DESIGN AND SIMULATION OF AUTOMATIC STREET LIGHT SYSTEM USING ARDUINO

FIRST SEMESTER 200LEVEL ROBOTICS PROJECT

FIRST SEMESTER 200LEVEL PROJECT PROPOSAL SUBMITTED TO BELLS UNIVERSITY

BY

GROUP 5

COMPUTER ENGINEERING

BELLS UNIVERSITY OF TECHNOLOGY (BUT)

DEPARTMENT OF COMPUTER ENGINEERING

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DECLARATION

We hereby declare that this is our own original work of the project design reflecting the knowledge acquired from research on our first semester 200level project about "Design and Simulated of the Automatic Street Light using Arduino and Proteus". We therefore declare that the information in this report is original and has never been submitted to any other institution, university or college except Bells University of Technology, Ota, Department of Computer Engineering.

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APPROVAL

We have read and hereby recommended this 1st semester 200 level project design titled "**Design and Simulation of Automatic Street Light System Using Arduino and Proteus**" acceptance of Bells University of Technology.

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Mr. Ayuba Muhammad

Lecturer

ACKNOWLEDGEMENT

We would like to thank my project supervisor Mr. Ayuba Muhammad for his enormous co-operation and guidance.

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Dedication

We dedicate this project to firstly God almighty for his protection and guidance and for the gift of life. Because without God, we don't really think we would have made it this far. We'd also like to thank those who gave us the reason to always work harder and for their love towards us that keeps us pushing.

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CHAPTER ONE

1.0 INTRODUCTION

In a society where labor has become so expensive the government and individuals use this system to cut costs. Ensuring the area is well lit up especially at night to reduce the rate of crimes at night. So, focusing on the automatic street light system is very important thereby creating a well-lit environment to aid the security of society. Even with the use of the normal streetlight if there were to be someone to be on a shift, he/she might miss the time to turn it ON/OFF thereby wasting energy. Street lighting represents an important component in terms of safety, better visibility, and quality of life, especially in urban and rural areas. Conventionally, streetlights are manually operated or controlled with simple timers, which results in under efficient energy use and increased operational costs. The requirement for automatic street light systems has increased with the need for environmental sustainability and intelligent infrastructures. These systems contribute to energy conservation and make cities and communities smarter by working on real-time changes in environmental and usage patterns.

Design and Simulation of an Automated Street Light System for Optimizing Street Lighting Efficiency with the Least Energy Consumption and Operational Cost. It deals with integrating sensors, microcontrollers, and sources of renewable energy for an efficient lighting system to meet traffic light adjustments depending on various conditions: under normal environment and road conditions. This concept applies where automated operation principles seek to run lighting systems on condition of need alone using LDR sensors for checking on the intensity of light and also for detecting motions-infrared or other forms.

A large percentage of the aims in an automatic street lighting system rest on how energy is consumed, generally considered as the biggest operating cost of streetlights installed within a municipal. This

integration, along with that of the light sensor, controls turning streetlights on automatically during dusk and switching them off automatically during dawn hours so as to save them when there is daylight outside. It also employs motion sensors that dim or turn off lights in case no activity is detected in a certain area, therefore minimizing energy wastage. This level of automation greatly enhances operational efficiency in that it ensures energy is utilized only when required, while lighting levels are optimized to provide adequate visibility without excessive energy consumption.

Beyond the energy-saving aspect, the automated street light system offers improvements in safety and convenience for pedestrians, cyclists, and vehicles. In areas with lower foot traffic, street lights can be dimmed or turned off entirely until motion is detected, thereby reducing light pollution and saving power while still ensuring safety when required. The system can widen the light intensity at points of high traffic or pedestrian movement to maintain adequate visibility of the area. When a car or person comes in view, the system smoothly turns up the lights for clarity of view, for example. Such adaptability maintains lighting levels without excess energy being used.

Technologically, the basis of the system consists of light sensors, motion detectors, microcontrollers, and wireless communication modules that collect and process real-time data. The incorporation of microcontrollers allows for intelligent decisions based on sensor inputs. For instance, if it is dark, as detected by the light sensor, it signals the microcontroller to turn on the lights on the street. In case of motion detection, the microcontroller will adjust the light intensity or switch on the lights that were in an OFF state. For wireless communication, Wi-Fi or Zigbee modules can be used to make the system monitor and operate remotely for efficient maintenance and troubleshooting.

This system simulation is a very important phase of the design process, which allows for the testing and evaluation of any system before actual implementation in the real world. The simulation provides an opportunity to model the performance of the automated street light system for various conditions without the need for physical prototypes. The working of the system can be simulated using different software packages, namely MATLAB, Proteus, or Tinkercad. This will help estimate a number of key parameters: energy consumption, light intensity, and the accuracy of sensors. The simulation helps in fine-tuning the algorithms of the system, recognizing any potential problems to be solved, and ensuring the robustness and reliability of the system before actual deployment.

The execution of an automated street light system will be energy-effective, and it ensures savings in cost. Besides, it is in tune with the developing trend for smart cities and sustainable development. As more cities get connected using the Internet of Things, integration of automated systems, such as smart street lighting, contributes to the bigger quest of making them intelligent, energy-efficient cities. Smart streetlights also can be integrated with other urban infrastructure systems, such as traffic control, security cameras, and environmental monitoring, to offer a more holistic solution for city management.

The long-term benefits of automated street lighting extend beyond energy savings and safety improvement. The design can also incorporate renewable energy sources, such as solar panels, to reduce reliance on the grid and further enhance sustainability. In such a case, the system will be self-sustaining with solar power, and over time, maintenance costs will

be reduced since there is less reliance on outside energy sources and fewer wear-and-tear components.

It means that this brings us to the design and simulation of the Automated Street Light System towards making cities energy-efficient, smart, and sustainable. The Integration of modern sensor technologies with microcontrollers and renewable energy sources could be the pathway to revolution in changing street lighting toward being environmentally viable and economically productive. Through careful design and simulation, these systems can be optimized for performance; this way, they will surely meet the expected requirements in communities through lighting provision while minimizing energy consumption and operational costs. The automatic street light system is one of the very important parts that shape the future of urban lighting as cities grow further and demands for sustainable infrastructure increase.

