

Prototype of a Warehouse Shoe Lamp Automation System Using Motion Sensors Based on the Internet of Things (IoT)

Pandu Mardya Wijaya^{1*}
Abdi Pandu Kusuma¹
Rizki Dwi Romadhona¹

¹Computer Systems, Information Technology, Islamic University of Balitar, Blitar, Indonesia

Abstract

This research presents the design and development of a monitoring and control system for warehouse lighting using the SR501 passive infrared (PIR) motion sensor, which is based on the Internet of Things (IoT). The goal of this research is to improve the comfort, efficiency, and security of the Jeensneakers Shoe Warehouse in Kedawung, Nglegok, Blitar. By introducing IoT-based automatic lights accessed through a smartphone, users can monitor and control the lights remotely, making lighting usage more effective and efficient. The research employs a prototype design using ESP32 and PIR sensors, conducted through survey methods, observations, and interviews. The testing results show that the automatic lights can be controlled remotely using a smartphone, and the motion sensor can function as a security feature for the Jeensneakers shoe warehouse. The evaluation of the IoT-based automatic lighting system was considered feasible, with an 80% acceptance rate from experts, indicating a sufficient level of feasibility.

Keywords: IoT, Lighting Control, Monitoring, Motion Sensor

1. INTRODUCTION

Indent the first line of every paragraph by 1 cm. State the objectives of your work and provide an adequate background, avoiding a detailed literature survey or a summary of the results. Explicitly state the gap in the literature, which signifies the significance of In Line with the development of development, the amount of electricity demand in Indonesia has increased rapidly. The increase in electricity demand can be caused by the addition of new loads, or it can also be caused by wasteful use of electricity. Waste of electricity must be prevented, because the supply of electricity from PLN is increasingly limited. One of the increasingly popular innovations is the application of the Internet of Things (IoT) in the Shoe Warehouse automation system. IoT allows devices to connect

^{1*}Corresponding author, email: pandumardyawijaya30061@gmail.com

DOI: <https://doi.org/10.35457/josar.v9i2.3888>

Citation in APA style: Wijaya, P. M., Kusuma, A. P., Romadhona, R.D. (2024). Prototype of a Warehouse Shoe Lamp Automation System Using Motion Sensors Based on the Internet of Things (IoT). *JOSAR*, Vol. 9. No. (2):63-73.

Received:
August, 28st 2024

Revised:
September, 13st 2024

Published:
September, 31st 2024

and communicate with each other via the internet network, so that users can monitor and control these devices in real time from a distance.

In this context, automatic lights based on motion sensors are one example of an IoT application that provides significant benefits, both in terms of energy efficiency and user comfort. This system works by integrating motion sensors to detect the presence of individuals in an area, so that the lights can turn on or off automatically without requiring manual interaction. The use of motion sensors not only helps in saving energy by preventing the lights from turning on continuously when there is no activity, but also improves the security aspect by ensuring optimal lighting at the right time.

Designing and implementing IoT technology in these automatic lights allows users to monitor and control the lighting system via a mobile application. Users can set motion sensors and on/off times. With this feature, users have full control over the lighting of Gudang Sepatu, which not only increases comfort but also significantly reduces energy consumption.

The adoption of an IoT-based automatic lighting system is also in line with the global trend towards smart homes, where every electronic device is designed to work automatically and integrated into one ecosystem. Thus, this study aims to develop and test a prototype of an automatic lamp based on a motion sensor connected via IoT, which is expected to provide a practical and efficient solution for modern lighting needs.

2. LITERATURE REVIEW

In previous research titled "Design of Monitoring and Control Systems for Lights Using Motion Sensors and Light Sensors Equipped with Internet of Things (IoT): A Case Study of the Faculty of Information Technology, Bale Bandung University" by (Imamah & Sagara Andika, 2021). a lighting control system was designed so that the lights could be monitored and controlled remotely, and their status could be known in real-time, allowing lighting to be adjusted as needed. The aim of this research was to create a system design for monitoring and controlling lights so that electricity usage for lighting would be more effective and efficient by using motion and light sensors equipped with the Internet of Things (IoT).

