. This tool can be used as early detection of fire that can detect gas and fire at a 5-30cm distance. The tool can also send fire messages can be used effectively on 2G signals and above. Furthermore, the tool has AR gamification for escape navigation purposes and is very suitable for use if registered in the AR creation software.*

Keywords — *Augmented Reality, Internet of Things, Fire early warning*

I. INTRODUCTION

Fire is a disaster that often occurs in cities and tourism centers due to several contacts from gas, electrical shorts, and many more. Fires usually happen due to human carelessness, due to neglect of safety protocols, and other negligence. According to[1], it is fired that makes people lose their lives, but the eroding oxygen levels are also significant. So the chain effects created by a fire are numerous. Mainly the panic occurs when evacuating people to the right track.

Most offices, universities, and schools have used many innovations, one of which is IoT (Internet of Things). For the development of IoT itself, it has been widely applied, especially for households. [2]. From the start of daily use [3], and can also be involved in the future, with IoT technology that is increasingly developing with 5G communication technology[4]–[6].

It is only natural that IoT is called a renewable technology for the 4.0 industrial revolution. The Indonesian government has provided many grants for innovations in IoT. This technology is usually made using a microcontroller, using a simple controller for Android and Arduino [7], [8]. In previous research, IoT can also be used on 2-sided mirrors. The innovation provided is the interaction between educators. For another study[9], It is also mentioned that IoT is the power of the future of technology.

Many fires occur in buildings, especially government agencies, because essential files are still stored outside the network. The use of IoT for the early detection of fires is necessary because fire detection can now detect it early to warn employees, consumers, and people in the building. Simple detection for fires is usually just sounding the alarm and turning on the water. However, it is complicated to escape purpose routes when a fire occurs, especially for several people who are in a room alone.

In previous research[10], forest fire detection mode is based on the flame. Quadrotor crewless aerial vehicle (UAV) All these video series are collected using preprocessing processes such as image filtering and enhancement. According to[11]. Describes several different solutions that have emerged for the early detection of traditional forest fires. From the two previous studies, it is more early to detect fires. There is no solution after the detection of what should be done by people in the area.

Several studies rarely explored early fire detection in previous studies, such as escaping escape purpose routes. Therefore, researchers try to do some experiments about early detection using Augmented Reality (AR) [12], [13] gamification technology for the escape purpose routes process where the user is augmented road designation. Because basically, people in a state of emergency will panic and can't do anything on their own, especially with no one to guide them.

It is hoped that the manufacturing results can help in various ways, especially in pathfinding escape purpose routes for the early detection of office building fires. The path search will be more interesting if packaged with good gamification such as AR[14]–[16]. Another characteristic is that the database can be controlled using an open Android application that is dynamic so that some online features can be innovated in the future. The fundamental differences with other fire detection are interacting with AR gamification, Alarm, Vibration, and Standby light to help raise awareness. Classrooms for Binus University Bandung can be used as

trials such as; Meeting rooms 4 and lecture halls from the 8th - 12th floor. Then, it is also hoped that this AR guide with IoT detection collaborating with game-making devices, where game-making software is very interactive and open.

II. LITERATURE REVIEW

Previous research[11], such as early detection, can be used for drone-based early detection of forest fires and image processing. However, it is unclear what review will be used to see more detailed research in this paper. Therefore, more details will be described in the following table:

Table1. Previous Research

No	Author	Title	Result
1	HristovGeorgi, RaychevJordan, KinanevaDiyana, ZaharievPlamen[11]	*Emerging methods for early detection of forest fires using unmanned aerial vehicles and LoRaWAN sensor networks*	Described and showed some answers for early detection of forest fires. this answer involves the use of air vehicles
2	Ma Sha, Zhang Youmin, XinJing, Yi Yingmin, Liu Ding. Liu Han[10]	*An Early Forest Fire Detection Method Based on Unmanned Aerial Vehicle Vision*	New detection stages for early detection. Experimental results can detect quickly and effectively
3	YangXingsha TangLinbo WangHongshuo HeXinxin[17]	*Early Detection of Forest Fire Based on Unmanned Aerial Vehicle Platform*	The researcher proposes a forest fire detection method that utilizes optical imagery to detect it immediately and infrared imagery to detect fires
4	ChenKe, ChengYanying, BaiHui, MouChunjie, ZhangYuchun[18]	*Research on Image Fire Detection Based on Support Vector Machine*	Suspected fire area. Then, the uniform size is sampled again. Researchers detect color moment features, and texture features are extracted and entered into a supporting vector engine for classification and recognition.

