Correspondence Documents

DESIGN OF FIRE EXTINGUISHER ROBOT USING IOT WITH ANDROID APPLICATION CONTROL

1. Submitted to the journal “Jurnal Ilmu Pengetahuan dan Teknologi Komputer (JITK)” – 11/11/2024

Gmail — Budy Satria <budysatriadeveloper@gmail.com>

[jitk] Submission Acknowledgement
1 pesan

Siti Nurhasanah Nugraha <ejournal@nusamandiri.ac.id> — 11 November 2024 pukul 21.33
Kepada: Budy Satria <budysatriadeveloper@gmail.com>

Budy Satria:

Thank you for submitting the manuscript, "DESIGN OF FIRE EXTINGUISHER ROBOT USING IOT WITH ANDROID APPLICATION CONTROL" to JITK (Jurnal Ilmu Pengetahuan dan Teknologi Komputer). With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

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2. First “Revisions Required”– 26/12/2024

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ejournal@nusamandiri.ac.id <ejournal@nusamandiri.ac.id> — 26 Desember 2024 pukul 15.50
Balas Ke: Siti Nurhasanah Nugraha <siti.nhg@nusamandiri.ac.id>
Kepada: Budy Satria <budysatriadeveloper@gmail.com>, Syarif Hidayatullah <zthsyarif.03@gmail.com>

Dear Author,
Budy Satria, Syarif Hidayatullah:

We have reached a decision regarding your submission to JITK (Jurnal Ilmu Pengetahuan dan Teknologi Komputer), "DESIGN OF FIRE EXTINGUISHER ROBOT USING IOT WITH ANDROID APPLICATION CONTROL".

Our decision is: Revisions Required
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3. Reviewer A (21/11/2024)

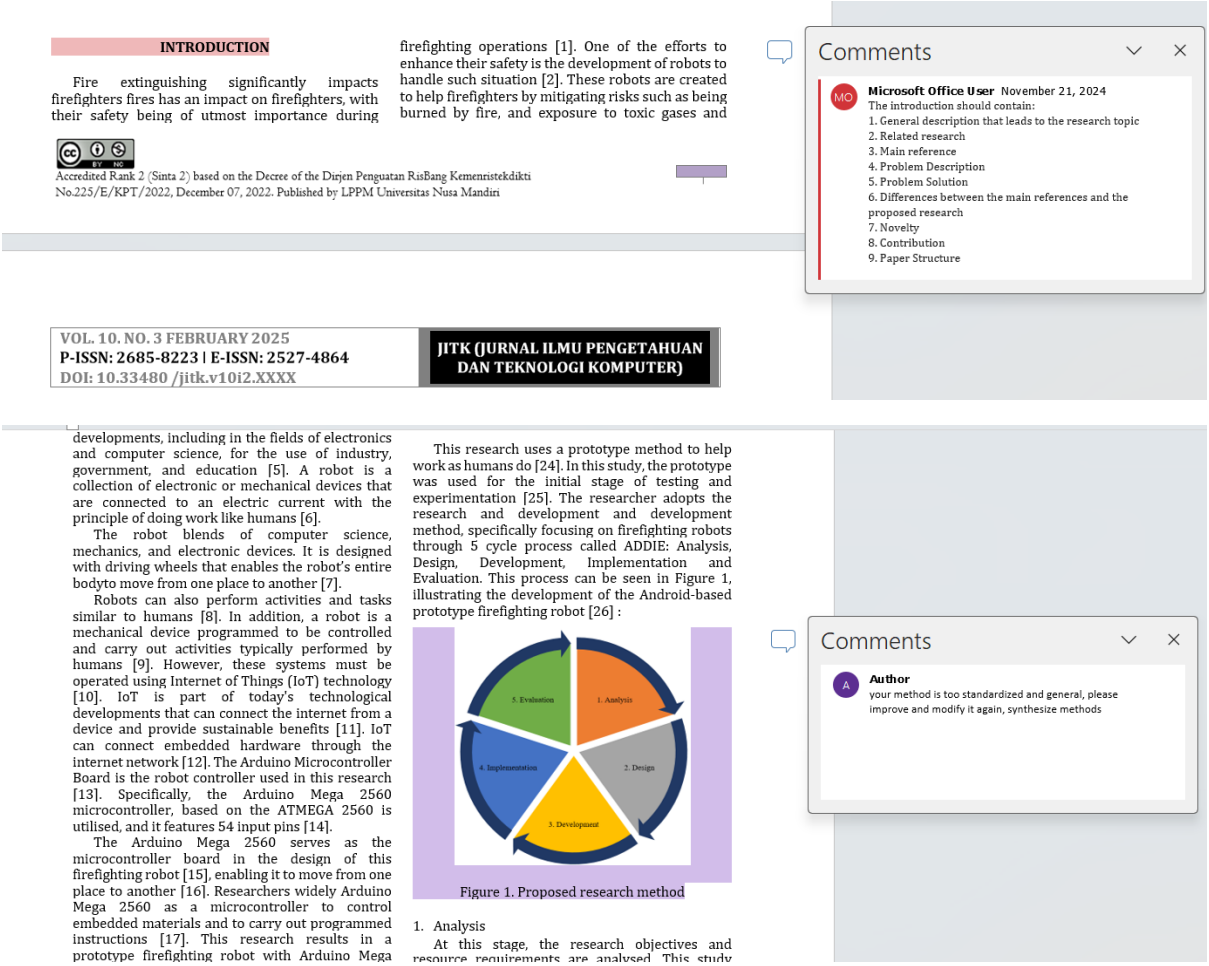
Comment and Suggestions for Authors	Authors Responds
The introduction should contain: 1. General description that leads to the research topic 2. Related research 3. Main reference 4. Problem Description 5. Problem Solution 6. Differences between the main references and the proposed research 7. Novelty 8. Contribution 9. Paper Structure	Dear Reviewer The comments provided have been corrected Thank you for your suggestion Fire extinguishing significantly impacts firefighters' safety, as they are often exposed to numerous risks such as burns, toxic gases, and the possibility of explosions during firefighting operations [1]. One of the efforts to enhance their safety is the development of robots to handle such situations [2]. These robots assist firefighters by mitigating risks and enhancing the effectiveness of fire extinguishing tasks [3]. With the deployment of these robots, the risk to firefighter personnels can be significantly reduced [4]. Many people can feel technological developments, including in the fields of electronics and computer science, for the use of industry, government, and education [5]. A robot is a collection of electronic or mechanical devices that are connected to an electric current with the principle of doing work like humans [6]. The robot blends of computer science, mechanics, and electronic devices. It is designed with driving wheels that enables the robot's entire bodyto move from one place to another [7]. Robots can also perform activities and tasks similar to humans [8]. In addition, a robot is a mechanical device programmed to be controlled and carry out activities typically performed by humans [9]. This study builds upon prior research by integrating IoT-based technologies with hardware components such as Arduino Mega 2560, Node MCU ESP8266, and the L298N motor driver. The system also utilizes Android applications to provide a user-friendly interface for controlling the robot. Previous studies highlight the efficacy of IoT and Arduino in robotics; for instance, Das et al. [7] illustrated an IoT-based fire detection robot capable of real-time response, providing a foundation for this research [10]. IoT is part of today's technological developments that can connect the internet from a device and provide sustainable benefits [11]. IoT can connect embedded hardware through the internet network [12]. The Arduino Microcontroller Board is the robot controller used in this research [13]. Specifically, the Arduino Mega 2560 microcontroller, based on the ATMEGA 2560 is utilised, and it features 54 input pins [14]. Fires pose significant threats to both human safety and property. Current firefighting methods rely heavily on manual operations, which can endanger the lives of firefighters. Moreover, these methods may not effectively address fire outbreaks in inaccessible or high-risk areas. Despite advancements in robotics, existing fire extinguishing robots often face limitations in range, control precision, and operational adaptability.

	Thus, there is a critical need for a more efficient and safer solution to mitigate these challenges. The Arduino Mega 2560 serves as the microcontroller board in the design of this firefighting robot [15], enabling it to move from one place to another [16]. Researchers widely Arduino Mega 2560 as a microcontroller to control embedded materials and to carry out programmed instructions [17]. This research results in a prototype firefighting robot with Arduino Mega 2560-based programming [18], using Internet of things technology controlled by the Android application. The Internet of Things (IoT) is a recent technological development capable of transferring large amounts of data through an Internet network that is connected to the destination source [19]. In recent years, Internet of Things has become a prominent research topic [20]. IoT typically integrates software and hardware components, often provided by IT companies [21]. Today, IoT techonology plays a significant role in human life, where each object is uniquely identifiable, equipped with sensors, and connect in real-time to the Internet [22]. This study uses, the ESP8266 MCU Node as an additional device to connect to Wi-Fi. ESP8266 is a Wi-Fi module with System on Chip on TCP/IP and has to control the microcontroller [18]. A robot is designed using Node MCU (ESP8266), which is easy to program [23].In this research, a prototype robot will be designed that can be used to extinguish fire remotely using control from an Android app. The novelty of this study lies in the integration of IoT technology with an Android-based control system to create a user-friendly interface for firefighting robots. Unlike previous designs, this prototype focuses on real-time control and operational efficiency within a defined range, as demonstrated through rigorous testing. The use of the L9110 fan for extinguishing fires and the implementation of a user-centric Android application provide unique contributions to existing solutions. In conclusion, this research aims to enhance firefighting operations by addressing existing limitations and providing a safer, more efficient solution through the integration of advanced technologies and innovative design.

