Smart Street Light using Iot

1. INTRODUCTION

1.1 OVERVIEW

Smart street lights are a type of lighting infrastructure that uses advanced technologies to improve energy efficiency, reduce maintenance costs, and enhance public safety. These lights incorporate sensors, communication networks, and intelligent control systems to enable remote monitoring and management of the lighting system. The key features of smart street lights include:

1. Energy efficiency: Smart street lights use LED bulbs and dimming capabilities to reduce energy consumption and lower costs.

2. Remote monitoring and control: These lights can be remotely controlled and monitored using a centralized management system, allowing for efficient maintenance and rapid response to issues.

3. Sensor integration: Smart street lights can be equipped with sensors to detect motion, temperature, air quality, and other environmental factors, providing valuable data for city planners and emergency responders.

4. Autonomous operation: Some smart street lights are equipped with artificial intelligence (AI) and machine learning capabilities, allowing them to adjust lighting levels and respond to changing conditions automatically.

5. Public safety: Smart street lights can incorporate cameras, microphones, and other sensors to enhance public safety and security.

Overall, smart street lights offer a range of benefits to cities and municipalities, including energy savings, cost reductions, improved safety, and enhanced data collection capabilities.

1.2 PURPOSE

The aim of Pervasive Computing Based Smart Street Light System is the conservation of energy by reducing electricity wastage as well as to reduce the manpower. The role of smart lighting solutions in the intelligent transformation of cities and buildings has gained momentum in the past years.

This development will continue in the coming years based on increased connectivity and internet of things solutions becoming a key element in most smart city strategies around the globe. The opportunities that cities can seize with the installation of smart lighting solutions go far beyond value creation through energy (cost) and maintenance savings or the improvement of the environmental impact. We are implementing three ideas:

Firstly by using sensors we can detect when sunsets and sunrises are taking place according to that automatically the street lights will be switched on and off. Secondly if any fire accident occurs then the alert buzzer will be indicated to the control panel in centralized light. For a specific street light the alarm sound will be buzzed. Thirdly whenever the obstacle passes through any street light the particular portion of light will be turned on.

By implementing these three ideas there will be reduction of electricity wastage and the people will be able to save if any accidents occurs. So that many lives can also be saved because the help will be reached to the incident spot earlier and faster. The buzzer in the centralized light will alert the nearby people so that they will do the needful. Street Lighting helps to reduce night-time crashes by improving visibility. And Can reduce pedestrian crashes by approximately 50% and help to aid navigation. Street lighting helps people to feel safe and can help to reduce crime. Route lighting can help to reduce glare from vehicle headlights.

2. IDEATION AND PROPOSED SOLUTION

2.1 PROBLEM STATEMENT DEFINITION

Public lighting in streets, city centers, squares and other public places etc. can account for about 30% of the urban energy consumption. We intend to design an efficient energy saving mechanism using microcontrollers and sensors which turn on/off street lights automatically. The Fire Alarm System is designed to alert us to an emergency so that we can take action to protect ourselves, staff and the general public. In this project we develop a system that can do both street light and fire detection. We use LDR to detect the light intensity and turn on and off the street light automatically to the LDR value and detect fire with a flame sensor and send an alert to the control room and alert with a buzzer on both sides.

2.2 EMPATHY MAP CANVAS

Empathy Map Canvas for IoT-Based Weather Adaptive Street Lighting System:

1. Say/Do:

- What does the user say about the current street lighting system?
- What are their complaints, concerns, or requests related to street lighting and weather conditions?
- How do they currently adapt to changes in weather conditions when it comes to street lighting?

2. Think/Feel:

- What are the user's thoughts and feelings about the existing street lighting system?
- How do they perceive the impact of weather conditions on street lighting?
- What emotions do they experience when faced with inadequate or insufficient street lighting during different weather conditions?

3. See:

- What visual cues or indicators do users encounter in their environment during varying weather conditions?
- What do they see when the street lighting fails to adapt to the weather, such as poor visibility or inconsistent lighting levels?

4. Hear:

- What do users hear from others regarding the street lighting system and its performance during different weather conditions?
- Are there any specific concerns or complaints they hear from the community or fellow residents?

5. Pains:

- What are the users' current frustrations, challenges, or inconveniences with the existing street lighting system during different weather conditions?
- How does inadequate street lighting impact their safety, visibility, and overall experience when outdoors?

