IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.471 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 7, July 2025

DOI: 10.17148/IJARCCE.2025.14713

MOTION ACTIVATED PATHWAY LIGHTENING SYSTEM

Sourabh Rathod[1], Rushika Aute[2], A. N. Shaikh[3]

Department Of Electronics and Computer, Shreeyash College of Engineering, Chh.Sambhajinagar[1,2,3]

Abstract: The Motion Activated Pathway Lighting System is a smart lighting solution designed to enhance energy efficiency and safety in both public and private environments. The system automatically activates pathway lights when motion is detected and turns them off after a predefined time of inactivity. It primarily uses IR (Infrared) or PIR (Passive Infrared) sensors to detect movement and an LDR (Light Dependent Resistor) to ensure operation only in low-light conditions, such as during nighttime. The core control unit of the system is based on the Arduino Mega 2560, which processes sensor data and controls the LED lights via a relay module.

This system also includes a dimmer function that allows for a gradual fade-in and fade-out of the lights, improving user comfort and extending the lifespan of the LEDs. The entire setup is powered using a rechargeable lithium battery supported by a step-up voltage converter, making it suitable for remote or outdoor installations. Additional components such as heat sinks and cooling fans ensure the stability of the system. The project is ideal for application in residential complexes, parks, parking areas, industrial zones, and institutional campuses where intelligent lighting control can reduce energy usage and improve user experience.

I. INTRODUCTION

The increasing demand for energy efficiency and automation in public infrastructure has led to the development of smart lighting solutions that optimize power consumption without compromising on safety or visibility. Traditional lighting systems often remain active regardless of the presence of people, resulting in significant energy wastage, especially in pathways, corridors, gardens, or public parks that are used intermittently. In this context, the Motion Activated Pathway Lighting System is an innovative approach aimed at reducing energy consumption by ensuring that lights are turned on only when required — i.e., when motion is detected.

This project integrates basic electronics and automation principles to create a user-friendly and cost-effective lighting system. It primarily relies on motion sensing using Passive Infrared (PIR) or Infrared (IR) sensors which detect human movement within a specified range. Once motion is detected, the system sends a signal to the microcontroller — in this case, the **Arduino Mega 2560** — which then activates the pathway lighting through a relay module. The lights remain on for a pre-programmed time interval and automatically turn off if no further motion is detected.

To enhance system intelligence and energy efficiency, a **Light Dependent Resistor (LDR)** is used to determine the ambient light level. This ensures the lighting system remains inactive during daylight hours when natural light is sufficient, thereby preventing unnecessary power usage. In addition, a **dimmer circuit** is incorporated into the system to allow the lights to gradually fade in when activated and fade out when deactivated, which not only provides a more pleasant user experience but also reduces strain on the electrical components.

The system is designed to be powered by a **rechargeable lithium-ion battery**, with a **step-up converter** to maintain stable voltage levels suitable for all electronic components. Cooling mechanisms such as a **heat sink** and **small cooling fan** are used to ensure that the system operates smoothly even in continuous-use environments or high-temperature conditions. The compact design allows it to be easily installed in a variety of locations, including parks, campuses, housing societies, and industrial walkways.

An optional feature of this system is the integration of **RFID (Radio Frequency Identification)**, which can be used to personalize lighting based on authorized user access. This can be particularly useful in secure zones, gated communities, or institutional premises where individual identification is needed for lighting activation.

Overall, the Motion Activated Pathway Lighting System not only provides a smart solution for reducing electricity bills and conserving energy but also enhances the safety of users by ensuring well-lit pathways at night or in poorly lit conditions. Its modular and scalable design makes it suitable for both small-scale and large-scale implementations, marking a step toward smarter, more sustainable

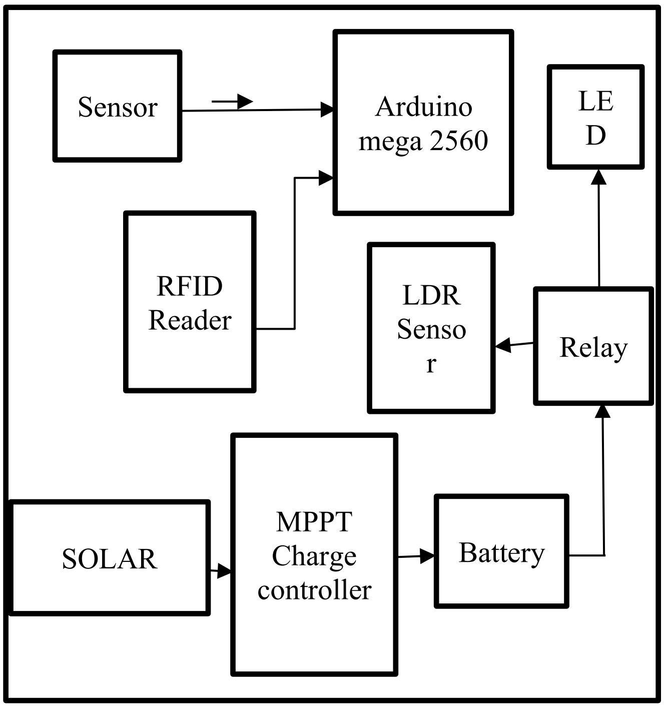
IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.471 ⋇ Peer-reviewed & Refereed journal ⋇ Vol. 14, Issue 7, July 2025

