SMART STREET LIGHT SYSTEM

A PROJECT REPORT

Submitted by

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in partial fulfilment for the award of the degree

of

BACHELOR OF TECHNOLOGY

IN

INFORMATION TECHNOLOGY

PANIMALAR INSTITUTE OF TECHNOLOGY

ANNA UNIVERSITY: CHENNAI 600 025

NOV-DEC 2023

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BONAFIDE CERTIFICATE

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ACKNOWLEDGEMENT

All praises goes to almighty Allah, the most gracious and most merciful, who bestowed upon us the courage and enthusiasm to complete the project work within the scheduled time. Our heartiest gratitude, profound indebtedness and deep respect go to our supervisor Lt. Col. A K M Nazrul Islam, PhD, EME, Instructor Class ‘A’ (Associate Professor), Department of Electrical Electronics and Communication Engineering (EECE), Military Institute and Science and Technology (MIST), Dhaka, Bangladesh, for his constant supervision, affection, guidance, great encouragement and motivation. His keen interest in this topic and valuable advices throughout the study was of great help in completing our project. We are especially grateful to Gp Capt Dr. Md Hossam-E-Haider, Head of the department, Department of Electrical Electronics and Communication Engineering (EECE), Military Institute and Science and Technology (MIST) for providing all support during project time. We are also grateful to all members of our faculty, lab assistants, subassistant engineers and all staffs of the department of EECE. Finally, we would like to thank our families and our course mates for their appreciable assistance, patience and suggestions during the course of our project.

CHAPTER 1

ABSTRACT

Street lights pay a very important role for lightening the walkway during nights when surroundings go dark. It is also very important for the vehicles running during the night for the proper direction of the roads. Nowadays controlling the street lights require human presence to switch them ON/OFF which means this system is not digitalized yet. This human controlled system has the disadvantage of having regular individual presence to turn the lights ON/OFF which is a loss of electrical energy and manpower because this people can be deployed somewhere else. Thus to overcome these problemsthe controlling system might be converted to a system where it is controlled via wireless technology. In this paper, an automatic system is demonstrated to control the system by wireless technology using Arduino Uno. The system is programmed in such a way that the whole street light is divided in some sections which can be turned ON/OFF with a single short message service (SMS). The system can also be turned ON/OFF by using the intensity of light basing on day or nighttime and if intensity of light goes up or down a certain threshold value, the lights will be switched ON/OFF. The feature of getting the feedback about the functionality of the lights has also been added on this project. That means a feedback message will be sent via short message service (SMS) if the lights are not functioning properly. This automation process if utilized will save manpower, huge amount of electrical energy and make the system easier to control than the conventional controlling system.

TABLE OF CONTENTS

CHAPTER 2

INTRODUCTION

1. OVERVIEW

The Smart Street Light System is a cutting-edge urban lighting management solution designed to revolutionize traditional street lighting infrastructure. The project integrates state-of-the-art technologies such as Internet of Things (IoT), advanced sensors, and intelligent algorithms to create a responsive and energy-efficient lighting network. The primary goal is to enhance sustainability, reduce operational costs, and improve overall urban living.

2. PROBLEM DEFINITION

Urban areas globally are faced with the challenge of inefficient and unsustainable street lighting systems. Traditional street lights often operate on fixed schedules and constant brightness levels, regardless of real-time environmental conditions or the presence of pedestrians and vehicles. This inefficiency results in unnecessary energy consumption, increased operational costs, and a higher carbon footprint. Moreover, inadequate lighting can compromise public safety, contributing to accidents and reduced overall quality of life for urban residents.

3. SCOPE

The Smart Street Light System project encompasses a comprehensive and adaptive solution to modernize urban lighting infrastructure. The scope of the project includes:

- Hardware Implementation:

Deployment of advanced sensors, including light sensors, motion sensors, and environmental sensors, integrated into street lights to collect real-time data.

- Communication Infrastructure:

Implementation of robust wireless communication protocols (e.g., Wi-Fi, Zigbee) to establish seamless connectivity between individual street lights and a centralized control system.

- Centralized Control System:

Development and implementation of a centralized management platform equipped with intelligent algorithms to collect, process, and analyze data from sensors in real-time.

- Adaptive Lighting Control:

Integration of adaptive lighting control mechanisms to dynamically adjust the brightness of each street light based on real-time environmental conditions, motion detection, and user-defined preferences.

- Energy-Efficient Lighting Technologies:

Incorporation of energy-efficient LED lighting technologies to maximize energy savings and contribute to the overall reduction of the carbon footprint.