Reviewer B : (26/11/2024)

Comment and Suggestions for Authors	Authors Responds
your method is too standardized and general, please improve and modify it again, synthesize methods	Dear Reviewer The comments provided have been corrected Thank you for your suggestion

4. Reviewer Attachment



INTRODUCTION

Fire extinguishing significantly impacts firefighters fires has an impact on firefighters, with their safety being of utmost importance during firefighting operations [1]. One of the efforts to enhance their safety is the development of robots to handle such situation [2]. These robots are created to help firefighters by mitigating risks such as being burned by fire, and exposure to toxic gases and

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Comments

Microsoft Office User November 21, 2024
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2. Related research
3. Main reference
4. Problem Description
5. Problem Solution
6. Differences between the main references and the proposed research
7. Novelty
8. Contribution
9. Paper Structure

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developments, including in the fields of electronics and computer science, for the use of industry, government, and education [5]. A robot is a collection of electronic or mechanical devices that are connected to an electric current with the principle of doing work like humans [6].

The robot blends of computer science, mechanics, and electronic devices. It is designed with driving wheels that enables the robot's entire bodyto move from one place to another [7].

Robots can also perform activities and tasks similar to humans [8]. In addition, a robot is a mechanical device programmed to be controlled and carry out activities typically performed by humans [9]. However, these systems must be operated using Internet of Things (IoT) technology [10]. IoT is part of today's technological developments that can connect the internet from a device and provide sustainable benefits [11]. IoT can connect embedded hardware through the internet network [12]. The Arduino Microcontroller Board is the robot controller used in this research [13]. Specifically, the Arduino Mega 2560 microcontroller, based on the ATMEGA 2560 is utilised, and it features 54 input pins [14].

The Arduino Mega 2560 serves as the microcontroller board in the design of this firefighting robot [15], enabling it to move from one place to another [16]. Researchers widely Arduino Mega 2560 as a microcontroller to control embedded materials and to carry out programmed instructions [17]. This research results in a prototype firefighting robot with Arduino Mega

This research uses a prototype method to help work as humans do [24]. In this study, the prototype was used for the initial stage of testing and experimentation [25]. The researcher adopts the research and development and development method, specifically focusing on firefighting robots through 5 cycle process called ADDIE: Analysis, Design, Development, Implementation and Evaluation. This process can be seen in Figure 1, illustrating the development of the Android-based prototype firefighting robot [26] :

Figure 1. Proposed research method

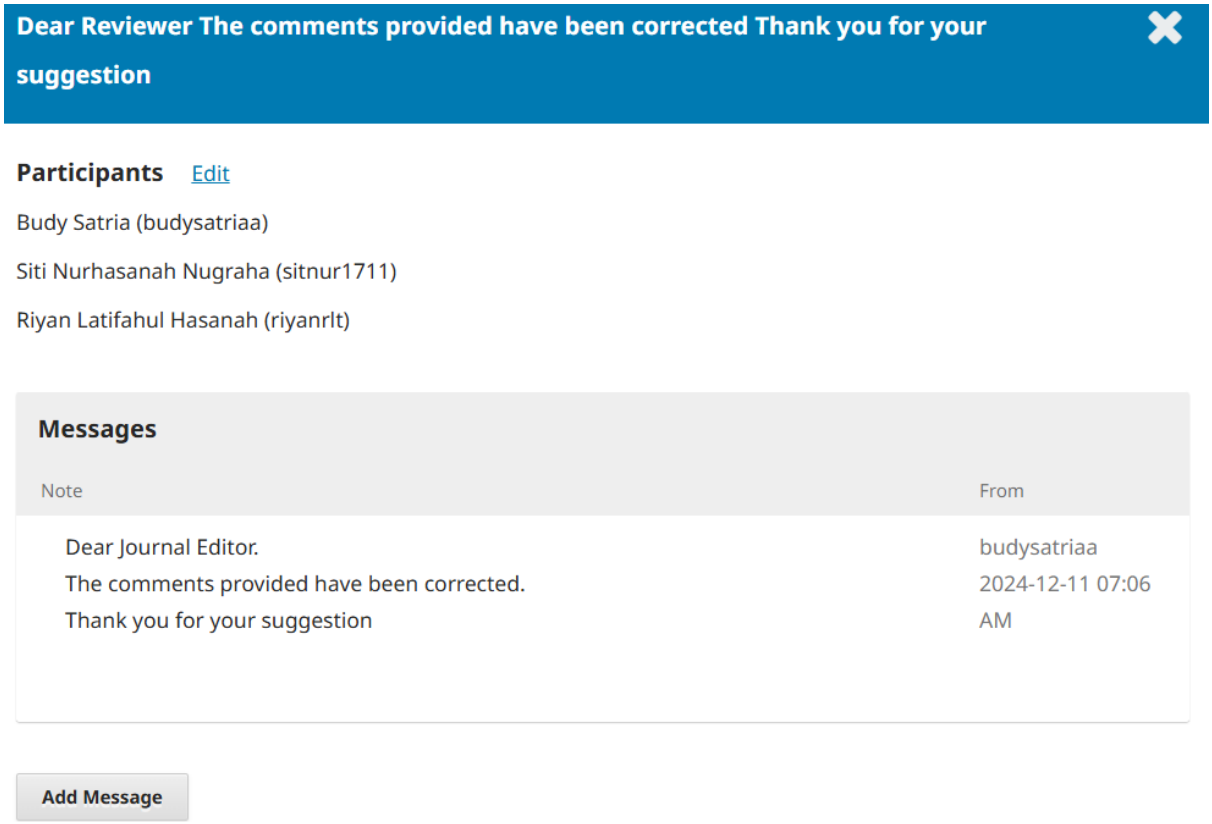
1. Analysis

At this stage, the research objectives and resource requirements are analysed. This study

Comments

Author
your method is too standardized and general, please improve and modify it again, synthesize methods

5. Resubmit Revision Manuscript – 11 /12/2024



6. File Revisions

JITK (JURNAL ILMU PENGETAHUAN DAN TEKNOLOGI KOMPUTER)
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DESIGN OF FIRE EXTINGUISHER ROBOT USING IOT WITH ANDROID APPLICATION CONTROL

Double Blind

(*) Corresponding Author

Abstract— *Fire is a disaster that can occur at any time, both under supervision and without supervision. This disaster has a detrimental impact on living and non-living things in the surrounding environment. This study was conducted to design an intelligent firefighting robot using Arduino Mega 2560 and Android-based IoT technology. This firefighting robot uses several Node MCU ESP8266 components as additional devices to connect to Wi-Fi. The L298N module regulates the speed and direction of rotation of the DC motor, followed by the L9110 fan as hardware to extinguish the fire. The mobile robot prototype uses a DC motor as its driver. In addition, an android application has been programmed to control the firefighting robot. This application is equipped with features that allow the robot to move in various directions and adjust the fan speed when extinguishing fires, all through an internet network connection. The results of the study showed that the application can be connected within a distance of 1-8 meters with good network quality. The test results showed that at a distance of 1-28 cm the fan worked very well according to its function and the android application also worked optimally. In that range the fan can extinguish the simulated fire source.*

Keywords: *arduino mega 2560, android, fire extinguisher, iot, robot.*

Intisari—Kebakaran merupakan bencana yang dapat terjadi kapan saja baik dalam pengawasan maupun tanpa pengawasan. Bencana ini memberikan dampak yang merugikan bagi makhluk hidup maupun tak hidup di lingkungan sekitar. Penelitian ini dilakukan untuk merancang robot pemadam kebakaran cerdas menggunakan Arduino Mega 2560 dan teknologi IoT berbasis Android. Robot pemadam kebakaran ini menggunakan beberapa komponen Node MCU ESP8266 sebagai perangkat tambahan untuk terhubung dengan Wi-Fi. Modul L298N mengatur kecepatan dan arah putaran motor DC, diikuti oleh kipas L9110 sebagai perangkat keras untuk memadamkan api. Prototipe robot bergerak menggunakan motor DC sebagai penggeraknya. Selain itu, telah diprogram sebuah aplikasi android untuk mengendalikan robot pemadam kebakaran. Aplikasi ini dilengkapi fitur yang memungkinkan robot bergerak ke berbagai arah dan mengatur kecepatan kipas saat memadamkan api, semuanya melalui koneksi jaringan internet. Hasil penelitian menunjukkan bahwa aplikasi dapat terhubung dalam jarak 1-8 meter dengan kualitas jaringan yang baik. Hasil pengujian didapatkan bahwa pada jarak 1-28 cm kipas angin bekerja sangat baik sesuai fungsinya dan aplikasi android juga bekerja dengan optimal. Pada rentang tersebut kipas angin dapat memadamkan sumber api yang disimulasikan.

Kata Kunci: *arduino mega 2560, android, iot, pemadam api, robot.*

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Fire extinguishing significantly impacts firefighters' safety, as they are often exposed to numerous risks such as burns, toxic gases, and the possibility of explosions during firefighting operations [1]. One of the efforts to enhance their safety is the development of robots to handle such situations [2]. These robots assist firefighters by mitigating risks and enhancing the effectiveness of fire extinguishing tasks [3]. With the deployment of these robots, the risk to firefighter personnels can be significantly reduced [4].

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7. Novelty
8. Contribution
9. Paper Structure

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In conclusion, this research aims to enhance firefighting operations by addressing existing limitations and providing a safer, more efficient solution through the integration of advanced technologies and innovative design.

