JURNAL TEKNISI **E-ISSN: 2775-0965**
(Jurnal Teknologi Komputer dan Sistem Informasi)
February 2026, Vol 6, No 1, Hlm. 39 – 44
Available online at http://jurnal.goretanpena.com/index.php/teknisi

AUTOMATIC LED SYSTEM USING INFRARED SENSOR BASED ON ARDUINO UNO

Muhammad Khairul Fahri[1], Fadli Anwar Sinaga[2], Ahmad Dani[3]
[1,2,3]Informatic Engineering, Universitas Asahan
Email: [3]ff3465819@gmail.com, [2]fadlisinaga.irc@gmail.com,
[3]adani8175@gmail.com**,**

Abstract: Manual lighting systems in residential and public facilities often lead to significant electrical energy waste when lights remain active in unoccupied areas. To address this issue, this research aims to develop an automatic LED lighting system using an infrared sensor based on the Arduino Uno microcontroller to optimize energy consumption through automation. The research methodology involves hardware integration, software development using the Arduino IDE, and system functional testing.**]** Experimental results demonstrate that the system successfully detects object presence with high precision, triggering the LED to turn on instantaneously and deactivate when no object is detected. The study concludes that the infrared-based automation system is stable, responsive, and provides an effective, low-cost solution for improving energy efficiency in smart building applications.

Keyword: arduino uno; infrared sensor; LED; microcontroller; automatic system

Abstrak: Sistem penerangan manual di fasilitas perumahan dan umum sering kali menyebabkan pemborosan energi listrik yang signifikan ketika lampu tetap menyala di area yang tidak berpenghuni. Untuk mengatasi masalah ini, penelitian ini bertujuan untuk mengembangkan sistem pencahayaan LED otomatis menggunakan sensor *infrared* berbasis mikrokontroler Arduino Uno untuk mengoptimalkan konsumsi energi melalui otomatisasi. Metodologi penelitian meliputi integrasi perangkat keras, pengembangan perangkat lunak menggunakan Arduino IDE, dan pengujian fungsional sistem. Hasil eksperimen menunjukkan bahwa sistem berhasil mendeteksi keberadaan objek dengan presisi tinggi, memicu LED untuk menyala secara instan dan mati ketika tidak ada objek yang terdeteksi. Penelitian ini menyimpulkan bahwa sistem otomatisasi berbasis *infrared* ini stabil, responsif, dan memberikan solusi efektif berbiaya rendah untuk meningkatkan efisiensi energi pada aplikasi bangunan pintar.

Kata kunci: arduino uno; sensor infrared; LED; mikrokontroler; sistem otomatis

INTRODUCTION

The development of microcontroller technology has encouraged the creation of various automated systems aimed at improving efficiency and comfort in daily life. One of its main implementations is an automated lighting system that can operate without manual operation. Although Light Emitting Diode (LED) technology has been widely adopted due to its energy-saving and durable nature, manual use often leads to energy waste due to negligence in turning off lights when not needed.

Electrical energy waste in manual lighting systems is a significant problem. Globally, lighting accounts for approximately 20% to 30% of total energy consumption in residential and commercial buildings (Bolton, 2006). Research shows that manual operation often leaves lights on in unoccupied rooms, which contributes to energy waste of 10% to 40% of the total

JURNAL TEKNISI **E-ISSN: 2775-0965**
(Jurnal Teknologi Komputer dan Sistem Informasi)
February 2026, Vol 6, No 1, Hlm. 39 – 44
Available online at http://jurnal.goretanpena.com/index.php/teknisi

building lighting budget. This efficiency is crucial because the use of highly efficient LEDs will still be wasted if the duration of use is not properly controlled. In the State of the Art (SOTA) of automated lighting system research, several common sensors have been used, such as Light Dependent Resistor (LDR) and Passive Infrared (PIR) sensors.