CHAPTER 3

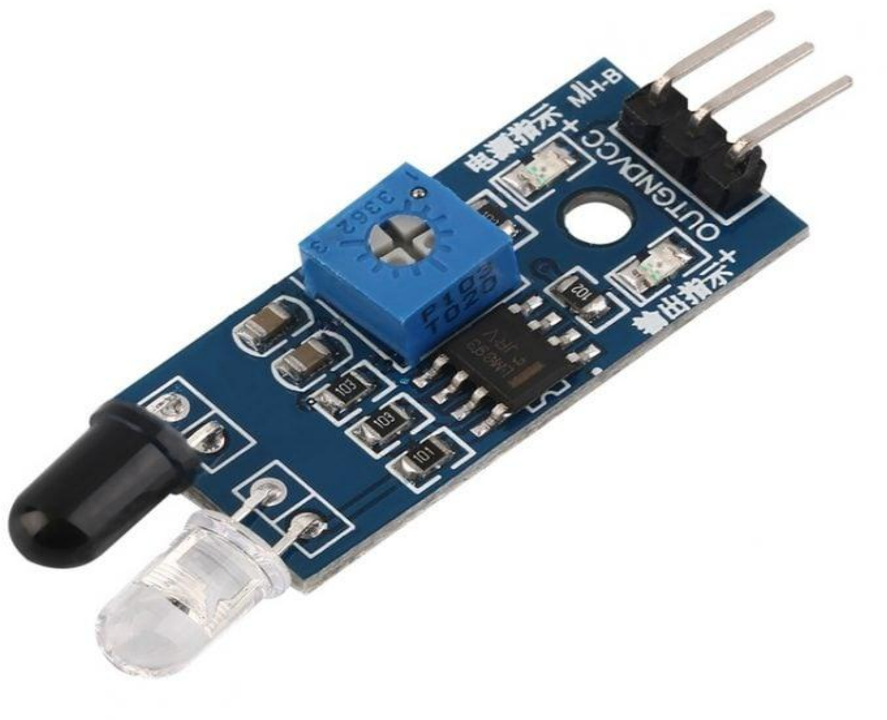
COMPONENT

MICROCONTROLLER (ARDUINO UNO)

- Prototyping: The Arduino Uno is commonly used as a prototyping platform. It provides an easy-to-use environment for quickly testing and iterating on electronic circuits and software.
- Sensor Integration: It's often used to interface with various sensors (like temperature sensors, motion sensors, etc.) and process the data for different applications.
- Control Systems: It can be used to build control systems for motors, lights, and other actuators. For example, you can build a robot or an automated home system.
- Data Logging: Arduino Uno can be used to log data from sensors or other sources to a storage medium like an SD card or transmit it to a computer over a communication interface.
- Interactive Art and Installations: Artists and makers use Arduino Uno for creating interactive art installations, kinetic sculptures, and other interactive projects.
- Education and Learning: Arduino Uno is widely used in educational settings to teach electronics, programming, and robotics due to its simplicity and accessibility.

IR SENSOR

IR sensor is an electronic device, that emits the light in order to sense some object of the surroundings. An **IR sensor** can measure the heat of an object as well as detects the motion. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, but infrared sensor can detect these radiations.



9V BATTERY

The 9V battery is used in many different applications. 9 volt batteries can frequently be seen used in radios, smoke alarms, wall clocks, walkie-talkies, portable electronics, and much more. In the American prison system inmates have even been known to utilize the 9 volt battery to light cigarettes by adding a steel wool or wire to create an ultra hot contact point. This is not recommended as it can cause harm to you and your battery, but goes to show how many uses 9Vbatteries can have.

3mm WHITE LED

LEDs, or Light Emitting Diodes, are specialized diodes that emit light when supplied with sufficient current at the appropriate voltage. These 3mm diameter LEDs are ideal for projects that require indicator lights for various purposes, such as debugging, notifications, and frequency control. They are also suitable for any other electronic project that requires a visual indication.

CHAPTER 4

SYSTEM ANALYSIS

EXISTING SYSTEM

A smart street light system incorporates a cluster of streetlight lamps that can communicate with each other and provide lighting data to a local concentrator. It allows facility managers to remotely control street lights while keeping track of electrical power consumption in the lamps and in the driving circuits.Streetlights are the elemental part of any city since it facilitates better night visions, secure roads, and exposure to public areas but it consumes a quite large proportion of electricity. In the manual streetlight system lights its powered from sunset to sunrise with maximum intensity even when there is sufficient light available. This energy wastage can be avoided by switching off lights automatically. The objects which means if there is an object passing by, the light will turn on and if there is no object passing by, the light will turn off. This detection can be monitored through Thing Speak and IoT platform on your computer.