MATERIALS AND METHODS

This research uses a prototype method to help work as humans do [24]. In this study, the prototype was used for the initial stage of testing and experimentation [25]. The researcher adopts the research and development and development method, specifically focusing on firefighting robots through 5 cycle process called ADDIE: Analysis, Design, Development, Implementation and Evaluation. This process can be seen in Figure 1, illustrating the development of the Android-based prototype firefighting robot [26] :

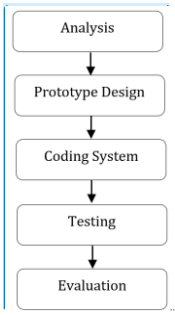

Figure 1. Proposed research method

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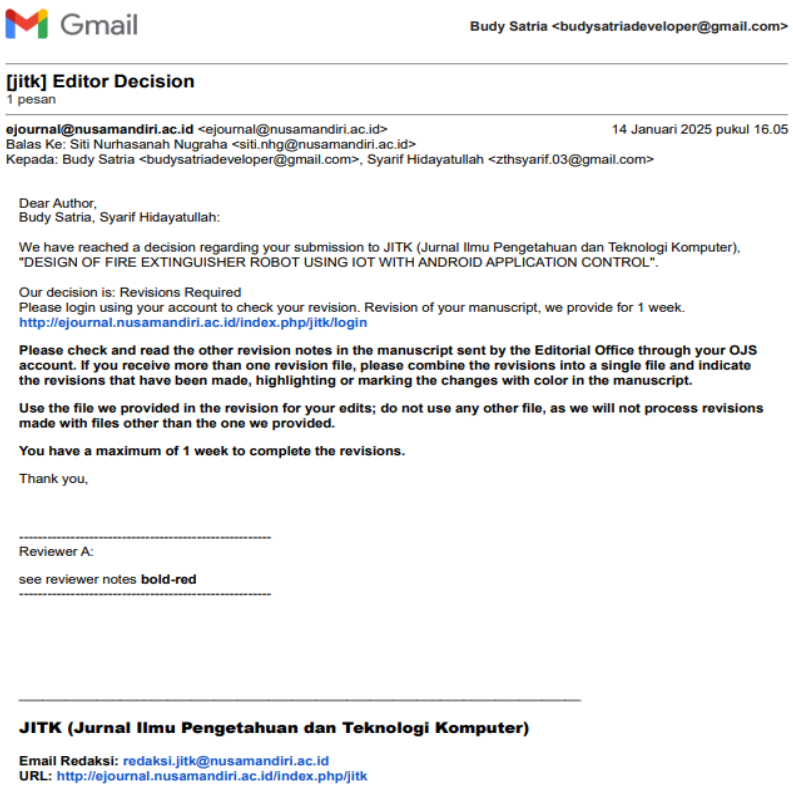

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Kepada: Budy Satria <budysatriadeveloper@gmail.com>, Syarif Hidayatullah <zthsyarif.03@gmail.com>

Dear Author,
Budy Satria, Syarif Hidayatullah:

We have reached a decision regarding your submission to JITK (Jurnal Ilmu Pengetahuan dan Teknologi Komputer), "DESIGN OF FIRE EXTINGUISHER ROBOT USING IOT WITH ANDROID APPLICATION CONTROL".

Our decision is: Revisions Required
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Use the file we provided in the revision for your edits; do not use any other file, as we will not process revisions made with files other than the one we provided.

You have a maximum of 1 week to complete the revisions.

Thank you,

Reviewer A:

see reviewer notes **bold-red**

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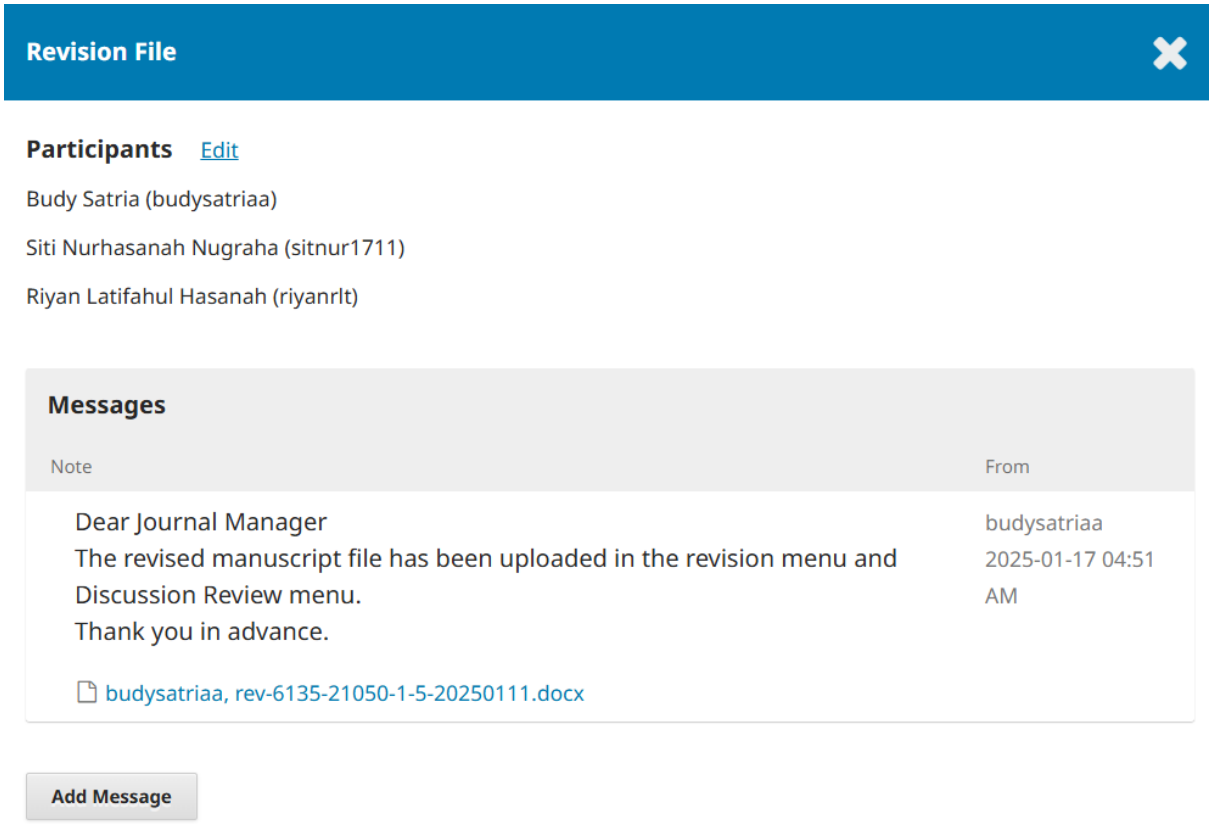
8. Reviewer A: (24/12/2024)

Comment and Suggestions for Authors	Authors Responds
no novety sentence for scientific contribution, only descriptive explanation!	Dear Reviewer The comments provided have been corrected Thank you for your suggestion This research has successfully designed and developed an innovative IoT-based fire fighting robot prototype. The use of Arduino Mega 2560 microcontroller, ESP8266 MCU Node, L298N Motor Driver, L9110 Fan and the use of IoT platform and Android application provide flexibility and convenience in monitoring and controlling the robot. This research makes a significant contribution to the field of robotics and intelligent systems, and opens up new opportunities for the development of more advanced fire safety systems in the future .

Please use english for this picture, because you will publish in Bahasa Inggris!	Dear Reviewer The comments provided have been corrected Thank you for your suggestion

9. Resubmit revision manuscript – 17/1/2025



10. File revisionss

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DESIGN OF FIRE EXTINGUISHER ROBOT USING IOT WITH ANDROID APPLICATION CONTROL

Double Blind

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Keywords: *arduino mega 2560, android, fire extinguisher, iot, robot.*

Intisari—Kebakaran merupakan bencana yang dapat terjadi kapan saja baik dalam pengawasan maupun tanpa pengawasan. Bencana ini memberikan dampak yang merugikan bagi makhluk hidup maupun tak hidup di lingkungan sekitar. Penelitian ini dilakukan untuk merancang robot pemadam kebakaran cerdas menggunakan Arduino Mega 2560 dan teknologi IoT berbasis Android. Robot pemadam kebakaran ini menggunakan beberapa komponen Node MCU ESP8266 sebagai perangkat tambahan untuk terhubung dengan Wi-Fi. Modul L298N mengatur kecepatan dan arah putaran motor DC, diikuti oleh kipas L9110 sebagai perangkat keras untuk memadamkan api. Prototipe robot bergerak menggunakan motor DC sebagai penggeraknya. Selain itu, telah diprogram sebuah aplikasi android untuk mengendalikan robot pemadam kebakaran. Aplikasi ini dilengkapi fitur yang memungkinkan robot bergerak ke berbagai arah dan mengatur kecepatan kipas saat memadamkan api, semuanya melalui koneksi jaringan internet. Hasil penelitian menunjukkan bahwa aplikasi dapat terhubung dalam jarak 1-8 meter dengan kualitas jaringan yang baik. Hasil pengujian didapatkan bahwa pada jarak 1-28 cm kipas angin bekerja sangat baik sesuai fungsinya dan aplikasi android juga bekerja dengan optimal. Pada rentang tersebut kipas angin dapat memadamkan sumber api yang disimulasikan.

Kata Kunci: *arduino mega 2560, android, iot, pemadam api, robot.*

INTRODUCTION

Robotics is proof that human civilization has advanced over time. The shape of a robot is not just a shape that resembles a human or animal, but moves to resemble the shape it imitates. The robot blends of computer science, mechanics, and electronic devices. It is designed with driving wheels that enables the robot's entire bodyto move from one place to another [1]. Robots can also perform activities and tasks similar to humans [2].

In addition, a robot is a mechanical device programmed to be controlled and carry out activities typically performed by humans [3]. The ability of the robot to complete its mission is very calculated, for that a reliable navigation system is needed so that it can support optimal robot performance. Robots were created to make it easier

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for humans to solve problems, for example in extinguishing fires [4].

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Fire is one of the disasters that can cause great losses, both in terms of material, environment, and human life. The firefighting process often presents high risks for firefighters, especially in areas that are difficult to reach or have the potential for additional hazards such as chemical leaks or explosions. Fire fighting significantly impacts the safety of firefighters, as they are often exposed to various risks such as burns, toxic gases, and possible explosions during extinguishing operations [7].