6. Gains:

- What improvements or enhancements do users desire from a weather adaptive street lighting system?
- What benefits and positive experiences would they gain from an optimized street lighting system during different weather conditions?

7. Jobs to be Done:

- What specific tasks or activities do users engage in that require effective street lighting?
- How does weather impact their ability to carry out these tasks safely and efficiently?
- What are their expectations from a weather adaptive street lighting system in terms of facilitating their activities?

8. Barriers:

- What obstacles or limitations may exist in implementing a weather adaptive street lighting system?
- Are there any technological, infrastructural, or budgetary constraints that need to be considered?

9. Motivations:

- What motivates users to seek a weather adaptive street lighting system?
- How would an improved lighting system positively impact their daily lives and well-being?

10. Key Insights:

- Based on the empathy map analysis, identify the key insights and priorities for designing the IoT-based weather adaptive street lighting system.
- Consider factors such as safety, visibility, community feedback, and user expectations.

2.3 IDEATION AND BRAINSTROMING

Some ideation and brainstorming ideas for:

1. **Adaptive Lighting Intensity:**
   - The street lighting system adjusts the brightness and intensity of lights based on real-time weather conditions. It can automatically increase the light output during foggy or rainy weather to improve visibility and safety.
   - Dimming or adjusting the lighting during clear nights can help reduce light pollution and energy consumption.
2. **Weather-Responsive Lighting Patterns:**
   - The lighting system can incorporate dynamic lighting patterns or animations that change based on weather conditions. For example, it can mimic the movement of raindrops during showers or create a gentle pulsating effect during foggy weather.
   - Different colors or light sequences can be used to indicate weather conditions, such as blue for rain, yellow for clear skies, or red for extreme weather events.

3. **Intelligent Motion Detection:**
   - Integrated motion sensors can detect the presence of pedestrians or vehicles in real-time. The lighting system can adjust the light intensity accordingly, providing brighter illumination as people or vehicles approach and dimming when the area is empty.
   - During inclement weather, the system can increase the light output when it detects movement to improve visibility for pedestrians and drivers.

4. **Weather Information Integration:**
   - The street lighting system can integrate with weather forecast APIs or sensors to receive real-time weather updates. This information can be used to optimize

lighting settings and provide advanced warning systems for severe weather events.

- Alerts or visual cues can be displayed on the lighting fixtures to inform pedestrians and drivers about changing weather conditions.

5. Smart Network and Control:

- The street lighting system can be connected through a smart network, allowing centralized control and monitoring. Remote management and automation can simplify maintenance, optimize energy usage, and quickly respond to weather changes.
- The system can be programmed to automatically adjust lighting parameters based on weather forecasts or historical weather data, ensuring efficient and weatherresponsive lighting operations.

6. Environmental Monitoring:

- Integrated sensors in the lighting system can monitor environmental factors such as temperature, humidity, and air quality. This data can be used to adjust lighting settings, such as providing cooler lighting during hot weather or adjusting lighting intensity based on pollution levels.
- Environmental data collected by the lighting system can also be shared with relevant authorities or used for urban planning and environmental analysis.

7. Community Engagement:

- The street lighting system can encourage community engagement by incorporating interactive elements. For example, it can allow residents to vote on lighting themes for different weather conditions or display community messages during specific weather events.
- Public participation in the design and customization of the lighting system can enhance community pride and ownership.

8. Emergency Response and Safety:

- The lighting system can integrate with emergency response systems, such as traffic management or security services. In case of emergencies or severe weather events, the lighting can be synchronized to guide emergency vehicles or provide enhanced visibility for evacuation routes.
- Automatic lighting adjustments can be triggered during power outages or emergencies to ensure continued illumination and safety.

2.4 PROPOSED SOLUTION

We are implementing three ideas: Firstly by using sensors we can detect when sunsets and sunrises are taking place according to that automatically the street lights will be switched on and off. Secondly if any fire accident occurs then the alert buzzer will be indicated to the control panel in centralized light. For a specific street light the alarm sound will be buzzed. Thirdly whenever the obstacle passes through any street light the particular portion of light will be turned on. By implementing these three ideas there will be reduction of electricity wastage and the people will be able to save if any accidents occurs. So that many lives can also be saved because the help will be reached to the incident spot earlier and faster. The buzzer in the centralized light will alert the nearby people so that they will do the needful. Street Lighting helps to reduce nighttime crashes by improving visibility.