Then, in the research titled "IoT-Based Lamp Control System Using Blynk 2.0 Application with Nodemcu Esp8266 Module" by (Herlina, Syahbana, Gunawan, & Rizqi, 2022). the implementation of IoT involved hardware devices connected to the internet using an IoT platform, an application used to collect data from various hardware devices, store and display data, control devices, and more. One of the IoT platforms is the Blynk Application, which can be downloaded for free from the Playstore or Appstore on Android. The purpose of this study was to create an IoT-based lamp control system using the new version of Blynk, Blynk 2.0.

DOI: <https://doi.org/10.35457/josar.v9i2.3888>

The study titled "Application of IoT in Room Lighting Automation Systems with Motion Sensors and Light Sensors Using Android" by (Husna dkk., 2019). Discusses a lighting control system that will turn on the lights as long as there is a person in the room and turn them off when the person leaves. The presence of people is detected by a passive infrared (PIR) sensor. The goal is to enable better electricity management at home by using an electronic device that can monitor energy usage on devices considered to be quite wasteful, utilizing a microcontroller.

The subsequent study titled "Utilization of Internet of Things in Lamp Control" by (Kusumaningrum, Pujiastuti, & Zeny, 2017). discusses how IoT refers to and leverages objects that will later be able to communicate with each other through an internet network. One of the applications of IoT is in lamp control.

2.1. Internet Of Things (IOT)

In a study on "Design and Development of an Automatic Lamp Control System Based on the Internet of Things (IoT) Using the BLYNK 2.0 Application," the researcher aimed to enhance the development of IoT for automatic lamp control systems, so that they could be more widely used by the general public. The Blynk 2.0 application was used as the controller.

2.2. ESP32

The ESP32 microcontroller is developed by a company named Espressif Systems. One of the advantages of the ESP32 is that it already includes WiFi and Bluetooth, making it very convenient for learning to create IoT systems that require wireless connections. The ESP32 microcontroller has several benefits, including being low-cost, low-power with an integrated WiFi module and microcontroller chip, and having dual-mode Bluetooth with power-saving features, making it more flexible (Rifky, 2021).

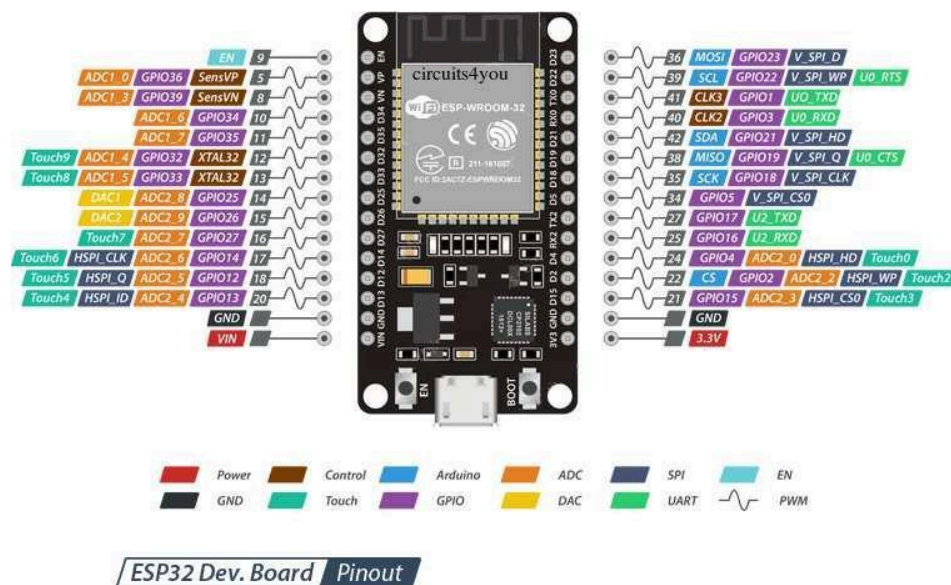


Figure 1. ESP32

Specifications of ESP32:

Number of pins: 30 including voltage pins and GPIO

15 ADC (Analog to Digital Converter) pins

3 UART Interfaces

3 SPI Interfaces

2 I2C Interfaces

16 PWM (Pulse Width Modulation) pins

2 DAC (Digital to Analog Converter) pins

2.3. Sensor Passive Infrared Receiver (PIR)

The PIR (Passive Infrared) sensor is used to detect infrared radiation emitted by an object. The PIR sensor is passive, meaning it does not emit infrared light but only receives infrared radiation from outside. The PIR sensor can detect radiation from various objects, as all objects emit radiant energy (Prastyo E. A., 2022).