The risks borne by the firefighting team are very high, therefore, an innovative solution is needed to minimize these risks and increase the effectiveness of the extinguishing process, namely the creation of a firefighting robot to assist humans in this work. One of the efforts to improve their safety is the development of robots to handle such situations [8]. These robots assist firefighters by mitigating risks and enhancing the effectiveness of fire extinguishing tasks [9]. With the use of these robots, the risk to firefighting personnel can be significantly reduced[10].

Related research on fire extinguishing robots has been carried out by the results of this study [11] a robot that functions to find the source point of the fire and then extinguish it using a fan using the L9110 fan motor drive module was designed and built. Infrared sensors and HC-SR04 ultrasonic, the process of finding the point of the fire source utilizes ultraviolet light emitted by the fire. Research on fire fighting robots has also been carried out in design and implementation of fire detection and extinguishing systems using dual axis mechanics [12]. Previous research has been conducted on the application of iot in the design of a miniature robot fire extinguishing system to assist the pre-evacuation evaluation process [13] the purpose of this research is the development of a miniature wheeled IoT (Internet of Things) robot that can monitor visual conditions using esp32-cam and retrieve data from the necessary sensors such as gas, fire, temperature, and distance sensors.

This study builds upon prior research by integrating IoT-based technologies with hardware components such as Arduino Mega 2560, Node MCU ESP8266, and the L298N motor driver. The system also utilizes Android applications to provide a user-friendly interface for controlling the robot. Previous studies highlight the efficacy of IoT and Arduino in robotics; for instance, Das et al. [7] illustrated an IoT-based fire detection robot capable of real-time response, providing a foundation for this research [14]. IoT is part of today's technological developments that can connect the internet from a device and provide sustainable benefits [15]. IoT can connect embedded hardware through the internet network [16]. The Arduino Microcontroller Board is the robot controller used in this research [17]. Specifically, the Arduino Mega 2560 microcontroller, based on the ATMEGA 2560 is utilised, and it features 54 input pins [18].

Fires pose significant threats to both human safety and property. Current firefighting methods rely heavily on manual operations, which can endanger the lives of firefighters. Moreover, these methods may not effectively address fire outbreaks in inaccessible or high-risk areas. Despite advancements in robotics, existing fire extinguishing robots often face limitations in range, control precision, and operational adaptability. Thus, there is a critical need for a more efficient and safer solution to mitigate these challenges.

The Arduino Mega 2560 serves as the microcontroller board in the design of this firefighting robot [19], enabling it to move from one place to another [20]. Researchers widely Arduino Mega 2560 as a microcontroller to control embedded materials and to carry out programmed instructions [21]. This research results in a prototype firefighting robot with Arduino Mega 2560-based programming [22], using Internet of things technology controlled by the Android application.

The Internet of Things (IoT) is a recent technological development capable of transferring large amounts of data through an Internet network that is connected to the destination source [23]. In recent years, Internet of Things has become a prominent research topic [24]. IoT typically integrates software and hardware components, often provided by IT companies [25]. Today, IoT techonology plays a significant role in human life, where each object is uniquely identifiable, equipped with sensors, and connect in real-time to the Internet [26].

This study uses, the ESP8266 MCU Node as an additional device to connect to Wi-Fi. ESP8266 is a Wi-Fi module with System on Chip on TCP/IP and has to control the microcontroller [22]. A robot is designed using Node MCU (ESP8266), which is easy to program [27].In this research, a prototype robot will be designed that can be used to extinguish fire remotely using control from an Android app.

The novelty of this study lies in the integration of IoT technology with an Android-based control system to create a user-friendly interface for

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firefighting robots. Unlike previous designs, this prototype focuses on real-time control and operational efficiency within a defined range, as demonstrated through rigorous testing. The use of the L9110 fan for extinguishing fires and the implementation of a user-centric Android application provide unique contributions to existing solutions. In conclusion, this research aims to enhance firefighting operations by addressing existing limitations and providing a safer, more efficient solution through the integration of advanced technologies and innovative design.

This article is written using the structure of introduction, materials and methods, results and discussion, conclusion and references.

MATERIALS AND METHODS

This research uses a prototype method to help work as humans do [28]. In this study, the prototype was used for the initial stage of testing and experimentation [29]. The researcher adopts the research and development and development method, specifically focusing on firefighting robots through 5 cycle process called ADDIE: Analysis, Design, Development, Implementation and Evaluation. This process can be seen in Figure 1, illustrating the development of the Android-based prototype firefighting robot [30] :

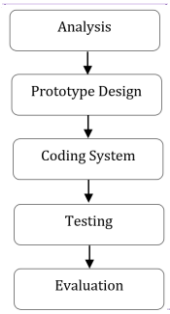

Figure 1. Proposed research method

1. Analysis

At this stage, the research objectives and resource requirements are analysed. This study aims to develop robotics skills by designing a prototype firefighting robot using Arduino Mega 2560 and the Android-based Internet of Things (IoT) technology. The final result of this stage serves as an input for the next phase the design stage [31].

2. Prototype Design

At this stage, An intelligent firefighting robot is designed using the Arduino Mega 2560 and Android-based IoT technology. The design process employs Fritzing software to schematically create the entire prototype circuit of the robot. The firefighting robot is designed to resemble a car, equipped with wheels for movementand fans to extinguish fires. This step serves as a references for the development stage [32].

3. Coding System

In this cycle, the researcher ensures that all designs have been completed and operated according to the research objectives. This involves creating hardware circuits and interconnecting components, such as the Arduino Mega 2560, Node MCU ESP 8266, L298N Module, Servo Motor, Power Supply and others. This stage is known as the development stage [33].

4. Testing

The implementation stage occurs after the development stage [34]. During this phase, after desigining the robot components, the next involves creating a combination of commands in the programming language using standard Arduino syntax to control microcontroller's performance in the device. Additionally, an Android application I developed to control the firefighting robot when connected to the internet.

5. Evaluation

Evaluation is the final stage of this research method to reveal the work's effectiveness [35]. In this stage, a series of tests is conducted the firefighting robots to identify any funtional errors pr deviations from the research objectives. If errors are found, they will be corrected, and if it's the robot functions as intended, further development will be pursued. Ultimately, the robot prototype is created and tested according to the experimental design [36].

RESULTS AND DISCUSSION

A. Block Diagram

The hardware made as a design is a collection of several modules to form a system to make it functional [37]. In system development, it begins with the implementation stage [38]. The design of a Smart Firefighting Robot Using Arduino Mega 2560 and Android-based IoT Technology is depicted in the block diagram as shown in Figure 2.

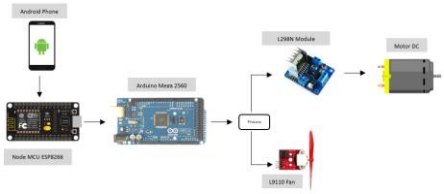

Figure 2. Block diagram design

Figure 2 explains that a Block Diagram that serves as a reference for connecting all components

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[39]. The design of this electronic manufacturer uses Arduino for the overall data processing [40]. A well-structured research design is essential to achieve the research objectives.

B. Robot Design

Figure 3 explains that this firefighting robot uses an Arduino Mega 2560 as a microcontroller and several other supporting hardware to ensure that the robot system works according to the research objectives. The hardware components in this firefighting robot is the Arduino Mega 2560, Node MCU ESP 8266, L298N Module, Servo Motor, Power Supply, and FAN L9110. In addition, an Android was also developed as supporting software to control the robot in extinguishing fires remotely. The following is the design of research methodology as illustrated in Figure 3.

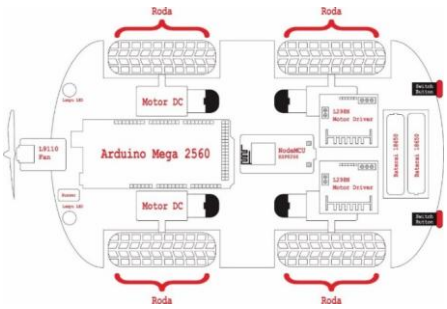

Figure 3. Hardware design

C. Wiring Design

Implementation is one of the activities in the system development section [41]. At this stage, the activity involves placing a prototype of a firefighting robot that as a functional part of the developed system. The design of wiring diagram as shown in Figure 4.

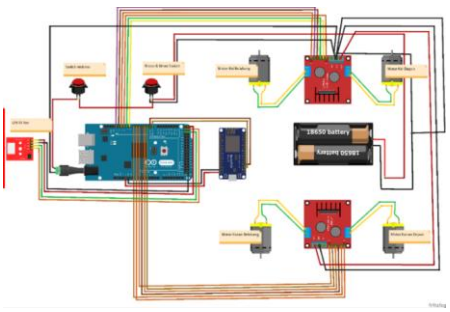

Figure 4. Wiring design

D. Flow Digram

Figure 5 is a Flow Diagram Design. When the Arduino component is electrified, the microcontroller will be in control and provide instructions to the ESP 8266 MCU Node and L298N Motor Driver. Once both components are activated, the MCU ESP 8266 Node will connect to the Android application, while the L298N will control the driver motor. Through the Android application, the firefighting robot can be controlled under 2 conditions. Firtsly, it can change the robot's direction of movemonet and secondly it can activate the fan to extinguish fires. The design of flow diagram as shown in Figure 5.