PROPOSED SYSTEM

A smart street light system is used to reduce the man power and it prevent from high level energy consuming. Everyday the street lights are ON at evening and OFF at morning, a man need to ON/OFF the light. But in our project the street lights are ON/OFF automatically. When any objects are crossing the road means then only the light will turn ON otherwise it automatically turn OFF. So, it reduce the usage of power. This is the major roll for creating the smart city.

CHAPTER 5

SYSTEM SPECIFICATION

These system specifications outline the essential components and functionalities of the Smart Street Light System, ensuring a robust, efficient, and user-friendly implementation aligned with project goals and requirements.

HARDWARE SPECIFICATION

Light Sensors:

1. Type: Ambient light sensors

2. Purpose: Measure ambient light levels for adaptive brightness control.

Motion Sensors:

1. Type: Infrared motion sensors

2. Purpose: Detect the presence of pedestrians, vehicles, or other activities for dynamic adjustments.

Environmental Sensors:

1. Type: Temperature and weather sensors

2. Purpose: Monitor environmental conditions to inform lighting control decisions.

SOFTWARE SPECIFICATION

PROGRAMMING LANGUAGE:

- The bot is typically programmed using the Arduino IDE, Platform IO, or a similar environment. The primary programming language is C/C++.

MICROCONTROLLER SOFTWARE:

The microcontroller software for the Smart Street Light System would typically involve the programming of the embedded systems within each street light to handle sensor data, communicate with the centralized control system, and control the brightness of the light. The choice of programming language may depend on the specific microcontroller platform being used. Here's an example using an Arduino-based microcontroller as a reference:

- **Sensor Data Handling:**

Read data from sensors (light, motion, environmental) connected to the microcontroller.
Convert analog sensor readings to digital values for processing.

- **Communication with Centralized Control System:**

Implement communication protocols to transmit sensor data to the central control system.
Example: HTTP requests, MQTT, or custom protocols depending on the communication infrastructure.

- **Adaptive Lighting Control:**

Implement algorithms to adjust the brightness of the LED lights based on sensor data.
Incorporate logic for dynamic adjustments, considering ambient light levels, motion, and user-defined preferences.

- **Energy-Efficient LED Control:**

Control the LED lights using pulse-width modulation (PWM) for energy efficiency. Adjust the duty cycle of the PWM signal to control the brightness of the LEDs.

CHAPTER 6

SYSTEM WORKING

The Smart Street Light System operates through an intelligent and adaptive process, involving various components working in tandem. Here's an overview of the system's working:

- **Sensor Data Acquisition:**

Ambient light sensors, motion sensors, and environmental sensors, embedded in each street light, continuously collect data.
Light sensors measure ambient light levels, motion sensors detect activity, and environmental sensors monitor factors such as temperature and weather conditions.

- **Microcontroller Processing:**

The microcontroller, embedded within each street light, processes the sensor data locally.
Algorithms on the microcontroller analyze the data to determine the optimal brightness level for the LED lights based on real-time environmental conditions, motion, and user-defined preferences.

- **Adaptive Lighting Control:**

The microcontroller dynamically adjusts the brightness of the LED lights in response to the analyzed sensor data.
During periods of low activity or sufficient ambient light, the system dims the lights to conserve energy.
Conversely, during periods of increased activity or low ambient light, the system increases brightness to ensure adequate illumination.

- **Wireless Communication:**

The microcontroller communicates with the central control system using wireless communication protocols (e.g., Wi-Fi or Zigbee).
Data, including sensor readings and the current status of each street light, is transmitted to the centralized platform in real-time.

- **Centralized Control System:**

The central control system receives the data from all street lights, aggregating and analyzing it in real-time.
Intelligent algorithms within the centralized system further optimize the overall lighting strategy for the entire urban area.

- **User Interaction:**

Users can interact with the system through mobile applications or web interfaces.
User preferences, feedback, and customizations influence the adaptive lighting control algorithms.

- **Remote Monitoring and Maintenance:**

The centralized control system monitors the health of each street light.
Fault detection mechanisms identify malfunctions or issues, and maintenance needs are predicted based on performance data.

- **Energy-Efficient LED Control:**

The system uses energy-efficient LED lighting technologies with pulse-width modulation (PWM) to control the brightness of the LEDs.

