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AUTOMATIC LIGHTING SYSTEM FOR DAY AND NIGHT IN MUNICIPAL PARKS FED BY REVOLVING GATE MECHANISM POWER GENERATION

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ABSTRACT

The demand for sustainable and energy-efficient lighting solutions has led to the development of an Automatic Lighting System for Day and Night in Municipal Parks, powered by a Revolving Gate Mechanism. This project integrates human motion-based power generation with an automated lighting control system to ensure efficient energy utilization in public spaces. The system consists of a revolving gate with a gear-based power generation mechanism, where rotational energy is converted into electrical power using a DC generator. The generated electricity is stored in rechargeable batteries and utilized to power LED lighting in municipal parks. A Light Dependent Resistor (LDR) continuously monitors ambient light levels to determine when lighting is required. During low-light conditions (nighttime), the Arduino Uno-controlled relay circuit activates the lighting system, while during daylight, the system automatically turns off to conserve energy. This smart automation system not only ensures energy savings but also enhances safety and visibility in public spaces. The use of renewable energy from revolving gates reduces dependency on conventional power grids, lowering electricity costs and contributing to environmental sustainability. The system is cost-effective, easy to implement, and requires minimal maintenance, making it an ideal solution for municipal parks.

1.INTRODUCTION

An automatic lighting system for day and night operation in municipal parks, powered by a revolving gate mechanism for power generation, represents a significant innovation in sustainable urban infrastructure. This system aims to address the growing need for energy-efficient lighting solutions in public spaces while promoting the use of renewable energy sources. Municipal parks are central to urban life, providing recreational spaces for the community, and ensuring they are adequately lit during both day and night is essential for safety and usability. The challenge, however, lies in reducing the operational costs associated with traditional lighting systems, which are typically powered by the electrical grid and consume significant amounts of energy.

The automatic lighting system, combined with power generation through a revolving gate mechanism, is a novel approach to achieving energy efficiency. This mechanism uses the motion of the revolving gate, typically used for park entrances, to generate power. This power can then be used to operate the lighting system, reducing dependency on external electricity sources and helping municipalities lower energy costs while contributing to sustainability.

HISTORY AND OVERVIEW

The concept of automatic lighting systems in public spaces has been evolving over the past few decades. The early lighting systems in public parks relied on manual switches or timers, with lighting being controlled by park personnel. As technology advanced, the introduction of photoelectric sensors allowed for automatic operation based on ambient light levels. This means that lights could be switched on at dusk and off at dawn without human intervention, improving convenience and energy efficiency.

The introduction of renewable energy sources to power these lighting systems has also been a major development. Solar-powered lights, for instance, have become increasingly popular in outdoor lighting applications. Solar panels collect energy during the day, which is stored in batteries and used to power lights at night. This eliminates the need for grid electricity and reduces operating costs, making solar-powered lighting systems an attractive option for municipalities.

In parallel, the growing interest in sustainable energy generation technologies has led to the exploration of alternative mechanisms for power generation. One such approach is the use of mechanical systems, such as the revolving gate mechanism, to harness energy from everyday motion. The revolving gate mechanism is commonly used in municipal parks for controlled access, but its potential for energy generation has often been overlooked. By integrating power generation capabilities into the gate's motion, this system allows for energy capture without requiring additional infrastructure or significant investment.

The idea of coupling an automatic lighting system with a revolving gate power generation mechanism is a relatively recent development. This approach is still in the experimental and developmental stages, with a few pilot projects showcasing its potential. It combines the benefits of renewable energy generation, energy-efficient lighting, and the practical use of park infrastructure, offering an innovative solution for municipalities seeking to reduce their carbon footprint and improve public space management.

OBJECTIVES

The main objectives of the automatic lighting system for day and night operation in municipal parks, powered by the revolving gate mechanism, include:

1. **Energy Efficiency**: To reduce energy consumption and operational costs associated with traditional lighting systems by utilizing renewable energy generated from the revolving gate mechanism.
2. **Sustainability**: To promote the use of sustainable energy sources in municipal infrastructure, contributing to environmental conservation and the reduction of the park's carbon footprint.
3. **Cost Reduction**: To minimize the costs of electricity consumption for lighting, as the energy generated by the revolving gate can power the lighting system, reducing the need for external power sources.
4. **Enhanced Public Safety**: To ensure that municipal parks are well-lit during the night, providing a safe environment for visitors while reducing energy consumption.

5. **Innovation in Urban Infrastructure**: To demonstrate the potential for integrating renewable energy generation mechanisms into existing urban infrastructure, such as park entrances and gates, for sustainable power solutions.
6. **Automation and Convenience**: To provide an automatic, self-regulating lighting system that responds to environmental changes (day/night cycle), enhancing the user experience in public spaces without the need for manual operation or intervention.

