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Mini Project Report

on

"SMART STREET LIGHT CONTROLLER"

Submitted in partial fulfillment of the requirements for the **First Semester of the Bachelor of Engineering Degree**, towards the completion of the **Mini Project** under the **Innovation & Design Thinking Laboratory**, Department of Basic Sciences.

by

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CERTIFICATE

This is to certify that the File Structures mini project entitled “SMART STREET LIGHT CONTROLLER” has been successfully carried out by Manvendra Singh Rao(N-58), M. Thanuj Abhinav Reddy(N-59), Meghana S.B. (N-60), bonafide students of **CMR Institute of Technology.**

The project is submitted in partial fulfillment of the requirements for the First Semester of the Bachelor of Engineering Degree, towards the completion of the Mini Project under the **Innovation & Design Thinking Laboratory, Department of Basic Sciences.**

It is further certified that all corrections and suggestions indicated during the Internal Assessment have been duly incorporated in the project report submitted to the departmental library. This File Structures mini project report has been reviewed and approved as it satisfies the academic requirements prescribed for the said degree.

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ACKNOWLEDGEMENT

I sincerely express my gratitude to **Dr. Sanjay Jain**, Principal, CMR Institute of Technology, Bangalore, for providing a supportive academic environment.

I extend my thanks to **Dr. Raveesha K H**, **HoD, Dept. of Physics, CMRIT** for his valuable guidance and support.

I am especially grateful to my internal guide, **Dr. Ashutosh Srivastava**, **Professor, Department of Electronics and Communication Engineering**, for her/his constant encouragement and guidance throughout this project.

I also thank all the faculty members, non-teaching staff, and others who contributed directly or indirectly to the successful completion of this work.

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ABSTRACT

Street lighting plays a vital role in public safety and urban infrastructure; however, conventional street lighting systems operate at full intensity throughout the night, leading to excessive energy consumption and increased maintenance costs. This project presents the design and implementation of a Smart Street Light Controller aimed at improving energy efficiency through sensor-based automation. The system utilizes an Arduino microcontroller as the central control unit, along with a Light Dependent Resistor (LDR) to detect ambient light conditions and Infrared (IR) sensors to sense vehicular or pedestrian movement. Based on the inputs received, the controller dynamically adjusts the brightness of LED streetlights, operating them at low intensity during low-traffic periods and increasing brightness when movement is detected. The proposed method ensures optimal utilization of electrical energy while maintaining adequate illumination for safety. Experimental results demonstrate reliable performance, accurate sensing, and a significant reduction in power consumption compared to traditional street lighting systems. The project confirms that a low-cost, scalable, and efficient automated lighting solution can effectively support smart city applications and sustainable energy management.

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Chapter 1

INTRODUCTION

Street lighting is an essential component of urban and rural infrastructure. Conventional street lighting systems are typically operated manually or through fixed-time schedules, causing lights to remain fully illuminated throughout the night regardless of actual usage. This results in excessive energy consumption and unnecessary operational costs. Smart street lighting systems address sustainable development by incorporating sensors and control units to dynamically regulate light intensity based on environmental conditions and human activity. This project focuses on the design and implementation of a sensor-based smart street light controller that enhances energy efficiency while maintaining adequate illumination for public safety.

1.1 Brief history of street light systems

The evolution of street lighting dates to the use of oil lamps and gas lamps in the 18th and 19th centuries, which provided limited illumination and required manual operation. With the advent of electricity, incandescent lamps were introduced, followed by fluorescent and high-intensity discharge lamps such as sodium vapor and metal halide lamps. These systems significantly improved brightness and coverage but lacked automation and energy efficiency. Streetlights were typically controlled using manual switches or simple timers, resulting in uniform illumination throughout the night. Although effective for basic lighting needs, traditional systems did not account for varying traffic conditions or ambient light levels, leading to energy wastage and increased maintenance requirements.

1.2 Modern streetlighting system

Modern street lighting systems integrate advanced technologies such as microcontrollers, sensors, and energy-efficient light sources to provide intelligent illumination. The widespread adoption of LEDs has significantly reduced power consumption and improved lifespan compared to traditional lamps. Sensors such as Light Dependent Resistors (LDRs) and motion sensors enable automatic detection of daylight conditions and human or vehicular movement. The transition to automated street lighting represents a crucial step toward sustainable energy management and intelligent urban infrastructure.

Chapter 2

Problem Statement

2.1 Description

Conventional street lighting systems operate at constant brightness throughout the night, irrespective of traffic density or environmental conditions. This continuous operation leads to excessive energy consumption, higher electricity costs, and unnecessary wear of lighting equipment. In many areas, street lights remain fully illuminated even during late-night hours when vehicular and pedestrian movement is minimal. Additionally, manual control and fixed-timer-based systems lack adaptability to changing daylight conditions, resulting in lights being turned ON earlier than required or remaining ON after sunrise. With increasing urbanization and rising energy demands, such inefficient lighting practices contribute significantly to power wastage and environmental impact. There is a pressing need for an automated solution that intelligently controls street lighting based on real-time conditions.

