STREET LIGHT MONITORING AND CONTROL SYSTEM

Abstract

Smart Street light is an automated system which automates the street. The main aim of Smart Street light is to reduce the power consumption when there are no vehicle movements on the road. The Smart street light will turned to be ON when there are vehicles on the road otherwise the lights will be switched OFF. With advancement of technology, things are becoming simpler and easier for everyone in the world today. Automation is the use of control systems and information technologies to reduce the need for human work in the production of goods and services. In the scope of industrialization, automation is a step beyond mechanization, whereas mechanization provided human operators with machinery to assist the users with the muscular requirements of work, automation greatly decreases the need for human sensory and mental requirements as well.

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Chapter 1

Introduction

1.1 Project Introduction

Internet of Things (IoT) is a network for connecting the different things or objects. A well-designed, street lighting system should permit users to travel at night with good visibility, in safety and comfort, while reducing many malfunctions occurs during night and enhancing the appearance of the neighborhood. Lighting can account for 10 – 38% of the whole energy bill in typical cities worldwide. Street lighting could be a notably crucial concern for public authorities in developing countries attributable to its strategic importance for economic and social stability.

Designing a street lighting system which targets the energy saving and autonomous operation on economical affordable for the streets and immediate remedy on complaints. The Energy Consumption of various services can be recorded and accounted. Build an energy saving lighting system with integrated sensors and controllers. Moreover, errors which occur due to manual operation can also be eliminated. As all the Street Lights can be switched ON/OFF automatically as sensor detects the person or vehicle and no labor is required for switching ON/OFF. Doing all these in turn increases the performance and life of the lamps. The proposed source of light on the side of a road or walkway, which is turned on or lit at a certain time every night. Significant benefits of street lighting include prevention of accidents and increase in safety.

1.2 Problem Description

In today's world of technology, it is very common to see the street light alight all night, which is a great waste of energy. The power consumption is relatively high day by day. Some streets are not fully occupied like the main city streets; sometimes they are empty for a certain period time.

Chapter 2

Literature Review

2.1 Literature Survey

In the paper titled "IoT-based Street Lighting Control System for Smart Cities" [1], the author M. A. Alawami et al. have proposed an IoT-based street lighting control system that uses cloud computing and machine learning algorithms to optimize the energy consumption of the street lights. By using Smart Street light, one can save surplus amount of energy which is done by replacing sodium vapor lamps by LED and adding an additional feature for security purposes.

In the paper titled "Wireless Sensor Network Based Smart Street Lighting System" [2] , the authors S. H. Shah and A. M. Bhatnagar have proposed a smart street lighting system that uses wireless sensor networks to monitor and control the street lights. Controlling of street light is of very much required in developing country like India to reduce power consumption.

In the paper titled “IoT-based Intelligent Street Lighting System" [3], V. Chandrasekhar and M. Veeraiah (2019) have proposed an intelligent street lighting system that uses IoT and machine learning algorithms to optimize the energy consumption of the street lights. This implemented concept expounds the configuration and development of Smart Street lighting control framework circuit. Circuit meets expectations appropriately to turn

road light ON/OFF.

In the paper titled “IOT-based Smart Street Lighting System” [4], the auathors S. Arun Kumar and Nirmala Devi have proposed a smart street light system that uses IoT to monitor and control street lights. The system used here is a closed loop on-off system.

In the paper titled "Smart Street Lighting System using IoT" [5], the authors V. Priyanka and M. Sandhya have proposed a smart street lighting uses IoT and cloud computing to monitor and control street lights. Street Light Glow on detecting vehicle movement using a sensor isa system that utilizes the latest technology for sources of light as LED lamps.
In the paper titled "Smart Street Lighting System using IoT" [6], the authors M. Ali, M. Shafique, M. Hassan, M. Raza, and N. Javaid have proposed a smart street lighting system that uses IoT to monitor and control the lighting system. The information gathered from the IR sensor and the LDR is sent to the PIC and the PIC in turn controls the relay and driver circuit which is used in the automatic switching control and adaptive dimming of the LED street lights.