LDR sensors are effective for outdoor lighting because they respond to ambient light levels, but they lack the ability to detect the presence of specific objects indoors. On the other hand, PIR sensors detect motion through heat radiation and are widely used in large rooms; however, these sensors often fail to maintain the "lights on" state if the subject remains still (static) and are susceptible to false triggers from changes in ambient temperature (Sedra & Smith, 2015).

To overcome these limitations, this study designed an automated LED system using an Arduino Uno-based Infrared (IR) sensor. Unlike LDRs, infrared sensors work by emitting infrared waves and detecting reflections from nearby objects without relying on the room's light intensity. Compared to PIRs, the IR sensors in this system offer more stable and precise proximity detection for small-scale applications or transition areas such as entrances and corridors of public facilities.

Arduino Uno acts as the main controller that processes input signals from the sensors to regulate the LED output in real-time. This approach enables a more responsive automation concept and is a simple yet effective solution in improving the efficiency of electrical energy use.

Theoretical Basis:

Arduino Uno

Arduino Uno is a board microcontroller based on the ATmega328P which has 14 digital pins and 6 analog pins. Arduino Lots used in embedded systems because convenience programming And support broad community .

Image 1. Arduino Uno
Source: google

Infrared Sensor

Infrared sensor working with emit wave infrared And detect reflection from object . When object detected , the sensor produces HIGH or LOW digital signal that can read by microcontroller .

Image 2. Infrared Sensor

Light Emitting Diode (LED)

LED is component emitting semiconductor light when flowing current electricity . LEDs have efficiency tall And consumption Power low so that suitable used in system automatic .

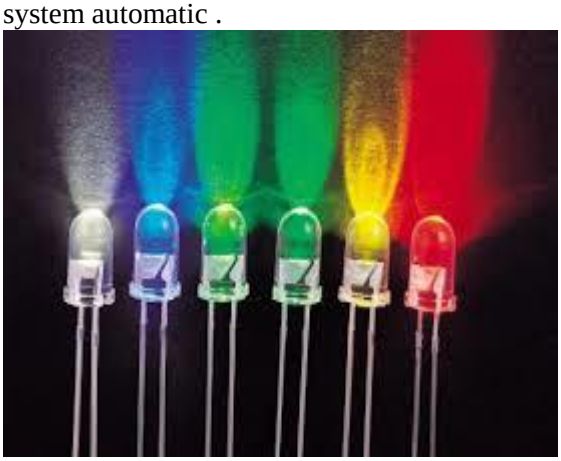

Image 3. Light Emitting Diode (LED)
Source: ResearchGate

JURNAL TEKNISI **E-ISSN: 2775-0965**
(Jurnal Teknologi Komputer dan Sistem Informasi)
February 2026, Vol 6, No 1, Hlm. 39 – 44
Available online at http://jurnal.goretanpena.com/index.php/teknisi

System Lighting Automatic

System lighting automatic is control system light based on condition certain using sensors and microcontroller as data processor .

METHOD

This research methodology is systematically structured to ensure the successful design and testing of the automated LED system. The research stages follow a flow consisting of component preparation, hardware design, software development, and system testing procedures.

Tools and Materials

The main components used in this research include:

Arduino Uno: An ATmega328P-based microcontroller that functions as a central processing unit (CPU) to control input and output.

Infrared (IR) Sensor: Functions as an object presence detector through infrared wave emission and reflection detection.

Light Emitting Diode (LED): Serves as an efficient lighting output component.

Jumper Wires and Breadboard: To connect components in a circuit without permanent soldering.

Hardware Design

This system is designed by connecting the IR sensor to the Arduino's digital input pins and the LED to the digital output pins. The VCC and GND pins on the sensor are connected to the 5V and Ground lines on the Arduino. The sensor data pin is connected to digital pin 2, while the positive LED pin is connected to digital pin 13, with a resistor added as a current limiter in accordance with microelectronic circuit principles (Sedra & Smith, 2015).