The tool made in this paper has a function as an IoT-based smart device with an AR gamification guide to improve the performance of early detection of fire tools through technology. The tool's design uses a simple ESP32 microcontroller and the Unity gamification application as a control processing center and game creation to fulfill all processing. IoT devices have so many modules, including simple control, alarm, vibration, standby light, MQ2-Sensor, IR Flame Sensor module, and other interactive programs. Several frameworks or ways of working are created to realize all the desired displays, as shown in figure1.

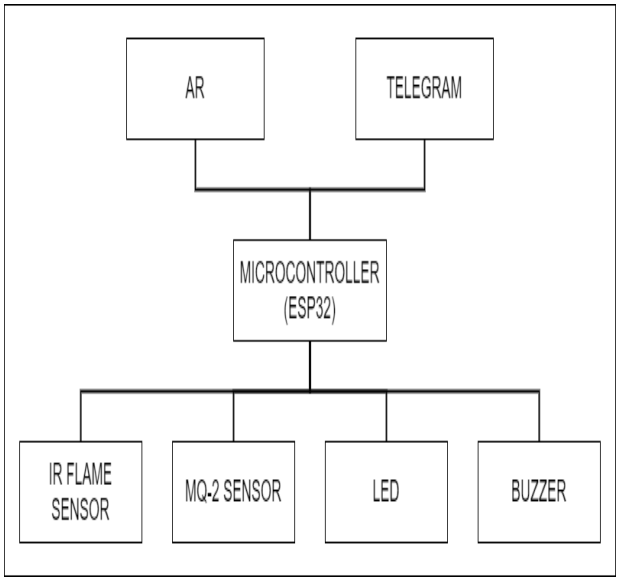

Fig 1. IoT Detection with AR Diagram Functions

According to Figure 1, the system provides comfort to users/visitors in fire-prone buildings, where detection is an early detection before the fire gets bigger, through this AR system. It will be easier for users/visitors at close range because the lights on the device will sound and vibrate to increase the awareness of people around.

This research using ESP32[19], [20] is a family of microcontrollers that are introduced and work like ordinary microcontrollers. This ESP32 is the successor of the ESP8266 microcontroller. This type of microcontroller is very similar and also works in the Arduino IDE. There is

already a wifi module available in this microcontroller and coupled with BLE (Bluetooth Low Energy) in the chip, so it is very supportive. Therefore, it can be a good choice for creating Internet of Things application systems.

Because the function of early fire detection will be made more interactive in design and use, this research has weaknesses, one of which is that it is not equipped with GPS location and anomaly tracking on the device.

III. METHODOLOGY

In this researcher, the researcher uses the prototype method to build pathfinding augmented reality. This method is this method according to which it is suitable to be applied in this case[21][22]. An essential concept of this method is the development of the model into a final system such as[23]–[28], [28]:

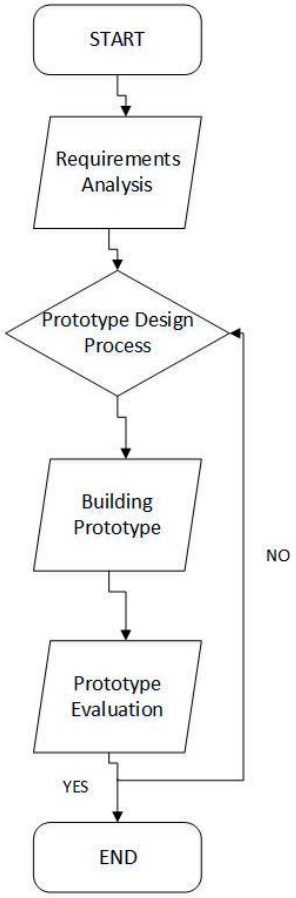

Fig 2. Prototype Model

The following are the stages of developing a prototype model:

A. Requirements Analysis

Designing and analyzing requirements is the stage where users and device developers decide on the definition of the application and look at the system requirements created with researchers[29]–[31].

B. Prototype Design Process

This stage is the process carried out by researchers in designing designs that are following user needs[32].

C. Building Prototype

The researcher makes a simple prototype while making a directly applied design to the tool[32].

D. Prototype Evaluation

At this stage, the researcher evaluates the device, the results of the software and tool design will be applied in the surrounding environment, whether the tool built is following user needs or not. The prototyping will be revised by repeating the previous steps [16],[17].

