IOT BASED SMART STREET LIGHT

ABSTRACT

People in today's modern environment expect to have all of their needs met. Scientific and technological advancements are speeding up to meet this human demand. The Internet of Things (IoT) is a critical component of technology's rapid advancement. For example, we now use a manual technique to turn on street lights, which wastes a lot of energy throughout the world and should be changed. The Smart Street Light System, which is powered by the Internet of Things, aims to conserve energy by reducing electrical waste while simultaneously reducing operating costs. The LDR sensor is used to switch the street light on and off dependent on the amount of ambient light. It's a simple light/dark switch. This project makes use of a programmable Arduino UNO board to deliver the proper light intensity at different times. When compared to the current system, the proposed work

INTRODUCTION

A smart street light is an automated version of the street light that will help us save the energy and also its operational cost. Lighting the streets is one of the expensive things done by the cities. If the smart street lights are installed in places, it can reduce the cost up to 50%. To make the street lights smart, we use the LDR sensor and IR sensor. light dependent resistor has variable resistance which changes with the intensity of light falling upon it while IR sensor measures the flow of people or vehicles in the street. Using this property of LDR and IR sensors we can make our street lights smart and efficient. According to the model we have presented, the lights will be completely off during the day light and will glow dimly when it starts to get dim, the lights will glow with more intensity when it senses the flow of vehicles or people in the street saving us 50% or more energy

OBJECTIVE

1. Energy Efficiency: Implement a system that dynamically adjusts the brightness of street lights based on real-time factors such as ambient light levels, traffic flow, and pedestrian activity to optimize energy usage and reduce carbon emissions.
2. Enhanced Safety: Enhance public safety by providing adequate illumination where and when it's needed, leveraging features such as motion sensing and adaptive lighting to improve visibility and deter crime in high-risk areas.
3. Cost Reduction: Reduce operational costs associated with street lighting through predictive maintenance, remote monitoring, and fault detection capabilities, thereby maximizing the lifespan of equipment and minimizing maintenance expenses.

4. Data-driven Decision Making: Collect and analyze data from sensors embedded within the street light infrastructure to gain insights into traffic patterns, environmental conditions, and usage trends, enabling data-driven decision-making for urban planning and resource allocation.
5. Scalability and Interoperability: Design a scalable and interoperable system architecture that can accommodate future expansion and integration with other smart city initiatives, ensuring compatibility with existing infrastructure and emerging technologies.

EXISITING SYSTEM

Traditional street lighting systems have been the backbone of urban infrastructure for decades, providing illumination for roads, sidewalks, and public spaces. However, these systems are plagued by several limitations that hinder their efficiency, effectiveness, and sustainability.

1. **Fixed Illumination Levels**: Conventional street lighting systems typically operate on fixed schedules or rely on photocells to switch lights on/off based on ambient light levels. This static approach fails to adapt to dynamic factors such as varying traffic patterns, weather conditions, or changes in pedestrian activity, leading to inefficient energy usage.

2. **High Energy Consumption**: Traditional street lights, often equipped with high-pressure sodium or metal halide lamps, consume significant amounts of energy. The constant operation of these lights at full brightness, regardless of actual lighting needs, results in unnecessary energy wastage and contributes to high electricity bills and carbon emissions.

3. **Limited Monitoring and Control**: Conventional street lighting systems lack real-time monitoring and control capabilities, making it challenging for maintenance personnel to identify faults, malfunctions, or inefficiencies promptly. This limitation can lead to prolonged downtime, increased maintenance costs, and compromised safety for pedestrians and motorists.

4. **Maintenance Challenges**: Maintaining traditional street lighting infrastructure can be labour intensive and costly. Identifying malfunctioning lights, replacing bulbs or fixtures, and addressing wiring or electrical issues often require manual inspection and intervention, leading to delays and disruptions in service.