In the paper titled "Smart Street Lighting System based on IoT" [7], the authors M. Khan, S. U. Rehman, and M. R. Baig was experimented, a circuit contains a sensing component known as LDR, followed by Relay, the input is given from the direct supply and the relay converts them to a required voltage and then the switching ON the street lights takes place.

In the paper titled “IoT-based Smart Street Lighting System for Energy Management" [8], the authors J. H. Park and J. H. Lee have proposed an IoT-based smart street lighting system that uses energy-efficient LEDs and sensors to monitor and control the lighting system. It discusses an intelligent system that takes automatic decisions for ON/OFF/DIMMING considering the vehicle movement or pedestrian and also the surrounding environment.
In the paper titled “Smart Street Lighting System based on IoT for Energy Conservation” [9], the authors A. Shetty, S. Baliga, and P. R. Shetty presents a smart street lighting system that uses IoT to monitor and control the lighting system for energy conservation. The design of a control circuit was experimentally done in this work.

In the paper titled “IoT-based Smart Street Lighting System using Renewable Energy Sources" [10], the authors M. V. C. P. Prasad, N. J. Amutha, and M. P. Rajesh have

proposed an IoT-based smart street lighting system that uses renewable energy sources, including solar and wind power, to power the lighting system. the energy reducing system by automatically switching ON and OFF the street lights.

2.2 Comparative analysis of the related work

The table 2.1 shows the comparative analysis of the current systems in light of the suggested proposal.

Table 2.1 Comparative analysis

SI.NO	Author(s)	Techniques	Performance measures
1	M. A. Alawami et al.	LED, IR Sensor	To optimize the Energy consumption of the street lights
2	S. H. Shah and A. M. Bhatnagar	LDR Sensor, LEDs, Semiconductor	Uses Wireless Sensor
3	V. Chandrasekhar and M. Veeraiah	LDR Sensor, IR Sensor	The system includes sensors that detect the presence of vehicles
4	Arun Kumar and M. Nirmala Devi	LDR sensor , Arduino UNO	provides real-time monitoring of the system status
5	V.Priyanka and M. Sandhya	LEDs , IR Sensor	Mobile app that allows users to remotely control the lights
6	M. Ali, M. Shafique, M. Hassan, M. Raza, and N. Javaid	IR Sensor, LDR Sensor	Uses various sensors to detect the presence of vehicle, objects
7	M. Khan, S. U. Rehman, and M. R. Baig.	LDR, Communication Model	Sensors to detect the presence of vehicles
8	J. H. Park and J. H. Lee.	LEDs, IR sensor	Accuracy

9	A. Shetty, S. Baliga, and P. R. Shetty.	IR Sensor	Monitor and control the lighting system for energy conservation
M	M. V. C. P. Prasad, N. J. Amutha, and M. P. Rajesh.	LEDs, IR Sensor, Arduino UNO	Accuracy

Street light monitoring using IoT with Arduino, LED, LDR, and IR sensor is a system designed to monitor the status of street lights and automate their control based on ambient lighting conditions. The system utilizes Arduino, a microcontroller platform, as the central control unit. It is connected to various components including LEDs (light-emitting diodes) for street lighting, LDR (light-dependent resistor) sensors to measure ambient light intensity, and IR (infrared) sensors to detect the presence of vehicles or pedestrians. The LDR sensors continuously monitor the surrounding light levels.

When the ambient light drops below a certain threshold during evening or night time, indicating the need for street lighting, the Arduino triggers the LEDs to turn on and illuminate the street. The IR sensors are used to detect the presence of vehicles or pedestrians. If an IR sensor detects movement within its range, the Arduino responds by intensifying the brightness of the street lights in that particular area, providing better visibility and safety.