PWM allows for precise control of the LED brightness while maximizing energy efficiency.

- **Scalability and Integration:**

The system is designed to be scalable, accommodating the addition of new street lights and integrating seamlessly with other smart city initiatives.

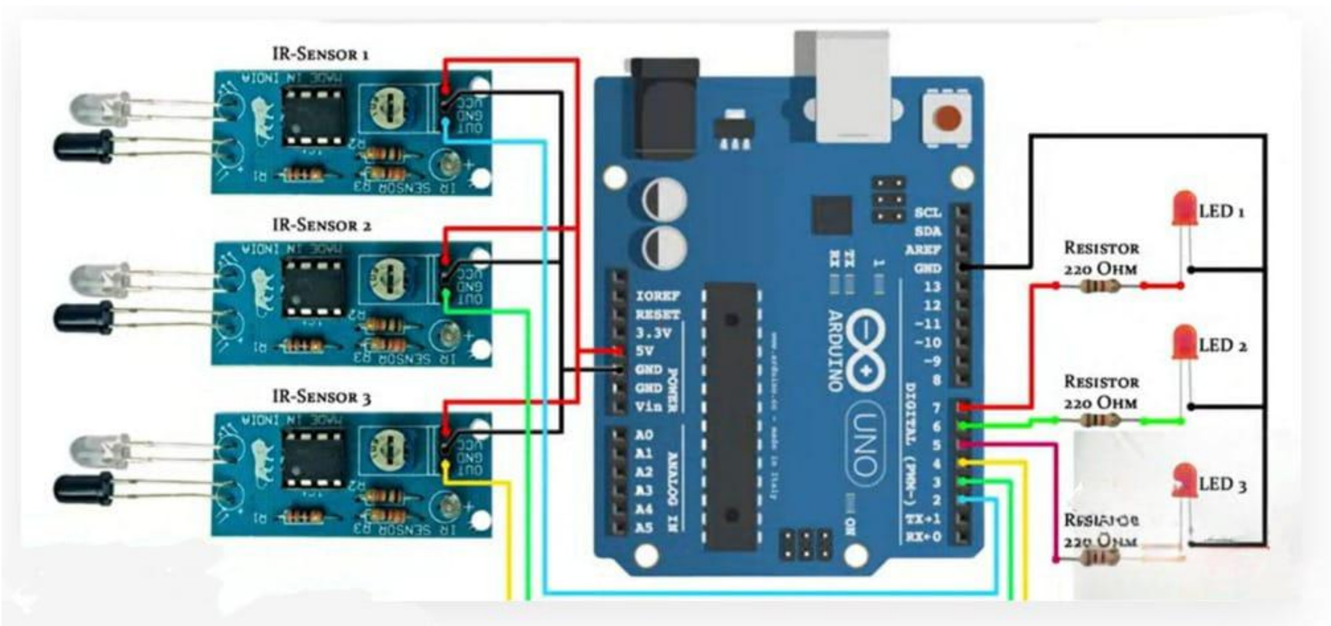
- **Security Measures:**

Basic security measures, such as encryption and authentication, are implemented to ensure the integrity of data transmission and system operation.

- Documentation and Reporting:

The system generates documentation and reports on performance metrics, compliance with regulations, and user engagement.

CIRCUIT DIAGRAM



CHAPTER 7

SOFTWARE

SOFTWARE CODE

Open your Arduino IDE and go to File > New. A new file will open. Copy the code given below in that file and save it.

This sketch will display the human temperature, pulse rate. Moreover it will give voice alert.

CODE:

```
 void setup() {
 pinMode(2,INPUT);
 pinMode(3,INPUT);
 pinMode(4,INPUT);
 pinMode(5,OUTPUT);
 pinMode(6,OUTPUT);
 pinMode(7,OUTPUT);
}
void loop() {
 if (digitalRead(2)==HIGH&&digitalRead(3)==HIGH&&digitalRead(4)==HIGH)
{
 digitalWrite(5,HIGH);
 digitalWrite(6,HIGH);
 digitalWrite(7,HIGH);
}
else if(digitalRead(2)==HIGH&&digitalRead(3)==HIGH)
{
 digitalWrite(5,HIGH);
 digitalWrite(6,HIGH);
 digitalWrite(7,LOW);
```

```
}
else if(digitalRead(3)==HIGH&&digitalRead(4)==HIGH)
{
  digitalWrite(6,LOW);
  digitalWrite(7,HIGH);
  digitalWrite(5,HIGH);
}
else if (digitalRead(2)==HIGH&&digitalRead(4)==HIGH)
{
  digitalWrite(5,HIGH);
  digitalWrite(6,LOW);
  digitalWrite(7,HIGH);
}
else if (digitalRead(2)==HIGH)
{
  digitalWrite(5,HIGH);
  digitalWrite(6,LOW);
  digitalWrite(7,LOW);
}
else if (digitalRead(3)==HIGH)
{
  digitalWrite(5,LOW);
  digitalWrite(6,HIGH);
  digitalWrite(7,LOW);
}
else if (digitalRead(4)==HIGH)
{
  digitalWrite(5,LOW);
  digitalWrite(6,LOW);
  digitalWrite(7,HIGH);
```

```
}
else
{
  digitalWrite(6,LOW);
  digitalWrite(7,LOW);
  digitalWrite(5,LOW);
}
}
```