5. **Environmental Impact**: High-energy consumption and inefficient operation of traditional street lighting systems contribute to environmental degradation and climate change. The carbon footprint associated with energy generation and consumption exacerbates environmental challenges and undermines efforts towards sustainability.

PROPOSED SYSTEM

The proposed smart street light IoT system represents a paradigm shift in urban lighting infrastructure, leveraging the capabilities of Internet of Things (IoT) technology to create intelligent, energy-efficient, and sustainable lighting networks. The system introduces several innovative features and functionalities aimed at addressing the limitations of traditional street lighting systems and optimizing the overall performance and efficiency of urban lighting infrastructure.

1. **Dynamic Lighting Control**: Unlike conventional street lighting systems with fixed illumination levels, the proposed system incorporates dynamic lighting control capabilities. Using data from various sensors, including ambient light sensors, motion sensors, and environmental sensors, the system dynamically adjusts the brightness of street lights in real-time based on changing conditions such as traffic density, pedestrian activity, weather conditions, and time of day. This dynamic control mechanism ensures optimal illumination levels while minimizing energy consumption and light pollution.

2. **Remote Monitoring and Control**: The proposed system enables remote monitoring and control of individual street lights through a centralized control unit. Maintenance personnel can access a web-based dashboard or mobile application to monitor the status of each street light, receive real-time alerts for faults or malfunctions, and remotely adjust lighting settings as needed. This remote monitoring and control functionality streamline maintenance operations, reduce response times to issues, and minimize downtime, ensuring continuous and reliable operation of the lighting infrastructure.

3. **Energy Efficiency and Sustainability**: By dynamically adjusting lighting levels and optimizing energy usage based on actual requirements, the proposed system significantly enhances energy efficiency and sustainability. The use of energy-efficient LED luminaires further reduces energy consumption and carbon emissions compared to traditional lighting technologies. Additionally, the system incorporates features such as dimming schedules, motion-based activation, and adaptive lighting algorithms to further enhance energy savings without compromising safety or visibility.

4. **Data Analytics and Insights**: The proposed system collects and analyzes data from sensors deployed across the lighting network to generate valuable insights into usage patterns, environmental conditions, and performance metrics. These insights can inform strategic decision-making, infrastructure planning, and policy formulation aimed at optimizing urban lighting infrastructure, enhancing public safety, and improving overall quality of life in urban areas.

5. **Scalability and Interoperability**: The proposed system is designed to be scalable and interoperable, allowing for seamless integration with existing infrastructure and future expansion. Modular components, standardized communication protocols (e.g., Zigbee, LoRa, MQTT), and open-source software platforms facilitate interoperability and compatibility with third-party systems and devices, enabling cities to build upon existing investments and adapt to evolving technology trends and requirements.

BLOCK DIAGRAM AND CIRCUIT DIAGRAM

The block diagram illustrates the key components and their interactions within the smart street light IoT system. Each component plays a crucial role in the overall functionality of the system, enabling dynamic lighting control, remote monitoring, and energy optimization.

1. **Street Light Fixture**: At the core of the system are the street light fixtures equipped with LED luminaires, sensors, microcontrollers, communication modules, and power supplies. These components enable individual street lights to collect data, adjust lighting levels, and communicate with the central control unit.

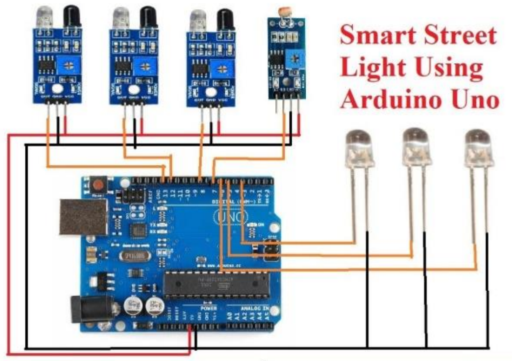
2. **Sensors**: Ambient light sensors, motion sensors, and environmental sensors are deployed within each street light to collect data on various parameters such as light intensity, motion, temperature, humidity, and air quality. These sensors provide real-time inputs to the microcontroller for decision-making.