Figure 2. Sensor PIR

Tabel 1. Spesifikasi sensor PIR

Voltage	4.5v – 20v
Current	<50uA
Output level	3.3V High 0V Low.
Delay Time	0.5s – 200s (adjustable)
Blocking Time	2.5s (default)

2.4. Relay

A relay is an electronic component that acts like a switch and is operated using electricity. This component consists of two parts: an electromagnet (coil) and mechanics (switch). In operation, the relay uses electromagnetic principles to move the switch and conduct electricity (Misel, 2022).

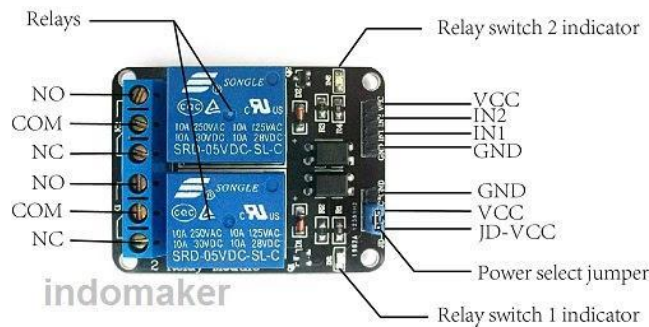


Figure 3. Relay 2 channel

Tabel 2. Relay Specification

Dimensions	7*5,3*1,8cm
Relay voltage	5 volts
Max voltage/current	10A 125VAC / 10A 28VDC

2.5. BLYNK

Blynk is an Internet of Things (IoT) platform that can be used to connect IoT hardware devices with an IoT platform. By using this platform, we can control and monitor hardware devices remotely. Additionally, this platform can store data from sensors and display the measurement results. The automatic lamp uses voice commands (Hakim, 2023).

2.6. Arduino Ide

Arduino is an open-source electronic platform commonly used for designing and creating electronic devices and software that are easy to use. Arduino is designed to facilitate the use of electronic devices in various fields (Setiawan, 2022).

2.7. USB Adaptor

A USB adaptor is an electronic device that is useful for converting high AC voltage (alternating current) into low DC voltage (direct current). The adaptor functions to supply power to the ESP32 from an outlet to avoid short circuits in the ESP32 (Abid, 2023).

2.7. Incandescent Lamp

An incandescent lamp is a type of lamp whose light comes from a thin filament that is heated. This lamp was the first one created by humans, specifically by Thomas Alva Edison. To light an incandescent lamp, a power source is needed to heat the filament located at the center of the bulb (Widiastuti, 2021). In an automatic lighting system, the incandescent lamp will only turn on when needed. This helps save energy because the lamp is not left on continuously.

3. METHODS

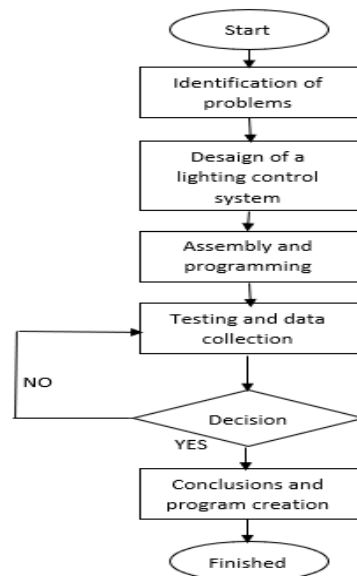


Figure 4. Research flowchart

1. Problem Identification

The initial process in problem-solving aims to identify issues, obstacles, or challenges in the shoe warehouse that need to be addressed.