The benefits of this system include energy efficiency by automatically adjusting lighting based on ambient conditions, improved safety by providing brighter lighting in areas with movement and offers automated control of street lights based on ambient lighting conditions and the presence of vehicles or pedestrians. It provides energy efficiency, enhanced safety, and the ability to remotely monitor and control the system.

2.3 Summary

In this project, we used the sensors with the Arduino to build an amazing Smart Street light project. With smart street light system we can greatly reduce the energy cost and moreover smart street lights more efficiently manage electricity with lower chances of the automatic street light system overheating and risk of accidents is also minimized..

Chapter 3

Problem Formulation

3.1 Problem Statement

In this project, we find out the effectiveness of power consumption. We have seen in the number of cities where the street lights are the one of the huge energy expense for a city. Currently we have manual control system where the light will be switched ON when the sensor detects the vehicle on road and with the help of LDR sensor, the light is being switched OFF day morning after there is sufficient light outside. So, there saves lot of energy waste between ON and OFF timing.

3.2 Objectives of the Present Study

The objectives of the proposed project are as follows:

1. To study and analyse the related work on street light monitoring.
2. To save the lot of energy waste in between ON and OFF.
3. To evaluate ON and OFF of street light automatically by reducing energy consumption and with more configuration.

3.3 Summary

Our proposed system consists of smart street lights that have external light sensing that automatically turns on at desired intensity based on amount of lighting needed. Instead of turning ON the street lights for the entire night, we can design a low cost and efficient smart street light system using the Arduino, IR sensors, LDR sensor and some other electronics components. In this, smart street light that will be turned on and off whenever there is some vehicle or object.

Chapter 4

Requirements and Methodology

4.1 Requirements

The proposed project consists of following requirements:

4.1.1 Hardware Requirements

The hardware requirements for the proposed project are depicted in the Table 4.1 below:

Table 4.1: Hardware requirements

Sl. No	Hardware/Equipment	Specification
1.	IR Sensor	2cm-30cm
2.	LDR Sensor	3-20mm
3.	Resistor	1k om
4.	Arduino UNO	ATmega38P-8bit
5.	Bread board	Distribution Strips are two.
6	Connecting wires	diameter 0.6mm with a tolerance of +0.01mm

4.1.2 Software Requirements

The software requirements for the proposed project are depicted in the Table 4.2 below:

Table 4.2: Software requirements

Sl. No	Software	Specification
1.	Arduino IDE	64 bits

4.2 Methodology Used

1. The first step is to define the requirements of the street light system. This includes the number of lights, their brightness levels, and the time duration they should remain on.
2. Based on the requirements, we chose the components needed for the system. We have used an Arduino board, a light sensor, LEDs, and resistors.
3. Designing the circuit by connecting the components.
4. Writing the code and testing for the Arduino board that controls the street light system.
5. Once the system has been thoroughly tested, it can be deployed in the field. Ensure that the system is placed in a suitable location and that all the wiring is properly secured.
6. Overall, implementing a street light system using Arduino involves a combination of electronics, programming, and field deployment skill.