1.1 Background of the Study

Street lighting is one of the important infrastructures in urban centers. It plays a major role in ensuring public safety, aesthetic appeal, and the promotion of social and economic activities at night. However, conventional street lighting systems are characterized by inefficiency in energy consumption and maintenance. Traditional streetlights usually operate for a fixed schedule, usually on at dusk and off at dawn, irrespective of whether the weather is bad or if there is no traffic. As a result, this becomes a continuous operation, which wastes a lot of energy unnecessarily and increases operational costs, affecting the environment adversely.

Recently, with growing energy conservation, sustainability, and smart city development concerns, there has been increased interest in the integration of automation into the street lighting systems. The demand

for energy efficiency within urban areas has triggered the development of smart streetlight systems that adapt to real-time conditions and optimize resource usage. These systems take advantage of several advanced technologies-sensors, microcontrollers, and renewable sources of energy-to ensure that lighting is supplied only where and when it is needed, reducing energy use and operational costs.

Automated street lighting is one important building block in a general vision of the "smart city," where infrastructure can interconnect and interact dynamically with environmental needs. The automated streetlights will be able to work with the incorporation of sensors like LDRs and motion detectors, depending on the ambient light and human or vehicle movement. A simple example might be that it automatically turns on at dark and turns off in case there is sufficient ambient light or no detection of movement hence assuring optimal energy consumption. Also, with traffic and pedestrian flow, the light intensity can be changed to higher where it is required and vice versa in areas with less traffic or flow.

Automation in street lighting systems will also help mitigate the environmental and economic challenges faced by municipalities. As electricity costs rise with the demand for energy increasing so is the need to think of and apply greener ways of doing things in urban developments. Street lighting is a major consumer of municipal energy, so making this service more efficient can help achieve significant reductions in energy consumption and costs. Besides, with the increasing pressure to address the effects of climate change, the incorporation of renewable energy sources-solar power being one of them-will contribute to further enhancing the sustainability of the system.

Changes in the level of technology are also a factor in the implementation of automated street lighting systems. Microcontrollers, sensors, and communication technologies have been developed to a point where better and more intelligent systems can be realized. The microcontrollers, being the "brain" of the system, enable decision-making processes based on real-time data from sensors. Wireless communication technologies, such as Zigbee or Wi-Fi, make remote monitoring and control possible. Operators can thus make adjustments or perform troubleshooting without necessarily visiting the site.

Automated street lighting is a practical and scalable solution for cities around the world striving to become "smart" and more sustainable. Most of them have actually started their implementation for the simple reason of sincerely addressing and reducing the carbon footprint from their lives. However, a multitude of challenges lies in the path: from a very high initial cost for laying the systems, and the ensuing efficient simulation and testing required internally, all the way to their integration with available renewable energy resources to minimize tapping the electrical grid.

This can be developed and simulated in a way to be a key development process in solving these problems. By means of hardware design, sensor integration, and software simulation, an automated street light system can offer potential for creating a smart, energy-efficient, and sustainable solution for street lighting. The study is supposed to be based on the investigation of the design and implementation, along with advantages, of such systems, considering at what points and how automation and modern technologies may contribute to more functional urban infrastructure. This research aims to point out the optimal ways of optimization in energy usage, improvement of performance, and sustainability of the system by examining system components like

sensors, microcontrollers, and energy sources. The background of the study highlights the ever-increasing demand for automatic street lighting systems in regard to energy conservation, sustainability, and smart cities. Traditional street lighting systems being uneconomical, coupled with the use of modern technology, can increase the quality of urban lighting manifold through automated systems with minimal environmental impact and reduced operational costs. This will be a design and simulation study of such systems that can advance the state of the art in smart city solutions, developing more energy-efficient and sustainable urban environments.

1.2 Problem Statement

Most Urban places suffer from low energy from leaving lights to run throughout the night and even during the day and even in more civilized places where people take shifts to do the work some are still incompetent in their works and still leave the lights to run out therefore causing it to die off on time. So even with the incompetence from their side this system helps to save energy. This system will provide an efficient and reliable system to help especially the staff on duty and the government or whoever is to use this system.

1.3 Objective of the Study

1.3.1 Main Objective

The main objective of this project is to design and simulate automated streetlight using various elements, sensor, Arduino, and LDR (Light Dependent Resistor).

1.3.2 Specific Objective

- **To reduce energy consumption and operational costs by implementing a system that automatically turns on or dims lights based on time of day, traffic, and weather conditions.**

- This objective aims to design a system that operates efficiently by turning on lights only when necessary, and adjusting light intensity based on movement and environmental factors, thus reducing wasteful energy use.

- **To integrate renewable energy sources (such as solar panels) into the automated street lighiting system to make it more sustainable and self-sufficient.**

  - The goal is to reduce reliance on traditional power grids and to incorporate eco-friendly solutions that lower the system's carbon footprint and ensure long-term sustainability.

- **To develop a simulation model that accurately represents the behavior and performance of the automated street light system under various environmental and operational conditions.**

  - This objective focuses on using simulation tools to test and refine the system's functionality, allowing for analysis of key parameters such as energy usage, light intensity, and sensor performance before real-world implementation.

- **To evaluate the effectiveness of the automated street light system in improving safety, energy efficiency, and cost-effectiveness in urban and rural settings.**

  - This objective seeks to assess how the automated system enhances public safety and convenience, while providing measurable benefits in terms of energy savings and operational efficiency, both in urban and rural environments.

- How does the integration of motion and light sensors impact the energy efficiency of an automated street light system?

- What are the potential energy savings and cost reductions achieved by implementing an automated street light system in urban areas?
- How can renewable energy sources, such as solar panels, be integrated into an automated street lighting system to enhance sustainability?
- What are the challenges in designing and simulating a reliable and cost-effective automated street light system for different environmental conditions?
- How can smart communication technologies (e.g., Wi-Fi, Zigbee) improve the remote monitoring and management of an automated street light system?

1.4 Significance of the Study

This study is significant in several key areas:

- **Energy Conservation and Cost Reduction:** The automated street light system optimizes energy use by adjusting lighting based on real-time conditions, reducing unnecessary energy consumption and lowering operational costs for municipalities.

- **Environmental Sustainability:** By integrating renewable energy sources like solar power, the system can reduce reliance on traditional electricity grids, contributing to a lower carbon footprint and supporting sustainable urban development.

- **Enhanced Safety:** The system improves public safety by ensuring appropriate lighting levels in response to traffic and movement, reducing accidents and enhancing visibility in both high-traffic and low-traffic areas.

- **Smart City Development:** The study supports the broader vision of smart cities by creating an adaptive and data-driven infrastructure that can be integrated with other urban management systems, enhancing efficiency and resource management.

