Jurnal E-Komtek
Vol. 7, No. 2 (2023) pp. 302-310
https://jurnal.politeknik-kebumen.ac.id/index.php/E-KOMTEK
p-ISSN : 2580-3719 e-ISSN : 2622-3066

Automatic Fire Extinguisher Simulation Using Arduino Uno-Based Flame Sensor

Asni Tafrikatin[1], Rouf Wangafif[2], Jati Sumarah[3], Ajeng Tiara Wulandari[4], Apriansyah Zulatama[5]
[1-4]Department of Electrical Engineering, Politeknik Piksi Ganesha Indonesia, Indonesia, 54311
[5]Department of Mining Equipment Maintenance Engineering, Akademi Komunitas Industri Pertambangan Bukit Asam, Indonesia, 31716

asnitafrikhatin@gmail.com

https://doi.org/10.37339/e-komtek.v7i2.1545

Published by Politeknik Piksi Ganesha Indonesia

Artikel Info
Submitted:
30-11-2023
Revised:
12-12-2023
Accepted:
12-12-2023
Online first :
12-12-2023

Abstract

One of the efforts to prevent fires is by providing occupational health and safety (K3) learning. In the learning process, the material is only in videos and power points about fire prevention and control. Conversely, students more easily understand contextualized material. One of them is an automatic fire extinguisher simulation. This simulation uses a fire sensor as its input, Arduino uno as its control, and a relay as an output from Arduino. This learning media was tested on 40 people with backgrounds as students and employees. Based on the results of this learning media trial, the average questionnaire assessment reached 87.6%, so this learning medium is effective as a learning medium for fire extinguisher simulation.

Keywords: Learning Media, Fire Extinguisher, Arduino Uno

Abstrak

Salah satu upaya untuk mencegah terjadinya kebakaran adalah dengan memberikan pembelajaran kesehatan dan keselamatan kerja (K3). Dalam proses pembelajaran, materi yang diberikan hanya berupa video dan power point tentang pencegahan dan penanggulangan kebakaran. Sebaliknya, siswa lebih mudah memahami materi yang bersifat kontekstual. Salah satunya adalah simulasi alat pemadam kebakaran otomatis. Simulasi ini menggunakan sensor api sebagai inputnya, arduino uno sebagai kontrolnya, dan relay sebagai output dari arduino. Media pembelajaran ini diujicobakan kepada 40 orang yang berlatar belakang sebagai mahasiswa dan karyawan. Berdasarkan hasil uji coba media pembelajaran ini, rata-rata penilaian kuesioner mencapai 87,6%, sehingga media pembelajaran ini efektif sebagai media pembelajaran simulasi pemadam kebakaran.

***Kata-kata kunci**: Media Pembelajaran, Pemadam Kebakaran, Arduino Uno*

1. Introduction

Fire is an event that cannot be predicted when, where, and who becomes a victim. A variety of factors causes fires, both small and large, intentional and unintentional. Fires can occur in homes, work environments, and nature such as forests [1]. Based on data from fire departments throughout Indonesia, the number of fire incidents in residential areas is around 1000 yearly (very grace) [2]. The high incidence of fires in residential homes is caused by human negligence and system disruption. Fire problems that often occur at home are due to electrical short circuits, gas leaks, or forgetting to turn off the stove; the location of dense settlements is also a factor in the fire spreading quickly.

In terms of security, fire is an element of security disturbance, while in terms of safety, the fire incident is a loss [3]. Based on these problems, we must avoid things that cause fires, including making sure the stove is off if you leave the kitchen, when recharging the device, if the device is complete, immediately remove the cable, and always check the wiring of the house installation [4]. Fire prevention and disaster management must be done early and as soon as possible because fires can harm us physically and psychologically.

Preventing fires includes providing students with Occupational Health and Safety (OHS) learning [5]. K3 learning includes safety at work, in which there are ways to prevent and extinguish fires. One way to extinguish a fire is by using an automatic fire extinguisher. This automatic fire extinguisher is usually placed in companies, hospitals, apartments, hotels, and offices.