Chapter 5

System Design

5.1 Architecture of the Proposed System

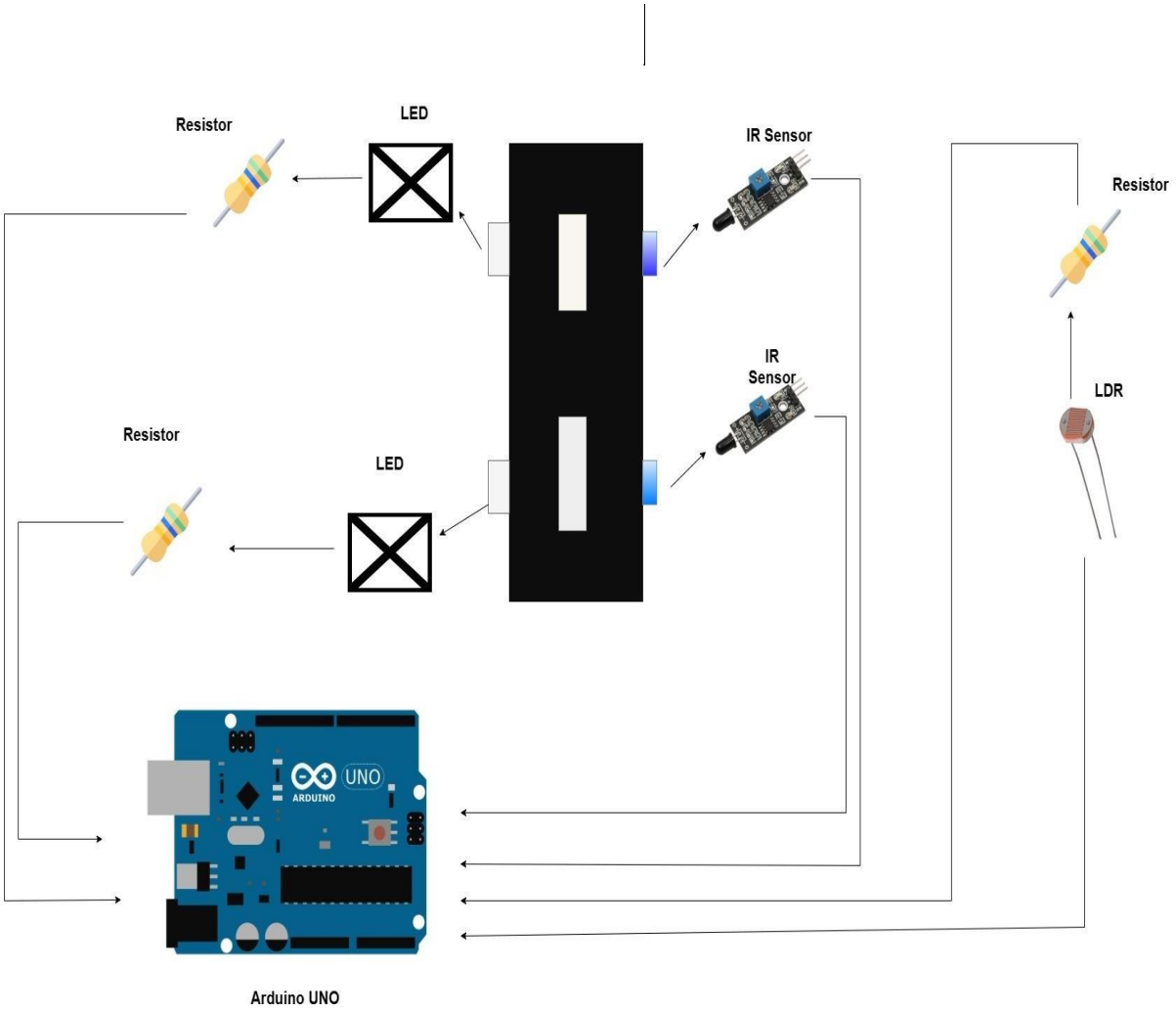

Figure 5.1: Architecture of the Proposed System

Here, the figure represents an integration of Street light monitoring and control system

Components: Arduino Uno,

LDR Sensor,

IR Sensor,

Resistor (e.g., 1kΩ),

LED (to represent the street lights)

Circuit Connections:

- Connect the LDR sensor: Connect one leg of the LDR sensor to the Arduino Uno. Connect the other leg of the LDR sensor to an analog input pin (e.g., A0) on the Arduino Uno. Connect a resistor (e.g., 1kΩ) from the analog input pin to the ground (GND) pin on the Arduino Uno.
- Connect the IR sensor: Connect the VCC pin of the IR sensor to the Arduino Uno.
- Connect the LED: Connect the long leg (anode) of the LED to a current-limiting resistor. Connect the short leg (cathode) of the LED to the ground (GND) pin on the Arduino Uno.