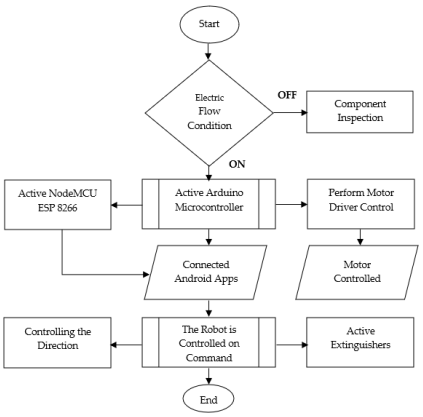

Figure 5. Flow diagram

E. Program Code

At this stage, commands in the programming language are command to control the microcontroller's performance in the designed device. The programming language used is C ++, implemented through Arduino software. The program code as shown in this link https://github.com/budysatria/Fire-Extinguisher-Robot/tree/master

F. Application Design

To facilitate the control of the robot, android application software is needed as a remote control. User interface layout as shown in Figure 6.

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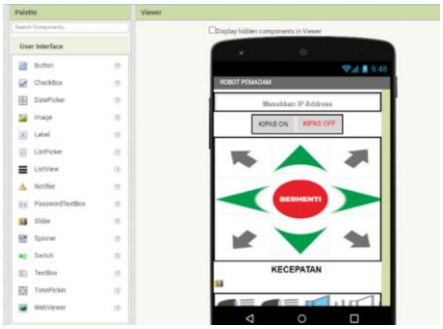

Figure 6. Application interface

G. Prototype Robot

The prototype of the Fire Extinguisher Robot can be viewed from various perspectives. Figure 7 depicts the top view, while Figure 8 illustrates the side view perspective.

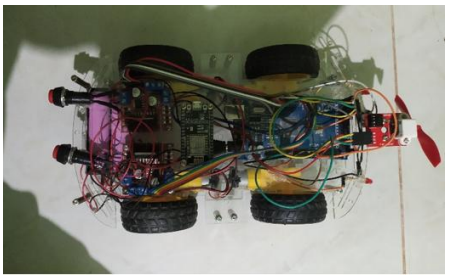

Figure 7. Top view

Figure 8. Side view

H. Functionality Test Result

Table 1 represents the results of functionality testing on all hardware components. Each component has been througly tested anda functions well-funtioned base on the predetermined pameters and criteria. Functionality test result as shown in Table 1.

Table 1. Functionality Test Result

No	Component Name	Information	Result
1	Microcontroller Arduino Mega 2560	- Connectable to a computer and Connected to Internet	100%
2	NodeMCU ESP8266	- Connected on an Android device	100%
3	L298N Motor Driver	- The wheels on the robot have moved	100%
4	Power supply	- Components have electricity	100%
5	L9110 Fan	- Spin when activated	100%
6	Android Application	- Controlling Fire Extinguisher Robot	100%

I. Prototype Robot Test Result

The tests in Table 2 were performed to assess the performance of the HC-SR 04 ultrasonic sensor, which serves as a robot protection system. The test was conducted 15 time at 1 cm up to 30 cm intervals. Protection system test results as shown in Table 2.

Table 2. Ultrasonic sensor test

Test	Distance Measured by Sensor	Result
1	2 cm	Has stopped
2	4 cm	Has stopped
3	6 cm	Has stopped
4	8 cm	Has stopped
5	10 cm	Has stopped
6	12 cm	Has stopped
7	14 cm	Work
8	16 cm	Work
9	18 cm	Work
10	20 cm	Work
11	22 cm	Work
12	24 cm	Work
13	26 cm	Work
14	28 cm	Work
15	30 cm	Work

Table 2 it can be explained that the results of tests that have been carried out at a distance of 2-12 cm, the robot will stop because it has been programmed that the robot must stop when it detects an object in front of it based on that distance. However, at a distance of 14-30 cm the robot will still move.

The next test is involves testing the connectivity of robot control using an Android application against concrete obstacles as shown in Table 3. The testing is conducted at distance ranging from 1-20 meters. Based on the test results, It was obtained that robot navigation control through an Android application connected to the internet network, function appropriately within range of 0-5 meters. Test results for android applications as shown in Table 3.

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Table 3. Application test result

Test	Distance	Android Application	Signal
1	1 m	Work	Good
2	2 m	Work	Good
3	4 m	Work	Good
4	8 m	Work	Good
5	10 m	Doesn't work	Bad
6	12 m	Doesn't work	Bad
7	14 m	Doesn't work	Bad
8	16 m	Doesn't work	Bad
9	18 m	Doesn't work	Bad
10	20 m	Doesn't work	Bad

Table 3 it can be concluded that testing the Android application at a distance of 1 - 8 meters will get good signal quality, but if it is at a distance of 10-20 meters what happens is that the Android application does not work and the signal quality is bad.

Next is testing the fire extinguishing robot. The tests carried out started from setting the distance between the robot and the fire, the amount of time to extinguish the fire and the test results which can be seen in Table 4 below.

Table 4. Fire extinguishing robot

Test	Distance	Duration	Fire Condition
1	5 cm	2 second	Off
2	10 cm	2 second	Off
3	15cm	3 second	Off
4	20 cm	3 second	Off
5	25 cm	4 second	Off
6	30 cm	4 second	Off
7	35 cm	5 second	Off
8	40 cm	6 second	Off
9	45 cm	7 second	Off
10	50 cm	10 second	Off

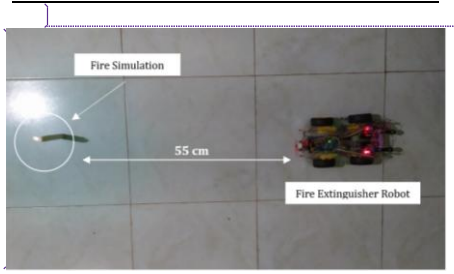

Figure 9. Robot a Distance of 55 Cm

L911 fan performance test results as shown in Table 5.

Table 5. L9110 fan performance test results

Test	Distance	Android Application	Fan Result
1	1 cm	Work	Spin
2	2 cm	Work	Spin
3	8 cm	Work	Spin
4	14 cm	Work	Spin
5	16 cm	Work	Spin
6	18 cm	Work	Spin
7	20 cm	Work	Spin
8	22 cm	Work	Spin
9	24 cm	Work	Spin
10	28 cm	Work	Spin

Table 5 shows that the test results were carried out to determine the state of the fan on the L9110 Fan when with distances ranging from 1 to 28 cm. The result is that the fan can be turned on and rotated appropriately according to its function.

CONCLUSION

The prototype of Fire Extinguishing Robot with Android Application control has been successfully implemented. The results indicated that the robot stopped at a distance of 2-12 cm but functioned properly at a distance of 14-30 cm. In addition, testing was carried out on the Android application, which is used for robot control in extinguishing fires within a range of 1-20 meters. The test results showed that the Android application worked properly and had good signal quality at distance of 1-8 meters. However, the application stopped working at distances of 8-20 meters. The test was also conducted on the L9110 fan component. Test results showed that the fan operated very well within a distance of 1-28 cm, fulfilling its intended function. Moreover, the Android application also functioned optimally within this range, successfully allowing the fan to extinguish the simulated fire source. This research has successfully designed and developed an innovative IoT-based fire fighting robot prototype. The use of Arduino Mega 2560 microcontroller, ESP8266 MCU Node, L298N Motor Driver, L9110 Fan and the use of IoT platform and Android application provide flexibility and convenience in monitoring and controlling the robot. This research makes a significant contribution to the field of robotics and intelligent systems, and opens up new opportunities for the development of more advanced fire safety systems in the future.

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11. Editor Decision : Resubmit for review – 28/1/2025

Gmail — Budy Satria <budysatriadeveloper@gmail.com>

[jitk] Editor Decision
1 pesan

ejournal@nusamandiri.ac.id <ejournal@nusamandiri.ac.id> — 28 Januari 2025 pukul 16.34
Balas Ke: Siti Nurhasanah Nugraha <siti.nhg@nusamandiri.ac.id>
Kepada: Budy Satria <budysatriadeveloper@gmail.com>, Syarif Hidayatullah <zthsyarif.03@gmail.com>

Dear Author,
Budy Satria, Syarif Hidayatullah:

We have reached a decision regarding your submission to JITK (Jurnal Ilmu Pengetahuan dan Teknologi Komputer), "DESIGN OF FIRE EXTINGUISHER ROBOT USING IOT WITH ANDROID APPLICATION CONTROL".

Our decision is: Revisions Required
Please login using your account to check your revision. Revision of your manuscript, we provide for 1 week.
http://ejournal.nusamandiri.ac.id/index.php/jitk/login

Please check and read the other revision notes in the manuscript sent by the Editorial Office through your OJS account. Use the file we provided in the revision for your edits; do not use any other file, as we will not process revisions made with files other than the one we provided.

If you receive more than one revision file, please combine the revisions into a single file and indicate the revisions that have been made, highlighting or marking the changes with color in the manuscript.

You have a maximum of 1 week to complete the revisions.

Reviewer A:

See reviewer notes

Recommendation: Resubmit for Review

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12. Notification from editor by OJS – 28/1/2025

Notifications

[jitk] Editor Decision

2025-01-28 09:35 AM

Dear Author,
Budy Satria, Syarif Hidayatullah:

We have reached a decision regarding your submission to JITK (Jurnal Ilmu Pengetahuan dan Teknologi Komputer), "DESIGN OF FIRE EXTINGUISHER ROBOT USING IOT WITH ANDROID APPLICATION CONTROL".

Our decision is: Revisions Required
Please login using your account to check your revision. Revision of your manuscript, we provide for 1 week.
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Please check and read the other revision notes in the manuscript sent by the Editorial Office through your OJS account. Use the file we provided in the revision for your edits; do not use any other file, as we will not process revisions made with files other than the one we provided.

If you receive more than one revision file, please combine the revisions into a single file and indicate the revisions that have been made, highlighting or marking the changes with color in the manuscript.