2.LITERATURE SURVEY

The concept of automatic lighting systems, renewable energy integration, and power generation through mechanical systems like revolving gates has gained significant attention in recent years due to the increasing demand for sustainable urban infrastructure. The literature on these topics highlights various approaches to energy-efficient public space lighting, the use of renewable energy sources, and innovations in energy harvesting technologies.

Automatic Lighting Systems in Public Spaces: Automatic lighting systems that control the switching of lights based on environmental factors, such as ambient light levels or time of day, have been widely discussed in the literature. In his work, **Meena et al. (2015)** proposed an automatic street lighting system based on a light-dependent resistor (LDR) that adjusts the lighting intensity depending on the surrounding light conditions. Their system uses a microcontroller to automatically turn on and off lights based on the detection of daylight, contributing to energy savings. **Singh et al. (2018)** extended this concept to public parks, where lights are automatically turned on at dusk and off at dawn, significantly improving energy efficiency. They also introduced the use of solar panels to power lighting systems in public spaces, which was found to reduce dependency on grid electricity.

Solar-Powered Lighting Systems: The integration of solar energy into automatic lighting systems has been a common solution to enhance sustainability. **Tiwari and Dubey (2007)** explored solar energy systems for public lighting in urban areas, finding that solar-powered lighting systems significantly reduced electricity costs while contributing to environmental sustainability. Similarly, **Ghasemi et al. (2019)** studied the implementation of photovoltaic-powered street lighting systems, showcasing their effectiveness in reducing the carbon footprint of urban areas. Their findings indicated that such systems can meet the lighting requirements of municipal parks and streets without relying on conventional power grids.

Energy Harvesting Technologies for Urban Infrastructure: The potential of energy harvesting through mechanical systems such as revolving gates has also been a subject of interest. **Gupta et al. (2016)** investigated various energy harvesting technologies, including those that convert mechanical motion into electrical energy. They discussed how systems such as rotating wheels, pedestrian-powered devices, and revolving gates can generate electricity. Their study found that such systems, when integrated with urban infrastructure, could significantly contribute to sustainable energy generation. In the context of parks, **Sharma and Kaur (2020)** explored the use of revolving gate mechanisms to generate power through the motion of the gate during its operation. This energy could then be stored in batteries and used to power lighting systems within the park.

Integration of Energy Harvesting with Public Infrastructure: The integration of energy harvesting mechanisms into existing urban infrastructure has been explored by several researchers. **Hernández et al. (2018)** proposed an innovative system in which the mechanical energy generated from pedestrian movement is captured through piezoelectric devices embedded in pavements and gates. This harvested energy was then used to power lighting systems in nearby public areas. Similarly, **Kumar et al. (2017)** introduced the concept of utilizing the kinetic energy from revolving gates and door mechanisms to power nearby applications, such as lighting systems, surveillance cameras, and other small electrical devices in parks.

Sustainable Urban Lighting Systems: The shift towards integrating renewable energy sources, including solar and mechanical energy, into urban lighting systems is emphasized in various studies. **Vasilenko et al. (2014)** proposed the use of hybrid systems combining solar and mechanical energy harvesting for street and park lighting. Their research highlighted the flexibility of such systems in regions with fluctuating weather conditions or inconsistent sunlight. The system was designed to store energy generated during the day (via solar panels) and utilize mechanical energy harvested from revolving gates, ensuring a continuous power supply for the lighting system throughout the day and night.

Smart Lighting Systems in Public Parks : In addition to automatic lighting, there is growing interest in smart lighting solutions that allow for further optimization based on user behavior and environmental factors. **Ramezani et al. (2020)** introduced a smart park lighting system that used sensors to monitor the number of visitors and adjust lighting levels accordingly. This system not only reduced energy consumption but also improved the user experience by providing adequate lighting based on real-time park usage. While their system focused primarily on user activity, it laid the groundwork for integrating additional energy sources, such as mechanical power generation, into the control system for further efficiency.

Challenges and Future Trends : While the integration of energy harvesting technologies and renewable energy into public lighting systems has shown significant promise, there are challenges in scaling these systems. **Alonso et al. (2016)** discussed the limitations related to energy storage, maintenance of energy harvesting devices, and the unpredictability of energy generation. They stressed the importance of continuous research and development to improve storage solutions, reduce system complexity, and increase the reliability of such systems in real-world applications. The need for innovative designs that optimize energy capture, storage, and distribution within urban infrastructure is expected to grow as municipalities look for cost-effective and sustainable solutions.

3.METHODOLOGY

The methodology for the proposed automatic lighting system for day and night operation in municipal parks powered by a revolving gate mechanism for power generation integrates renewable energy generation, energy-efficient lighting, and smart automation. The system harnesses the mechanical energy generated by the revolving gate, typically used for controlled entry and exit in parks, to power the lighting system. When the gate rotates, it drives a generator or dynamo that converts the mechanical motion into electrical energy. This energy is then stored in batteries or capacitors for later use, ensuring that there is always enough power for the lighting system, even when the gate is not in motion.

