IOT based Automatic Street Light Control

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Abstract. In this research, we designed an automated street light control system using IoT technology based on LDR sensors. The LDR sensor turns the lights on/off based on sunlight. The relay converts the system power before sending it to the street lights, then the system checks street light errors and sends alerts to authorized mobile numbers via GSM module. Through infrared sensors, the movement detected. If an object approaches the IR sensor, the program will automatically make the light shine brightly. Otherwise, the light will be dim.

Keywords: Street Light, IoT, LDR Sensor.

Introduction

Automated systems [1] provide advantages over manual systems in that they boost productivity, efficiency, and dependability while minimizing resource use to save energy and operating expenses, among other things. Automation systems are integral components of a "smart city" [2][3], facilitating users and enhancing the convenience of our daily lives. Street lights are among the many fascinating uses; they are vital to our surroundings and contribute significantly to nighttime commuter safety by giving light. The operation of street lights around the clock uses a lot of energy. It shortens the lifespan of electrical de-vices like gas discharge, high-intensity discharge, and incandescent and light-emitting diode candles. This significantly contributes to electricity usage and a city's most significant energy expense, particularly for metropolitan street lights. A system of automation is required in this situation to regulate the lighting [4][5].

Energy from electricity is becoming more and more necessary in the modern world. The environment may suffer from this incident, which could cause global warming. However, most of Palembang's street lights are on during the day, which can waste electricity. The conventional light street system maintains the street lights on constantly. Streetlights can use a lot of electricity and have a shorter lifespan if left on 24/7. This issue will result in financial squandering in addition to electricity wastage. Therefore, it is necessary to create an automated prototype to adjust the street light's output based on requirements [6].

Connecting electrical appliances to the internet is a significant undertaking facilitated by IoT; consequently, street lights will be more straightforward to regulate at all times and locations. The Arduino platform is utilized with controlling software and linked to multiple sensors to execute the automation prototype precisely as required. Arduino IDE is required throughout the procedure as programming software

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for Arduino. This programming software will create the automation prototype, which will be connected to the Arduino. Once the prototype is complete, the street light will be autonomously controlled through the Blynk IoT application and by the street's luminosity [7][8].

The Internet of Things is significant in linking electrical appliances to the Internet, making it more straightforward to operate street lights from anywhere at any time. The Arduino platform is utilized with controlling software and linked to multiple sensors to enable the automation prototype to be executed accurately. Arduino IDE, which serves as the programming software for Arduino, is needed at every stage. This programming software will create the automation prototype, which will be connected to the Arduino. The Blynk IoT program will automatically control the street light once the prototype is complete, changing its brightness to the surrounding conditions.

2 Research Method

The research development process is divided into hardware, mechanics, and software. The hardware configuration includes an Arduino as the logic controller, a Solar Charge Controller to stabilize the voltage from solar panels, an LDR (Light Dependent Resistor) Sensor to detect lights, an Ultrasonic Sensor as a passing things detector, a Relay to allow a small amount of electrical current to control high current loads, and an ESP8266 as a remote controller.

Mechanical stages are created by constructing a circuit from an Arduino Uno, a Solar Charge Controller, an ESP2866, a relay, an LDR sensor, and an ultrasonic sensor. The ESP8266 module has eight pins: GND, GPIO-0, GPIO-1, GPIO-2, GPIO-3, CHIP ENABLE, reset, VCC, antenna, power LED, and communication LED. To activate the ESP8266, the VCC pin must be linked to the enable pin. The ESP8266 must be connected to the Arduino as follows:

- The VCC pin must be attached to the 3v3 pin on the Arduino.
- The gnd pin must be connected to the gnd pin on the Arduino.
- The TX pin must be attached to pin two on the Arduino.
- The RX pin must be attached to pin three on the Arduino.

The device uses two HC-SR04 ultrasonic sensors to detect the presence of passing automobiles. The ultrasonic sensor HC-SR04 has four pins: VCC, Trig, Echo, and GND. The VCC pin is linked to the 5V pin on the Arduino to supply power to the sensor. The GND pin is connected to the Arduino's GND pin to provide a ground connection. The trigger pin sends an ultrasonic sound pulse to the target. The Echo pin is utilized to receive the reflected pulse of ultrasonic sound from the object being tracked. The time it takes for the sound pulse to reach the target and back can be used to compute the distance to the target. The second ultrasonic sensor is linked to pins 6 and 7 on the Arduino. This setup enables the device to identify vehicles approaching from two different directions.

The LDR sensor is a four-pin device that includes AO, DO, GND, and VCC. The VCC pin is linked to the 5V pin on the Arduino, the GND pin is connected to the GND pin on the Arduino, and the AO pin is attached to the AO pin on the Arduino. The LDR sensor detects the intensity of the direct sunlight.

The initial model is created using three relays. The first and subsequent relays regulate the transmission of electrical current to 8 and 12 volts, correspondingly. The third relay interrupts the flow of electrical current to the lamp. The relays consist of three pins: VCC, GND, and IN. The VCC pin is linked to the 5V pin on the Arduino, the GND pin is connected to the GND pin on the Arduino, and the IN pin is attached to a digital pin on the Arduino.

The street lighting automation system prototype in this study utilizes LDR and Ultrasonic Sensors based on IoT, with a solar panel as the primary power source. The solar panel is linked to a battery via a solar charge controller (SCC) to guarantee effective and secure charging of the battery. The battery then supplies electricity to the Arduino and bulb. The Arduino provides a 5V supply to every connected or used sensor. The whole circuit is in an acrylic box to shield it from the weather.