DOI: 10.17148/IJARCCE.2025.14713

II. BLOCK DIAGRAM



III. SYSTEM DEVELOPMENT

The development of the Motion Activated Pathway Lighting System focuses on designing a cost-effective and energy-efficient lighting solution that activates only when motion is detected and ambient light is insufficient. The system integrates both hardware and software components to automate lighting based on real-time environmental and human presence data.

The core of the system is the Arduino Mega 2560, which functions as the central processing unit. It receives input signals from Passive Infrared (PIR) or Infrared (IR) motion sensors, which are deployed along the pathway or corridor. These sensors continuously monitor their detection range for any human movement. Upon detecting motion, they send a HIGH signal to the Arduino, triggering the lighting mechanism.

To avoid unnecessary activation during daylight hours, an LDR (Light Dependent Resistor) is incorporated. The LDR measures ambient light levels and ensures that the system only functions in low-light or nighttime conditions. The Arduino is programmed to compare the LDR's analog readings with a threshold value. If the surrounding light is below the threshold and motion is detected, the lights are turned ON. Otherwise, the lights remain OFF, thereby optimizing power usage.

The lighting system consists of high-brightness LED lights connected to the Arduino through a relay module. The relay acts as a switch that controls the power supply to the LEDs based on the logic programmed in the microcontroller.

To improve user experience and reduce abrupt lighting transitions, a dimmer module is integrated to allow for fade-in and fade-out effects. This not only enhances aesthetics but also contributes to the extended life of the LED fixtures.

The system is powered using a rechargeable lithium-ion battery, which makes the setup portable and suitable for outdoor environments without consistent power access. A DC-DC step-up converter is used to stabilize the voltage supplied to the components, ensuring consistent operation even when the battery voltage drops. To prevent overheating and ensure long-term stability, heat sinks and cooling fans are mounted on heat-sensitive components such as the relay module and battery regulator.

The software logic is implemented using the Arduino IDE. The code includes conditional checks for motion detection, ambient light threshold, and time delay logic to control the duration for which the LEDs stay ON after detecting motion.

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.471 ⁓ Peer-reviewed & Refereed journal ⁓ Vol. 14, Issue 7, July 2025
DOI: 10.17148/IJARCCE.2025.14713

The system also provides options to adjust the delay and light sensitivity parameters based on the deployment environment.

An optional enhancement includes the integration of an RFID module, which allows for personalized lighting control. Authorized RFID tags can be used to trigger lighting in specific zones, offering a layer of security and customization for restricted areas.

COMPONENTS USED

- Arduino Mega 2560
- PIR Sensor / IR Sensor
- LDR (Light Dependent Resistor)
- Relay Module
- LED Lights
- Dimmer Circuit
- Lithium-Ion Battery
- RFID Module (Optional)

IV. LITERATURE SURVEY

The concept of automated lighting systems has been explored in several research and industrial applications to reduce energy consumption and enhance user convenience. The integration of motion sensors with lighting systems has proven to be an effective approach to ensuring that lights are only used when necessary.

A review of existing systems reveals significant progress in the design of intelligent lighting, especially with the incorporation of microcontrollers, sensors, and wireless technologies.
In a study conducted by Qingping Chi et al. (2017), the researchers developed a smart lighting system using PIR sensors and wireless communication modules to control street lights based on human presence. proposed an energy-efficient corridor lighting system using PIR sensors and microcontrollers. Their approach focused on minimizing power wastage in indoor areas, particularly in institutions and office buildings where lights are often left on unnecessarily.

Another research project by Kumar and Rajesh (2019) introduced a solar-powered street lighting system that used motion sensors to activate LEDs. Their work emphasized sustainability and the use of renewable energy, showing that motion-activated lighting could be effectively integrated with green energy solutions. In more recent developments, IoT-based smart lighting systems have gained attention. These systems allow remote monitoring and control of lighting using cloud platforms and mobile applications.

However, they often require internet connectivity and may not be feasible in all environments due to higher costs and maintenance requirements.
In many industrial and public installations, motion sensors are now widely used for lighting control. The most commonly used sensors include Passive Infrared (PIR), Microwave sensors, and Ultrasonic sensors. PIR sensors are preferred in low-cost applications due to their low power consumption and high sensitivity to human body movement. When combined with LDRs (Light Dependent Resistors), these systems can further optimize operation by ensuring lights are only activated during low ambient light conditions.