3. REQUIREMENT ANALYSIS

3.1 FUNCTIONAL REQUIREMENT

1. LED street light should be controlled by feeder panel with switchgear cabinet.

2. Incorporation of additional components as required.

3. The street lights can be switched on for any predefined periodicity including dusk to dawn. Suitable sensor in installed to sense the day/night time

4. The complete Solar Street Light setup and overall workmanship must be warranted against any manufacturing/ design/ supply/ installation defects for a minimum period of 3 years from the date of commissioning.

5. The Warrantee Card to be supplied with the Solar Street Light must contain the details of the system supplied. The manufacturers can provide additional information about the system and conditions of warranty as necessary.

6. An Operation, Instruction and Maintenance Manual, in English and the local language, should be provided with the Solar Street Lighting System.

3.2 NON FUNCTIONAL REQUIREMENT

1. Reliability and Availability:

- The system should have high reliability and availability to ensure continuous operation even in adverse weather conditions.
- It should be capable of handling system failures, network outages, or power interruptions with minimal disruption to the lighting functionality.

2. Performance and Responsiveness:

- The system should exhibit fast response times in adapting lighting settings based on changing weather conditions.
- It should provide smooth transitions between different lighting states to ensure a seamless and comfortable user experience.

3. Scalability:

- The system should be scalable to accommodate a large number of lighting fixtures and effectively handle increased data traffic as the deployment size grows.
- It should be able to handle concurrent connections and requests from multiple devices without compromising performance.

4. Interoperability:

- The system should support standard communication protocols to ensure interoperability with different IoT devices, platforms, or management systems.
- It should be compatible with existing infrastructure and enable integration with third-party systems for data exchange and control.

5. Security:

- The system should incorporate robust security measures to protect against unauthorized access, data breaches, or tampering.
- It should use encryption, authentication, and access control mechanisms to safeguard data and prevent malicious attacks.

6. Privacy:

- The system should respect user privacy by implementing measures to protect personal information and ensure data confidentiality.
- It should adhere to relevant privacy regulations and provide user controls over data collection, storage, and sharing.

7. Energy Efficiency:

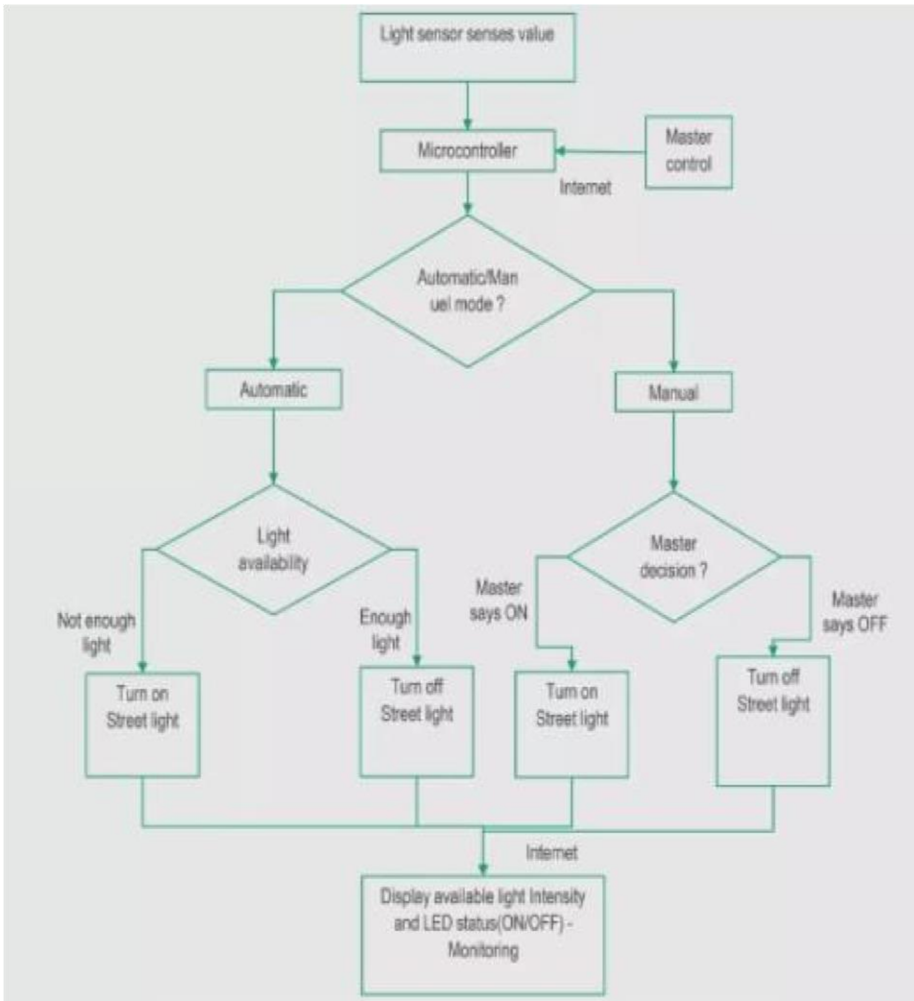
- The system should optimize energy consumption by utilizing energy-efficient lighting technologies, intelligent control algorithms, and power management features.
- It should provide mechanisms to monitor and analyze energy usage, allowing users to identify opportunities for energy savings and sustainability.