3. **Microcontroller**: The microcontroller acts as the brain of the street light, processing data from sensors and executing control algorithms to dynamically adjust lighting levels based on environmental conditions and predefined criteria. It also manages the operation of other components within the street light.

4. **Communication Module**: A communication module, such as Zigbee, LoRa, or Wi-Fi, enables wireless communication between street lights and the central control unit. This allows for real-time data exchange, remote monitoring, and control of individual street lights from a centralized location.

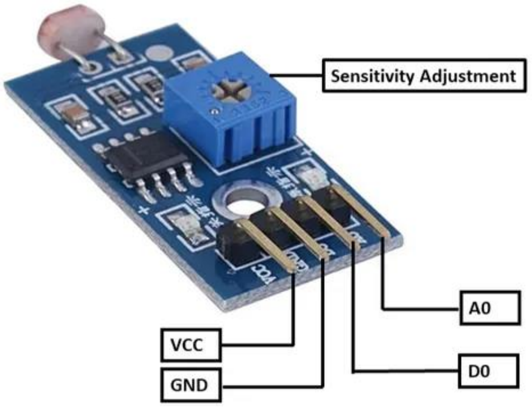
5. **Central Control Unit**: The central control unit serves as the nerve center of the system, receiving data from all street lights, analyzing it, and sending commands for adjusting lighting levels as necessary. It also provides a user interface for maintenance personnel to monitor the status of street lights and receive alerts for maintenance or troubleshooting.

6. **Power Supply**: The power supply provides the necessary electrical power to operate the street light and its components, including the LED luminaire, sensors, microcontroller, and communication module. It ensures reliable and uninterrupted operation of the system.

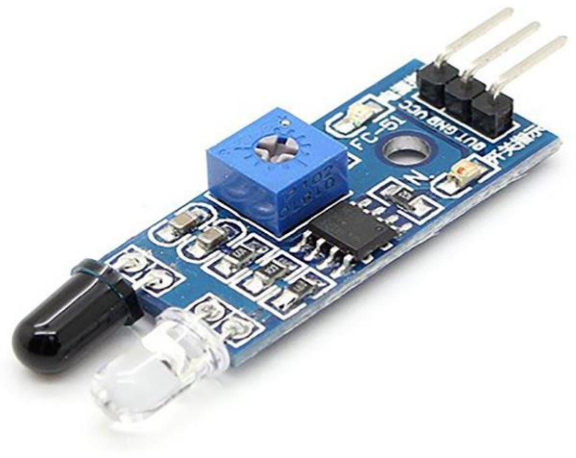


Components Used

LDR Sensor Module: A tool used to detect light is called an LDR Sensor (light dependent resistor). It has variable resistance that varies depending on the amount of light hitting it. They may now be employed in light sensor circuits as a result. A photoresistor, photocell, or photoconductor are other names for an LDR, or lightdependent resistor

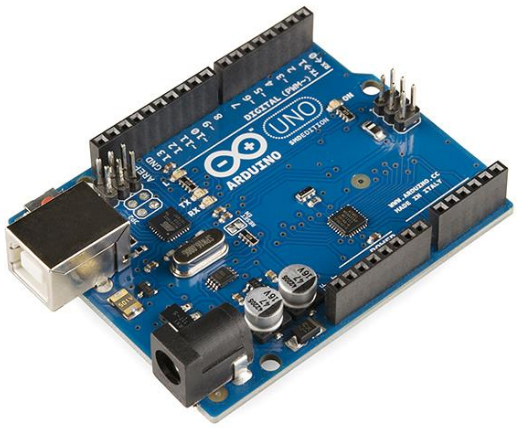


IR Sensor: An electrical gadget known as an IR sensor emits light in order to detect nearby objects. Both the heat and motion of an item may be measured by an IR sensor. Typically, all items emit some kind of heat radiation in the infrared range. Although these kinds of radiations are undetectable to the human eye, infrared sensors can pick them up



LED: A light source known as a light emitting diode produces light when current flows through it. The semiconductor's electron is recombined with electron holes, releasing energy in the form of photons.

