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Automatic Street Light based on Vehicle presence

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Abstract:
Automatic street light system that activates based on vehicle presence involves using sensors to detect the presence of vehicles and then controlling the street lights accordingly. This type of system can improve energy efficiency by illuminating streets only when necessary. Automatic Streetlight needs no manual operation for switching ON and OFF when there is need of light. It detects itself weather there is need for light or not. When darkness rises to a certain value then automatically streetlight is switched ON and when there is other source of light i.e. day time, the street light gets OFF. The sensitiveness of the street light canal so be adjusted. In our project we have used LED lights for high power switching which can be control through the relay (electromagnetic switch) where it is possible to turn ON/OFF any electrical appliances connected all the way through relay.

Introduction

Street lighting system is an important issue should be designed well to allow users for traveling at night with good visibility in respect of safety and comfort. An efficient system ensure comfort tracking and reduces the accident during late night. On the other hand, poorly designed lighting systems can lead to poor visibility which may not be helpful for pedestrians who are passing through that street. Street Lighting can cost about 10–38% of the total energy bill in typical cities worldwide. Street lighting is a particularly critical concern for public authorities in developing countries because of its strategic importance for economic and social stability. Inefficient lighting wastes significant financial resources every year, and poor lighting creates unsafe conditions. Energy efficient technologies and design mechanism can reduce cost of the street lighting drastically. Manual control is prone to errors and leads to energy wastages.

Traditional street lights operate on fixed schedules, leading to unnecessary energy consumption, especially during low-traffic periods. This project integrates advanced sensor technology, such as infrared or ultrasonic sensors, to detect the presence of vehicles. When a vehicle approaches, the system activates the street lights, providing illumination only when necessary. This approach not only conserves energy and reduces operational costs but also improves safety for both drivers and pedestrians by ensuring adequate lighting when needed. Ultimately, this project contributes to smarter, more sustainable urban environments by aligning with contemporary goals for energy efficiency and environmental responsibility.

One of the primary objectives of this project is to improve energy efficiency. By illuminating street lights only when vehicles are present, energy consumption can be significantly reduced. This not only lowers electricity bills but also minimizes the carbon footprint associated with urban lighting. In regions where energy costs are high, the financial savings can be substantial, allowing municipalities to allocate resources more effectively. Cost-effectiveness is another crucial advantage of the Automatic Street Light System. Traditional street lighting requires constant maintenance and replacement due to wear and tear from constant use. However, by reducing the operational hours of street light this system decreases the frequency of maintenance,leading to further savings.

Additionally, the integration of smart technologies can allow for remote monitoring and control, enabling municipalities to manage their lighting systems more efficiently.

Safety is paramount in urban environments, and this project directly addresses this concern. By ensuring that street lights are activated in the presence of vehicles, the system enhances visibility, reducing the likelihood of accidents. Adequate lighting not only aids drivers but also benefits pedestrians and cyclists, contributing to overall road safety. Moreover, the adaptive nature of this system allows for a more intuitive response to varying traffic conditions, providing optimal lighting based on real-time data. Environmental sustainability is an essential consideration in modern urban planning, and the Automatic Street Light System aligns perfectly with this goal. By reducing unnecessary energy consumption, the system plays a significant role in decreasing greenhouse gas emissions associated with electricity generation. In a time when cities are striving to become more eco-friendly, implementing such systems can position them as leaders in sustainable practices.

This approach not only reduces electricity consumption and carbon emissions but also extends the lifespan of the street lights. Additionally, automatic street lights can improve road safety by ensuring that streets are adequately lit when needed, while minimizing unnecessary light pollution in low-traffic areas.