2. Lamp Control System Design

In research that results in a product, the system design must be prepared to ensure that the product is ready for use. The design of the lamp control system is as follows:

- Block Diagram

The block diagram is a visual representation of the system that shows the relationship between various main components, namely the smartphone and motion sensor as inputs, the ESP32 as the processor, and the incandescent lamp as the output.

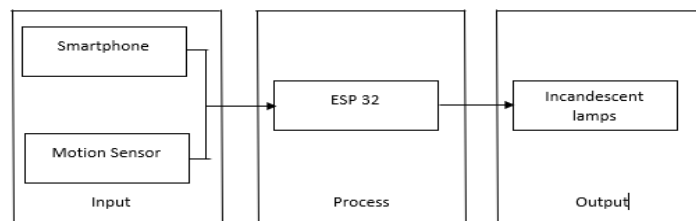


Figure 5. Block Diagram

- Automatic Lamp System Flowchart.

The flowchart of the automatic lamp system explains the process stages of the system or provides a graphical depiction of the stages of a program. The flowchart starts with data input from initialization, which is then processed by the ESP32 microcontroller. The sensor readings will be displayed on the Blynk application interface installed on the user's smartphone. As long as the system is connected to

the internet, users can monitor the condition of their home and control the lights using command inputs through buttons in the Blynk application. These button inputs are then translated into high and low logic on the 2-channel relay connected to two lamps.

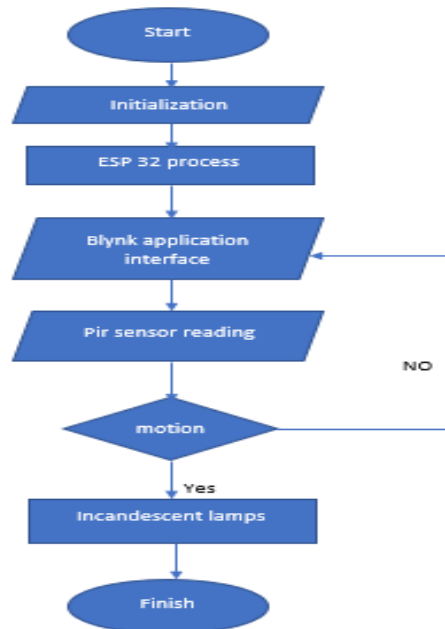


Figure 6. Automatic Lamp System Flowchart

3. Assembly and Programing

The assembly and programming for the lamp control system involve several important stages, including assembling electronic components, wiring, and programming the controller to manage the automatic lamp system.

- Creating an automatic lamp system.
- Testing the device that has been built to obtain data..
- In the programming process, the steps include selecting the programming platform and writing the program code.

4. RESULTS

In this chapter, the researcher discusses the testing stages. The researcher conducted tests on the Prototype of the Warehouse Lamp Automation System Using Motion Sensors Based on the Internet of Things

4.1 Component Testing

4.1.1 Pir Sensor Component Testing

This test aims to determine whether the PIR sensor is functioning and working properly.

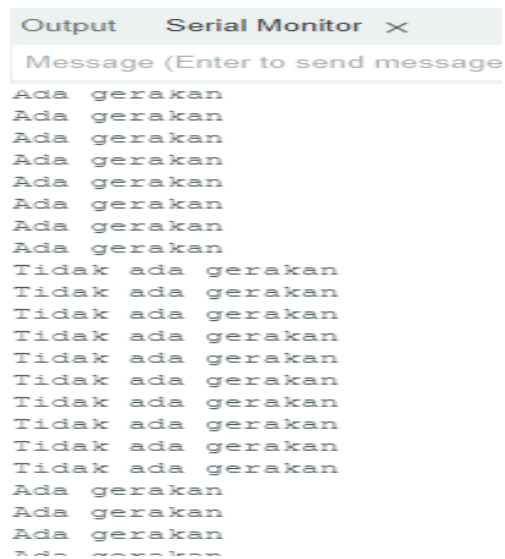


Figure 7. Pir Sensor Component Test Result

Based on Figure 7, the PIR sensor is functioning properly. The serial monitor will display "Motion detected" if there is movement, and "No motion" if there is no movement.

