International Journal of Scientific Research & Engineering Trends
Volume 12, Issue 1, Jan-Feb-2026, ISSN (Online): 2395-566X

Solar Powered Smart Street Light with Motion Detection

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Abstract - Street lighting plays a vital role in public safety but consumes a significant amount of electrical energy. Conventional street lights operate continuously throughout the night, leading to unnecessary power wastage. This paper presents the design and implementation of a solar powered smart street lighting system with motion detection to improve energy efficiency. The proposed system uses solar energy as the primary power source and a motion sensor to control light intensity based on human or vehicle movement. During periods of no motion, the light remains in dim mode, and it switches to full brightness when motion is detected. The system is controlled using a microcontroller and operates automatically without manual intervention. Experimental results show that the proposed system significantly reduces energy consumption and maintenance costs, making it suitable for smart city applications.

Keywords - Solar energy, Smart street light, Motion detection, PIR sensor, Energy efficiency.

INTRODUCTION

Street lighting is an essential public utility that plays a significant role in ensuring road safety, reducing accidents, and improving security in urban and rural areas. Proper illumination during nighttime helps pedestrians and drivers to navigate safely and also discourages criminal activities. Traditionally, street lights are powered by grid electricity and operate at full intensity throughout the night, irrespective of traffic density or pedestrian movement. Although this approach provides continuous lighting, it results in a large amount of unnecessary energy consumption and increased operational costs.

With the rapid growth of cities and expansion of road networks, the number of street lights has increased significantly. As a result, the demand for electrical energy for street lighting has also risen. This growing energy requirement places a heavy burden on power generation systems and contributes to higher carbon emissions. In many developing regions, street lighting consumes a considerable portion of municipal electricity budgets. Therefore, there is a strong need to develop energy-efficient and sustainable alternatives to conventional street lighting systems.

Renewable energy sources, particularly solar energy, offer a promising solution to this problem. Solar energy is clean, abundant, and freely available, making it an ideal power source for outdoor lighting applications. Solar-powered street lights operate independently of the electrical grid and store energy in batteries during daylight hours for use at night. This not only reduces electricity costs but also ensures uninterrupted operation during power outages. However, even solar-powered systems can waste energy if the lights operate continuously at full brightness when there is little or no traffic.

To further improve energy efficiency, intelligent control techniques such as motion detection can be integrated into street lighting systems. Motion sensors detect the presence of pedestrians or vehicles and allow the lighting intensity to be adjusted based on real-time requirements. When no movement is detected, the light can operate in a low-power or dim mode, and when motion is detected, it can switch to full brightness. This approach significantly reduces energy consumption while maintaining adequate illumination for safety.

This paper presents a solar powered smart street lighting system with motion detection designed to minimize energy wastage and improve efficiency. The proposed system combines solar power generation, energy storage, motion sensing, and automated light control using a microcontroller. The system operates autonomously without manual intervention and is suitable for deployment in smart cities, highways, parking areas, and residential streets. The objective of this work is to design a cost-effective, reliable, and environmentally friendly street lighting solution that contributes to sustainable development and efficient energy management.

Body of Paper

Street lighting systems have been widely studied with the aim of reducing energy consumption and improving efficiency. Traditional street lights consume a large amount of electrical power because they operate at full intensity throughout the night. To overcome this issue, researchers have proposed solar-powered street lighting systems that utilize renewable energy

sources. These systems reduce dependency on grid electricity and provide a sustainable solution.

Motion-based lighting systems have also been introduced to minimize unnecessary power usage. Passive Infrared (PIR) sensors are commonly used to detect movement and control light intensity. Some advanced systems integrate Internet of Things (IoT) technology for remote monitoring and control. However, many existing systems are expensive, complex, and require high maintenance. The proposed system focuses on a simple, low-cost, and efficient solution using solar energy and motion detection.

Block Diagram

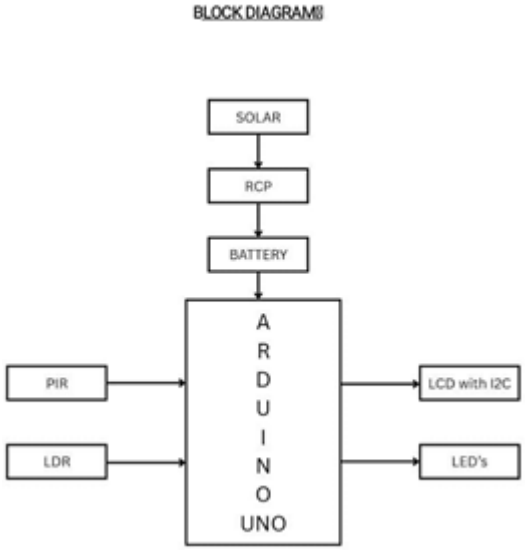


Fig: Block Diagram

Application

- Highways and Roads
- Rural and Remote Areas
- Smart City Infrastructure
- Residential Areas and Societies
- College and School Campuses
- Parking Areas
- Industrial Areas and Warehouses

Advantages

- Use of Renewable Energy
- Energy Efficient Operation
- Battery-Based Power Supply
- Automatic Day and Night Control
- Sequential LED Operation
- Reverse Current Protection (RCP)
- Low Maintenance Cost
- Real-Time Status Display
- Environment Friendly
- Improved Public Safety
- Suitable for Remote and Rural Areas
- Expandable and Future Ready