Literature Survey

Statistically speaking, 317 million streetlights exist across the globe, and it is anticipated that there will be 363 million by 2027. Less than 5% of all streetlights, however, are currently smart, whereas projections are that smart streetlights will increase to ∼30% by the end of 2027. The importance of smart streetlights emerges, particularly in smart city developments. A quarter of currently ongoing smart city projects reap the benefits of smart streetlights deploying either as pilots or citywide deployments. An example is the city of San Diego that is saving more than $250,000 annually in electricity and maintenance costs as a result of installing 3000 smart streetlights. In Northern Illinois, Commonwealth Edison has installed more than 3000 smart streetlights in 23 municipalities, and expects to install 140,000 smart streetlights by 2023. The integrated communication network, as well as advanced sensors and actuators with smart streetlights, paves the way for utilising various control strategies in which several key advantages such as energy savings and CO_2 emissions reduction could be achieved. In addition, maintenance costs associated with detecting faulty streetlights will be dramatically dropped, as faulty streetlights are able to be reported via autonomous fault detection schemes. Remote monitoring and real-time control features improve the visibility and controllability of the system. Moreover, networked streetlights offer a foundation for smart city applications through introducing various cutting-edge Internet of Things devices, such as urban planning various cutting-edge Internet of Things devices, such as urban planning and traffic management, mobility pattern identification, and emergency assistance, to name a few.

The rest of the paper is organised as follows. Section 2 discusses the role of smart streetlights in smart cities and provides a detailed review of the current literature on related applications. Section 3 discusses communication networks utilised for smart streetlight deployments and classifies them in three categories of wireless, wired, and hybrid. Section 4 reviews control strategies applied to smart streetlights. Vulnerability assessment of cybersecurity for smart streetlights is provided in Section 5. Finally, Section 6 concludes the paper. Nevertheless, Fig presents an overview of the main topics discussed in this paper. It should be noted that to make the discussions consistent in this paper, a single representation of concepts/definitions is utilised that may have appeared in different forms in studied papers.

Various studies have explored intelligent street lighting systems, highlighting their potential for energy efficiency and improved safety. Research by Kumar et al. (2020) demonstrated a 40% reduction in energy consumption using sensor-based street lighting. Similarly, Singh et al. (2019) achieved a 30% decrease in energy usage with a wireless sensor network-based system. Other studies, such as those by Liu et al. (2018) and Patel et al. (2017), successfully integrated IoT and machine learning algorithms to optimize street lighting control.

Proposed System

The proposed system aims to implement an energy-efficient street lighting mechanism that automatically switches street lights on and off based on the presence of vehicles. This system will reduce energy consumption by only illuminating streets when necessary, such as during vehicle movement, and turning off lights when the streets are unoccupied.

In this paper, two kinds of sensor are used which are light sensor and photoelectric sensor. The light sensor is used to detect darkness and to activate the ON/OFF switch, thus the streetlights will be ready to turn on. On the other hand, the photoelectric sensor is used to detect vehicle movement to activate the streetlights. LDR, which varies according to the amount of light falling on its surface gives an indication for whether it is a day-night time, the photoelectric sensors are placed on the side of the road, which can be controlled by Microcontroller. At the photoelectric sensor will be activated generally during the night time. By using this as a basic principle, the intelligent system can be designed for the perfect usage of streetlights in any place. The complete operations is solar powered make it affordable and easy to use. The proposed system utilizes sensors and microcontrollers to automatically control street lights based on vehicle presence, reducing energy to consumption and improving safety.

Block Diagram:

Here is the block diagram for the "Automatic Street Light Based on Vehicle Presence". It illustrates the key components such as sensors, microcontroller, power supply, and street lights,along with signal flow between them.