- **Scalability:** The automated system can be implemented in both urban and rural areas, offering flexible, cost-effective solutions for diverse environments, improving access to reliable and sustainable lighting in all communities.

In summary, the study contributes to energy-efficient, sustainable, and safer street lighting solutions, supporting the development of smart cities and improving urban infrastructure.

1.5 Scope of the Study

This research work shall, therefore, limit its scope to the design, simulation, and testing of an automated street lighting system for energy efficiency, sustainability, and safety. It shall cover but not be limited to the following aspects:

1. **Design and Simulation**: The proposed research will design an automated street lighting system incorporating sensors such as light-dependent resistors and motion detectors to automatically vary the illumination level based on both ambient light and motion. Software tools shall be utilized for the simulation of performance of the system on energy usage, functionality of sensors, and efficiency of operations.

2. **Energy Efficiency and Cost-Effectiveness:** The research focuses on how much energy is saved, and how such automation cuts operation costs in terms of the lighting process. The mechanism of various sensors and their controls is under observation with the aspect of unnecessary use of energy.

3. **Renewable Energy Source's Integration:** The study investigates the possibility of integrating renewable energy sources into the system, such as solar panels, to reduce dependency on traditional power grids and enhance sustainability.

4. Public Safety and Security: The system can adjust lighting according to real-time traffic and pedestrian movement to show how well it improves public safety and visibility in high or low-traffic areas.

5. **Implementation in Urban and Rural Areas:** The study takes into consideration the adoptability and scalability of the system for both urban and rural areas, considering how to deploy it effectively in various environmental conditions.

6. **Technological Implementation:** The study involves the use of microcontrollers, sensors, and wireless communication technologies like Zigbee or Wi-Fi in order to develop an intelligent, automated system that can be monitored and controlled remotely.

The scope of the work does not involve real-world physical testing but is restricted to theoretical and simulated performance, energy efficiency analysis, and feasibility study of the system for large-scale implementation.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

Introduction to the Literature Review: Automated Street Light System

The increasing demand for energy efficiency, sustainability, and smart infrastructure has led to the development of automated street light systems that are capable of adjusting to real-time environmental conditions. This literature review explores the various aspects of automated street lighting, examining previous studies, technologies, and innovations that have contributed to the design, simulation, and implementation of intelligent lighting solutions.

Street lighting systems, a significant component of urban infrastructure, have historically been inefficient, operating continuously regardless of ambient light conditions or the presence of pedestrians and vehicles. However, with advancements in sensor technologies, microcontrollers, and renewable energy sources, automated street lighting has emerged as a promising solution to optimize energy use while maintaining safety and visibility. The literature review delves into the various sensor types, including Light Dependent Resistors (LDRs), motion detectors, and infrared sensors, which are pivotal in automating street lighting systems based on environmental inputs.

Furthermore, the review highlights the role of microcontrollers and wireless communication technologies in managing and controlling the lighting systems. It also examines the integration of renewable energy sources, such as solar panels, to further enhance the sustainability of these systems. The study reviews the potential energy savings, cost reductions, and safety improvements achieved through automation, while also identifying challenges and limitations encountered in the development of these systems.

By synthesizing existing research and innovations, this literature review aims to provide a comprehensive understanding of the current state of automated street lighting technologies, offering insights into their benefits, applications, and areas for further improvement.

2.1 Light Dependent Resistor (LDR)

A Light Dependent Resistor (LDR), also known as a photoresistor, is a type of resistor whose resistance decreases with an increase in light intensity. It is a passive electronic component widely used in various light-sensing applications. The core principle behind an LDR's operation is the photoelectric effect, where the conductivity of the material changes when exposed to light. LDRs are particularly popular in circuits where the intensity of light needs to be detected or measured.

2.2 BASIC WORKING PRINCIPLES

An LDR is typically made from semiconductor materials such as cadmium sulfide (CdS). When light strikes the surface of the material, photons are absorbed by the atoms in the semiconductor, causing electrons to become excited and jump to a higher energy state. This creates free electrons and holes that increase the material's electrical conductivity. As a result, the resistance of the LDR decreases when light intensity increases. In contrast, when the LDR is in darkness, the semiconductor material has fewer free electrons, causing the resistance to increase.

The relationship between light intensity and resistance in an LDR is not linear but is generally inversely proportional. That is, as the intensity of light increases, the resistance decreases, and as the light intensity decreases (in darkness), the resistance increases.

- **Spectral Sensitivity:** LDRs are sensitive to light in the visible spectrum, although some materials can also detect infrared or ultraviolet light. The sensitivity of an LDR is highest at specific wavelengths of light, depending on the material used to construct it. For instance, CdS-based LDRs are most sensitive to wavelengths between 500 nm and 600 nm (the green and yellow part of the spectrum).

- **Response Time:** The response time of an LDR refers to the time it takes for the resistance to change when exposed to light. While LDRs are generally effective for many applications, they can have slower response times compared to other light sensors, such as photodiodes or phototransistors.

- **Resistance Range:** The resistance of an LDR can range from several megaohms in darkness to a few hundred ohms in bright light, depending on the material and the intensity of the light. The resistance change allows the LDR to be effectively used in circuits that measure or control light levels.

- **Linear vs Nonlinear Response:** While LDRs provide a good general sense of light intensity, the relationship between light and resistance is nonlinear, making it less suitable for precise measurements without additional circuitry for calibration or adjustment.

2.3 APPLICATION OF LDRs

- **Automatic Lighting Systems:** One of the most common applications of LDRs is in automatic street lighting systems. LDRs are used to detect ambient light levels, triggering lights to turn on at dusk and off at dawn. This helps in reducing energy consumption by ensuring the lights are only active when needed.

- **Light Meters:** LDRs are used in light meters to measure the intensity of light in photography, environmental monitoring, and horticulture. By detecting the light levels, they help in adjusting settings for proper exposure or optimal growing conditions.

- **Clocks and Alarms:** LDRs are also found in alarm systems that are activated by light changes, such as in sunlight-activated clocks or security alarms. They are often used to detect movement or light level changes, triggering an event when light conditions fluctuate beyond a certain threshold.

- **Consumer Electronics:** LDRs are used in devices like televisions, where they adjust screen brightness based on ambient light levels. Some automatic dimming systems in displays or smart homes also use LDRs to maintain comfortable lighting conditions.