The material about how to fight fires at this time is mostly only in the form of learning videos or PowerPoint material that explains how to use a fire extinguisher. Material about automatic fire extinguisher simulations still needs to be created. Even though most essential buildings built today use automatic fire extinguishers. According to research by Edi Nurhidin, contextual learning media can increase student understanding [6]. This aligns with Ni Nyoman Delia's research, stating that contextual learning media can increase student enthusiasm and make learning implementation more effective and efficient [7].

2. Method

2.1 Block diagram design

The working principle of this simulation is that when the fire sensor detects a fire, the signal is forwarded to Arduino, which will be processed to give a command to the relay so that

the relay enters the on/on condition[8], [9] . The relay is a 12 Volt DC connecting switch to turn on the buzzer, rotary lamp, and pump. The block diagram design can be seen in **Figure 1**.

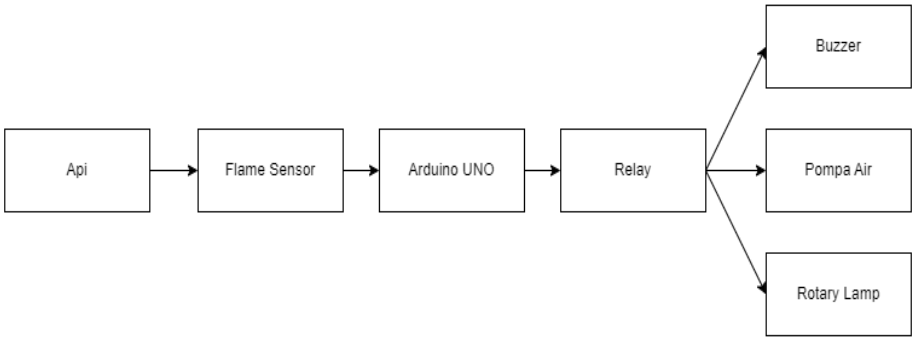

Figure 1. Diagram Block

2.2 Hardware Design

In the scheme, the legs of the fire sensor are connected to Arduino with the configuration of the GND leg connected to the ground, VCC connected to 5V, and out connected to input number 2. As for the relay, the GND leg is connected to the ground, VCC is connected to 5V, and IN is connected to PWM input 9. COM relay is connected to a 12V DC adapter and r and NO are connected to the pump, buzzer, and rotary lamp. Hardware schematic is presented in Figure 2.

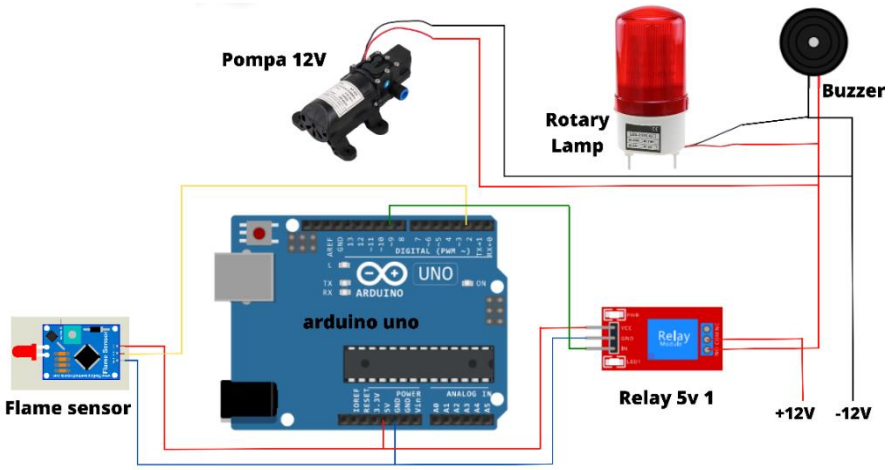

Figure 2. Hardware Schematic

2.3 Software Design

This automatic fire extinguisher simulation has several working steps. First, the fire sensor starts to detect the fire around it. Second, when the fire sensor detects a fire, the relay will receive a command to be in the on position. Third, when the relay is in the on position, the buzzer will sound, and the rotary lamp and pump will turn on. The design of the software flow chart can be seen in **Figure 3**.