Software Programming

The control logic is implemented using the C++ programming language within the Arduino Integrated Development Environment (IDE) (Rohmanu, 2018). The system's main logic uses if-else conditional instructions:

If the sensor signal is LOW (an object is detected), the Arduino applies a HIGH voltage to the LED pin.

If the signal is HIGH (no object is present), the Arduino applies a LOW voltage to turn off the LED.

Testing Procedure and Data Collection

The testing process was carried out by placing objects at various distances in front of the sensor to validate the system's response. The collected data included sensor detection status and LED on status, which were then analyzed to ensure system stability according to the research flowchart (Image 1).

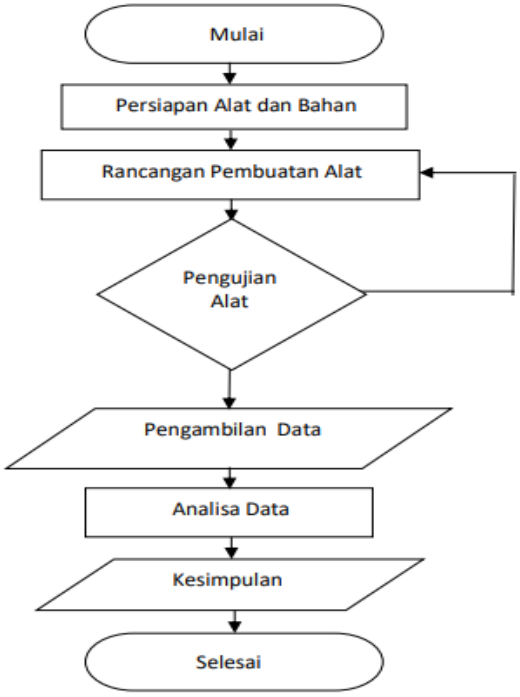

Image 4. Flow Diagram Study

Table 1. Sensor Test Data

No	Condition Testing	IR Sensor Response	LED Condition
1	No There is object	No detected	Off
2	Object near with sensor	Detected	Light up
3	Object avoid from the sensor	No detected	Off
4	Object is at in range	Detected	Light up

JURNAL TEKNISI **E-ISSN: 2775-0965**
(Jurnal Teknologi Komputer dan Sistem Informasi)
February 2026, Vol 6, No 1, Hlm. 39 – 44
Available online at http://jurnal.goretanpena.com/index.php/teknisi

RESULT AND DISCUSSION

The operational success of this automated LED system depends on the harmonious integration of hardware components and digital logic execution within the microcontroller. Based on test results (Image 2), the system demonstrated stable performance in responding to object presence in real time.

Mechanism Analysis

This system operates based on the principle of active infrared reflection. The sensor module continuously emits infrared waves into the surrounding environment; when an object enters the detection range, the waves are reflected back and captured by the receiving photodiode. This signal change is then processed by the ATmega328P on the Arduino Uno. The use of LEDs as outputs is ideal in this automated system due to their low power consumption and high switching speed, which supports overall energy efficiency (Bolton, Sedra & Smith, 2024).

System Limitations and Weaknesses

Although the system operates according to its designed logic, several technical factors can affect sensor accuracy in the field:

Sunlight Interference: The sunlight spectrum contains a broad range of infrared radiation. This can cause saturation of the sensor receiver, triggering "false positives" where the LED remains lit even though no physical object is present (Sedra & Smith, 2015). Therefore, this system is more effective when operated indoors with controlled natural light exposure.

Object Color Absorption:

Detection accuracy is also affected by the physical characteristics of the object. Dark or black objects tend to absorb infrared waves rather than reflect them (Margolis, 2011). This can cause the sensor to fail to detect an object even when it is within range.

Distance Limitations:

The standard infrared sensors used in this study have a limited effective range (typically below 30 cm), so their current application is more suitable for small-scale applications such as automated systems at entrances or workbenches rather than large rooms.

For further development, the use of modulated infrared signals or combining them with ultrasonic sensors could be considered to overcome environmental interference and extend the detection range of this automated system.