E. Manufacturing Stage

The Android AR system started as gamification of escape purpose routes was built using a software application to guide users to escape purpose routes. In making hardware, an Android-based esp32 microcontroller is used. This is done in stages:

1. The container is made of mild steel on top that has been appropriately modified not to be flammable.

Fig 3. Pathfinding Augmented Reality Fire Alarm Tool Case

2. Provide an ESP microcontroller with 32 sensors such as fire, gas, buzzer. Then devices such as LED, Breadboard, Lithium battery and resistor.

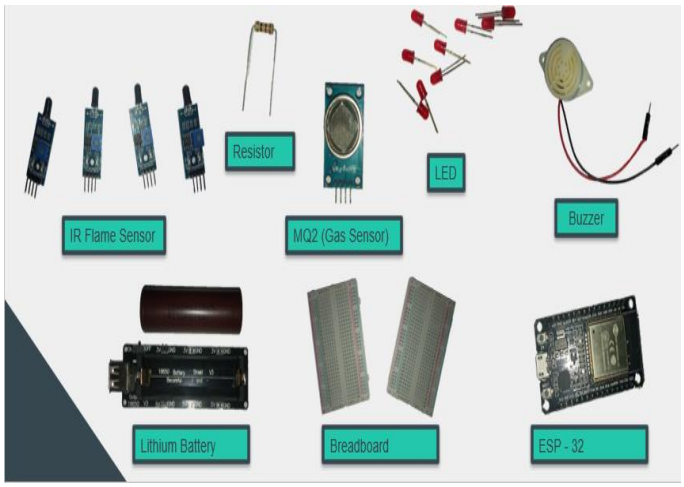

Fig 4. Devices used

3. Connect the ESP 32 microcontroller as the center and all components and sensors that exist.

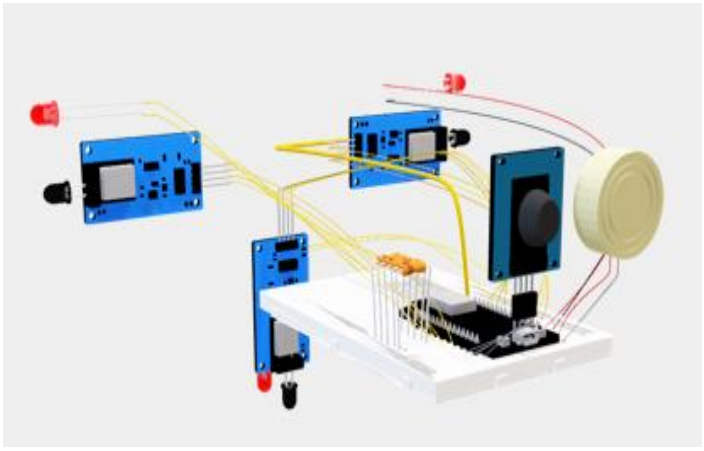

Fig 5. Devices design

4. Combine the pre-designed device with the receptacle.

Fig 6. Implementation result pathfinding augmented reality

5. Combine tool with escape purpose routes route creation software, with gamification creation software

The system hardware consists of refractory material (mild steel), breadboard board, ESP32 Arduino development board, smoke detector, mini Wifi, relay, and other components, as shown in Figure 4 - 6.

The tool itself will be placed on top with the sensor facing down so that when the fire is on or the CO level is over the threshold. Then the tool will turn on the LED and also the buzzer accompanied by sending a fire hazard via all telegram social media.

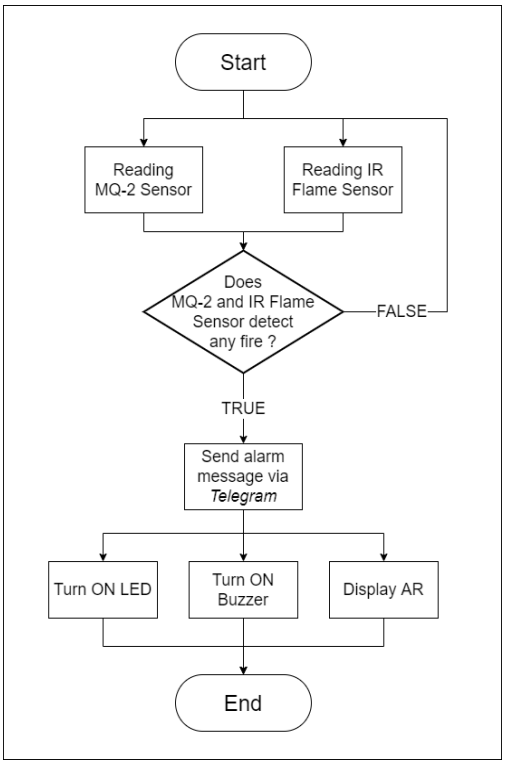

Fig 7. How the Pathfinding Augmented Reality Works

As explained in the previous chapter, figure 7 is a more detailed way of working a fire early detection tool with the help of the AR escape purpose route. Before using the tool, users/visitors of malls, supermarkets, and offices have already installed the AR application. The following is a systematic and gradual way of working:

- Beginning with how the tool works by detecting gas and fire using the MQ-2 sensor and Flame Sensor
- The sensor will work when both detect gas and fire. The tool will send alarms and messages via telegram to visitors/users
- When only one sensor is active, the tool will not continue the process so that the device will return to the sensor checking phase
- After the tool sends a message via telegram media, the tool will turn on the buzzer, LED lights and ask

visitors to turn on the AR application to guide visitors to the escape-purpose route site.

- After the visitor/user arrives at the escape purpose route site, the AR application will stop working.

IV. EXPERIMENTAL RESULT

Tools designed will implement a ceiling room that hasa the possibility of fire, shown in figure 9.

Fig 8. Location of Devices Pathfinding Augmented Reality

The design is placed above the ceiling to not interfere with the user and is not easily moved. On the other hand, the nature of smoke and fire that spreads upward is also considered for researchers to store the above tools. Finally, because the tool is expected to be fireproof and burn at the end after turning on all sensors and sending messages to users' social media, it is an important reason for researchers to keep the tool in the ceiling.

The tool is also equipped with pathfinders for escape purpose routes using AR gamification, as shown in figure 10.

Fig 9. AR Gamification Pathfinding Augmented Reality

After the tool gives a message and turns on its AR navigation application, this software aims to lead the user to escape pose and go to the evacuation place provided. This is because some people feel panic if the siren sounds and do not focus on finding an escape route or directly to the evacuation site

To be more precise, here are the steps for using the device to bring up the AR navigation application

A. Testing Tools and Systems

Testing of tools and systems can be done with the following stages:

1. First, turn on the augmented reality pathfinding tool by connecting the power to electricity
2. There are Buzzer, MQ sensor, IR Flame Sensor, and LED from the top of the augmented reality pathfinding tool. While in every other corner there are only LEDs and IR Flame Sensors

Fig 10. Pathfinding Augmented Reality Display

3. The MQ2 sensor will detect the gas, and at the same time, the fire sensor will detect the fire

Fig 11. Pathfinding Augmented Reality Test MQ2 and IR Flame

4. After detecting the augmented reality pathfinding tool, it will turn on the LED and Buzzer to alert nearby users

Fig 12. Pathfinding Augmented Reality display LED and Buzzer

5. At the same time, the tool will send a message using the social media bot to warn if the user is still not aware of a fire

Fig 13. Pathfinding Augmented Reality display Social Media Text

6. After the tool sends a message via social media, users can use the augmented reality pathfinding application to find an escape purpose route

Fig 14. Pathfinding Augmented Reality for Escape Purpose Route

B. Pathfinding Augmented Reality Tool Analysis

In this research, BlackBox and questionnaire tests were conducted by distributing questionnaires to 70 participants. The following are the results of a questionnaire on the use of Pathfinding Augmented Reality tools and applications in accordance with the following: [33]which inquires about the usability of the tool::

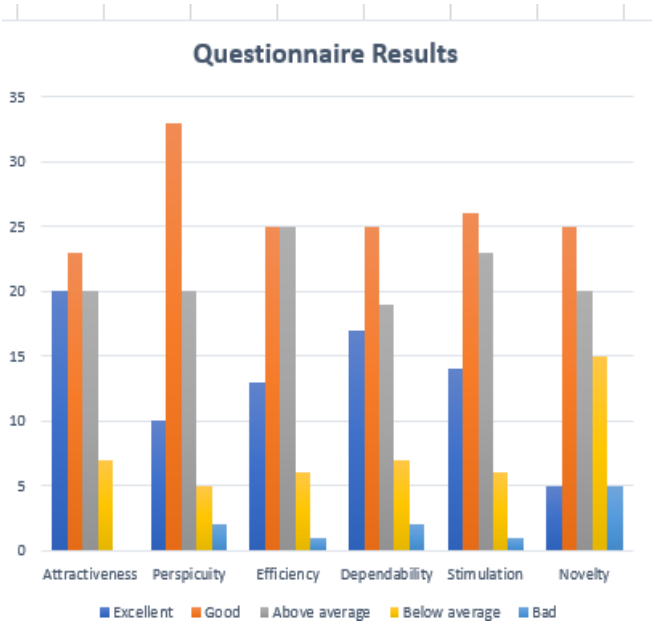

Fig 15. Questionnaire

Based on Figure 15, it can be seen that the average number of people, as in attractiveness, is as many as 20