Arduino UNO: The Arduino UNO is a Microchip product built on a microcontroller board with an open source design. The board is equipped with a number of analog and digital I/O (input or output) pins that may be connected to other circuits, shields, and evolution boards. The interface employs the original STK500 protocol.



WORKING MODEL

The working model of the smart street light IoT system involves the seamless integration of hardware and software components to achieve efficient and intelligent lighting control. The following steps outline the operation of the system:

1. **Data Collection**: Sensors installed on each street light continuously monitor environmental parameters such as ambient light levels, traffic density, and weather conditions.

7. **Data Processing**: The microcontroller within each street light processes the incoming data and determines the appropriate lighting level based on predefined algorithms.
8. **Wireless Communication**: The street light communicates with the central control unit via wireless communication protocols such as Zigbee, LoRa, or Wi-Fi.
9. **Centralized Control**: The central control unit receives data from all street lights, analyzes it, and sends commands for adjusting lighting levels as necessary.
10. **Remote Monitoring and Control**: Maintenance personnel can remotely monitor the status of each street light and receive alerts in case of any issues or malfunctions.
11. **Dynamic Adjustment**: The system dynamically adjusts lighting levels in real-time based on changing environmental conditions, optimizing energy usage and ensuring optimal visibility on streets.

Method

The LDR sensor, IR sensor and Arduino UNO are tested individually and then integrated aas per the setup. The smart street light system uses the LDR's property of variable resistance to identify day and night and IR's general property to identify the flow of traffic. During the day, the light remains completely turned off. During the night wheen the IR sensor doesn't sense any traffic, the light remains turned on but dim and when the IR sensor senses some traffic, the light gglows with higher intensity. I used the device during different times of day and also with different intensity of lights to check the performance and accuracy of the device.

CODE:

```
int IR1 = 8;
int IR2 = 12;
int IR3 = 13;
int LDR = 7;
int led1 = 3;
int led2 = 5;
int led3 = 6;
int val1;
int val2;
int val3;
int val4;

void setup()
{
pinMode(IR1,INPUT);
pinMode(IR2,INPUT);
```

```
pinMode(IR3,INPUT);
pinMode(LDR,INPUT);
pinMode(led1,OUTPUT);
pinMode(led2,OUTPUT);
pinMode(led3,OUTPUT);

}

void loop() {
val1 = digitalRead(IR1);
val2 = digitalRead(IR2);
val3 = digitalRead(IR3);
val4 = digitalRead(LDR);

if(val1==1&&val4==0&&val2==1&&val3==1)
{
digitalWrite(3,LOW);
digitalWrite(5,LOW);
digitalWrite(6,LOW);

}
else if(val1==1&&val4==1&&val2==1&&val3==1)
{
analogWrite(3,20);
analogWrite(5,20);
analogWrite(6,20);
}

else if(val1==0&&val4==1&&val2==1&&val3==1)
{
analogWrite(3,500);
analogWrite(5,20);
analogWrite(6,20);
}
else if(val1==1&&val4==1&&val2==0&&val3==1)
{
analogWrite(3,20);
analogWrite(5,500);
analogWrite(6,20);
}
else if(val1==1&&val4==1&&val2==1&&val3==0)
{
analogWrite(3,20);
analogWrite(5,20);
analogWrite(6,500);
}
}
```

OUTPUT

Sketch uses 1346 bytes (4%) of program storage space. Maximum is 32256 bytes.

Global variables use 15 bytes (0%) of dynamic memory, leaving 2033 bytes for local variables. Maximum is 2048 bytes.