EXPECTED OUTPUT

The expected output of the provided Arduino code depends on the combination of HIGH and LOW states of the input pins (2, 3, and 4). Let's break down the code and analyze the expected behavior:

Input Conditions:

If all three input pins (2, 3, and 4) are HIGH, then all three output pins (5, 6, and 7) will be set to HIGH.
Output Configurations Based on Input Conditions:

If only pin 2 and pin 3 are HIGH, output pins 5 and 6 will be HIGH, and pin 7 will be LOW.
If only pin 3 and pin 4 are HIGH, output pins 6 and 7 will be HIGH, and pin 5 will be HIGH.
If only pin 2 and pin 4 are HIGH, output pins 5 and 7 will be HIGH, and pin 6 will be LOW.
If only pin 2 is HIGH, output pin 5 will be HIGH, and pins 6 and 7 will be LOW.
If only pin 3 is HIGH, output pin 6 will be HIGH, and pins 5 and 7 will be LOW.
If only pin 4 is HIGH, output pin 7 will be HIGH, and pins 5 and 6 will be LOW.
If none of the above conditions are met, all output pins (5, 6, and 7) will be set to LOW.

CODE EXPLANATION

- **Setup Function:**

The setup function is called once when the Arduino is powered on or reset. In this function: Pin modes are set for pins 2, 3, 4 as INPUT (for reading digital signals) and pins 5, 6, 7 as OUTPUT (for controlling digital outputs).

- **Loop Function:**

The loop function is the main execution loop that continuously runs after the setup. In this function:
The states of pins 2, 3, and 4 are checked using digitalRead.

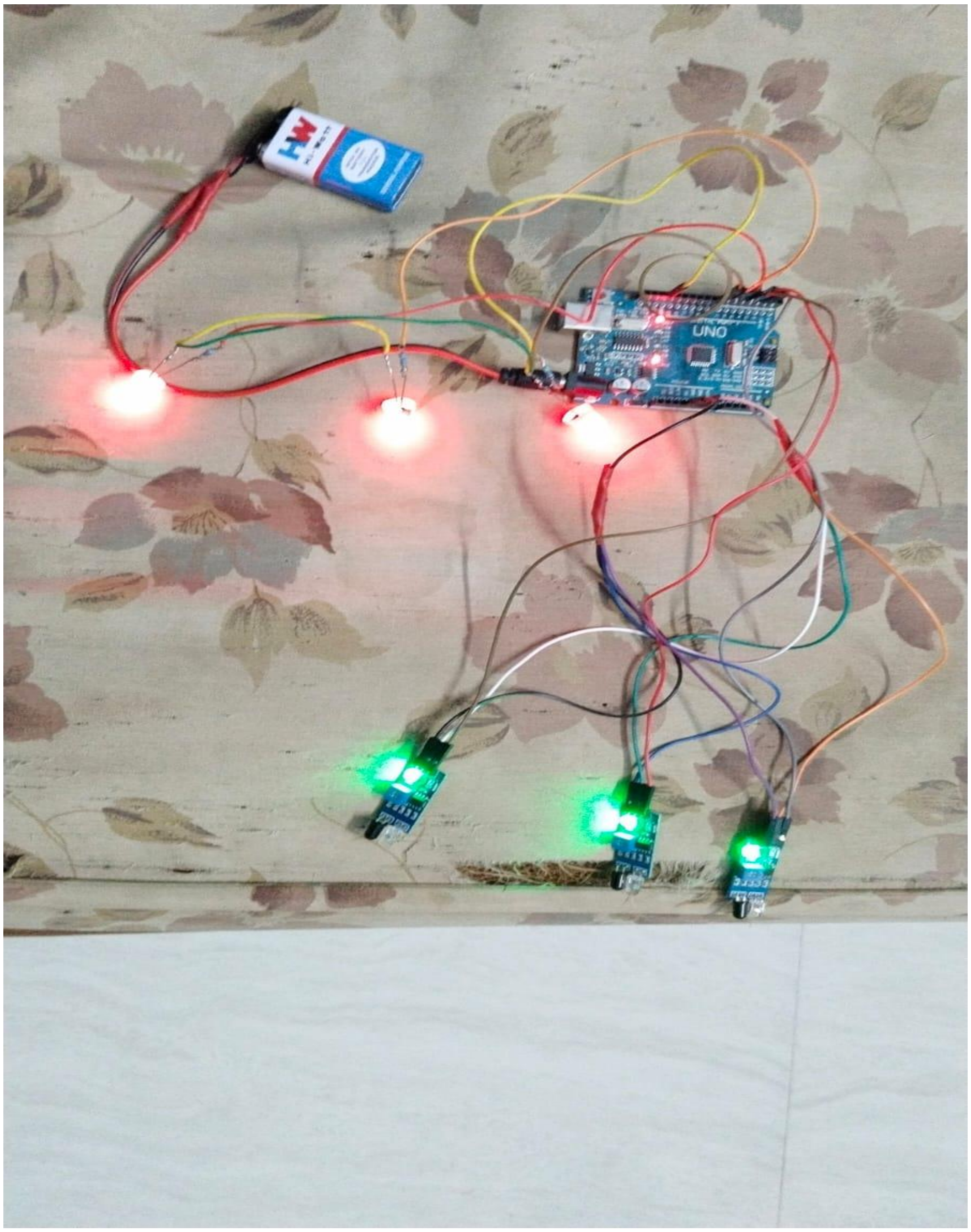
Based on the combinations of HIGH and LOW states of these pins, the corresponding output pins (5, 6, and 7) are set to HIGH or LOW.