The final stage of this research is software design, which plays a crucial part in decoding the data for Android. Therefore, the street lights may be managed and observed from any location. The software needed for the research includes Fritzing, Arduino IDE, and Blynk IoT. Fritzing is a program used for creating circuit diagrams. The Arduino IDE is also crucial for creating the software. Blynk IoT is a user interface app that remotely controls and monitors street lights.

3 Discussion and Result

3.1 Voltage Results

The voltage measurement of the components in the circuit is performed in a systematic and sequential manner. The initial step is to check the voltage source, which is the solar panel. The next step is to measure the voltage of the solar charge controller. Once the voltage of the solar charge controller is known, the voltage of the battery can be measured. Finally, the voltage of each Arduino pin is measured. The measurement of each component is performed using a digital multimeter. The solar panel measures the input DC voltage of 21.6 VDC. This voltage is used to recharge the battery.

The solar charge con-troller measures the input DC voltage, which is in the range of VDC, and out-puts a voltage of 12 VDC. This voltage is used to power the Arduino, allowing it to operate. The Arduino Uno measurement process involves the systematic collection and analysis of data on the voltage at each pin on the Arduino. This data can be used to determine the power requirements of each sensor and sup-porting component in the device. The measurement process can be conducted using a variety of methods, including a multimeter, oscilloscope, or digital log-ic analyzer. The step-down measurement is essential for the proper function-ing of the road lighting automation system. The solar charge controller pro-duces a 12 VDC voltage, which is too high for the light to dim. The step-down circuit reduces the voltage to 7.67 Volts, which is the optimal voltage for the light to dim.

The voltage measurement of a relay is a critical step in ensuring that the relay functions properly. The measurement determines the operating voltage required for the relay to receive data on the IN pin. The IN pin is re-sponsible for receiving commands from Arduino. The voltage results on ESP8266 are important to know how many used voltage with RX and TX pins. The result is the input voltage works well on 3.2 V. The measurement of the LDR sensor is essential to determine the voltage source required for proper operation. The LDR sensor is designed to operate at a voltage of 5 volts. The measurement of ultrasonic sensors is essential to determine the voltage source that is required for proper operation. Ultrasonic sensors can operate effective-ly with a voltage of 5 volts.

3.2 Remote Monitoring Results

The testing of the prototype automation and monitoring device for road lighting based on the Internet of Things (IoT) using a light dependent resistor (LDR) sen-sor and an ultrasonic sensor using Blynk was conducted using the Blynk applica-tion. The Blynk application was configured to send values in the form of the numbers 1 and 0. If the Blynk application sent the number 1, the relay would be in the NC state and turn off the light. If the Blynk application sent the number 0, the relay would go to the NO state and turn on the light.

3.3 Connectivity Distance ESP8266

This study conducted a Wifi connectivity distance test to determine the range of the ESP8266 module when installed in a control system. The test was conducted in two conditions: in a place without obstacles and in a place with obstacles. The results of the test are shown in Tables 1 and 2.

Table 1. Connectivity Distance of ESP8266 WiFi without obstacles

No	Distance (m)	Condition	Status
1	1	Without Obstacles	Connected
2	10	Without Obstacles	Connected
3	20	Without Obstacles	Connected
4	> 40	Without Obstacles	Not Connected

Table 2. Connectivity Distance of ESP8266 WiFi with obstacles

No	Distance (m)	Condition	Status
1	1	Without Obstacles	Connected
2	5	Without Obstacles	Connected
3	10	Without Obstacles	Connected
4	14	Without Obstacles	Connected
5	>14	Without Obstacles	Not Connected

3.4 LDR Sensor Testing

The lamp performance test was conducted to assess the lamp's ability to function in accordance with the values provided by the LDR sensor to the Arduino. In a typical scenario, the lamp is turned on at 17:50 WIB and turned off at 06:10 WIB. However, several experiments were required to achieve the desired level of performance.

Table 3. Testing the lamp's LDR sensor-based functionality

No	Time	Condition

	Testing Day -1	
1	05.00-06.00	ON
2	06.00-07.00	OFF
3	17.30-18.00	OFF
4	18.00-18.30	ON
	Testing Day -2	
1	05.00-06.00	ON
2	06.00-07.00	OFF
3	17.30-18.00	OFF
4	18.00-18.30	ON

3.5 Ultrasonic Sensor Testing

Ultrasonic sensor measurements are critical to determine the state of a lamp when it is passed by a vehicle. In the normal state, the lamp is dim. When a vehicle passes through ultrasonic sensor 1, the ultrasonic sensor sends a signal to the Arduino to command relay 1 to turn on, supplying 12 VDC voltage to the lamp, causing it to turn on. If ultrasonic sensor 2 is passed by a vehicle, the ultrasonic sensor sends a signal to the Arduino to command relay 2 to turn on, also supplying 12 VDC voltage to the lamp, causing it to turn on. Relay 1 is then turned off, causing lamp 1 to return to a dimmed state.

4 Conclusion

The operational testing of the prototype automation and monitoring of road lighting based on the internet of things (IoT) was carried out to ensure that the device could function properly and to identify any errors that may occur. The testing was conducted in two stages: testing through an application and testing using sensors. The testing through an application was conducted to verify that the device could be controlled and monitored remotely. The testing was successful, as the device could be turned on and off using the Blynk application. The testing using sensors was conducted to verify that the device could operate as expected. The testing was successful, as the device could turn off at 06:30 WIB and turn on at 18:30 WIB in response to the LDR sensor. When a vehicle passed in front of the ultrasonic sensors, the corresponding light would turn on and the other light would dim. The results of the testing indicate that the prototype automation and monitoring of road lighting based on the internet of things (IoT) is a functional and reliable device. The device can be used to automate and monitor road lighting, which can help to improve safety and efficiency.

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