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Automatic Street Light Control Using IoT and Solar Energy

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Abstract
The concept of automatic street light illumination based on IoT (Internet of Things) is becoming increasingly popular in smart city development. This system involves the use of sensors and wireless communication technologies to automate the operation of streetlights. The system works by installing sensors, such as light sensors or motion sensors, on the streetlights. These sensors detect the presence of people or vehicles and adjust the intensity of the streetlights accordingly. For example, if there are no vehicles or pedestrians around, the system will dim the streetlights to save energy. On the other hand, if there is activity detected, the system will increase the brightness of the lights.

Keywords: *LDR Sensor, Ultrasonic Sensor, Relay, Node MCU, Arduino*

1. Introduction
Automatic illumination is a system or technology that automatically adjusts lighting levels based on the surrounding environment or user preferences. It has become increasingly popular in recent years, as it provides a convenient and efficient way to control li6ghting levels, improve energy efficiency, and create a more [1] comfortable and productive environment. This technology typically uses sensors or cameras to detect changes in lighting conditions, such as changes in natural light levels or occupancy in a room. In offices and public spaces, these systems can help improve productivity and reduce energy costs by adjusting lighting levels based on occupancy and activity levels. automatic illumination systems provide a convenient and efficient way to control lighting levels, improve energy efficiency, and create a more comfortable and productive environment. [5]

2. Objectives
The objective of an automatic street light control system is to efficiently manage and control street Lighting to achieve several key goals, including:

Energy Efficiency: Reduce energy consumption and associated costs by ensuring that streetlights are on only when needed. [4] This involves automatically turning off or dimming lights during periods of low activity or ample natural light.

Environmental Sustainability: Minimize light pollution and carbon footprint by using energy-efficient lighting technologies (such as LEDs) and optimizing their usage. [6]

Safety: Enhance road safety and pedestrian visibility by providing adequate lighting during nighttime, adverse weather conditions, or in areas with limited visibility.

Operational Cost Savings: Reduce maintenance and operational costs by implementing remote monitoring and predictive maintenance capabilities, which help identify and address issues proactively, reducing downtime and repair expenses.

Customization and Adaptability: Allow for the adjustment of lighting levels and schedules to match specific needs and requirements of different

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areas within a city, taking into account factors like traffic patterns, pedestrian activity, and local regulations.

Traffic Management: Integrate street light control with traffic management systems to synchronize traffic signals and lighting to improve traffic flow and reduce congestion. [7]

Environmental Monitoring: Use street light poles as platforms for environmental sensors to collect data on air quality, temperature, humidity, and other environmental factors that can inform urban planning and public health initiatives

3. Methodology

Sensors: Sensors such as light sensors or motion sensors are installed on the streetlights. These sensors detect the presence of people or vehicles and adjust the intensity of the streetlights accordingly.

Microcontroller Unit (MCU): An MCU is a small computer that is used to control the streetlights. It receives the signals from the sensors and controls the brightness of the lights accordingly. [8]

Wireless communication module: The wireless communication module is used to establish communication between the MCU and the central control unit.

Central control unit: The central control unit can be located in a central command centre or in the cloud. It monitors and controls the entire system. It can also send alerts in case of any issues with the system. [9]

Power supply: The streetlights are powered by electricity. A power supply is needed to ensure that the lights are always on. The proposed system works by detecting the presence of people or vehicles using sensors. The MCU receives the signals from the sensors and adjusts the brightness of the lights accordingly. The wireless communication module is used to send the data from the MCU to the central control unit. The central control unit can monitor the entire system and can send alerts in case of any issues and update the all Information in IOT. ATMEGA328P Microcontroller Block diagram shown in Figure 1. [10]

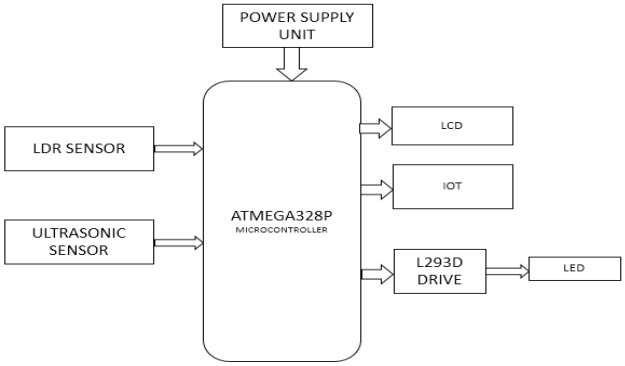

Figure 1 Block Diagram

3.1 LDR Sensor

An LDR, or Light-Dependent Resistor, is an electronic component that changes its electrical resistance in response to changes in light levels. LDRs are also known as photo resistors or photocells. These components are commonly used in various applications where the detection of light or darkness is required. [11] LDR sensor diagram shown in Figure 2.