4.1.2 Relay component testing

Relay testing is conducted to determine whether the relay is functioning and working properly.

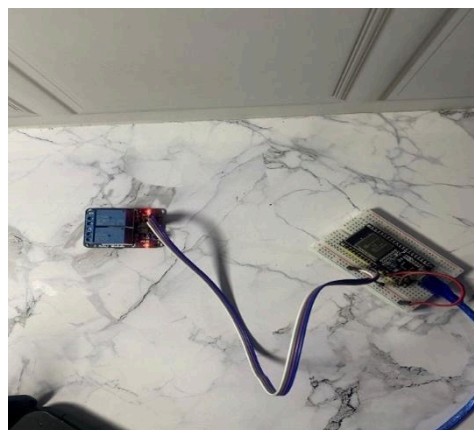
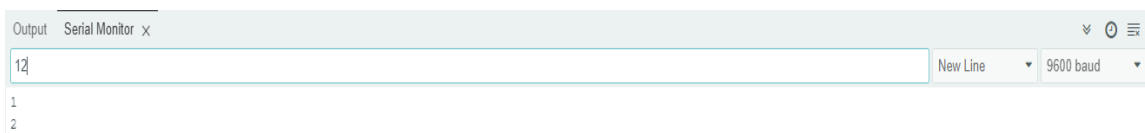


Figure 8. Relay component test result

DOI: <https://doi.org/10.35457/josar.v9i2.3888>

Based on the Figure 8, to activate IN1 and IN2 simultaneously, type 1 and 2 on the serial monitor and press ENTER. Both indicator lights on the relay will then light up.

4.1 Functional Testing

The prototype of the automatic lamp using an IoT-based PIR sensor was tested to ensure its functionality. The testing was conducted to verify that the lamp can be controlled via a smartphone, to assess its accuracy, and to confirm that the motion sensor functions correctly. This testing includes checking whether the lamp turns on or off using the smartphone and motion sensor.

Table 3. Pir Device Test Result

Distance (meter)	Test					
	1	2	3	4	5	6
1 m	✓	✓	✓	✓	✓	✓
1,25 m	✓	✓	✓	✓	✓	✓
1,50 m	✓	✓	✓	✓	✓	✓
1,75 m	✓	✓	✓	✓	✓	✓
2 m	✓	✓	✓	✓	✓	✓
2,25 m	✓	✓	✓	✓	✓	✓
2,50 m	✓	✓	✓	✓	✓	✓
2,75 m	✓	✓	✓	✓	✓	✓
3 m	✓	✓	✓	✓	✓	✓
3,25 m	✓	✓	✓	✓	✓	✓
3,50 m	✓	✓	✓	✓	✓	✓
3,75 m	✓	✓	✓	✓	✓	✓
4 m	✓	✓	✓	✓	✓	✓
4,25 m	✓	✓	✓	✓	✓	✓

DOI: <https://doi.org/10.35457/josar.v9i2.3888>

Distance (meter)	Test					
	1	2	3	4	5	6
4,50 m	✓	✓	✓	✓	✓	✓
4,75 m	✓	✓	✓	✓	✓	✓
5 m	✓	✓	✓	✓	✓	✓
5,25 m	✓	✓	X	X	X	X
5,50 m	✓	✓	X	X	X	X
5,75 m	✓	✓	X	X	X	X
6 m	✓	X	X	X	X	X
6,25 m	X	X	X	X	X	X
6,50 m	X	X	X	X	X	X
6,75 m	X	X	X	X	X	X
7 m	X	X	X	X	X	X
7,25 m	X	X	X	X	X	X
7,50 m	X	X	X	X	X	X
7,75 m	X	X	X	X	X	X
8 m	X	X	X	X	X	X

Based on Table 3, tests were conducted six times to determine the detection range of the PIR sensor in the automatic lamp control system. It was found that the sensor could detect movement at a maximum distance of 5 meters. At a distance of 5.75 meters, movement was detected in two out of six trials. At a distance of 6 meters, movement was detected in one out of six trials. From the data obtained, it was determined that the maximum consistent detection range of the PIR sensor, with sensitivity maintained across six trials, is 5 meters.