5.2 System Flowchart

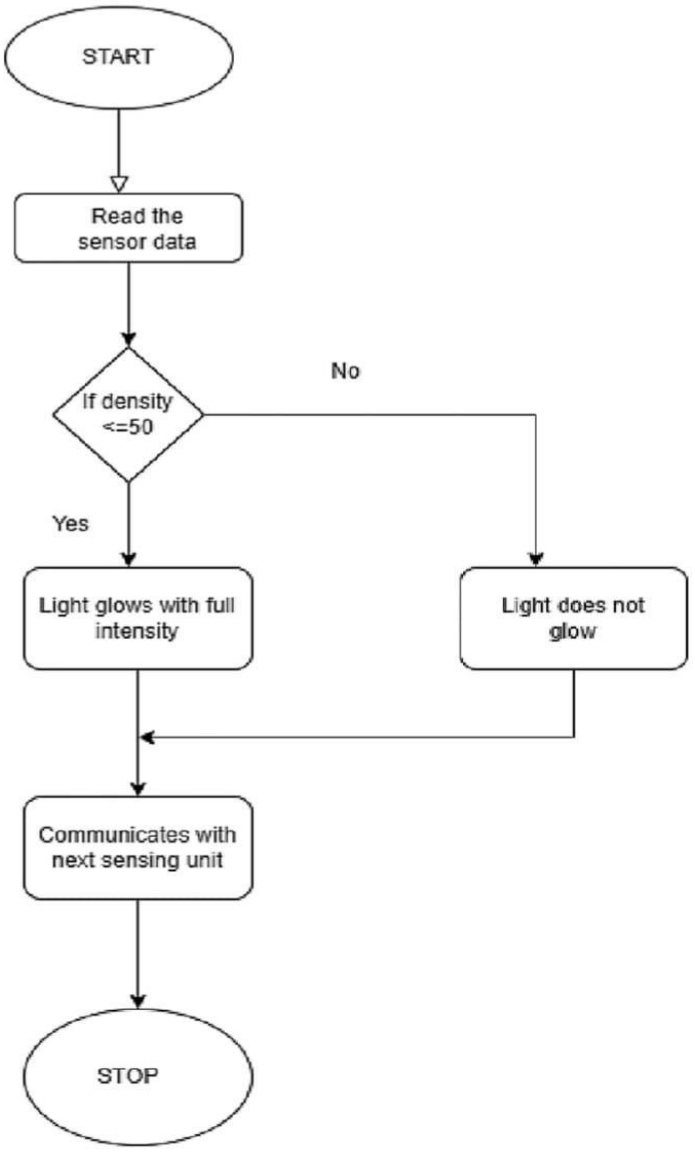

Figure 5.2: Flowchart of the Proposed System

Figure 5.2 shows a basic flowchart of Street light monitoring and control system. Firstly, In the first step the sensor reads the data. Then in second step if the density is less than or equal to fifty then the light glows with full intensity. If the density is not less than or equal to fifty then the light does not glows only.

Chapter 7

System Testing, Results and Discussion

7.1 System Testing

Here are the test cases for the equipment connection of a street light monitoring and control system using Arduino Uno, LDR sensor, IR sensor, and resistor:

- Equipment Connectivity: Verify that the Arduino Uno is properly connected to the LDR sensor, IR sensor, and resistor according to the wiring diagram or schematic. Ensure that the connections are secure and that there are no loose wires or improper connections that could cause malfunctions. Sensor Readings: Test the LDR sensor by measuring the analog input values and ensure they correspond to the ambient light levels in the environment. Test the IR sensor by detecting the presence of a vehicle or pedestrian and verifying that it provides the expected digital output (e.g., HIGH or LOW).
- Resistor Functionality: Check the value of the resistor and ensure it is within the required specifications for the circuit.Verify that the resistor is properly connected and functioning as intended in the circuit.
- Control System Logic: Develop and execute test cases to validate the control system's logic and behavior. Simulate different scenarios by providing specific sensor readings (light and presence) and verify that the control system reacts accordingly. Test cases can include turning on/off the street lights based on light levels or adjusting the brightness of the lights based on presence detection.
- Manual Override Testing: Test the manual control mechanism, such as a button or switch, that allows manual override of the street lights. Verify that pressing the manual control activates/deactivates the street lights regardless of the sensor inputs. Ensure that the manual control does not interfere with the normal operation of the system.
- System Integration: Verify the overall integration of the components by running the complete system. Ensure that the Arduino Uno, LDR sensor, IR sensor, and resistor are working together harmoniously. Check for any interference or conflicts between the components that could affect the system's performance.
- Robustness and Reliability: Run the system for an extended period to test its robustness and reliability. Monitor the system's performance over time to ensure that it remains stable and accurate in detecting light levels and presence.

7.2 Result Analysis

Represents an integration of Street light monitoring and control system using some components: Arduino Uno, LDR Sensor, IR Sensor, Resistor (e.g., 1kΩ), LED (to represent the street lights).

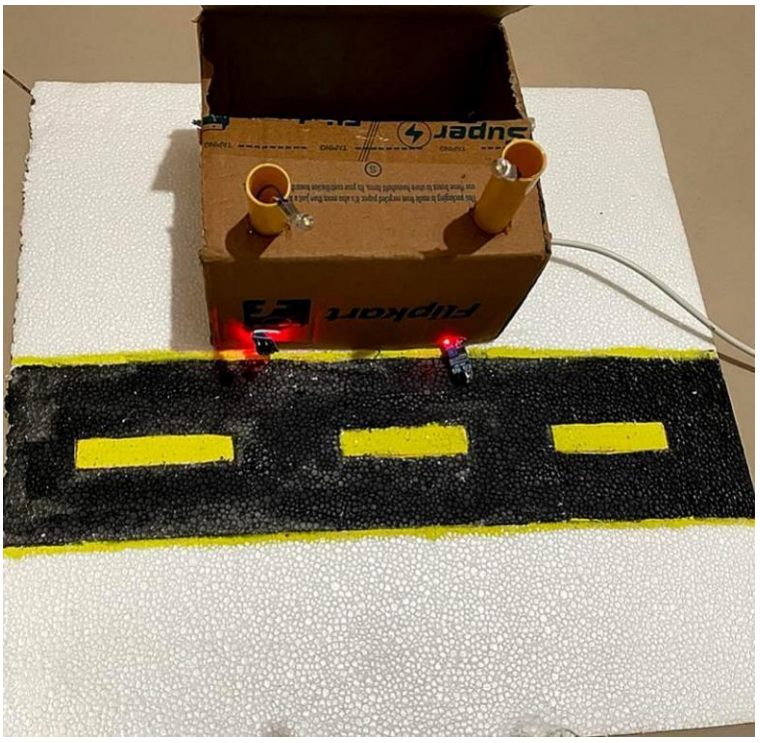

Fig: 7.1 Result of the Proposed System

To implement a street light monitoring and control system using Arduino Uno, LDR sensor, IR sensor, a 1k ohm resistor, and a breadboard, follow these steps:

- Gather the required components: Arduino Uno board, LDR (Light Dependent Resistor) sensor, IR (Infrared) sensor, 1k ohm resistor, Breadboard, Jumper wires
- Connect the LDR sensor: Connect one leg of the LDR sensor to the 5V pin on the Arduino Uno. Connect the other leg of the LDR sensor to the A0 analog input pin on the Arduino Uno. Use jumper wires to make the connections and ensure they are secure.
- Connect the IR sensor: Connect the resistor:Connect one leg of the 1k ohm resistor to the A0 pin on the Arduino Uno. Connect the other leg of the resistor to the junction of the LDRsensor's leg and the A0 pin on the Arduino Uno.
- Set up the street lights: Determine the control mechanism of the street lights (e.g., relay, transistor, solid-state switch) and its compatibility with the Arduino Uno. Connect the control mechanism to the appropriate output pins of the Arduino Uno. Power the Arduino Uno: Connect the Arduino Uno to your computer using a USB cable or use an external

power supply to power it up.