Figure 2 LDR sensor

3.2 Ultrasonic Sensor

The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object. It offers excellent range accuracy and stable readings in an easy-to-use package. Its operation is not affected by sunlight or black material like Sharp rangefinders are (although acoustically soft materials like cloth can be difficult to detect). Ultrasonic sensor diagram shown in Figure 3.

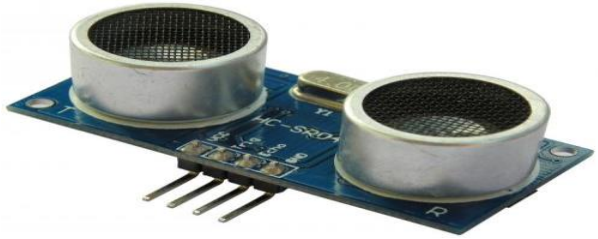

Figure 3 Ultrasonic sensor

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3.3 Relay

A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. Relay diagram shown in Figure 4. [12]

Relay Specifications

- Nominal Voltage (VDC): 12V
- Coil Resistance (Ω) (± 10%): 400Ω
- Power Consumption (W): 0.36 W
- Nominal Current (mA) (± 10%): 30 mA
- Pull in Voltage (VDC): 75% Max.
- Max. Allowable Voltage (VDC): 130%

Figure 4 Relay

3.4 Node MCU

Node MCU is the Wi-Fi equivalent of Ethernet module. It combines the features of Wi-Fi access point and station + microcontroller. [13] These features make the Node MCU extremely powerful tool for Wi-Fi networking. It can be used as access point and/or station, host a web server or connect to internet to fetch or upload data. Node MCU diagram shown in Figure 5.

Figure 5 Node MCU

3.5 Arduino

Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. [14] You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. [15] You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing it was shown in Figure 6.

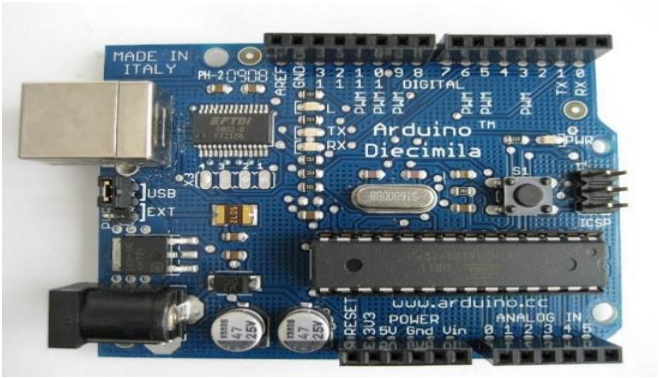

Figure 6 Arduino uno

4. Working of Project

The proposed smart streetlight can be operated automatically street light control system. The system can be made more reliable by using auto changeover technique; in which streetlight is automatically switched to [2] utility power supply. The LDR sensor to help of the light detecting of sunlight. If the sunlight energy are high to inmate the microcontroller through operate LED off condition. If the LDR is detect sunlight energy are

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low condition through operate the LED blinking condition to help of the microcontroller. The ultrasonic sensor is help of the object detection. If any person are walking the road in dark night. The LED are automatically on condition through help of the ultrasonic sensor and microcontroller update all Information in IOT. [3]

Conclusion

In conclusion, automatic illumination refers to a lighting system that uses sensors or timers to turn lights on and off based on the presence or absence of people or ambient light levels. Automatic illumination systems can also enhance safety and security by providing adequate lighting in areas where it may be difficult or inconvenient to manually control the lights, such as stairwells, hallways, and outdoor areas. They can also provide a deterrent to potential intruders or burglars by giving the appearance that someone is home. Overall, automatic illumination systems are an effective and efficient way to manage lighting in both residential and commercial settings. They offer a range of benefits that can improve energy efficiency, convenience, safety, and security and update all information IOT.

Applications

1. Automatic Street light control is often integrated into smart city initiatives, allowing for remote monitoring and management of lighting systems, as well as data collection for urban planning.
2. Automatic control can help minimize light pollution by ensuring that lights are only on when necessary and reducing glare and skyglow.
3. Properly lit streets deter criminal activity and improve security in public areas.
4. Some systems use sensors to adjust the brightness of streetlights based on environmental conditions, such as ambient light levels or motion detection.

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