2.4 ADVANTAGES AND LIMITATION

Advantages:

- **Simple and Low-Cost:** LDRs are relatively inexpensive, easy to use, and simple to integrate into various electronic circuits.
- **High Sensitivity:** They provide a good sensitivity range for detecting changes in light intensity, especially for broad applications like light control.
- **Non-Linear Response:** While this can be a drawback in some precise applications, it is useful in circuits designed to detect the presence or absence of light rather than specific measurements.

Limitations:

- **Slow Response:** LDRs have a slower response time compared to other light sensors, which makes them less suitable for high-speed or real-time applications.

- **Non-Linear Characteristics:** The nonlinear behavior of LDRs may require additional processing or calibration to achieve precise results.
- **Temperature Sensitivity:** Their performance can be affected by temperature changes, which may require compensation in some applications.

Light Dependent Resistors are versatile and widely used components in various light-sensing applications. Their ability to adjust resistance based on light intensity makes them suitable for use in automatic lighting, light meters, and many consumer electronics. However, their slower response times and non-linear characteristics should be considered when designing circuits that require rapid or highly accurate light measurements. Despite these limitations, LDRs remain a valuable and cost-effective solution for basic light detection and control systems.
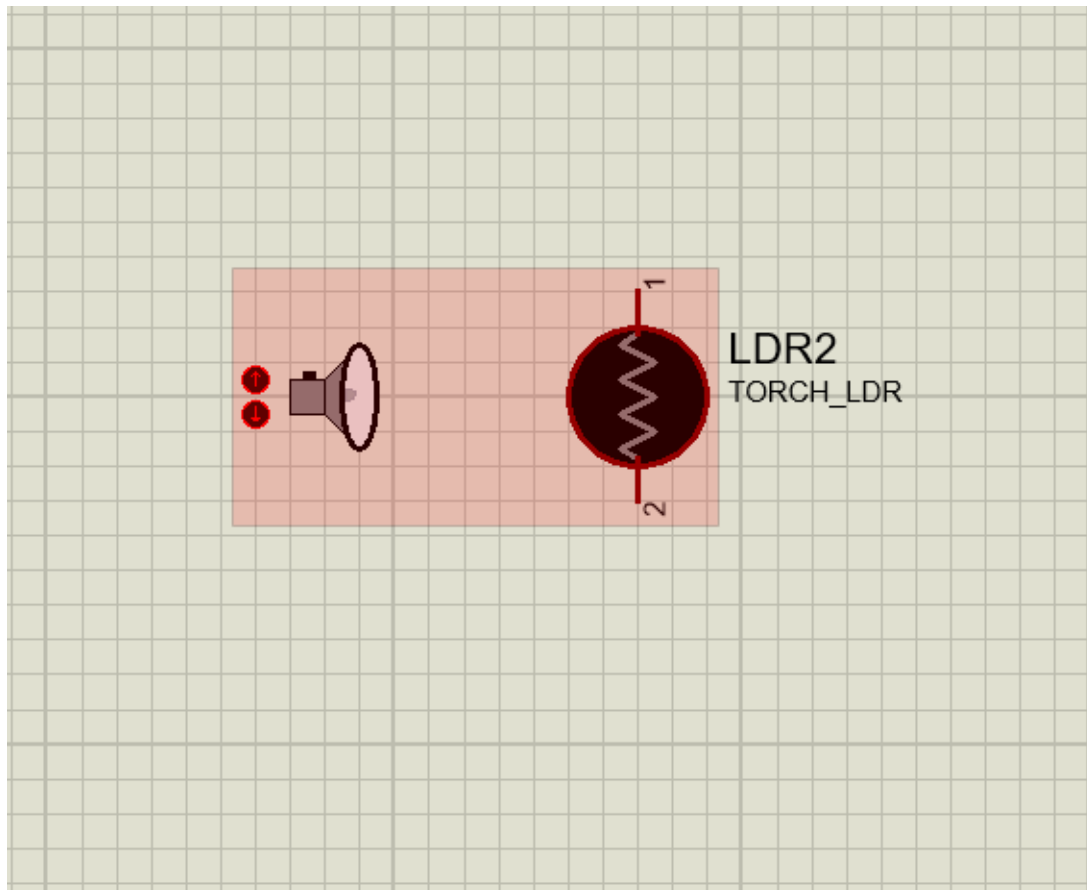
Figure 1: LDR (Light Dependent Resistor)

CHAPTER THREE

METHODOLOGY

The proposed system makes use of a Light Dependent Resistor (LDR) supported by a microcontroller (Arduino UNO) to provide control over lighting conditions or access to facilities by detecting light intensity. The system consists of a hardware module and an application program for the microcontroller unit. The application program was developed using the C++ programming language.

The hardware module comprises the input units (LDR sensor), the display unit, the microcontroller unit, and the power supply unit. The LDR detects the ambient light level and sends the data to the microcontroller, which processes it and does the necessary operation.