- Write and upload the code: Write the code to read sensor values, implement control logic, and control the street lights accordingly. Use the Arduino IDE or any compatible programming software to write and upload the code to the Arduino Uno.
- Test and monitor the system: Place the LDR sensor and IR sensor in their desired locations for monitoring. Observe the sensor readings through the Arduino Uno's serial monitor or any output mechanism you have implemented. Verify that the street lights are controlled based on the sensor inputs and the defined rules. Make any necessary adjustments to the code or circuitry to optimize the system's performance.

  By following these steps, you can implement a street light monitoring and control system using Arduino Uno, LDR sensor, IR sensor, a 1k ohm resistor, and a breadboard.

7.2.1 Arduino UNO

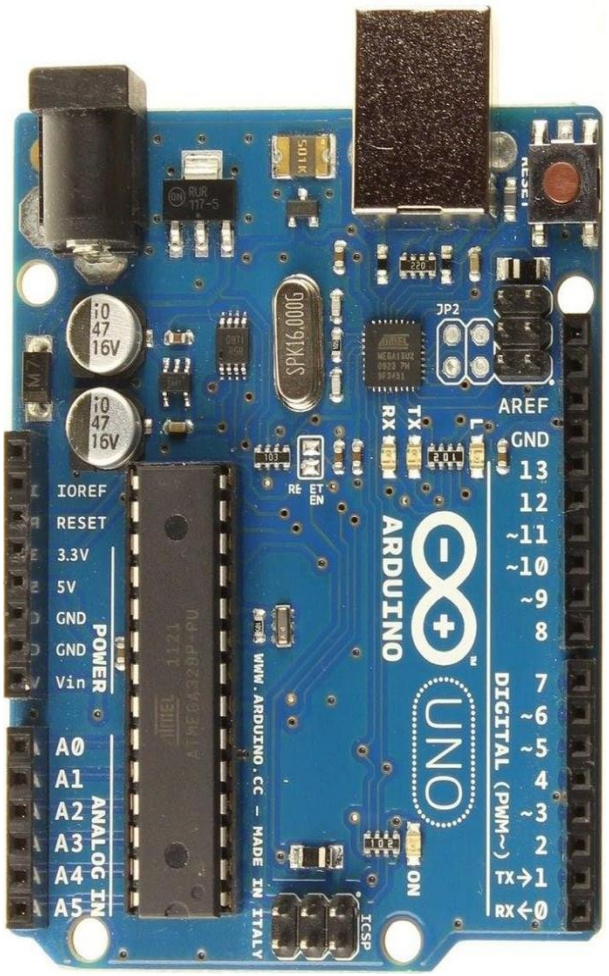

Fig: 7.2 Arduino UNO

The Arduino Uno is a popular microcontroller board widely used in various projects, including street light monitoring and control systems. Here's an overview of its functionality and its specific use in a street light monitoring and control system:

Functionality of Arduino Uno:

Microcontroller in Arduino Uno is based on the ATmega328P microcontroller, which provides processing power and memory for running programs and controlling connected devices. Digital and Analog I/O in Arduino Uno has a set of digital and analog input/output (I/O) pins that can be used to read sensor values, control actuators, and communicate with other devices. Integrated Development. Environment (IDE) in Arduino IDE provides an easy-to-use platform for writing, compiling, and uploading code to the Arduino Uno board. Use in Street Light Monitoring and Control System in Arduino Uno is commonly utilized in street light monitoring and control systems due to its versatility and ease of use.