Table 4. Relay tool testing

Test	Input		Light Result 1	Light Result 2
	Button1 Smartphone	Button2 Pir Sensor		
1	1	1	1	1
2	1	0	1	0
3	0	1	1	1
4.	0	0	0	0

Based on Table 4: When both the smartphone button and PIR sensor are ON (1), both lamps turn on. If only the smartphone button is ON (1), Lamp 1 turns on while Lamp 2 remains off. If only the PIR sensor is ON (1), both lamps turn on. If both the smartphone button and the PIR sensor are OFF (0), both lamps will be off.

Table 5. Distance Testing

Test	Distance variations	Unstable network	Result
Smartphone	100m	ON	ON
	200m	ON	ON
	400m	OFF	ON
	800m	OFF	ON
	1km	OFF	ON
PIR sensor	30cm		Motion Detected
	300cm		Motion Detected
	500cm		Motion Detected
	600cm		Motion Stopped
	700cm		Motion Stopped

Based on Table 5, the test results show that the automatic lamp on the smartphone can be accessed at a distance of 1 km if the internet connection is stable. If the internet connection is unstable, the maximum distance is less than 400 meters between the smartphone and the ESP32. Meanwhile, the PIR sensor can detect movement at a maximum distance of less than 600 cm; beyond this distance, it cannot detect movement

5. DISCUSSION

Before installing the Internet of Things (IoT)-based automatic lamps, a survey was conducted with the Owner of Jeensneakers, the Head of the Jeensneakers Warehouse, and the Head of the Jeensneakers Store who will be using these IoT-based automatic lamps. The survey results can be seen in Appendix 3. From the survey, 66% strongly agreed with the program, and 34% agreed.

Based on the validation results of the automatic lamps, the IoT-based motion sensor lamps are considered valid and meet the expected outcomes. In the validation results by experts, the programming aspect received a percentage of 75%, categorized as good. Usability analysis results are as follows: usefulness aspect with 83%, satisfaction aspect with 79%, and ease of use aspect with 79%. The cumulative result is 80%, categorized as feasible.

6. CONCLUSION

Based on the problem formulation and objectives mentioned, this research can be concluded as follows:

- 1) The design of an automatic lighting system using a motion sensor (PIR) based on the Internet of Things for the Jeensneakers Shoe Warehouse in Kedawung Nglegok Blitar. The design involves creating the device and writing the program. This system uses a smartphone for remote control and a PIR motion sensor for securing the Jeensneakers Shoe Warehouse. To turn on the automatic lights, users must log in to the Blynk application and then press the buttons on Blynk according to the needs of the Jeensneakers Shoe Warehouse.
- 2) The testing of the Internet of Things (IoT)-based automatic lighting is considered feasible, based on two sources. First, from user testing, the usability analysis

DOI: <https://doi.org/10.35457/josar.v9i2.3888>

showed a percentage of 83% for the usefulness aspect, 79% for the satisfaction aspect, and 79% for the ease of use aspect. The cumulative result is 80%, categorized as feasible. Second, from expert testing, the feasibility rating by experts resulted in a criteria value of 75%, which is considered feasible.