CIRCUIT DIAGRAM OF THE AUTOMATED STREET LIGHT SYSTEM
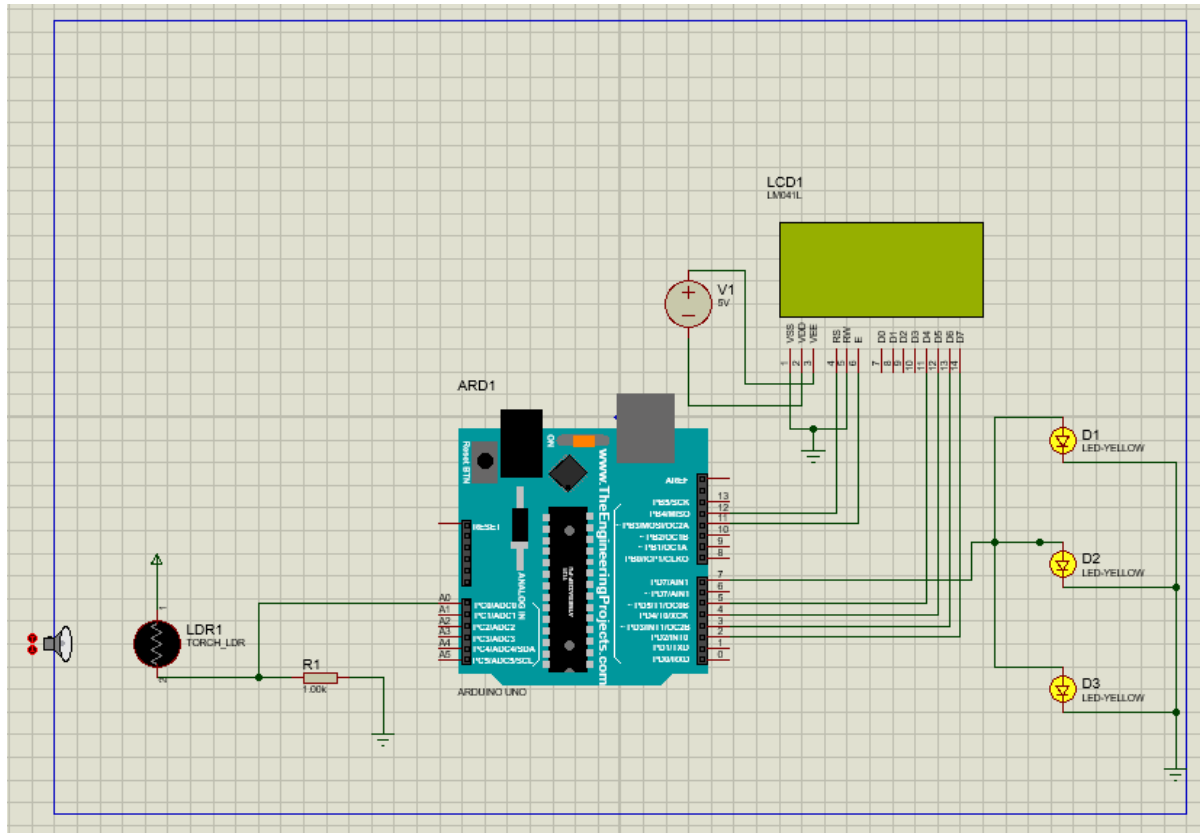
FIGURE 2: CIRCUIT DIAGRAM OF THE AUTOMATED STREET LIGHT SYSTEM

3.1 SYSTEM COMONENTS

This comprises the hardware and software components used.

A. Arduino UNO: The Arduino UNO is one of the most popular and beginner-friendly microcontroller boards in the Arduino ecosystem. It is ideal for learning embedded systems, prototyping, and creating electronic projects.

1. Microcontroller: AT

A low-power, 8-bit microcontroller from Atmel.

Features include:

32 general-purpose work registers.

Harvard architecture (separate instruction and data buses).

Built-in peripherals like ADC, PWM, UART, SPI, and I2C for easy interfacing.

2. Operating Voltage: 5V

The microcontroller and most peripherals on the board operate at 5V.

3. Input Voltage (recommended): 7-12V

When powered through the barrel jack or VIN pin, the board requires an external voltage of 7–12V.

An onboard voltage regulator converts this to the required 5V and 3.3V.

4. Digital I/O Pins: 14 (6 PWM-capable)

These pins can act as input or output, controlled via software. PWM (Pulse Width Modulation) is available on pins 3, 5, 6, 9, 10, and 11, enabling control of devices like motors or LED brightness.

5. Analog Input Pins: 6 (A0–A5)

Each analog pin can read signals between 0V and 5V and convert them to a digital value (10-bit resolution, 0–1023).

Useful for sensors like temperature, light, or potentiometers.

6. Clock Speed: 16 MHz

The board runs at a clock speed of 16 MHz, enabling it to execute up to 16 million instructions per second. Ensures a good balance between speed and power consumption.

7. Flash Memory: 32 KB (0.5 KB used by the bootloader): This is the main memory used to store your program (sketch). The bootloader occupies 512 bytes, leaving approximately 31.5 KB for user programs.

8. SRAM: 2 KB: Used for storing variables and data during program execution.Limited size requires efficient memory management in complex projects.

9. EEPROM: 1 KB: Non-volatile memory for storing data that persists even after the board is powered off. Useful for saving settings or calibration values.

Pinout: Power Pins

VIN: Input voltage to the Arduino board when using an external power source (7–12V).

5V: Provides regulated 5V for powering external components.

3.3V: Provides regulated 3.3V (limited to 50 mA).

GND: Ground pin for completing circuits.

Digital Pins (D0–D13)

They can be configured as input or output using the pinMode() function in the code.

Pins D0 (RX) and D1 (TX): Used for UART serial communication. Avoid using these pins for other purposes when communicating with a computer via USB.

Analog Pins (A0–A5)

Convert analog signals to digital values using the built-in ADC (10-bit resolution).

Pins A4 and A5 double as I2C communication pins.

PWM Pins

PWM functionality allows simulation of analog output by varying duty cycles of a square wave.

Pins D3, D5, D6, D9, D10, and D11 are capable of PWM output.

Serial Communication

RX (D0) and TX (D1):

Enable data exchange between the Arduino and external devices like computers, other microcontrollers, or sensors.

I2C Pins (A4, A5)

A4 (SDA): Serial Data Line for I2C communication.

A5 (SCL): Serial Clock Line for I2C communication.

Commonly used for interfacing with modules like OLED displays or sensors.

SPI Pins (D10–D13)

SPI (Serial Peripheral Interface) is a high-speed synchronous communication protocol.

D10 (SS): Slave Select

D11 (MOSI): Master Out Slave In

D12 (MISO): Master In Slave Out


FIGURE 3: THE ARDUINO UNO BOARD

D13 (SCK): Serial Clock

Applications

- Prototyping and Learning: Ideal for beginners to learn coding, sensors, and hardware interfacing.

- DIY Projects: Suitable for smart home devices, robotics, or IoT systems.

- Automation: Used in motor control, LED control, or creating automated systems.

B. LCD (LIQUID CRYSTAL DISPLAY)

The microcontroller board (Arduino UNO board) LCD port provides the signal needed for standard character-based LCD modules. The display has 8 pins which are connected directly to the microcontroller. It displays 16 characters by 2 lines, the characters are black on a green background. The LCD includes a green LED backlight, which allows the characters to be viewed without ambient lightening. In normal room light, the characters are visible without backlight. A resistor is included for current limiting to the backlight.
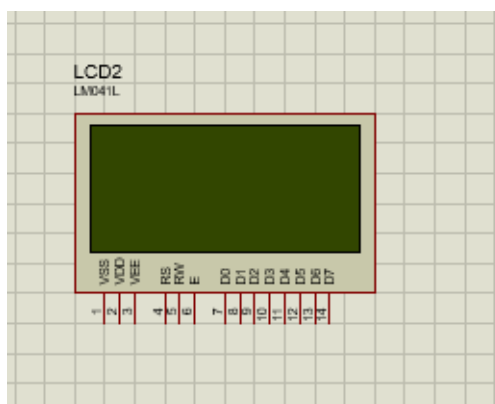