people say they can't. So that participants feel like this tool because it is easy to install and durable against fire. For perspicuity, it can be seen that 35 participants said it was good. So the Pathfinding Augmented Reality tool is still relatively easy to learn for new users. This happens because the series of tools and sensors are not large enough and can be reassembled.

For efficiency, 25 people said it was good and above average. This tool still works very effectively. This happens because the tool's usefulness gives information about the threat of fire and guides users to find escape purposes. On dependability, 25 people say good. This tool supports new users because the necessary security factors have been provided in this tool.

For stimulation, 26 people chose either. This tool motivates users to use this tool because the tools are simple and possibly cheaper than those provided by big companies. Finally, in Novelty, here, the tool does not get good marks. This is because the innovations made are almost the same as those that already exist. The plus of this tool is only sending messages to social media. Then the Pathfinding Augmented Reality tool has AR navigation which is the main supporting factor.

After knowing how the Questionnaire results, a trial is carried out BlackBox testing on how far the device can detect fire, gas and send messages on social media. Tables2 and 3 will show the results.

Table 2. Testing the MQ2 and IR Flame Sensor

No	Distance	Obstacle	No Obstacle
1	5 cm	Accepted	Accepted
2	10 cm	Accepted	Accepted
3	20 cm	Accepted	Accepted
4	30 cm	Accepted	Accepted
5	50 cm	Not Accepted	Not Accepted

Table 3. Testing Signal Send Text to Media Social

No	Signal	Expected Result	Result
1	4G	Accepted	Accepted
2	H+	Accepted	Accepted
3	3G	Accepted	Accepted
4	2G	Accepted	No Accepted

Table 4. Testing AR Navigation

No	Type of Place	Expected Result	Result
1	Mall	Detected	Detected
2	Building	Detected	Detected
3	Market	Detected	Detected
4	Unknown Place	Detected	No Detected

Table 2-4 found that if the sensor can detect a 5-30 cm distance, this is quite good if the room is not large. This is because the sensors used are specifically for small rooms and no open spaces.

Sending messages using ESP32 is good because it is integrated with social media but not all social media can communicate with ESP32. There are also problems sending fire messages for weak or below 2G signals. This is because some social media can only be accessed with a certain bandwidth.

AR navigation can be used in all places that have been registered in the application. If it has not been reported, the application cannot be used properly. This happened because of the need to adapt the application to a new place to rebuild the software.

C. Tool Advantages and Disadvantages

Each tool has its strengths and weaknesses. As with the Pathfinding Augmented Reality tool, the advantages and disadvantages of the tool will be described below:

- The tool is more durable against fire because it is made of mild steel
- The tool doesn't just turn on the lights. It turns on the alarm
- Not only that, the tool uses messages to social media if the user is not aware that there is a fire going on
- After sending letters to social media, the tool also provides users with a software application for escape purposes and search for escape routes

Following are the disadvantages of the tool:

- Detection of fire and gas is not optimal because it requires close range, not good for outdoor environments.
- Social media messaging has a disadvantage because smartphone users must be on a good network because some social media require a large enough bandwidth
- For new places, it needs to be initialized for AR navigation since registration is required in the application creation software

V. CONCLUSION

Results of experiments if the prototype of the Pathfinding Augmented Reality tool for early detection can see hotspots early and escape routes. Applications can be used appropriately by utilizing the ESP32 microcontroller to control and send messages to social media, MQ2 sensor for gas, IR Flame sensor for detecting fires, LED for warning devices, and buzzer to convey sound and vibration. The response from users who use the questionnaire is that this tool is well received based on the average participant saying it is above average. Blackbox testing also states that one of the fire and gas sensors can be used up to a distance of 50 cm. For signal transmission, at least 2G signals. The augmented reality pathfinder tool can be used for all the places already in the AR creation tool app for new sites

needing to adjust by way of registration. This tool is expected to be used according to users' needs, especially users in urban areas.

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