Future Scope

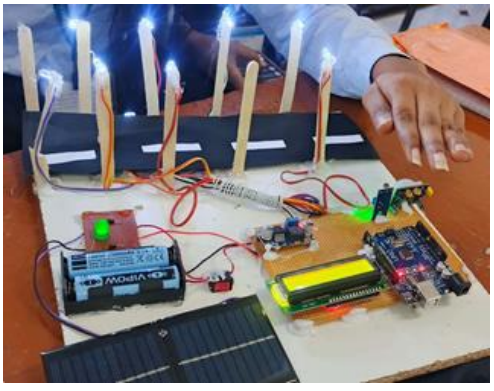
The Solar Powered Smart Street Light with Motion Detection project successfully demonstrates an energy- efficient and automated street lighting system using renewable energy. Although the current system meets the basic requirements of smart lighting, there is significant scope for further enhancement and upgradation using advanced technologies.

In the future, the system can be integrated with Internet of Things (IoT) technology to enable remote monitoring and control of street lights. Using wireless communication modules such as GSM, Wi-Fi, or LoRa, real- time data related to battery status, light condition, and fault detection can be transmitted to a central monitoring station. This will reduce maintenance time and improve system reliability.

The project can also be enhanced by implementing adaptive brightness control, where the intensity of LEDs is adjusted not only based on motion detection but also according to traffic density and time duration. This will further optimize energy consumption and extend battery life.

Another important future improvement is the use of advanced energy storage systems such as lithium-ion batteries with better charge management techniques like MPPT (Maximum Power Point Tracking). This will improve charging efficiency and ensure better performance even during cloudy or low-sunlight conditions.

Result



II. CONCLUSIONS

The solar-powered smart street light with motion detection is an efficient, sustainable, and intelligent solution for modern outdoor lighting needs. By using renewable solar energy, it significantly reduces electricity consumption, operational costs, and carbon emissions. The integration of motion sensors ensures that lighting is provided only when needed, improving energy efficiency while maintaining safety and visibility.

This system is especially suitable for roads, campuses, parks, parking areas, and remote locations where grid power is limited or unavailable. Its automated operation minimizes human intervention and maintenance requirements, making it both cost-effective and reliable. Overall, solar-powered smart street lighting with motion detection represents a practical step toward smarter cities, environmental conservation, and energy-efficient infrastructure.

Acknowledgement
I would like to express my sincere gratitude to my project guide for their valuable guidance, continuous encouragement, and constructive suggestions throughout the development of this project titled Solar Powered Smart Street Light with Motion Detection.

I am also thankful to the Head of the Department and all faculty members for providing the necessary resources and support. My heartfelt thanks go to my friends and classmates for their cooperation and assistance during the project work.

Finally, I express my deepest appreciation to my family for their constant motivation and moral support, without which this project would not have been possible.

REFERENCES

1. M. A. Wazed, N. Nafis, and M. T. Islam, “Design and Implementation of an Automatic Solar Powered LED Street Light System,” International Journal of Scientific & Engineering Research, vol. 5, no. 1, pp. 1–5, Jan. 2014.
2. S. Avinash, R. Kumar, and P. S. Reddy, “Smart Street Lighting System Using Arduino and PIR Sensor,” International Journal of Engineering Research and Technology (IJERT), vol. 6, no. 4, pp. 227–230, Apr. 2017.
3. R. Karthik, S. Mahalakshmi, and K. Balaji, “Energy Efficient Smart Street Lighting System Using IoT,” International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 7, no. 3, pp. 1295–1301, Mar. 2018.
4. A. Jain and P. Kumar, “Solar Powered Automatic Street Light System Using LDR and PIR Sensor,” International Journal of Innovative Research in Science, Engineering and Technology, vol. 6, no. 5, pp. 8765–8770, May 2017.
5. A. S. Joshi and P. V. Kulkarni, “Automatic Street Light Control System Using Microcontroller,” International Journal of Engineering Science and Computing, vol. 7, no. 4, pp. 10243–10247, Apr. 2017.
6. M. R. Patel and Y. K. Mehta, “Design of Solar Based Smart Street Light System,” International Journal of Emerging Technology and Advanced Engineering, vol. 5, no. 2, pp. 180– 185, Feb. 2015.
7. N. R. Prasad, S. D. Shinde, and P. S. Patil, “Motion Detection Based Street Light Control System Using Arduino,” International Journal of Engineering and Technical Research (IJETR), vol. 4, no. 6, pp. 90–94, Jun. 2016.
8. J. Bhattacharya and S. Banerjee, “Smart LED Street Lighting System Using Renewable Energy,” International Journal of Research in Engineering and Technology, vol. 4, no. 6, pp. 345–350, Jun. 2015.
9. Arduino, “Arduino UNO Rev3 – Datasheet,” Arduino.cc, 2023.
[Online]. Available: https://www.arduino.cc
10. Texas Instruments, “Passive Infrared (PIR) Motion Sensor Fundamentals,” TI Application Note, 2022.
11. M. R. Alam and M. Z. Hasan, “Energy Conservation in Street Lighting System Using Solar Power,” International Journal of Computer Applications, vol. 95, no. 8, pp. 15–19, Jun. 2014.
12. IEEE Standards Association, “IEEE Guide for Smart City Infrastructure,” IEEE Std., 2021.