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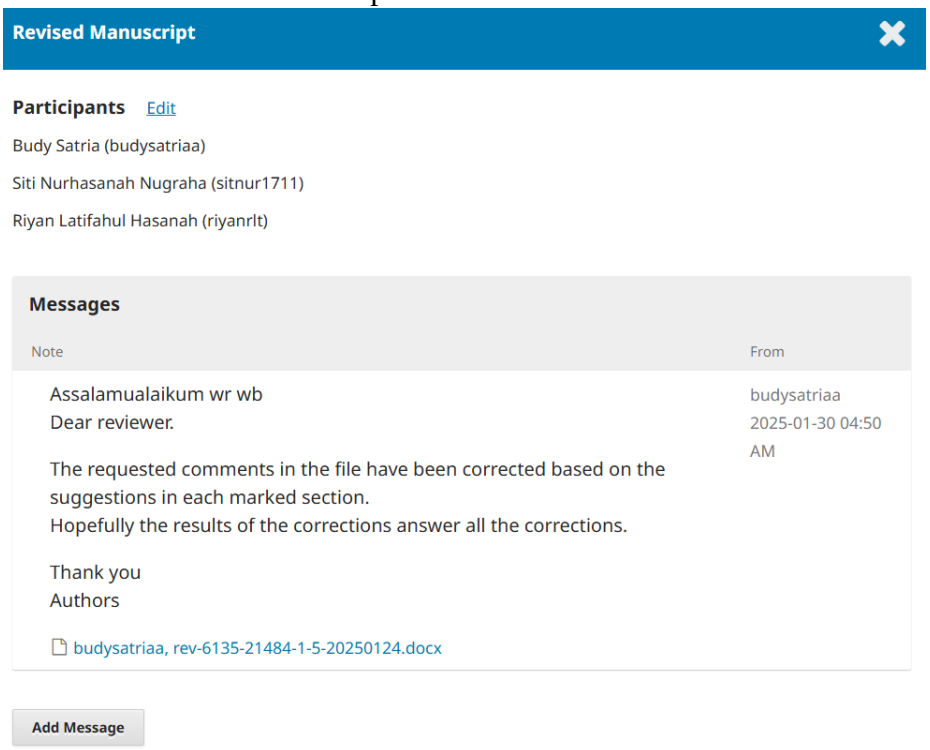
13. Resubmit revision manuscript – 30/1/2025



14. File Revisions

JITK (JURNAL ILMU PENGETAHUAN DAN TEKNOLOGI KOMPUTER)
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DOI: 10.33480/jitk.v10i2.XXXX

DESIGN OF FIRE EXTINGUISHER ROBOT USING IOT WITH ANDROID APPLICATION CONTROL

Double Blind

(*) Corresponding Author

Abstract— *Fire is an unsupervised incidental disaster. This disaster has a detrimental impact on living and non-living things in the surrounding environment. This study was conducted to design an intelligent firefighting robot using Arduino Mega 2560 and Android-based IoT technology. This firefighting robot uses several Node MCU ESP8266 components as additional devices to connect to Wi-Fi. The L298N module regulates the speed and direction of the DC motor rotation, followed by the L9110 fan as hardware to extinguish the fire. The mobile robot prototype uses a DC motor as its driver. In addition, an android application has been programmed to control the firefighting robot. This application is equipped with features that allow the robot to move in various directions and adjust the fan speed when extinguishing fires, all through an internet network connection. The results of the study showed that the application can be connected within a distance of 1-8 meters with good network quality. The test results showed that at a distance of 1-28 cm the fan worked very well according to its function and the android application also worked optimally. In that range the fan can extinguish the simulated fire source. The results of this study obtained a new approach to autonomous fire detection and extinguishing using IoT and robotic technology. In addition, it is able to integrate an Android-based IoT controller to enable remote control with real-time monitoring to overcome problems in previous research.*

Keywords: *arduino mega 2560, android, fire extinguisher, iot, robot.*

Intisari— Kebakaran merupakan bencana insidentil tanpa pengawasan. Bencana ini memberikan dampak yang merugikan bagi makhluk hidup maupun tak hidup di lingkungan sekitar. Penelitian ini dilakukan untuk merancang robot pemadam kebakaran cerdas menggunakan Arduino Mega 2560 dan teknologi IoT berbasis Android. Robot pemadam kebakaran ini menggunakan beberapa komponen Node MCU ESP8266 sebagai perangkat tambahan untuk terhubung dengan Wi-Fi. Modul L298N mengatur kecepatan dan arah putaran motor DC, diikuti oleh kipas L9110 sebagai perangkat keras untuk memadamkan api. Prototipe robot bergerak menggunakan motor DC sebagai penggeraknya. Selain itu, telah diprogram sebuah aplikasi android untuk mengendalikan robot pemadam kebakaran. Aplikasi ini dilengkapi fitur yang memungkinkan robot bergerak ke berbagai arah dan mengatur kecepatan kipas saat memadamkan api, semuanya melalui koneksi jaringan internet. Hasil penelitian menunjukkan bahwa aplikasi dapat terhubung dalam jarak 1-8 meter dengan kualitas jaringan yang baik. Hasil pengujian didapatkan bahwa pada jarak 1-28 cm kipas angin bekerja sangat baik sesuai fungsinya dan aplikasi android juga bekerja dengan optimal. Pada rentang tersebut kipas angin dapat memadamkan sumber api yang disimulasikan. Hasil penelitian ini memperoleh suatu pendekatan baru untuk deteksi dan pemadaman kebakaran secara otonom dengan menggunakan IoT dan teknologi robotik. Selain itu mampu mengintegrasikan pengontrol IoT berbasis Android guna memungkinkan pengendalian jarak jauh dengan pemantauan waktu nyata guna mengatasi permasalahan pada penelitian sebelumnya.

Kata Kunci: *arduino mega 2560, android, iot, pemadam api, robot.*

INTRODUCTION

Robotics is proof that human civilization has advanced over time. The shape of a robot is not just a shape that resembles a human or animal, but moves to resemble the shape it imitates. The robot blends of computer science, mechanics, and electronic devices. It is designed with driving

Commented [A1]: Dear Reviewer
The comments given have been corrected in the abstract section, namely " Fire is an unsupervised incidental disaster"

Thank you for your suggestion

Commented [A2]: Dear Reviewer
The comments given have been corrected by adding sentences containing offers of novelty and problem gaps based on previous research in abstract

Thank you for your suggestions

Commented [A3]: This sentence is long-winded! try it like this:
Kebakaran merupakan bencana insidentil tanpa pengawasan!
A strong statement, and not a common sense

Commented [A4R3]: Dear Reviewer
The comments provided have been corrected

Thank you for your suggestion

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The comments given have been corrected by adding sentences containing offers of novelty and problem gaps based on previous research in Intisari (Indonesia)

Thank you for your suggestions

Commented [A7]: The introduction should contain:
1. General description that leads to the research topic
2. Related research
3. Main reference
4. Problem Description
5. Problem Solution
6. Differences between the main references and the proposed research
7. Novelty
8. Contribution
9. Paper Structure

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The comments provided have been corrected

Thank you for your suggestion

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wheels that enables the robot's entire bodyto move from one place to another [1]. Robots can also perform activities and tasks similar to humans [2].

In addition, a robot is a mechanical device programmed to be controlled and carry out activities typically performed by humans [3]. The ability of the robot to complete its mission is very calculated, for that a reliable navigation system is needed so that it can support optimal robot performance. Robots were created to make it easier for humans to solve problems, for example in extinguishing fires [4].

Many people can feel technological developments, including in the fields of electronics and computer science, for the use of industry, government, and education [5]. A robot is a collection of electronic or mechanical devices that are connected to an electric current with the principle of doing work like humans [6].

Fire is one of the disasters that can cause great losses, both in terms of material, environment, and human life. The firefighting process often presents high risks for firefighters, especially in areas that are difficult to reach or have the potential for additional hazards such as chemical leaks or explosions. Fire fighting significantly impacts the safety of firefighters, as they are often exposed to various risks such as burns, toxic gases, and possible explosions during extinguishing operations [7].

The risks borne by the firefighting team are very high, therefore, an innovative solution is needed to minimize these risks and increase the effectiveness of the extinguishing process, namely the creation of a firefighting robot to assist humans in this work. One of the efforts to improve their safety is the development of robots to handle such situations [8]. These robots assist firefighters by mitigating risks and enhancing the effectiveness of fire extinguishing tasks [9]. With the use of these robots, the risk to firefighting personnel can be significantly reduced[10].

Related research on fire extinguishing robots has been carried out by the results of this study [11] a robot that functions to find the source point of the fire and then extinguish it using a fan using the L9110 fan motor drive module was designed and built. Infrared sensors and HC-SR04 ultrasonic, the process of finding the point of the fire source utilizes ultraviolet light emitted by the fire. Research on fire fighting robots has also been carried out in design and implementation of fire detection and extinguishing systems using dual axis mechanics [12]. Previous research has been conducted on the application of iot in the design of a miniature robot fire extinguishing system to assist the pre-evacuation evaluation process [13] the purpose of this research is the development of a miniature wheeled IoT (Internet of Things) robot that can monitor visual conditions using esp32-cam and retrieve data from the necessary sensors such as gas, fire, temperature, and distance sensors.

This study builds upon prior research by integrating IoT-based technologies with hardware components such as Arduino Mega 2560, Node MCU ESP8266, and the L298N motor driver. The system also utilizes Android applications to provide a user-friendly interface for controlling the robot. Previous studies highlight the efficacy of IoT and Arduino in robotics illustrated an IoT-based fire detection robot capable of real-time response, providing a foundation for this research [14]. IoT is part of today's technological developments that can connect the internet from a device and provide sustainable benefits [15]. IoT can connect embedded hardware through the internet network [16]. The Arduino Microcontroller Board is the robot controller used in this research [17]. Specifically, the Arduino Mega 2560 microcontroller, based on the ATMEGA 2560 is utilised, and it features 54 input pins [18].