- **Conditions Explained:**

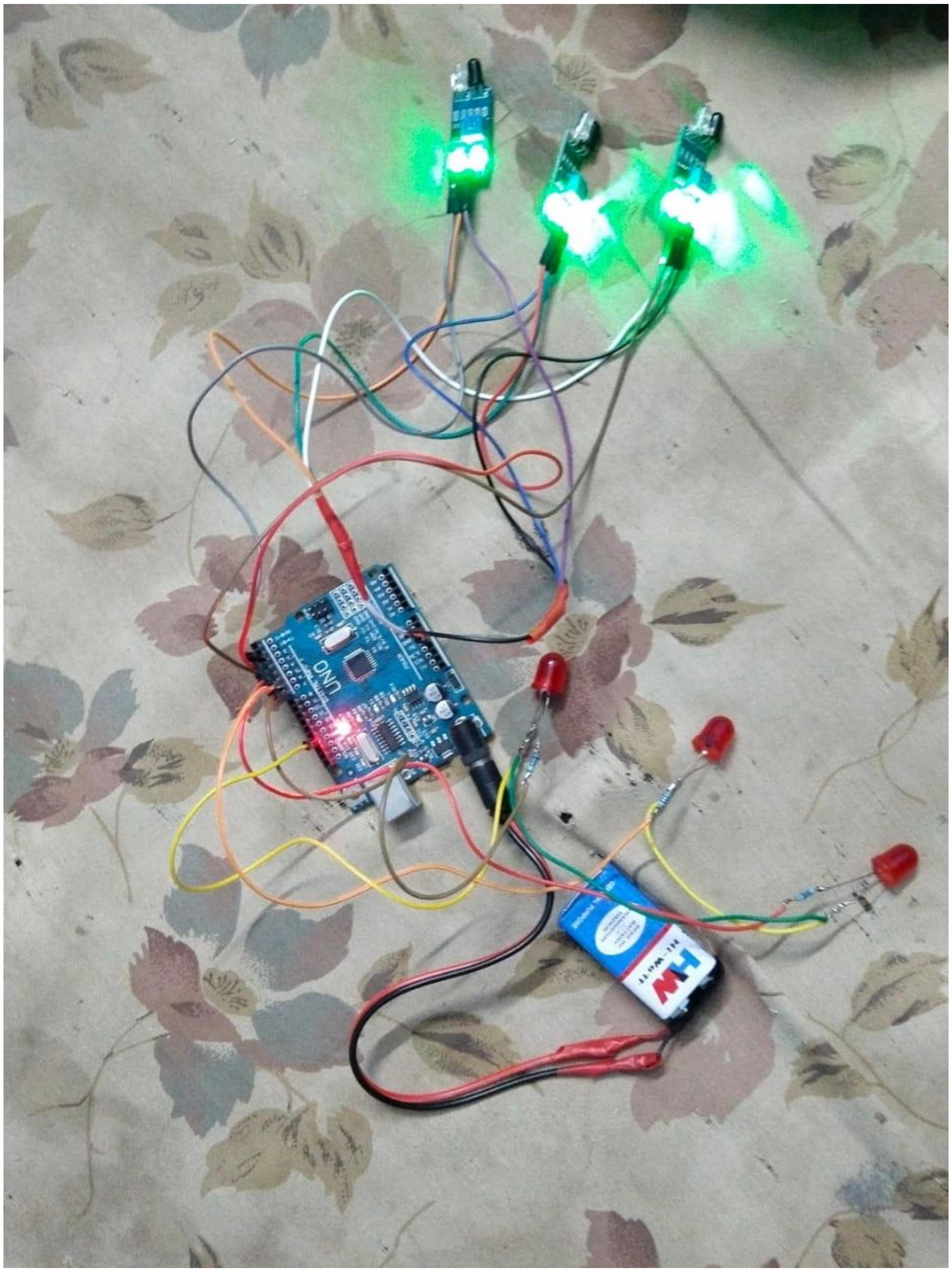
The conditions in the if and else if statements check various combinations of HIGH and LOW states of the input pins to determine the appropriate configuration of the output pins.