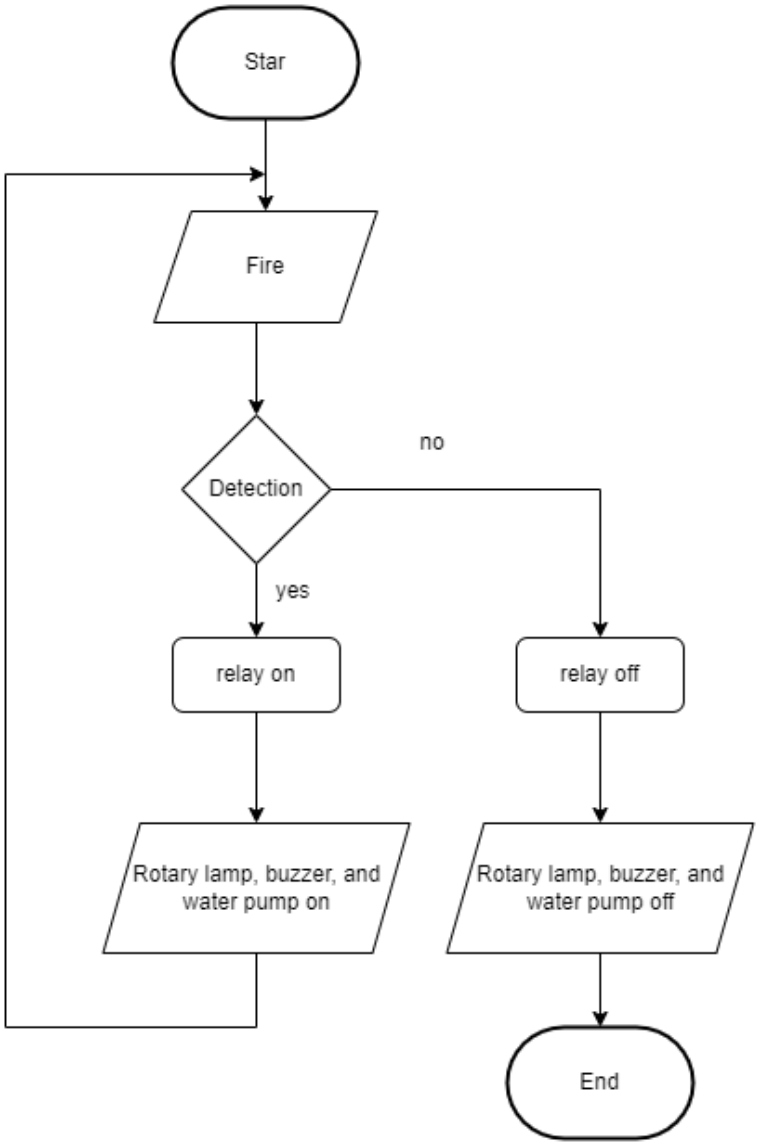

Figure 3. Flowchart of the Automatic Fire Extinguisher Program

The program uploaded to Arduino is a program to detect the flame around the sensor. The detection results will be processed to produce a command that will be forwarded to the relay.

2.4 Overall device design

In this method, the circuit is arranged and installed according to the type of components. First, the flame sensor is attached to the sensor display cover by punching a hole in the cover according to the diameter of the sensor. Second, an electronic black box is mounted on the top of the cover. This black box contains the Arduino Uno, relay, buzzer, fire sensor module, and water pump. Third, a rotary lamp connected to a relay is next to the fire sensor. Fourth, under the sensor, there is a water storage box to collect water during the simulation, and a water nozzle is installed on the lid. The overall tool design can be seen in **Figure 4**.