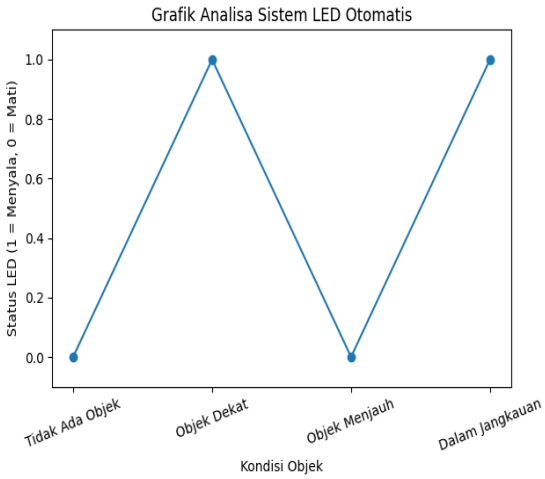

Image 5. Testing data graph

Based on Image 2 (Automatic LED System Analysis Graph) contained in your research document, here are the results of an in-depth analysis that you can use to strengthen the Results and Discussion chapter: Automatic LED System Analysis Graph. This graph represents empirical validation of the performance of the microcontroller-based lighting control system. The following are the main points of the analysis: System Binary

Logic Validation:

The graph shows the movement of the LED status in binary, namely between 0 (Off) and 1 (On). This proves that the program embedded in the Arduino Uno successfully translates the digital signal from the infrared sensor into precise automatic switch actions according to the designed if-else logic.

Direct Correlation of Object Detection: There is a consistent positive correlation between the presence of an object and the output status. In the "No Object" and "Object Away" conditions, the LED status is at 0, indicating that the sensor is not receiving infrared wave

reflections. In the "Object Near" and "In Range" conditions, the LED status instantly rises to 1, indicating that the infrared wave reflections have reached the threshold specified to trigger the microcontroller.

Operational Stability:

The sharp "valley" and "peak" pattern of the graph indicates high system stability and fast response time. There are no floating points found between 0 and 1, indicating that the electronic circuit is quite stable and has minimal noise during data collection.

Conclusion Based on the Graph:

This visual data effectively proves that this automatic lighting system operates according to the research methodology plan. The system successfully eliminates energy usage when there is no activity (condition 0) and only consumes power when needed (condition 1), which theoretically supports the electrical energy efficiency efforts that are the background of this research.

CONCLUSION

This research successfully designed and implemented an automatic LED lighting system based on Arduino Uno microcontroller and infrared sensor. Based on the results of system testing, it can be concluded that: System Integration Success: Arduino Uno is effectively able to process input signals from infrared sensors to control the LED output according to the designed program logic, where the lights turn on instantly when an object is detected and turn off when there is no object. Stability and Accuracy: The results of data testing show that the system works very stably and has a high level of precision in responding to the presence of objects within the specified sensor range. Energy Efficiency: The implementation of this automation technology provides a practical solution to minimize the waste of electrical energy in manual lighting systems, so it is very suitable for application in residential environments and public facilities. As a suggestion for further development, subsequent research can integrate sensors with a wider range or use signal modulation methods to overcome sunlight interference, so that this system can be implemented in more complex outdoor areas.

BIBLIOGRAPHY

Arifin, M. S., & Wijaya, A. (2025). Rancang bangun IoT otomatis berbasis sensor PIR untuk menghemat energi listrik pada saat ruangan kosong. *Jurnal Sistem Komputer dan Informatika (JSON)*, 6(2), 210–218. https://doi.org/10.30865/json.v6i2.5671

Fadli, R., & Hartono, B. (2026). Perancangan dan implementasi sistem penerangan otomatis menggunakan sensor PIR berbasis Arduino Uno. *Jurnal LITEK: Jurnal Listrik Telekomunikasi Elektronika*, 23(1), 24–29. https://doi.org/10.30811/litek.v23i1.73

Gunawan, H., & Pratama, Y. (2024). Analisis efisiensi daya listrik rumah berbasis Arduino Uno dengan sistem otomasi lampu. *Jurnal POLEKTRO: Jurnal Power Elektronik*, 13(1), 45–53.