This code essentially represents a digital logic control system where the output pins respond to specific combinations of input pin states. The exact behavior of the system would depend on the external connections and the purpose of the project.

PROJECT OUTPUT



PROJECT SETUP



CHAPTER 8

APPLICATIONS

The Smart Street Light System has a wide range of applications, contributing to various aspects of urban living and infrastructure management. Here are some key applications for this project:

- **Urban Lighting Optimization:**

The primary application is the optimization of urban lighting. The system ensures that street lights operate at the right brightness levels based on real-time conditions, leading to energy savings and improved efficiency.

- **Energy Efficiency and Sustainability:**

Reducing energy consumption through adaptive lighting control and the use of energy-efficient LED technologies contributes to overall energy efficiency and sustainability in urban areas.

- **Enhanced Public Safety:**

Dynamic adjustments to street light brightness based on motion detection and environmental conditions improve visibility and contribute to enhanced public safety. Well-lit areas deter criminal activities and reduce the risk of accidents.

- **Environmental Impact Reduction:**

By minimizing unnecessary illumination during low-activity periods, the system helps reduce light pollution, contributing to a positive environmental impact.

- **User-Centric Lighting Preferences:**

Users can customize their lighting preferences through mobile applications or web interfaces, allowing for a more personalized and user-centric experience.

- **Predictive Maintenance:**

The system's ability to predict maintenance needs and promptly address faults ensures that street lights remain operational, minimizing downtime and disruptions in public lighting.

- **Smart City Integration:**

Integration with broader smart city initiatives allows for synergies with other urban management systems, contributing to a holistic and interconnected smart city ecosystem.

- **Community Engagement:**

Users can actively participate in the maintenance and optimization of the lighting system by providing feedback and reporting issues through user-friendly interfaces. This fosters a sense of community engagement.

- **Traffic Management:**

Adaptive lighting can contribute to better visibility on roads, improving traffic management and reducing the risk of accidents, particularly during low-visibility conditions.

- **Event Lighting Management:**

During events or special occasions, the system can adapt to specific lighting requirements, providing additional illumination as needed.

- **Remote Monitoring and Control:**

Remote monitoring capabilities enable administrators to monitor the entire lighting infrastructure, identify issues, and perform control actions without physical inspection.

- **Cost Savings:**

The system's energy-efficient features and predictive maintenance contribute to cost savings for municipalities, reducing operational expenses associated with traditional street lighting systems.

- **Quality of Life Improvement:**

The overall improvement in urban lighting quality contributes to a better quality of life for residents, making public spaces more inviting and safe.

- **Adaptation to Seasonal Changes:**

The system can adapt to seasonal changes in daylight duration, ensuring that street lights provide the appropriate level of illumination during different times of the year.

The applications of the Smart Street Light System demonstrate its versatility and potential to positively impact various aspects of urban living, making it a valuable addition to smart city initiatives.