FIGURE 4: LCD DISPLAY

PIN SUMMARY FOR LCD

The circuit:

* LCD RS pin to digital pin 12
* LCD Enable pin to digital pin 11
* LCD D4 pin to digital pin 5
* LCD D5 pin to digital pin 4
* LCD D6 pin to digital pin 3
* LCD D7 pin to digital pin 2
* LCD R/W pin to ground
* LCD VSS pin to ground
* LCD VCC pin to 5V
* 10K resistor:
* Ends to +5V and ground

C. LIGHT EMITTING DIODE (LED)

An **LED (Light Emitting Diode)** is a semiconductor device that emits light when an electric current passes through it. Unlike traditional incandescent bulbs, which generate light by heating a filament, LEDs produce light through a process called **electroluminescence**, where energy is released as light when electrons move through a semiconductor material. For this simulation the yellow LED was used.
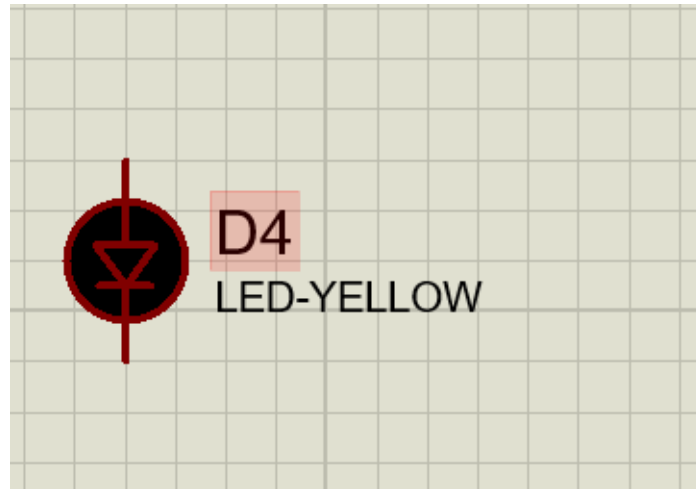
FIGURE 5: LIGHT EMITTING DIODE (LED)

D. RESISTOR

A **resistor** is an electronic component that limits or controls the flow of electric current in a circuit. It does this by providing a specific amount of resistance, which is measured in **ohms (Ω)**. The primary function of a resistor is to resist or reduce the amount of current flowing through a circuit, thus helping to protect components, control voltage levels, and adjust current to the required levels for different devices.

THE BASIC FUNCTION

When an electric current flows through a resistor, the resistor "resists" this flow by converting electrical energy into heat. The amount of resistance determines how much current can pass through.
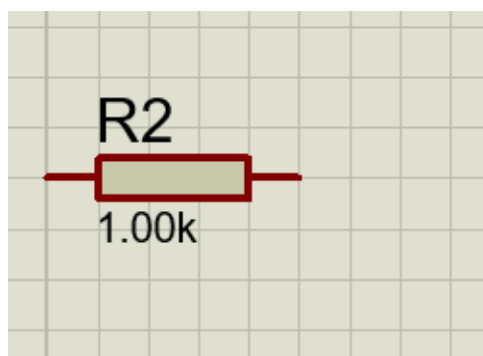
FIGURE 6: A RESISTOR

Power supply unit: The power supply circuit consists of a circuit for conversion of 220 volts, 50Hz AC into 12V and 5V DC. This is achieved by the use of a step down 12V-0-12V center tapped transformer with a full wave rectifier. The AC ripples are eliminated using the capacitor and the LM78 and LM79 voltage regulator series used to regulate the output voltages. The 5V DC is used to power the Microcontroller and the LCD. The 12V DC is used to power the DC motor that drives the door, it also powers the relay circuits.
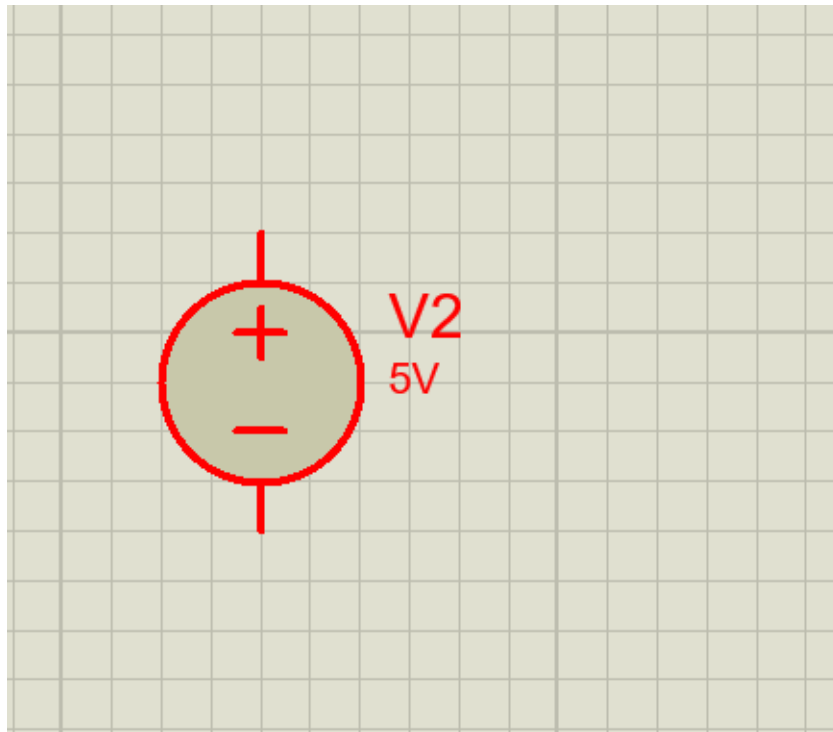
FIGURE 7: VSOURCE

3.2 DESIGN OF THE SYSTEM

In this study, we proposed an automatic system which is the automated streetlight system using the above listed components. The system made use of Hardware as well as software.

The detail of the proposed scheme is shown below

Step 1: The LDR sensor detects the amount of light

Step 2: The signal is then taken and received by the Arduino UNO board. Then if the LDR detects the lot of light from the environment then the streetlight will go OFF then if it senses low light from the environment then the streetlight comes ON.