ADVANTAGES:

1. Energy Efficiency: Smart street lights can dynamically adjust their brightness based on factors like ambient light levels and traffic conditions, leading to significant energy savings compared to traditional street lighting systems.
2. Cost Savings: By using sensors and IoT technology, municipalities can optimize maintenance schedules, detect faults remotely, and reduce operational costs associated with street lighting.
3. Enhanced Safety: Smart street lights can improve public safety by providing better illumination where and when it's needed, such as dimming lights in less trafficked areas to conserve energy and brightening them when pedestrians or vehicles are detected.
4. Environmental Impact: With energy-efficient LED technology and smart control systems, smart street lights can reduce carbon emissions and contribute to a more sustainable environment.
5. Data Collection and Analysis: Smart street lights equipped with sensors can gather valuable data about traffic flow, air quality, and weather conditions, which can be used for urban planning, traffic management, and environmental monitoring.

APPLICATIONS:

1. Urban Street Lighting: Smart street lights can be deployed in urban areas to provide efficient and adaptive lighting solutions tailored to the specific needs of different locations and times.
2. Highways and Expressways: Along highways and expressways, smart street lights can adjust brightness levels based on traffic flow, weather conditions, and visibility requirements to enhance safety and reduce energy consumption.
3. Public Parks and Walkways: Smart street lights can be installed in public parks and walkways to improve safety for pedestrians and cyclists, with features like motion sensing to illuminate pathways as needed.
4. Commercial and Industrial Zones: In commercial and industrial zones, smart street lights can provide enhanced security by integrating with surveillance systems and alerting authorities to suspicious activities.
5. Smart City Initiatives: Smart street lighting is often a cornerstone of broader smart city initiatives, contributing to a more connected and sustainable urban environment through data-driven decision-making and resource optimization.

FTURE ENHANCEMENT OR SCOPE FOR IOT-BASED SMART STREET LIGHT PROJECT:

1. Integration with Traffic Management Systems: Future enhancements could involve integrating smart street lights with traffic management systems to optimize traffic flow, reduce congestion, and improve overall urban mobility.
2. Advanced Sensor Technologies: Incorporating advanced sensor technologies such as LiDAR (Light Detection and Ranging) or cameras with image recognition capabilities can enable more sophisticated detection and analysis of environmental conditions and traffic patterns.
3. Predictive Maintenance: Implementing predictive maintenance algorithms can help anticipate and prevent equipment failures, reducing downtime and maintenance costs.
4. Energy Harvesting: Exploring energy harvesting techniques, such as solar panels or kinetic energy converters, can further enhance the sustainability of smart street lighting systems by reducing reliance on the grid.
5. Enhanced Connectivity: Leveraging emerging communication technologies like 5G or low-power wide-area networks (LPWANs) can improve the reliability and responsiveness of smart street light networks, enabling real-time monitoring and control from centralized management platforms.
6. Community Engagement: Involving local communities in the design and implementation of smart street lighting projects can help ensure that the system meets the needs and preferences of residents while fostering a sense of ownership and pride in the neighborhood's infrastructure.

CONCLUSION

This project is the cost effective, eco-friendly and safest way to save energy and also reduce its expenses. It tackles the two main problems the world is facing today: saving of energy and also disposal of incandescent lamps. We can also keep track of the status of light by replacing the arduino uno with node mcu and integrating it with the blynk application; an app that tracks the real time status of the IoT projects.

REFERENCES

1. Parkash, P. V., & Rajendra, D. (2016). Internet of things based intelligent street lighting system for smart city. International journal of innovative research in science, engineering and technology, 5(5). 2. Kokilavani, M., & Malathi, A. (2017). Smart street lighting system using IoT. Int. J. Adv. Res. Appl. Sci. Technol, 3(11), 08-11. 3. Mohd. Saifuzzanman, and Nazmun Nessa Moon, Femaz Narin Nur. “IoT Based Street Lighting and Traffic Management System”. IEEE Region 10 Humanitarian Technology Conference (R10-HTC), 2017.