CHAPTER 9

FUTURE ENHANCEMENT

The Smart Street Light System project has a solid foundation, but there are several opportunities for future enhancements and expansions to make it even more robust and adaptive to evolving urban needs. Here are some potential future enhancements:

- **Integration with Smart City Ecosystems:**

Explore deeper integration with broader smart city initiatives, such as traffic management systems, waste management, and environmental monitoring. This integration can create a more interconnected and synergistic urban environment.

- **Advanced Predictive Analytics with Machine Learning:**

Implement more advanced machine learning algorithms for predictive analytics. This could involve predicting not only maintenance needs but also anticipating changes in usage patterns and environmental conditions for more proactive and accurate lighting adjustments.

- **Dynamic Light Scheduling:**

Introduce dynamic light scheduling based on specific events, seasons, or community activities. For example, the system could adjust lighting levels for festivals, public gatherings, or seasonal changes.

- **Human-Centric Lighting:**

Incorporate human-centric lighting principles to align street lighting with circadian rhythms. This could contribute to the well-being of residents by providing lighting that supports natural sleep-wake cycles.

- **Augmented Reality (AR) for Maintenance:**

Explore the use of augmented reality for maintenance activities. Maintenance personnel could use AR devices to visualize real-time data, identify faulty components, and perform repairs more efficiently.

- **Smart Grid Integration:**

Integrate the Smart Street Light System with smart grid technologies. This integration can enhance energy management, allowing the system to respond to grid demands and optimize energy consumption in coordination with other utilities.

- **Climate-Responsive Lighting:**

Implement climate-responsive lighting strategies that take into account weather conditions, such as adjusting brightness during fog, rain, or snow for improved visibility and safety.

- **Enhanced User Engagement Strategies:**

Develop and implement strategies to enhance user engagement. This could involve gamification elements, community challenges, or incentives for users to actively participate in the optimization and maintenance of the system.

- **Environmental Monitoring and Reporting:**

Expand environmental monitoring capabilities to include air quality, noise levels, and other relevant factors. Provide real-time reporting and alerts to both administrators and the public, contributing to overall urban environmental awareness.

- **Edge Computing for Real-Time Processing:**

Implement edge computing capabilities at the street light level for more efficient real-time data processing. This can reduce latency and enhance the system's responsiveness to changing conditions.

- **Blockchain for Security and Transparency:**

Explore the use of blockchain technology for enhanced security and transparency in data transactions. This can provide a secure and tamper-proof record of sensor data and system actions.

- **Community-Driven Initiatives:**

Foster community-driven initiatives by providing platforms for residents to propose and vote on lighting strategies. This participatory approach can create a sense of ownership and community involvement
.

- **Vehicle-to-Infrastructure (V2I) Communication:**

Implement communication protocols for interaction with connected vehicles. The system could dynamically adjust lighting in response to traffic patterns and enhance safety for both pedestrians and drivers.

- **Solar and Renewable Energy Integration:**

Explore the integration of solar panels or other renewable energy sources to power street lights. This can contribute to sustainability and reduce reliance on conventional energy sources.

Continuous research, development, and collaboration with stakeholders will be key to unlocking the full potential of the Smart Street Light System and ensuring its adaptability to the changing needs of urban environments.

CHAPTER 10

CONCLUSION

This intelligent and smart project on street light will help us a lot for the maintenance of the street lights around the whole country. The project is very much user friendly and easy to implement. For various purpose and necessity, we can use all four features of the project. It will help us to reduce the inefficiency and waste of energy at the same time. In this project paper, we have described the research carried out by the researchers and different technology of the street lighting system followed by the countries around the world. We have shown in our project about how the street lights are connected and how they receive power with the help of diagrams. We have also discussed how the lights can be controlled in different ways. We have shown the working principle of the project with the circuit diagram, its key features and the changes that have to be made for its implementation in AC line. We have analyzed the wastage of power in conventional street lighting system, which can be saved by implementing our proposed system.

This project will be greatly beneficial to reduce the manpower necessary for the maintenance of street lights in highways. The number of people used there can be deployed somewhere else which will reduce the cost of total system and will make it a cost effective project. This project with a better maintenance will easily last longer than the typical system as well as it will digitalize the whole system and is convenient for an individual to control when necessary without any physical presence. The future aspect of smart street lighting is very emerging. Almost all the modern countries are nowadays replacing the existing street lights and modernizing the system. Replacing the existing system may cost some money but it can be easily overcome by the electrical power and maintenance cost, which will be saved by the new system and the system, is also more sustainable than the conventional switching and control system. With apparently low cost, if this system can be utilized properly, it will have a greater effect of functionality than the other systems.

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