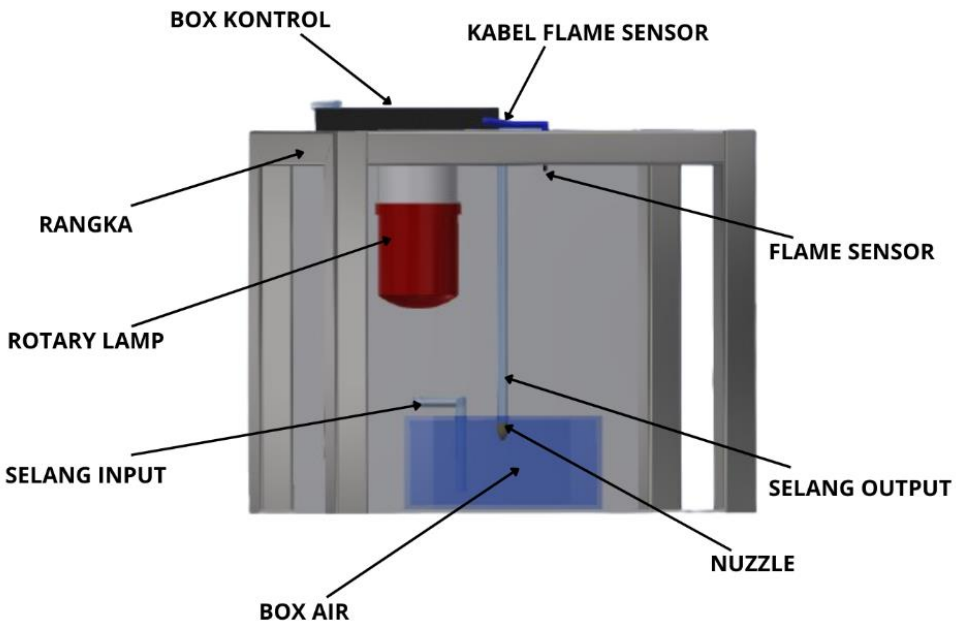

Figure 4. Overall device design

3. Results and Discussion

3.1 Measurement results of fire sensor input values based on distance

Measurement of the sensor input value against changes in distance is done by recording changes in the sensor input value when the fire source is at a specified distance. The distances determined in this measurement are 20 cm, 30 cm, 40 cm, 50 cm, 60 cm, and 70 cm. The graph of the input value measurement against changes in distance can be seen in **Figure 5**.

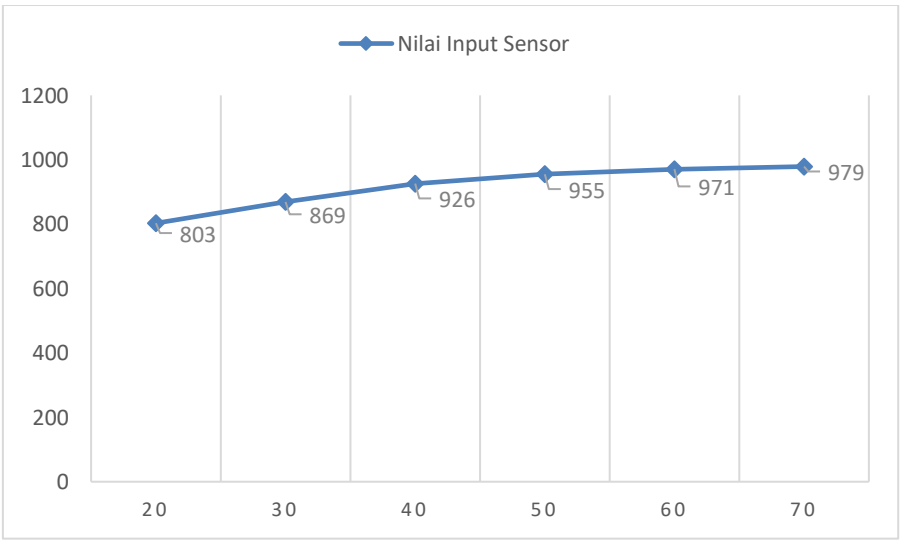

Figure 5. Measurement Graph of Sensor Input Value Against Distance Change

Figure 5 shows that the further the distance between the fire source and the sensor, the greater the input value read. The most significant change in input value occurs at the initial change in distance between the fire source and the sensor. The minor changes in input value occur at the last distance change.

3.2 Measurement Results of Fire Sensor Input Values Based on Time

Fire sensor input value is measured per second by recording the change in input value every second according to the specified distance. This measurement is carried out to compare changes in input value every second between predetermined distances. The graph of the measurement of the input value per second can be seen in **Figure 6.**