2.2 Challenge Statement

The primary challenge is to design a reliable and cost-effective street lighting system that minimizes energy consumption without compromising safety. The system must be capable of automatically detecting ambient light conditions and human or vehicular movement, adjusting light intensity accordingly. It should be simple to implement, require minimal maintenance, and be scalable for deployment in both urban and semi-urban areas. Achieving accurate sensing, efficient control, and consistent performance using low-cost components remains a key technical challenge addressed in this project.

Chapter 3

3.1 Design Thinking Process

a) **Empathize**: Upon talking to students and faculty members and observing existing street lighting practices, it was found that conventional streetlights remain fully operational throughout the night regardless of actual usage. Concerns were raised regarding excessive energy consumption, rising electricity costs, and lack of automation in current systems. These discussions helped identify the need for a smarter and more energy-efficient street lighting solution that maintains safety while reducing power wastage.

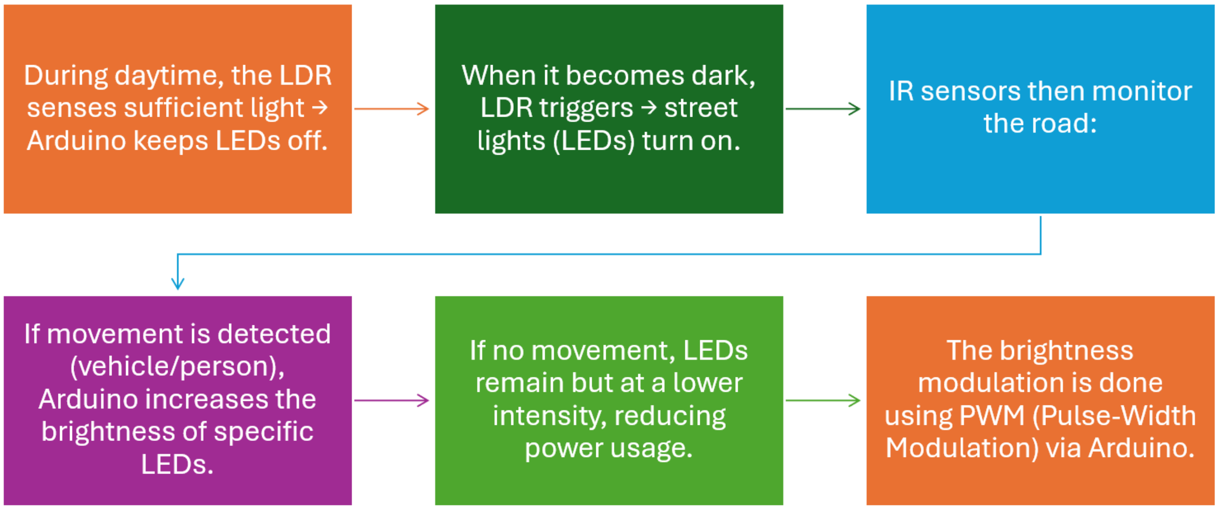
b) **Define**: The problem was defined as the absence of an adaptive street lighting system that can automatically adjust light intensity based on ambient light conditions and real-time movement. The goal is to reduce energy consumption while ensuring adequate illumination during night hours.

c) **Ideate**: Multiple approaches were considered, including manual control, timer-based systems, and sensor-driven automation. A microcontroller-based system using LDR and IR sensors was selected as an effective and low-cost solution for dynamic brightness control.

d) **Prototype**: A working prototype was developed using an Arduino, LDR, IR sensors, and LEDs. The system was programmed to operate automatically, switching OFF during daytime, dimming during low activity, and increasing brightness upon motion detection.

e) **Test**: The prototype was tested under various conditions and demonstrated reliable sensing and responsive brightness control, validating the effectiveness of the proposed design.

3.2 Methodology



3.3 Prototype Description

The prototype of the Smart Street Light Controller was designed to demonstrate automated and energy-efficient street lighting using low-cost electronic components. The system is built around an Arduino microcontroller, which acts as the central control unit. An LDR sensor is used to detect ambient light conditions and determine whether it is day or night. IR sensors are positioned to detect the presence of vehicles or pedestrians. LEDs are used to represent streetlights, and their brightness is controlled by the Arduino through programmed logic.

During daytime, the LDR senses sufficient light and keeps the LEDs switched OFF. At night, the system activates the LEDs in a dim mode to conserve energy. When motion is detected by the IR sensors, the Arduino increases the LED brightness to provide adequate illumination. Once the movement ceases, the LEDs return to dim mode. The prototype successfully simulates real-world street lighting behaviour and validates the feasibility of sensor-based automation for reducing power consumption.