Here's how it is employed in such systems:

- Sensor Integration: Arduino Uno can interface with various sensors used in street light monitoring, such as LDR sensors to measure ambient light levels and IR sensors to detect the presence of darkness or vehicles.
- Actuator Control: It can control the street lights or LED indicators using digital output pins. By controlling the state of these pins, the Arduino Uno can turn the lights on or off based on sensor readings or predetermined conditions.
- Data Processing and Logic: Arduino Uno's microcontroller processes the sensor data and implements the necessary control logic, such as determining when to activate or deactivate the street lights based on specific thresholds or triggers. Communication: Arduino Uno can facilitate communication with other devices or systems, such as sending data to a central monitoring system or receiving commands for remote control or configuration.

In summary, Arduino Uno's flexibility, sensor integration capabilities, digital and analog I/O, and communication features make it an ideal choice for street light monitoring and control systems, enabling efficient control, data processing, and integration with other components of the system

7.2.2 LDR Sensor

Fig: 7.3 LDR Sensor

An electronic component like LDR or light-dependent resistor is responsive to light. Once light rays drop on it, then immediately the resistance will be changed. The resistance values of an LDR may change over several orders of magnitude. The resistance value will be dropped when the light level increases. The resistance values of LDR in darkness are several mega ohms whereas in bright light it will be dropped to hundred ohms. So due to this change in resistance, these resistors are extremely used in different applications.

7.2.3 IR Sensor

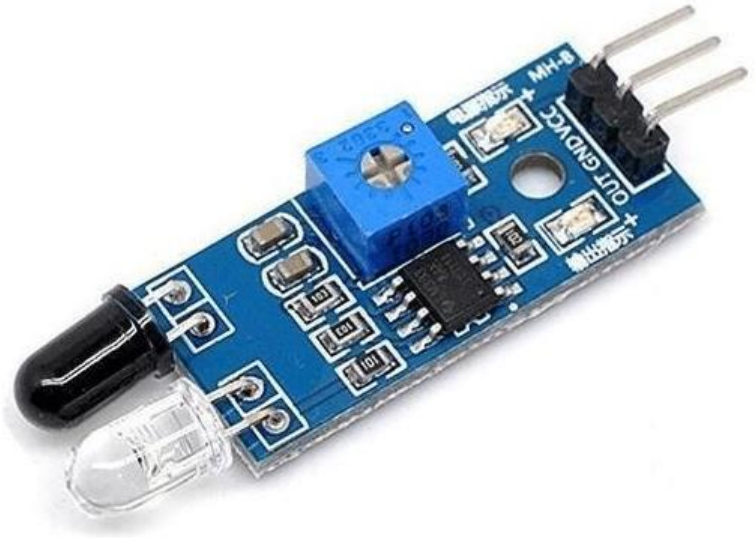

Fig: 7.4 IR Sensor

The light sensor module have strong adaptable to the environment, having a pair of infrared transmitter and receiver, transmitter launch a certain frequency infrared, when meet obstacle in the detection direction, the infrared receiver is reflected back by the receiver tube, after processing through the comparator circuit, the green indicator light will illuminate while the signal output interface output digital signal (a low-level signal) can be adjusted via potentiometer knob detection.

Chapter 8

Conclusion and Scope for Future Work

8.1 Conclusion

Today most of the cities need an effective Street Light System that controls the illumination of light; it saves energy and enables efficient management of street lights, optimizing energy consumption, and reducing maintenance costs. Overall, the IoT-based street light monitoring and control system enhances operational efficiency, reduces energy waste, and improves overall sustainability. It offers a scalable and intelligent solution for urban lighting management, making cities safer, greener, and more cost-effective.

8.2 Scope for Future Work

Future street light monitoring and control system using IoT focuses on advancing energy efficiency, maintenance practices, data analytics, integration with other smart city systems, and user experience. Continued research and development in these areas will contribute to creating smarter, more sustainable, and safer urban environments. System upgrades may include several sensors, if they were practical at the time. As technology progresses, additional sensors might also be added to the system to satisfy demands. It is possible to create smart phone applications for monitoring of street light are easier to use, more effective, and more user-friendly.

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