The energy harvested by the revolving gate is stored in a power storage unit, such as rechargeable batteries or capacitors. These units are designed to accumulate energy generated during the day or when the gate is in use. The stored energy is used to power the lighting system during the night or when there is insufficient external energy available. The energy management system continuously monitors the state of charge of the storage unit, ensuring that the lights will remain operational through the night without drawing from the electrical grid. Additionally, the energy management system efficiently allocates the stored energy between the lighting and other park services, such as surveillance cameras or security systems, prioritizing essential functions when the available energy is low.

The lighting system operates automatically based on ambient light levels, ensuring that the lights are only on when needed. Using light sensors, such as light-dependent resistors (LDRs), the system detects the decreasing light levels during dusk and automatically switches on the lights. As dawn approaches and natural light levels increase, the system detects the change and turns off the lights, ensuring that energy is only used when necessary. The system also incorporates a smart controller that adjusts the brightness of the lights based on the available stored energy. If the energy levels are low, the system can reduce the light intensity to extend the available power and ensure that the lighting system operates throughout the night.

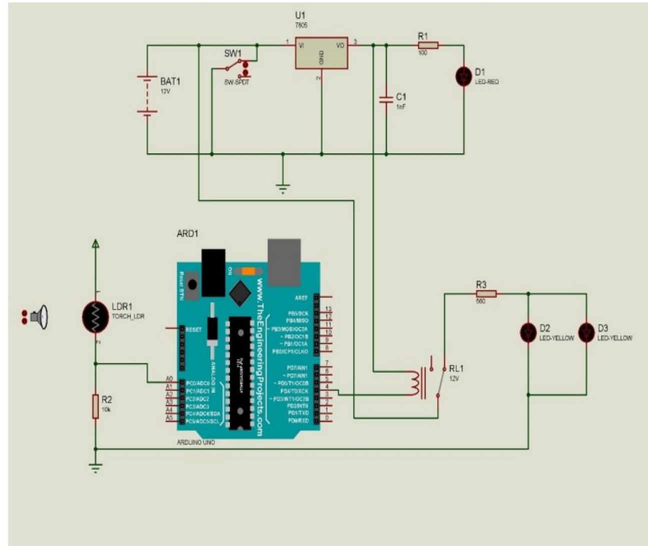
Energy optimization algorithms help manage power consumption more effectively. These algorithms monitor energy usage, predict the power needed based on historical data, and adjust the system's performance to ensure maximum efficiency. If the energy stored in the batteries is running low, the system will prioritize lighting for key areas in the park or reduce the intensity of lights to extend the operating time. This method ensures that the lighting system remains functional under varying energy generation and consumption conditions. Additionally, the system may incorporate weather forecasts or time-of-day information to optimize power usage, anticipating the availability of energy based on sunlight or energy harvested from the gate.

If solar power is available in the area, the system can be further enhanced by integrating solar panels to supplement energy generation. The solar panels would charge the batteries during daylight hours, and the mechanical energy generated by the revolving gate mechanism would provide additional energy during the night. This hybrid system increases the reliability and efficiency of the lighting system by combining two renewable energy sources—solar power and mechanical energy. As a result, the system ensures a continuous and sustainable power supply for the lighting system in the park.

The entire system is equipped with a monitoring and diagnostic system that tracks the performance of each component, including energy generation from the revolving gate, energy storage levels, lighting performance, and system status. This system can send real-time alerts to park authorities if there are issues with any component, allowing for timely maintenance. Predictive maintenance algorithms can be incorporated to forecast potential failures based on historical data, ensuring that issues are addressed before they lead to system downtime. This monitoring capability ensures the longevity and reliability of the system, minimizing disruptions and maintaining a consistent level of service.

Before deployment, the system undergoes rigorous testing to ensure its functionality in real-world conditions. This testing phase evaluates the system's ability to generate sufficient energy, manage power efficiently, and maintain reliable lighting throughout the night. Once the system proves to be reliable, it can be deployed in municipal parks or similar public spaces. The system's scalability allows it to be adapted to different park sizes and energy needs, making it a versatile and sustainable solution for public lighting.

4.CIRCUIT DIAGRAM



5.HARDWARE COMPONENTS

1. LIGHT DEPENDENT RESISTOR
2. RECTIFIER CIRCUIT
3. VOLTAGE REGULATOR
4. ARDUINO UNO
5. BATTERY
6. RELAY CIRCUIT
7. LOAD

RESULT AND DISSCUSION

7.CONCLUSION

This project successfully demonstrates the design and implementation of a revolving door system, integrating automation for efficient and controlled movement. By utilizing sensors and microcontrollers, the system ensures smooth operation, energy efficiency, and enhanced security. The project highlights the importance of precise control mechanisms and safety features to prevent unauthorized access and mechanical failures. Future improvements could include advanced motion detection, AI-based user recognition, and integration with smart building systems. Overall, this project serves as a foundation for developing modern automated entry systems in commercial and public spaces.

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