3.3.1 Materials Used

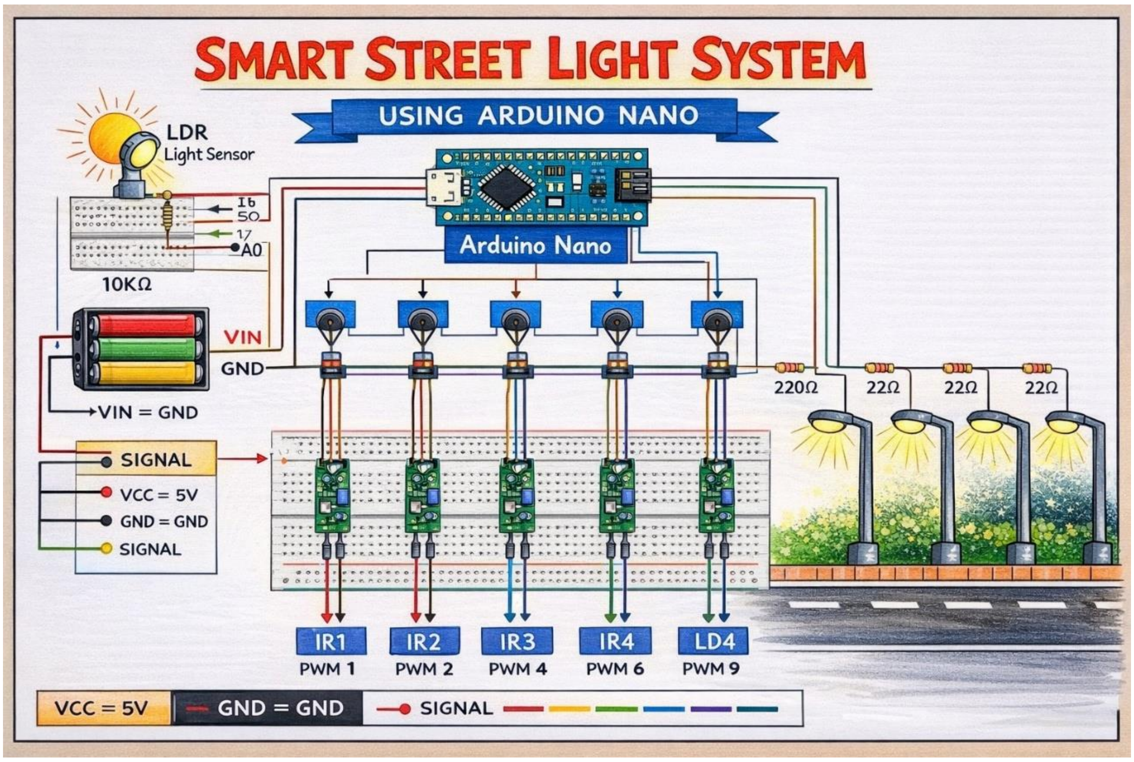
- **Arduino**: Arduino is a microcontroller-based development board used as the central control unit of the system. It processes inputs from sensors and controls the output devices based on programmed logic. It operates at 5 V with digital and analog input/output pins.

- **LDR (Light Dependent Resistor):** An LDR is a light-sensitive resistor whose resistance varies with the intensity of incident light. It is used to detect ambient light conditions for day–night operation. The resistance decreases as light intensity increases.

- **IR (Infrared) Sensors:** IR sensors are used to detect the presence of vehicles or pedestrians by sensing reflected infrared radiation. They operate at 5 V and provide a digital output to the microcontroller upon motion detection.

- **LEDs:** LEDs are energy-efficient light sources used to represent street lights in the prototype. They operate at low voltage and support brightness control using pulse-width modulation (PWM). LEDs offer high efficiency and long operational life.