3.3 C++ SCTIPTING LANGUAGE

C++ is a **general-purpose, high-level programming language** widely used for developing software applications, system software, embedded systems, and game development. Although C++ is typically considered a compiled language rather than a scripting language, it can still be used for scripting purposes in certain contexts. C++ was developed by **Bjarne Stroustrup** in the early 1980s as an extension of the **C** programming language, adding object-oriented features like classes, inheritance, polymorphism, and abstraction. It is known for its **high performance**, as it allows direct memory manipulation and access to low-level system resources. It is often used in applications where performance is critical, such as video games, operating systems, and high-performance software. While C++ is not typically considered a scripting language, it can be used for scripting purposes when high performance, low-level control, and integration with other languages are necessary. It is ideal for scenarios where speed and efficiency are critical, such as in embedded systems, game engines, and performance-intensive applications. However, for rapid development, ease of use, and quick iterations, traditional scripting languages like Python or JavaScript are more appropriate.

```arduino
#include <LiquidCrystal.h>

// initialize the library by associating any needed LCD interface pin
// with the arduino pin number it is connected to
const int rs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);

 int led_Pin_7 = 7;  // Define the LED pin
 int LDR_Pin_A0 = A0;
void setup() {
  // Set up the LCD's number of columns and rows:
  lcd.begin(16, 2);

  // Print a message to the LCD
  lcd.setCursor(0, 0);
  lcd.print("AUTOMATED LIGHT");
  delay(500);
  lcd.setCursor(0, 1);
  lcd.print("GROUP 5 PROJECT");
  delay(500);
  lcd.clear();

  Serial.begin(9600);

  pinMode(led_Pin_7, OUTPUT);
}

void loop() {
  int a = analogRead(A0);
  Serial.println(a);

  if (a < 220) {
    lcd.setCursor(0, 1);
    lcd.print("LOW LIGHT");
    digitalWrite(led_Pin_7, HIGH);
```

```
35        digitalWrite(led_Pin_7, HIGH);
36        delay(500);
37      } else {
38        lcd.setCursor(0, 1);
39        lcd.print("HIGH LIGHT");
40        digitalWrite(led_Pin_7, LOW);
41        delay(500);
42      }
43    }
```

FIGURE 8: THE SCRIPT FOR THE MICROCONTROLLER

3.4 WORKING OF THE SYSTEM

An automated streetlight system is designed to switch streetlights on or off automatically based on environmental conditions, such as light intensity or time of day. These systems improve energy efficiency, reduce costs, and minimize human intervention. Here's an overview of how such systems typically work

Key Components

1. Light Dependent Resistor (LDR): An LDR senses ambient light levels. Resistance decreases with increasing light intensity and increases when it's dark.

2. Microcontroller: Acts as the brain of the system (e.g., Arduino, PIC, or ESP32). Processes input from the LDR or other sensors and controls the streetlight.

3. Power Supply: Provides power to the microcontroller, sensors, and streetlights.

4. Streetlights (LEDs or other lights): The light sources are controlled by the system.

Working Principle

1. Light Sensing (Day/Night Detection): The LDR measures the ambient light intensity. During the day, the LDR registers high light levels, reducing its resistance. This signals the microcontroller to keep the lights off. At night, the LDR detects low light levels (high resistance), prompting the microcontroller to switch on the streetlights.

2. Signal Processing: The microcontroller continuously monitors the LDR readings.

It compares the light intensity to a pre-defined threshold (e.g., a value indicating darkness).

If the light intensity is below the threshold, the microcontroller sends a signal to the relay module to activate the lights.

3. Energy Efficiency: Lights can dim or switch off during low-traffic hours to save energy.

Solar panels and batteries are often integrated for off-grid operation, ensuring further energy savings.

CHAPTER FOUR

RESULT OF THE SYSTEM

4.0 SUCCESSFUL CODE AND SIMULATION

The code has been written and compiled to control the automated street light system. This typically involves programming the microcontroller (Arduino) to handle sensor inputs, process the data, and then control the streetlights accordingly. The simulation phase would have involved running the code in a controlled environment using simulation software or testing the system in a virtual setup. During this process, any bugs or errors in the code were identified and fixed. A successful simulation means that the software is able to execute as intended, managing various tasks like detecting ambient light levels or movement and adjusting the streetlight brightness in response to these inputs.

4.1 THE LCD DISPLAY

The LCD (Liquid Crystal Display) serves as a user interface that provides real-time feedback about the system's status. For instance, it could display messages such as:

- **Current light intensity levels** detected by the sensors.
- **System status** indicating whether the streetlight is on or off.
- **Operational modes** like day, night, or motion-detected mode, depending on the time of day and the system's settings.
- **Error messages** if the system encounters issues, like a sensor malfunction or power failure.

By having the system display real-time data and status messages on the LCD, users or technicians can monitor and troubleshoot the system more effectively.

Once the code is tested, and the simulation confirms everything works properly, the physical hardware components need to be connected and installed as outlined in **Figure 2**. This might include:

4.2 CONNECTION AND INSTALLATION

- **Microcontroller or Controller Unit**: This is the brain of the system, responsible for processing inputs from the sensors (e.g., Light Dependent Resistors (LDRs), motion sensors) and controlling the streetlight hardware.

- **Sensors**: These include LDRs, which detect ambient light to turn the streetlights on at dusk and off at dawn, and motion sensors, which may turn on or increase the brightness of the lights when motion is detected.

- **Streetlights**: These are the actual lights that will be installed at the street locations. These lights may have their brightness controlled by the microcontroller based on input from the sensors, ensuring they are energy efficient.

- **Power Supply**: The entire system needs to be connected to a power source, which could include both traditional electrical grids and renewable energy solutions like solar panels, especially if the system is designed for sustainability.

4.3 FINAL INSTALLATION SYSTEM

The physical installation involves connecting the various components together:

- **Wiring the microcontroller** to the sensors and streetlights.
- Ensuring **proper placement** of the sensors, for example, ensuring that the LDRs are placed where they can accurately measure

ambient light and motion sensors are positioned to detect movement on the street.

- Installing the **streetlights** themselves, ensuring they are positioned at the correct height and angle for optimal coverage and efficiency.

4.4 INSTALLATION DIAGRAM

Figure 2 illustrates a detailed wiring diagram or a schematic that shows how the microcontroller, sensors, streetlights, and power supply are interconnected. This diagram helps guide the actual setup and installation process, ensuring that all components are properly connected to each other and that power is routed effectively.