Irawan, D., & Saputra, E. (2025). Smartlighting: Sistem penerangan otomatis berbasis sensor kehadiran untuk hemat energi maksimal. *JATI (Jurnal Mahasiswa Teknik Informatika)*, 9(1), 120–127.

Mulyana, A., & Sari, K. (2026). Lampu indikator otomatis untuk kamar mandi berbasis Arduino dan sensor gerak. *Jurnal Sains dan Teknologi (JSIT)*, 6(1), 88–95.

Nugroho, A. S., & Susanto, T. (2023). Implementasi sistem lampu tangga otomatis berbasis Arduino menggunakan sensor ultrasonik dan infrared. *Jurnal Pengabdian Masyarakat dan Riset Pendidikan*, 2(4), 512–520.

Purnama, I., & Ramadhan, F. (2024). Pengembangan sistem smart room dengan kombinasi sensor photodioda dan sensor PIR sebagai upaya penghematan energi listrik. *Jurnal Pengembangan Riset dan Observasi Sistem Komputer*, 11(2), 102–110.

Rakayama, I., & Firmawati, N. (2022). Rancang bangun sistem otomatisasi lampu belajar menggunakan sensor PIR dan sensor load cell berbasis mikrokontroler Arduino. *Jurnal Fisika Unand*, 11(2), 228–234.

https://doi.org/10.25077/jfu.11.2.228-234.2022

Rahmatillah, Z., & Fitriati. (2026). Rancang bangun smart lighting system berbasis website untuk monitoring penggunaan energi secara real-time. *Jurnal Sains dan Teknologi*, 6(1), 15–23.

Sushmasri, M., & Jameel, M. (2024). Automatic security light and alarm using Arduino and PIR sensor. *International Journal of Innovative Science and Research Technology*, 9(12), 440–447. https://doi.org/10.5281/zenodo.14550740

Syahputra, R., & Utomo, S. (2026). Autolight: Smart motion detection lighting system using passive infrared sensor. *International Journal of Research and Scientific Innovation (IJRSI)*, 13(1), 611–621. https://doi.org/10.51244/IJRSI.2026.1301

Zaman, K., & Hidayat, R. (2023). Optimalisasi penggunaan sensor infrared pada sistem kendali lampu otomatis untuk koridor gedung publik. *Jurnal Teknik Elektro dan Komputer*, 12(3), 175–182.

Adithya, M., & Kumar, R. (2025). Smart lighting systems for sustainable urban development using Arduino-based sensor networks. *International Journal of Sustainable Engineering and Technology*, 14(1), 55–63.

Fauzi, A., & Ramadhani, S. (2024). Analisis perbandingan akurasi sensor PIR dan Infrared dalam sistem saklar lampu otomatis berbasis IoT. *Jurnal Teknik Elektro dan Vokasional (JTEV)*, 10(2), 201–210. https://doi.org/10.24036/jtev.v10i2.11582

Pratama, D. A., & Sari, N. P. (2026). Optimasi konsumsi energi pada gedung perkantoran melalui implementasi sistem kendali lampu otomatis berbasis ATmega328P. *Jurnal Teknologi Informasi dan Terapan (JTT)*, 8(1), 32–40.

Setyawan, B., & Utami, W. (2023). Prototype sistem penghemat listrik otomatis menggunakan sensor jarak infrared berbasis Arduino untuk perpustakaan sekolah. *Jurnal Riset Sistem Informasi dan Teknik Informatika (JURASIK)*, 8(2), 145–154.

Tanaka, H., & Lee, S. (2026). Advancements in proximity sensing for home automation: A review of infrared and ultrasonic integration. *Journal of Advanced Robotics and Automation*, 15(1), 77–85.