Fires pose significant threats to both human safety and property. Current firefighting methods rely heavily on manual operations, which can endanger the lives of firefighters. Moreover, these methods may not effectively address fire outbreaks in inaccessible or high-risk areas. Despite advancements in robotics, existing fire extinguishing robots often face limitations in range, control precision, and operational adaptability. Thus, there is a critical need for a more efficient and safer solution to mitigate these challenges.

The Arduino Mega 2560 serves as the microcontroller board in the design of this firefighting robot [19], enabling it to move from one place to another [20]. Researchers widely Arduino Mega 2560 as a microcontroller to control embedded materials and to carry out programmed instructions [21]. This research results in a prototype firefighting robot with Arduino Mega 2560-based programming [22], using Internet of things technology controlled by the Android application.

The Internet of Things (IoT) is a recent technological development capable of transferring large amounts of data through an Internet network that is connected to the destination source [23]. In recent years, Internet of Things has become a prominent research topic [24]. IoT typically integrates software and hardware components, often provided by IT companies [25]. Today, IoT techonology plays a significant role in human life, where each object is uniquely identifiable, equipped with sensors, and connect in real-time to the Internet [26].

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Thank you for your suggestion

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In 2023, an Arduino-controlled wireless fire extinguishing robot designed for residential areas has been produced by L. Wasu. et al. [27] This robot offers an alternative to fighting fires in enclosed areas, buildings and residential areas. By remotely operating the robot outside the disaster area, the spread of fire and property damage can be stopped before further help arrives. IoT Technology Based Fire-Fighter Robot [28] The robot is controlled through a remote desktop application. The connection between the robot and the application (authority) is done through the Internet. This paper introduces how the concept of Internet of Things (IoT) is introduced to robots. The IoT-based automatic fire detection and extinguishing robot addresses these challenges by utilizing a combination of advanced sensor technology, robotics, and IoT [29] to provide autonomous and real-time solutions. The robot is equipped with fire and temperature sensors that can detect fires at an early stage.

This study uses, the ESP8266 MCU Node as an additional device to connect to Wi-Fi. ESP8266 is a Wi-Fi module with System on Chip on TCP/IP and has to control the microcontroller [22]. A robot is designed using Node MCU (ESP8266), which is easy to program [30].In this research, a prototype robot will be designed that can be used to extinguish fire remotely using control from an Android app.

The novelty of this study lies in the integration of IoT technology with an Android-based control system to create a user-friendly interface for firefighting robots. Unlike previous designs, this prototype focuses on real-time control and operational efficiency within a defined range, as demonstrated through rigorous testing. The use of the L9110 fan for extinguishing fires and the implementation of a user-centric Android application provide unique contributions to existing solutions. In conclusion, this research aims to enhance firefighting operations by addressing existing limitations and providing a safer, more efficient solution through the integration of advanced technologies and innovative design.

This article is written using the structure of introduction, materials and methods, results and discussion, conclusion and references.

MATERIALS AND METHODS

This research uses a prototype method to help work as humans do [31]. In this study, the prototype was used for the initial stage of testing and experimentation [32]. The researcher adopts the research and development and development method, specifically focusing on firefighting robots through 5 cycle process called ADDIE: Analysis, Design, Development, Implementation and Evaluation. This process can be seen in Figure 1, illustrating the development of the Android-based prototype firefighting robot [33] :

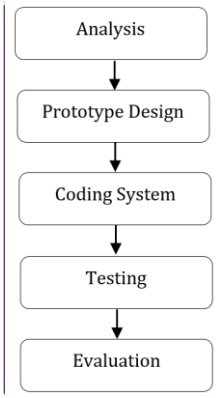

Figure 1. Proposed research method

1. Analysis

At this stage, the research objectives and resource requirements are analysed. This study aims to develop robotics skills by designing a prototype firefighting robot using Arduino Mega 2560 and the Android-based Internet of Things (IoT) technology. The final result of this stage serves as an input for the next phase the design stage [34].

2. Prototype Design

At this stage, An intelligent firefighting robot is designed using the Arduino Mega 2560 and Android-based IoT technology. The design process employs Fritzing software to schematically create the entire prototype circuit of the robot. The firefighting robot is designed to resemble a car, equipped with wheels for movementand fans to extinguish fires. This step serves as a references for the development stage [35].

3. Coding System

In this cycle, the researcher ensures that all designs have been completed and operated according to the research objectives. This involves creating hardware circuits and interconnecting components, such as the Arduino Mega 2560, Node MCU ESP 8266, L298N Module, Servo Motor, Power Supply and others. This stage is known as the development stage [36].

4. Testing

The implementation stage occurs after the development stage [37]. During this phase, after desigining the robot components, the next involves creating a combination of commands in the programming language using standard Arduino syntax to control microcontroller's performance in the device. Additionally, an Android application I developed to control the firefighting robot when connected to the internet.

5. Evaluation

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Thank you for your suggestion

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Thank you for your suggestion

Commented [A16]: Novelty

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Evaluation is the final stage of this research method to reveal the work's effectiveness [38]. In this stage, a series of tests is conducted the firefighting robots to identify any funtional errors pr deviations from the research objectives. If errors are found, they will be corrected, and if it's the robot functions as intended, further development will be pursued. Ultimately, the robot prototype is created and tested according to the experimental design [39].

RESULTS AND DISCUSSION

A. Block Diagram

The hardware made as a design is a collection of several modules to form a system to make it functional [40]. In system development, it begins with the implementation stage [41]. The design of a Smart Firefighting Robot Using Arduino Mega 2560 and Android-based IoT Technology is depicted in the block diagram as shown in Figure 2.

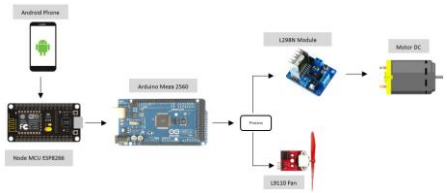

Figure 2. Block diagram design

Figure 2 explains that a Block Diagram that serves as a reference for connecting all components [42]. The design of this electronic manufacturer uses Arduino for the overall data processing [43]. A well-structured research design is essential to achieve the research objectives.

B. Robot Design

Figure 3 explains that this firefighting robot uses an Arduino Mega 2560 as a microcontroller and several other supporting hardware to ensure that the robot system works according to the research objectives. The hardware components in this firefighting robot is the Arduino Mega 2560, Node MCU ESP 8266, L298N Module, Servo Motor, Power Supply, and FAN L9110. In addition, an Android was also developed as supporting software to control the robot in extinguishing fires remotely. The following is the design of research methodology as illustrated in Figure 3.

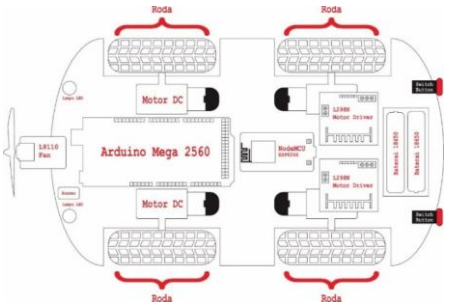

Figure 3. Hardware design

C. Wiring Design

Implementation is one of the activities in the system development section [44]. At this stage, the activity involves placing a prototype of a firefighting robot that as a functional part of the developed system. The design of wiring diagram as shown in Figure 4.

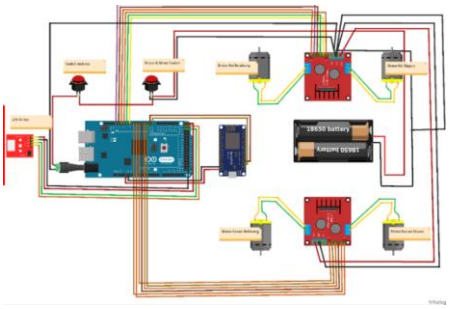

Figure 4. Wiring design

D. Flow Digram

Figure 5 is a Flow Diagram Design. When the Arduino component is electrified, the microcontroller will be in control and provide instructions to the ESP 8266 MCU Node and L298N Motor Driver. Once both components are activated, the MCU ESP 8266 Node will connect to the Android application, while the L298N will control the driver motor. Through the Android application, the firefighting robot can be controlled under 2 conditions. Firtsly, it can change the robot's direction of movemonet and secondly it can activate the fan to extinguish fires. The design of flow diagram as shown in Figure 5.

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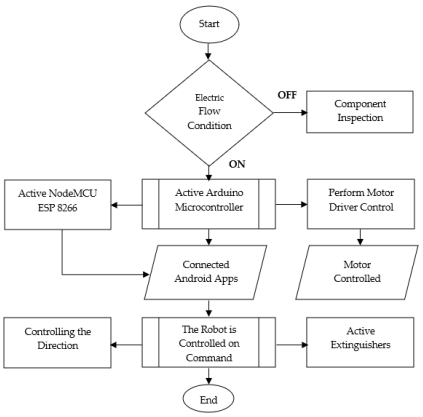

Figure 5. Flow diagram

E. Program Code

At this stage, commands in the programming language are command to control the microcontroller's performance in the designed device. The programming language used is C ++, implemented through Arduino software. The program code as shown in this link https://github.com/budysatria/Fire-Extinguisher-Robot/tree/master

F. Application Design

To facilitate the control of the robot, android application software is needed as a remote control. User interface layout as shown in Figure 6.