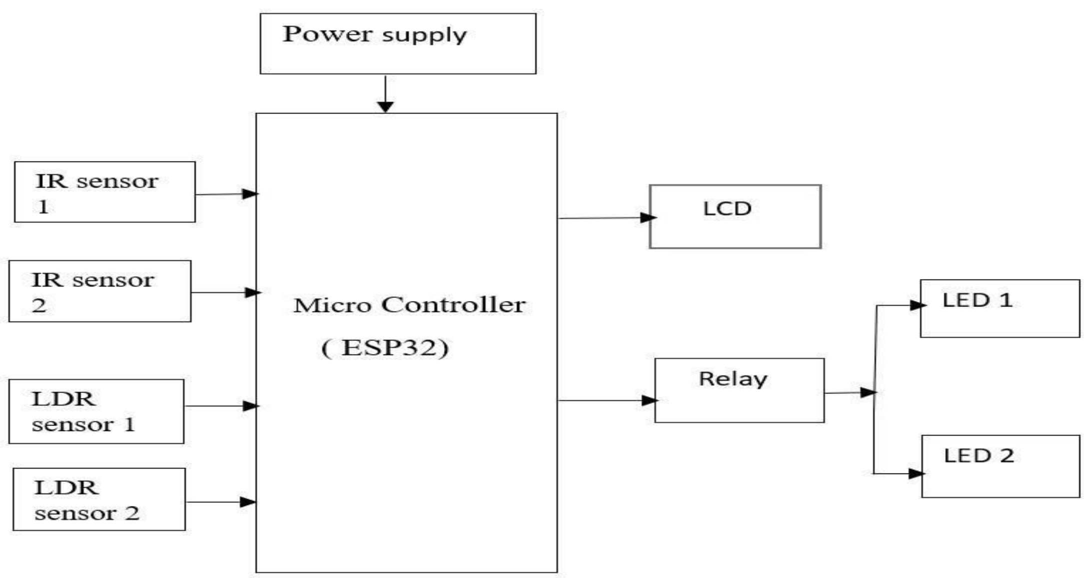


Figure 2.1: Block diagram

Methodology

The methodology involves several key steps that outline how the system is designed, developed, and implemented. Here's a detailed description of the methodology:

1. Problem Identification: Traditional street lights remain on throughout the night, wasting significant amounts of energy. A system is required to reduce energy consumption by turning on street lights only when a vehicle is present.

2. System Design:

The system consists of several key components, including sensors, a microcontroller, and street lights. The design is based on the concept of activating the street lights only when vehicles are detected.

Components:

IR Sensors or Ultrasonic Sensors: These are used to detect the presence of vehicles. They can sense motion and proximity within a specified range.
Microcontroller: This processes the signals from the sensors and triggers the street lights accordingly.
Relay Module: The microcontroller sends signals to a relay module, which controls the street lights.
Power Supply: Provides power to the sensors, microcontroller, and street lights.
Street Lights (LED): These serve as the output, turning on or off based on vehicle detection.

3. Sensing Vehicle Presence**:**

Sensor Placement: IR or ultrasonic sensors are placed at the side of the road or embedded in the road itself. These sensors constantly monitor for approaching vehicles within a certain distance.
Signal Detection: When a vehicle approaches, the sensor detects its presence and sends a signal to the microcontroller.

4. Signal Processing:

Microcontroller Programming: The microcontroller is programmed to interpret the signals received from the sensors. When the vehicle is detected, the microcontroller generates an output signal to turn on the corresponding street light.
Timing Mechanism: The system is designed to keep the street light on for a specified time (e.g., 30 seconds or until the vehicle passes the sensor), after which it turns off automatically.

Implementation

1. Start: The system is turned on and initializes all components.
2. The system measures the light intensity
3. Based on the light condition it waits for the IR sensor to trigger
4. If the IR sensor triggers it turns on the relay

Flowchart:

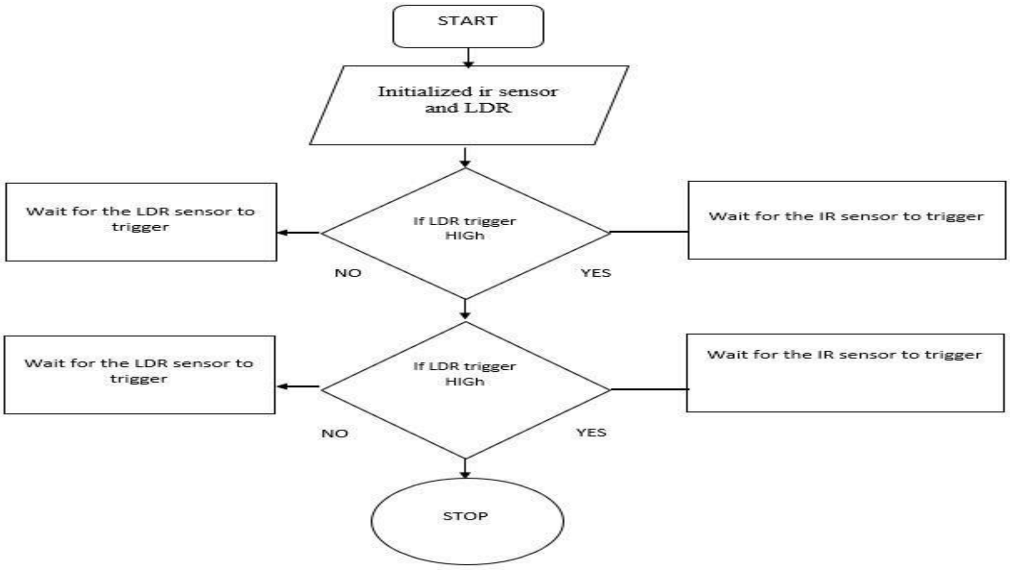
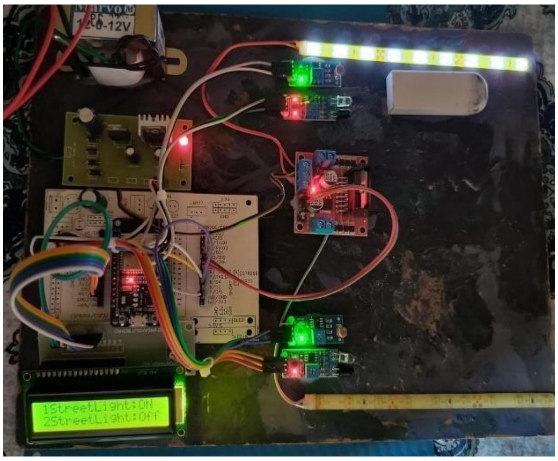


Figure: Flowchart

Result

Finally, we have successfully implemented the circuit. It can be easily implemented in industrial parks, streets.



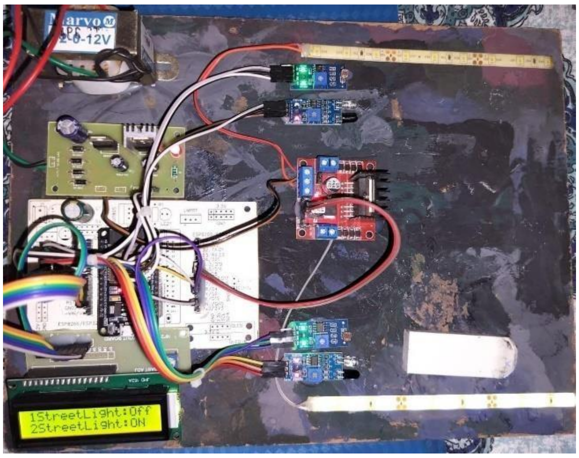


Fig 5.1: the intensity of LDR sensor

Fig 5.2: street light gets turn ON in dark sets to high mode

In the fig.5.1 , the display shows:

1StreetLight: ON: The first streetlight is turned on because a vehicle is detected in that area.

2StreetLight: OFF: The second streetlight is off because there's no vehicle in that zone. In the fig.5.2, the situation is reversed:

1StreetLight: OFF: The first streetlight is off as no vehicle is detected.

2StreetLight: ON: The second streetlight is turned on because a vehicle is present there.

The project **"Automatic Street based on vehicle presence "** has been successfully designed and tested. It has been developed by integrating features of all the hardware components used. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly using highly advanced IC's and with the help of growing technology the project has been successfully implemented.

However, the project also highlights certain limitations, such as the need for regular sensor maintenance, potential environmental impacts on sensor accuracy, and initial installation costs. Despite these challenges, the system is scalable and adaptable for various applications, including urban, rural, and industrial areas, making it a promising solution for smart city infrastructure and energy management.

In conclusion, the automatic street light system offers a modern approach to reducing energy consumption and improving road safety, with the potential for further enhancements such as solar power integration and advanced sensor technologies.

Future Scope

- Scope industries
- Scope in efficient usage of power.
- Integration with Smart City Infrastructure
- Solar Power Integration
- Advanced Sensor Technology
- Adaptive Lighting
- Pedestrian and Cyclist Detection

Conclusion and Future Scope

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