REFERENCES

- Adam, A., Muharnis, M., Ariadi, A., & Lianda, J. (2020). Penerapan IoT untuk Sistem Pemantauan Lampu Penerangan Jalan Umum. *Elinvo (Electronics, Informatics, and Vocational Education)*, 5(1), 32–41. <https://doi.org/10.21831/elinvo.v5i1.31249>
- Artiyasa, M., Nita Rostini, A., Edwinanto, & Anggy Pradifta Junfithrana. (2021). Aplikasi Smart Home Node Mcu Iot Untuk Blynk. *Jurnal Rekayasa Teknologi Nusa Putra*, 7(1), 1–7. <https://doi.org/10.52005/rekayasa.v7i1.59>
- Avallone, E., Mioralli, P., Natividade, P., Palota, P., da, C., Antonio, J., & Aparecido, V. (2019). An inexpensive anemometer using Arduino board. *Facta Universitatis - Series: Electronics and Energetics*, 32(3), 359–368. <https://doi.org/10.2298/fuee1903359a>
- Fadil, M. R., Suhendi, A., & ... (2022). Sistem Otomasi Lampu Penerangan Umum Berbasis Sensor Pir Dan Ldr Dan Monitoring Penggunaan Energi Listrik Berbasis Iot. *EProceedings ...*, 9(4), 1879–1884. <https://openlibrarypublications.telkomuniversity.ac.id/index.php/engineering/article/view/18247%0Ahttps://openlibrarypublications.telkomuniversity.ac.id/index.php/engineering/article/view/18247/17825>
- Faiz, M., Sanjaya, R., Studi, P., Informatika, T., Adhirajasa, U., Sanjaya, R., Studi, P., Informasi, S., Adhirajasa, U., & Sanjaya, R. (2023). *Implementasi Lampu Otomatis Berbasis Sensor Gerak Dengan Teknologi IoT Peningkatan Efisiensi Energi di Madrasah Diniyah Darul Muttaqin Kota Bandung*. 4(2), 466–477.
- Hamiddin, I. (2018). Saklar Otomatis Sistem Kontrol Terpadu Menggunakan Arduino Uno. *Jurnal Elektronik Pendidikan Teknik Elektronika*, 8(1), 33–41.
- Herlina, A., Syahbana, M. I., Gunawan, M. A., & Rizqi, M. M. (2022). Sistem Kendali Lampu Berbasis Iot Menggunakan Aplikasi Blynk 2.0 Dengan Modul Nodemcu Esp8266. *INSANtek*, 3(2), 61–66. <https://doi.org/10.31294/instk.v3i2.1532>
- Husna, A., Toha Hidayat, H., & Mursyidah. (2019). Penerapan IoT Pada Sistem Otomatisasi Lampu Penerangan Ruang Dengan Sensor Gerak Dan Sensor Cahaya Menggunakan Android. *Jurnal Teknologi Rekayasa Informasi Dan Komputer*, 3(1), 10–16.
- Imam, M. (2019). Perancangan dan Pembuatan Sistem Penyalaan Lampu Otomatis Dalam Ruang Berbasis Arduino Menggunakan Sensor Gerak dan Sensor Cahaya. *Jurnal Intake : Jurnal Penelitian Ilmu Teknik Dan Terapan*, 10(1), 9–16. <https://doi.org/10.48056/jintake.v10i1.4>
- Imamah, N., & Sagara Andika, D. (2021). Perancangan Sistem Monitoring Dan Pengendalian Lampu Menggunakan Senso Gerak Dan Sensor Cahaya Dielengkapi *Internet of Things (IOT)* (Studi Kasus Fakultas Teknologi Informasi Universitas Bale Bandung). *Jurnal Informatika-COMPUTING*, 08, 14–21.
- Jaya, H., & Ramadhan, M. (2018). Rancang Bangun Lampu Belajar Otomatis Dengan

DOI: <https://doi.org/10.35457/josar.v9i2.3888>

Menggunakan Sensor Ultrasonic Berbasis Arduino. *Jurnal SAINTIKOM (Jurnal Sains Manajemen Informatika Dan Komputer)*, 17(2), 206.
<https://doi.org/10.53513/jis.v17i2.45>

Juwariyah, T., Prayitno, S., & Mardhiyya, A. (2018). Perancangan Sistem Deteksi Dini Pencegah Kebakaran Rumah Brbasis Esp8266 dan Blynk. *Jurnal Transistor Elektro Dan Informatika (TRANSISTOR EI)*, 3(2), 120–126

Kusumaningrum, A., Pujiastuti, A., & Zeny, M. (2017). Pemanfaatan Internet of Things Pada Kendali Lampu. *Compiler*, 6(1), 53–59.
<https://doi.org/10.28989/compiler.v6i1.201>