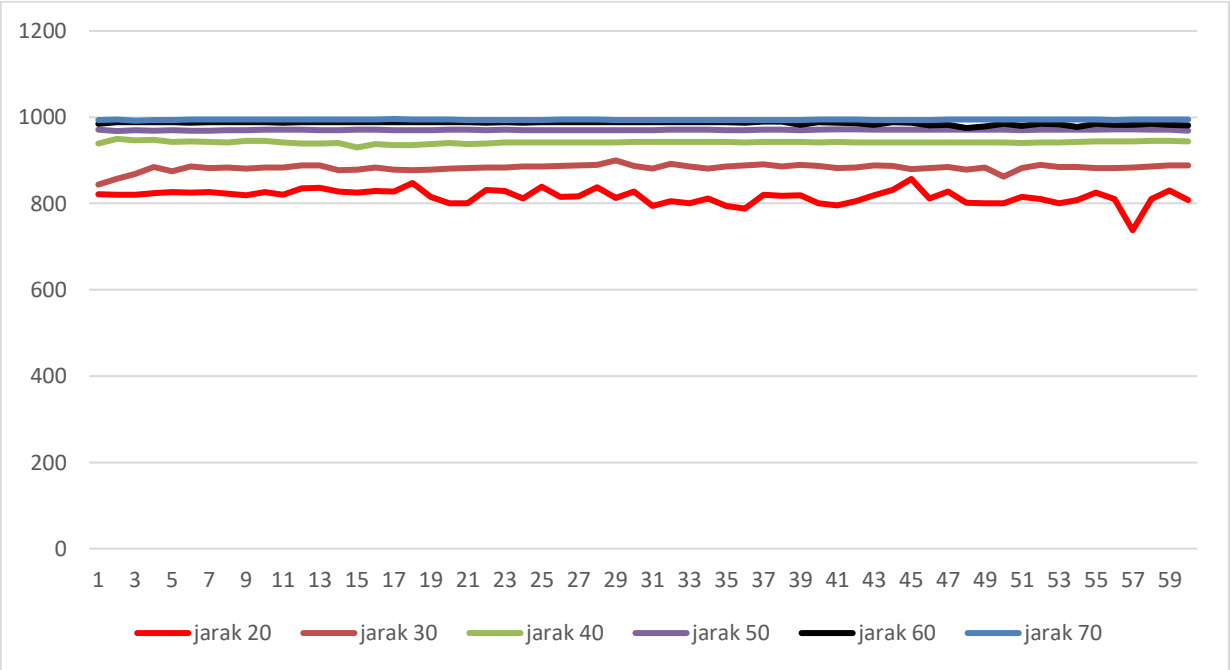

Figure 6. Measurement Result Graph of Input Value per Second

The change in sensor input value that occurs every second is different from the first to the last distance. The change in input value per second is more significant as the distance between the fire source and the sensor gets closer. The more the distance between the sensor and the fire source increases, the more stable the change in the sensor input value read per second. After this learning media has been running well, it is tested using students taking K3 courses and employees in a company with afire risk. During the implementation of the product demonstration, students and employees filled out a questionnaire about the effectiveness of the learning media. The process of testing this learning media can be seen in **Figure 7** and **Figure 8**.

Figure 7. Learning Media Trial at CV Astoetik

Figure 8. Learning Media Trial at Politeknik Piksi Ganesha Indonesia

A questionnaire assesses students and employees about the effectiveness of learning media. Forty people conducted this assessment. The results of the questionnaire assessment can be seen in **Table 1**.

Table 1. Results of the Questionnaire Assessment

No	Indicator	Result
1	This prop makes it easier to learn material on how to use fire fighting simulation.	3,48
2	These props increase the enthusiasm for learning firefighting simulations	3,41
3	This teaching aid increases knowledge of firefighting simulations	3,48
4	This teaching aid provides a clear picture of the firefighting simulation	3,48
5	This prop works well	3,52
6	This prop is easy to use	3,48

Based on Table 1, this learning media is quite effective. This is evident from the results of the questionnaire assessment, which used a scale of 1 to; the average assessment results are above point 3. The highest assessment on props functions well, while the lowest assessment on props can increase enthusiasm for learning. Many factors make students more eager to learn, including a high desire to learn, student achievement, and student mood [10]–[12]. Therefore, if student

enthusiasm is still lacking, it does not mean that students do not like the learning media made; maybe other factors affect the enthusiasm for learning..

4. Conclusion

This automatic fire extinguisher simulation tool uses a fire sensor controlled by Arduino Uno and uses a fire sensor. This learning media is compelling enough to make K3 learners, especially for fire extinguisher simulation material, easier to understand how the fire extinguisher simulation tool works.