- ## 3.3.2 System Diagram



Chapter 4

Implementation

Code used:

```
/ Smart Street Light (4-lamp version)

// Arduino Nano + LDR + IR Sensors + LEDs

// ---------------- PIN MAPPING ----------------

const int LDR_PIN = A0;                  // LDR analog pin

const int IR_SENSOR_PINS[4] = {2, 3, 4, 5}; // IR sensor digital pins

const int LED_PINS[4] = {3, 5, 6, 9};       // PWM pins for LEDs

// ------------- LDR THRESHOLDS ----------------

const int LDR_THRESHOLD_NIGHT = 400;  // below this = night

// ------------- LED BRIGHTNESS ----------------

const int LED_DIM  = 60;   // dim light (0–255)

const int LED_FULL = 255;  // full brightness

void setup() {

  Serial.begin(9600);

  pinMode(LDR_PIN, INPUT);

  for (int i = 0; i < 4; i++) {

    pinMode(IR_SENSOR_PINS[i], INPUT_PULLUP); // IR sensors are ACTIVE-LOW

    pinMode(LED_PINS[i], OUTPUT);

    analogWrite(LED_PINS[i], 0); // turn off initially

  }

}
```

```
void loop() {
  int ldrValue = analogRead(LDR_PIN);
  bool isNight = (ldrValue < LDR_THRESHOLD_NIGHT);
  // Debug (optional)
  // Serial.println(ldrValue);
  if (!isNight) {
    // DAY TIME → lights OFF
    for (int i = 0; i < 4; i++) {
      analogWrite(LED_PINS[i], 0);
    }
  } else {
    // NIGHT → dim lights
    for (int i = 0; i < 4; i++) {
      analogWrite(LED_PINS[i], LED_DIM);
    }
    // Check IR sensors
    for (int i = 0; i < 4; i++) {
      if (digitalRead(IR_SENSOR_PINS[i]) == LOW) { // object detected
        analogWrite(LED_PINS[i], LED_FULL);
      }
    }
  }
  delay(100);
}
```

Chapter 5

Results and Analysis

User Testing & Feedback

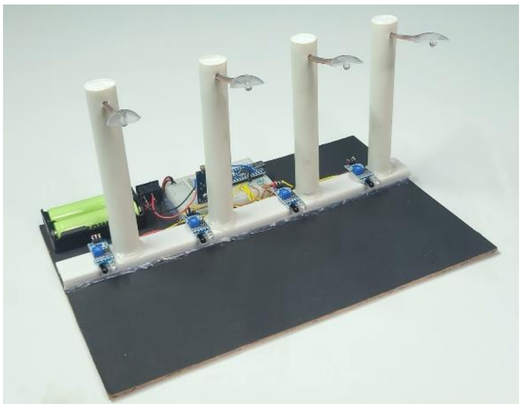
The Smart Street Light Controller prototype was successfully implemented and tested under various conditions to evaluate its performance. User testing was conducted by demonstrating the system to students and faculty members, who observed its automatic operation and responsiveness. Feedback indicated that the system effectively addresses energy wastage by adjusting light intensity based on real-time conditions.

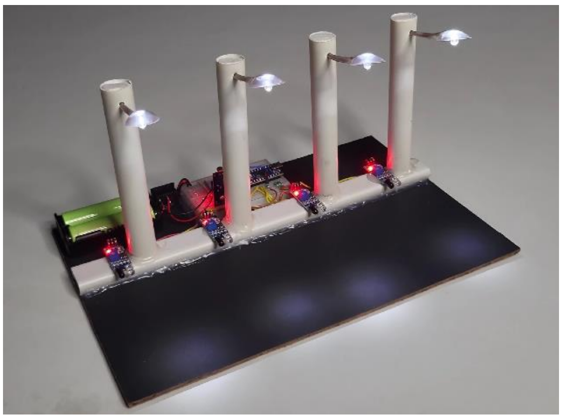
During testing, the LDR accurately detected ambient light levels, ensuring that the LEDs remained OFF during daytime and activated only during night-time. The IR sensors reliably detected movement, triggering an increase in LED brightness when vehicles or pedestrians were present. In the absence of movement, the lights returned to a dim mode, demonstrating efficient power management.

The observed results confirm that the hardware implementation operates as intended, providing adequate illumination when required while minimizing unnecessary energy consumption. The system's simplicity, reliability, and low-cost design make it suitable for small-scale applications and educational demonstrations, validating the effectiveness of sensor-based automated street lighting.

Screenshots of the developed software or website are included. Each screenshot is followed by a brief explanation describing its functionality and output.

The results demonstrate that the project objectives have been successfully achieved.





Chapter 6

Conclusion & Future Work

The Smart Street Light Controller project successfully demonstrates an automated and energy-efficient street lighting system using sensor-based control. By integrating an Arduino microcontroller with LDR and IR sensors, the system dynamically adjusts light intensity based on ambient light conditions and movement detection. The prototype effectively reduces unnecessary power consumption while ensuring adequate illumination for safety. The results validate the feasibility of implementing a low-cost and reliable smart lighting solution suitable for small-scale and educational applications.

Future work can focus on enhancing the system by incorporating IoT technology for remote monitoring and control. Features such as wireless communication, real-time energy consumption tracking, and fault detection can further improve system efficiency and scalability. Additionally, integrating solar power and advanced motion sensors can make the system more sustainable and suitable for large-scale smart city deployments.

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- "Smart Street Light – Instructables," *Instructables.com* — https://www.instructables.com/Smart-Street-Light/

Annexures

Annexure A – User Feedback Forms

Annexure B – Iteration Notes

Annexure C – Team Roles