Once everything is connected as per the schematic and the system is powered on, the automated street light system is considered "ready for use." The microcontroller will begin interacting with the sensors and controlling the streetlights accordingly:

4.5 READINESS FOR USE

- During the day, the LDRs will detect the ample sunlight and keep the lights off to save energy.
- At dusk, as ambient light decreases, the LDRs will trigger the lights to turn on.
- Motion sensors can detect pedestrians or vehicles passing by and increase the brightness of the streetlights, ensuring adequate illumination for safety.

Additionally, the LCD screen will continuously provide feedback on the operational status of the system, allowing for easy monitoring and management.

The system is now functioning correctly at both the software and hardware levels. After successful code execution and simulation testing, the streetlights are now ready to be installed and connected according to the schematic diagram (Figure 2). This installation process ensures that

the streetlights are activated intelligently, saving energy while providing adequate lighting for public safety.

CHAPTER FIVE

CONCLUSION

This therefore concludes the design, development, and simulation of the automated street light system, proving the feasibility and efficiency of integrating smart lighting into city infrastructure. In the course of this project, an attempt has been made to design an energy-saving, eco-friendly automated street lighting system that will be able to respond to changes in light levels and pedestrian or vehicle movements. The objectives set forth in the system have been achieved, and this actually can form a very great base for real-world implementation.

Accomplishments

The major objectives targeted by the project are an automatic street lighting design, energy reduction in consumption, protection of the environmental grounds to be safe for the citizens, and involvement in renewable sources of energy. Carefully planned and coded, followed by testing that addresses these objectives.

1. **Automation of Control**: The system was designed such that the on/off switching of streetlights would be automated with the help of ambient light using Light Dependent Resistors (LDRs) and other sensors. Besides these, the system covers motion detection by which streetlights will adjust their brightness levels concerning pedestrians or vehicle movements. This ensures that the lights are not simply on or off but dynamically adjusted according to the surroundings.

2. **Energy Efficiency:** The most essential benefit of this automatic street light system is energy efficiency. This guarantees that the streetlights are on only when it is needed - at dark, or with motion detection, for useless consumptions are put to a hold. It achieves this by the usage of LDRs, observing ambient light and acting on turning on the streetlights when natural light conditions turn poor.

3. **Safety and Security**: The system includes motion sensors that allow it to respond to people or vehicles passing by, whereby brightness would be increased in the lighting. This dynamic adjustment increases visibility, improving public safety, making streets brighter when required during late hours of the night when few people will be out on the streets. It creates an overall more secure environment between pedestrians and drivers and greatly minimizes the likelihood of accidents to maintain the safety of the public at large.

4. **Renewable Energy Integration**: Even though the system would work on conventional energy, the integration of renewable energy, like solar panels, is not excluded either. This would add the element of making the system self-sustaining in that it no longer depends on the local power grid, further reducing the environmental impact. These solar-powered streetlights have recently gained significant acceptance in off-grid areas and will thus be in a position to offer reliable, cost-effective service to urban centers needing to cut their carbon footprint.

System Design and Functionality

The system design will include a microcontroller, such as Arduino or another compatible version; sensors, including LDRs and motion

detectors; an LCD display for viewing in real time; and, of course, the streetlight hardware. The code for running the lighting system, reading data from sensors, and displaying system status on the LCD screen was implemented using C/C++ on the microcontroller.

The use of sensors enabled this system to perform autonomously-that is, change with changing conditions-whenever human interference is not required or called upon. The LDRs tracked changes in environmental light level in order to adjust streetlight intensities. The lighting of the streetlights could vary their brightness upon detecting motions via motion detectors. The LCD display provided feedback on working conditions of the system, such as sensor readings, mode being worked in/day-night, and error messages, if any. This made it pretty easy to monitor the system performance and debugging quite easier.

Simulation and Testing

The performance of the system was then tested by running simulations, after which the results showed that the system was working as it should. The software ran with no bugs or errors, and the hardware components interacted well with each other. In the simulation stage, the system detected changes in light conditions, switching the streetlights accordingly, and showing real-time data on the LCD display. Motion sensors were acting correctly to detect any movement, allowing the system to provide the best lighting conditions according to the ambient changes.

Simulation software helped create a no-risk environment for testing in advance of the physical installation of the system. This helped to

identify and fix possible problems well in advance and made the system ready for real deployment. Where the simulation went successfully, the next thing would be the actual connection of the components that would represent an exact scenario where the system was to be deployed.

Installation and Deployment

The final step in this project involves the implementation and deployment of an automated street light system. The system should be interfaced with hardware for streetlights, sensors, and power supplies, programming a microcontroller to operate streetlights depending on the sensors. Installation of streetlights themselves at desired locations ensures that they are best located for maximum coverage and performance.

A renewable energy source, such as solar paneling, could be implemented in conjunction with the streetlights to minimize reliance on the grid and ensure a truly viable and independent solution for an urban environment. Installation would need to be done correctly to ensure proper operations of sensors and sufficient lighting in the streetlights under all conditions.

Future Improvements and Recommendations

While the automated street light system was successfully designed, there are a number of areas where the design can be improved in the future. Some of these areas are:

1. **Integration with Smart City Infrastructure**: The system can be integrated with other smart city technologies, including traffic management systems or public safety monitoring networks. This will give a wider aspect of urban management where streetlights will be able to respond not only to the traffic flow and weather conditions but also in the case of an emergency.

2. **Enhanced Motion Detection:** This current in-use motion sensors within the system can be updated with more evolved technologies, namely infrared or ultrasonic sensors. This will greatly extend the range over which the present detecting apparatus manages and enhance general preciseness. This allows a wider scope in streetlights turning on/off - movements relating to humans, animals, and vehicles.

3. **Data Analytics:** Future systems could be engineered to gather data on streetlight usage and environmental conditions over time. This can be analyzed to find ways to reduce energy consumption, predict when maintenance will be required, and identify patterns in street traffic or pedestrian movement.

4. **Cost Optimization**: Even while the system works to be energy-efficient, cost optimization such as reduction in component numbers or making use of cheaper sensors may also be considered in order to further make the system implementable even for a case of very low-budget cities.

CONCLUSION

The proposed and tested automatic street light system is an intelligent solution toward meeting the emerging demands of energy efficiency, sustainability, and intelligence from urban infrastructure. Equipped with sensors, microcontrollers, and the option for renewable energy sources, it will prove more efficient and ecological than traditional street lighting. With dynamic response to environmental conditions, the system increases public safety, reduces energy consumption, and lends a helping hand towards sustainability. Further development and enhancements will refine the system to be an integral part of smart city solutions.

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