References

[1] R. A. Kowara, "Analisis Sistem Proteksi Kebakaran Sebagai Upaya Pencegahan Dan Penanggulangan Kebakaran," *Jurnal Manajemen Kesehatan Yayasan RS.Dr. Soetomo*, vol. 3, no. 1, p. 69, Apr. 2017, doi: 10.29241/jmk.v3i1.90.

[2] M. Ruslan and M. S. Al Amin, "Perancangan Sistem Fire Alarm Kebakaran Pada Gedung Laboratorium XXX," *Jurnal Tekno*, vol. 18, no. 2, pp. 51–61, 2021.

[3] C. Owens, A. B. Le, T. D. Smith, and S. E. Middlestadt, "Beliefs of University Employees Leaving During a Fire Alarm: A Theory-based Belief Elicitation," *Saf Health Work*, vol. 14, no. 2, pp. 201–206, Jun. 2023, doi: 10.1016/j.shaw.2023.03.002.

[4] L. Xu and W. Zheng, "Numerical simulation on the influence of low air pressure upon smoke spread and fire alarm process," *Case Studies in Thermal Engineering*, vol. 26, p. 101004, Aug. 2021, doi: 10.1016/j.csite.2021.101004.

[5] A. Balboa, A. Cuesta, J. González-Villa, G. Ortiz, and D. Alvear, "Online experiments and regression analysis of evacuation decisions in response to fire alarms," *Fire Saf J*, vol. 141, p. 103954, Dec. 2023, doi: 10.1016/j.firesaf.2023.103954.

[6] E. Nurhidin, "INOVASI PEMBELAJARAN PENDIDIKAN AGAMA ISLAM (PAI) MELALUI PEMANFAATAN MEDIA PEMBELAJARAN KONTEKSTUAL DAN PENGEMBANGAN BUDAYA RELIGIUS DI SEKOLAH," *Kuttab*, vol. 1, no. 1, Jan. 2017, doi: 10.30736/ktb.v1i1.23.

[7] N. N. D. Kristanti and I. W. Sujana, "Media Pembelajaran Interaktif Berbasis Pembelajaran Kontekstual Muatan IPS pada Materi Kenampakan Alam," *Jurnal Penelitian dan Pengembangan Pendidikan*, vol. 6, no. 2, pp. 202–213, Jul. 2022, doi: 10.23887/jppp.v6i2.46908.

[8] A. Tafrikhatin and Dwi Sri Sugiyanto, "Handsanitizer Otomatis Menggunakan Sensor Ultrasonik Berbasis Atmega 328 Guna Pencegahan Penularan Virus Corona," *Jurnal E-Komtek (Elektro-Komputer-Teknik)*, vol. 4, no. 2, pp. 127–135, Dec. 2020, doi: 10.37339/e-komtek.v4i2.394.

[9] Arba'i Yusuf, Asni Tafrikhatin, Jati Sumarah, and N. N. Hudaifah, "Media Pembelajaran Sensor Berbasis Arduino Uno Untuk Pembelajaran Mikrokontroler Pemula," *JASATEC : Journal of Students of Automotive, Electronic and Computer*, vol. 3, no. 1, pp. 15–26, Sep. 2023, doi: 10.37339/jasatec.v3i1.1403.

[10] D. Yuniarni, R. P. Sari, and A. Atiq, "Pengembangan Multimedia Interaktif Video Senam Animasi Berbasis Budaya Khas Kalimantan Barat," *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, vol. 4, no. 1, p. 290, Nov. 2019, doi: 10.31004/obsesi.v4i1.331.

[11] M. V. Al Zuhry and M. A. Ghofur, "Pengaruh Tingkat Pendidikan, Pendapatan Orang Tua, Semangat Belajar, dan Fasilitas Belajar terhadap Prestasi Belajar Siswa di Masa Pandemi," *EDUKATIF : JURNAL ILMU PENDIDIKAN*, vol. 3, no. 5, pp. 2501–2512, Jul. 2021, doi: 10.31004/edukatif.v3i5.895.

[12] O. Nurdiawan, I. Ali, C. L. Rohmat, and A. R. Rinaldi, "Sistem Kendali Sensor Tanah Sebagai Pemonitor Tingkat Kelembaban Media Tanam Padi," *Jurnal InfoTekJar*, vol. 5, no. 1, 2020.