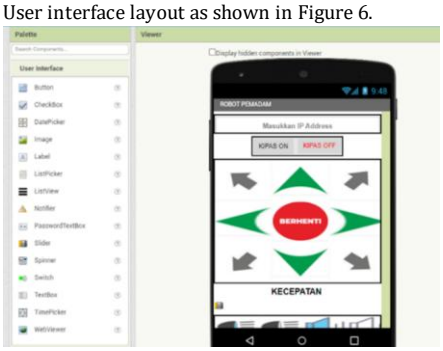

Figure 6. Application interface

G. Prototype Robot

The prototype of the Fire Extinguisher Robot can be viewed from various perspectives. Figure 7 depicts the top view, while Figure 8 illustrates the side view perspective.

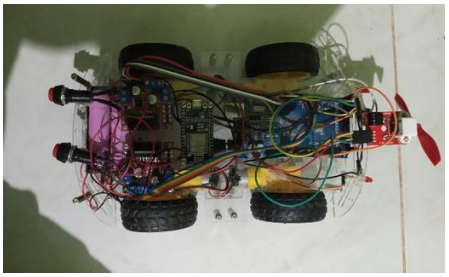

Figure 7. Top view

Figure 8. Side view

H. Functionality Test Result

Table 1 represents the results of functionality testing on all hardware components. Each component has been througly tested anda functions well-funtioned base on the predetermined pameters and criteria. Functionality test result as shown in Table 1.

Table 1. Functionality Test Result

No	Component Name	Information	Result
1	Microcontroller Arduino Mega 2560	- Connectable to a computer and Connected to Internet	100%
2	NodeMCU ESP8266	- Connected on an Android device	100%
3	L298N Motor Driver	- The wheels on the robot have moved	100%
4	Power supply	- Components have electricity	100%
5	L9110 Fan	- Spin when activated	100%
6	Android Application	- Controlling Fire Extinguisher Robot	100%

I. Prototype Robot Test Result

The tests in Table 2 were performed to assess the performance of the HC-SR 04 ultrasonic sensor, which serves as a robot protection system. The test was conducted 15 time at 1 cm up to 30 cm intervals. Protection system test results as shown in Table 2.

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Table 2. Ultrasonic sensor test

Test	Distance Measured by Sensor	Result
1	2 cm	Has stopped
2	4 cm	Has stopped
3	6 cm	Has stopped
4	8 cm	Has stopped
5	10 cm	Has stopped
6	12 cm	Has stopped
7	14 cm	Work
8	16 cm	Work
9	18 cm	Work
10	20 cm	Work
11	22 cm	Work
12	24 cm	Work
13	26 cm	Work
14	28 cm	Work
15	30 cm	Work

Table 2 it can be explained that the results of tests that have been carried out at a distance of 2-12 cm, the robot will stop because it has been programmed that the robot must stop when it detects an object in front of it based on that distance. However, at a distance of 14-30 cm the robot will still move.

The next test is involves testing the connectivity of robot control using an Android application against concrete obstacles as shown in Table 3. The testing is conducted at distance ranging from 1-20 meters. Based on the test results, It was obtained that robot navigation control through an Android application connected to the internet network, function appropriately within range of 0-5 meters. Test results for android applications as shown in Table 3.

Table 3. Application test result

Test	Distance	Android Application	Signal
1	1 m	Work	Good
2	2 m	Work	Good
3	4 m	Work	Good
4	8 m	Work	Good
5	10 m	Doesn't work	Bad
6	12 m	Doesn't work	Bad
7	14 m	Doesn't work	Bad
8	16 m	Doesn't work	Bad
9	18 m	Doesn't work	Bad
10	20 m	Doesn't work	Bad

Table 3 it can be concluded that testing the Android application at a distance of 1 - 8 meters will get good signal quality, but if it is at a distance of 10-20 meters what happens is that the Android application does not work and the signal quality is bad.

Next is testing the fire extinguishing robot. The tests carried out started from setting the distance between the robot and the fire, the amount of time to extinguish the fire and the test results which can be seen in Table 4 below.

Table 4. Fire extinguishing robot

Test	Distance	Duration	Fire Condition
1	5 cm	2 second	Off
2	10 cm	2 second	Off
3	15cm	3 second	Off
4	20 cm	3 second	Off
5	25 cm	4 second	Off
6	30 cm	4 second	Off
7	35 cm	5 second	Off
8	40 cm	6 second	Off
9	45 cm	7 second	Off
10	50 cm	10 second	Off

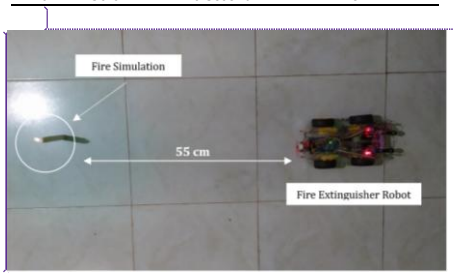

Figure 9. Robot a Distance of 55 Cm

L911 fan performance test results as shown in Table 5.

Table 5. L9110 fan performance test results

Test	Distance	Android Application	Fan Result
1	1 cm	Work	Spin
2	2 cm	Work	Spin
3	8 cm	Work	Spin
4	14 cm	Work	Spin
5	16 cm	Work	Spin
6	18 cm	Work	Spin
7	20 cm	Work	Spin
8	22 cm	Work	Spin
9	24 cm	Work	Spin
10	28 cm	Work	Spin

Table 5 shows that the test results were carried out to determine the state of the fan on the L9110 Fan when with distances ranging from 1 to 28 cm. The result is that the fan can be turned on and rotated appropriately according to its function.

CONCLUSION

The prototype of Fire Extinguishing Robot with Android Application control has been successfully implemented. The results indicated that the robot stopped at a distance of 2-12 cm but functioned properly at a distance of 14-30 cm. In addition, testing was carried out on the Android application, which is used for robot control in extinguishing fires within a range of 1-20 meters. The test results showed that the Android application worked properly and had good signal quality at distance of 1-8 meters. However, the application stopped working at distances of 8-20 meters. The test was

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also conducted on the L9110 fan component. Test results showed that the fan operated very well within a distance of 1-28 cm, fulfilling its intended function. Moreover, the Android application also functioned optimally within this range, successfully allowing the fan to extinguish the simulated fire source. The results of this study obtained a new approach to autonomous fire detection and extinguishing using IoT and robotic technology. In addition, it is able to integrate an Android-based IoT controller to enable remote control with real-time monitoring to overcome problems in previous research. The use of Wi-Fi communication with an Android app for dual-mode (manual and automatic) operation is a notable enhancement in usability and accessibility. Use of servo-controlled FAN L9110 improves fire-fighting efficiency. Cost-Effective Design for Multiple Applications such as by using the Arduino Mega 2560 microcontroller and ESP8266 MCU Node, which integrates Wi-Fi capabilities this system achieves functionality without significantly increasing costs, making it suitable for residential, commercial, and industrial applications. This research has successfully designed and developed an innovative IoT-based fire fighting robot prototype. The use of Arduino Mega 2560 microcontroller, ESP8266 MCU Node, L298N Motor Driver, L9110 Fan and the use of IoT platform and Android application provide flexibility and convenience in monitoring and controlling the robot. This research makes a significant contribution to the field of robotics and intelligent systems, and opens up new opportunities for the development of more advanced fire safety systems in the future.

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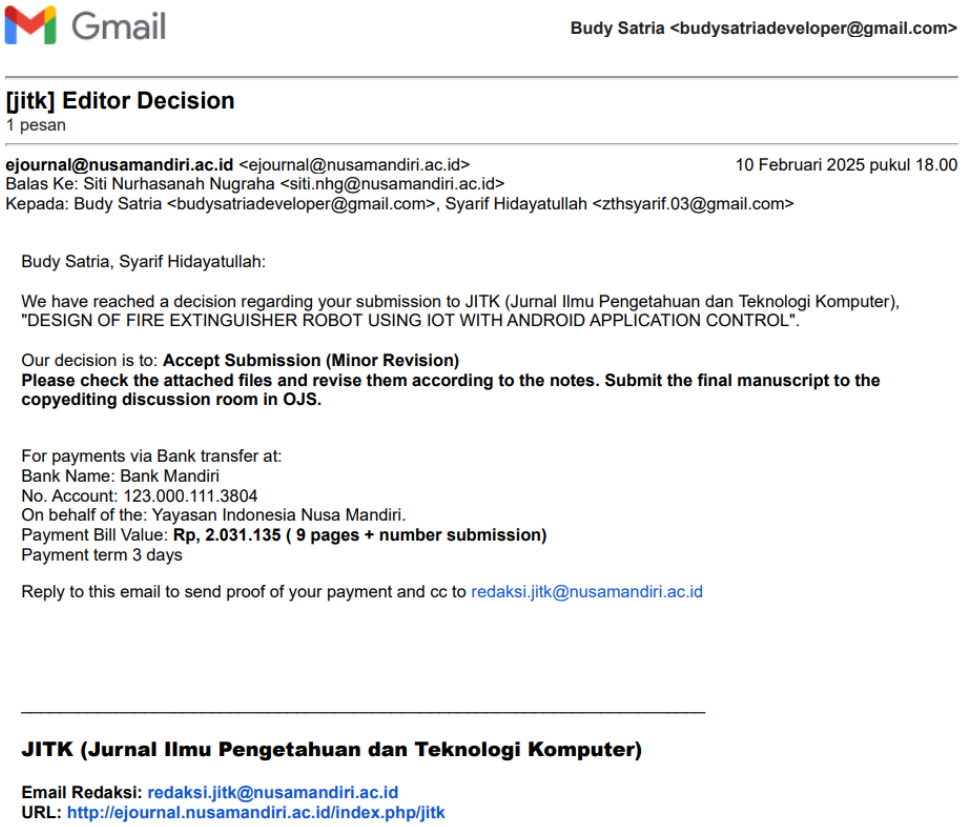

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