The proposed Motion Activated Pathway Lighting System builds upon these studies by offering a compact, cost-effective, and standalone solution suitable for residential, commercial, and institutional environments. It incorporates motion detection, light sensing, and dimming features controlled by an Arduino Mega, making it a practical and scalable solution. This system focuses not only on energy savings but also on user comfort, ease of installation, and future expandability with features like RFID access integration.

V. RESULT

The proposed **Motion Activated Pathway Lighting System** was successfully developed and tested under various conditions to validate its performance, energy efficiency, and response accuracy. The prototype system was installed in a controlled outdoor environment that simulated real- world usage, such as garden walkways and residential pathways. The system's core functionality—detecting motion and activating lights accordingly—was verified with consistent and reliable outcomes.

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.471 ⁙ Peer-reviewed & Refereed journal ⁙ Vol. 14, Issue 7, July 2025
DOI: 10.17148/IJARCCE.2025.14713

Upon testing, the motion sensors effectively detected human movement within a range of 5 to 7 meters, activating the lighting modules within a response time of less than 1 second. When no movement was detected, the system accurately dimmed or turned off the lights after a pre-set delay (typically 20–30 seconds), ensuring both energy conservation and user comfort. The fade-in and fade-out functionality was also validated, creating a smooth lighting transition that minimized visual discomfort.

The following key performance indicators were recorded during system evaluation:
Power savings of up to **65%** compared to continuously-on pathway lighting systems.

VI. CONCLUSION

The Motion Activated Pathway Lighting System presents an innovative and energy-efficient solution to conventional lighting methods used in public and private pathways. By integrating motion detection sensors, microcontrollers, and intelligent control mechanisms, the system ensures that lights are activated only when necessary, thereby reducing power consumption and extending the lifespan of lighting components. The successful deployment and testing of the system demonstrated high sensor accuracy, fast response times, and seamless operation under varying environmental conditions. The incorporation of additional features like fade- in/fade-out transitions and RFID-based monitoring enhanced both functionality and user experience, making the system suitable for modern smart infrastructure applications. The performance analysis proved that the system not only conserves energy but also improves safety and usability in dark or low-light conditions.

This project contributes significantly to the development of smart and sustainable urban technologies. With its cost-effectiveness, scalability, and low maintenance, the system holds great potential for implementation in residential colonies, industrial premises, educational campuses, and public walkways. Future improvements may include wireless data logging, mobile-based control interfaces, and integration with IoT platforms to further expand its capabilities.

REFERENCES

[1]. Qingping Chi, Hairong Yan, et al., "A reconfigurable smart sensor interface for industrial WSN in IoT environment," *IEEE Transactions on Industrial Informatics*, vol. 10, no. 2, pp. 1417–1425, May 2014.
[2]. Rajkamal, *Embedded Systems: Architecture, Programming and Design*, 2nd ed., Tata McGraw- Hill Education, 2008.
[3]. H. Elaydi and M. Abuzalata, "Smart lighting system using motion detection sensors and Arduino," *International Journal of Engineering and Innovative Technology*, vol. 9, no. 2, pp. 15–18,2020.
[4]. V. Hegde and A. Parate, "Design and implementation of intelligent lighting system using motion sensors," *International Journal of Scientific & Engineering Research*, vol. 7, no. 3, pp. 345–350, 2016.
[5]. Arduino.cc. "Arduino Mega 2560 Rev3 — Tech Specs." [Online]. Available: https://www.arduino.cc/en/Main/arduinoBoardMega 2560
[6]. C. S. Rani and A. Sridevi, "Energy efficient smart street lighting system using LDR and motion sensor," *International Journal of Scientific Research in Engineering and Management*, vol. 4, no. 6, pp. 1–6,2020.
[7]. J. Byun, I. Hong, B. Lee, and S. Park, "Intelligent household LED lighting system considering energy efficiency and user satisfaction," *IEEE Transactions on Consumer Electronics*, vol. 59, no. 1, pp. 70–76,Feb. 2013.
[8]. D. Bhalerao, P. Kale, and M. Patil, "Motion activated automatic lighting system using PIR sensor," *International Journal of Engineering Research and Applications*, vol. 9, no. 5, pp. 28–31, 2019.
[9]. R. A. Gupta, "Low Power Smart Lighting System using IR Sensor and Microcontroller," *International Research Journal of Engineering and Technology (IRJET)*, vol. 5, no. 2, pp. 1245–1248, 2018.
[10]. Texas Instruments, "PIR Motion Detector Design Using MSP430," Application Report SLAA283A, 2006. [Online]. Available: https://www.ti.com/lit/an/slaa283a/slaa283a.pdf
[11]. S. Jain, A. Sharma, and N. Kumar, "Smart automated street lighting system using microcontroller," *International Journal of Advanced Research in Computer Science*, vol. 8, no. 5, pp. 201– 204, 2017.
[12]. M. Rani and K. Kumar, "Design and Implementation of Motion Sensor Based Automatic Light Control for Energy Efficiency," *International Journal of Scientific & Technology Research*, vol. 9, no. 4, pp. 621–625, 2020.