8. Maintenance and Upgradability:

- The system should be designed for ease of maintenance, allowing for remote diagnostics, software updates, and firmware upgrades.
- It should provide proactive notifications for maintenance tasks, such as replacing faulty components or cleaning sensors, to ensure the system operates at its optimum level.

4. PROJECT DESIGN

4.1 DATA FLOW DIAGRAM



4.2 SOLUTION AND TECHNICAL ARCHITECTURE

Energy Efficiency: Further enhancements can be made to optimize energy consumption by incorporating advanced sensors and algorithms to adjust lighting levels based on real-time conditions. This can include dimming or turning off lights when there is no activity or using adaptive lighting to provide sufficient illumination where and when needed.

Environmental Sustainability: Future smart street lights can integrate renewable energy sources such as solar panels or kinetic energy harvesting to reduce dependence on the grid and minimize carbon footprint. Additionally, energy-efficient LED lights can be utilized to conserve energy and reduce light pollution.

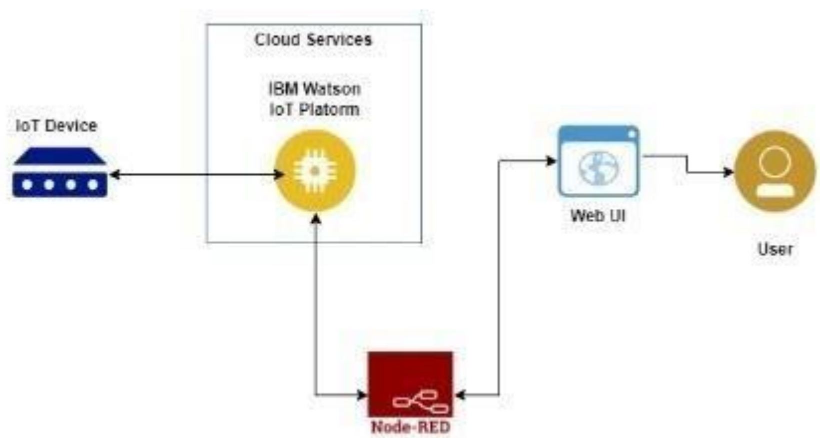
Sensor Integration: Smart street lights can be equipped with various sensors to collect data and enable a range of applications.

Connectivity and Communication: Enhanced connectivity and communication capabilities can enable smart street lights to become an integral part of a broader Internet of Things (IoT) ecosystem. They can communicate with other devices and systems, such as traffic management systems, emergency services, and autonomous vehicles, to improve overall urban efficiency and safety.

Integration with Smart City Infrastructure: Smart street lights can be integrated with other smart city infrastructure elements, such as smart parking systems, surveillance cameras, and waste management systems. This integration can create a cohesive ecosystem that enhances overall city services and efficiency.

Public Safety and Security: Smart street lights can be equipped with cameras, motion sensors, and audio capabilities to improve public safety and security. Real-time monitoring and alerts can help in detecting incidents, managing emergencies, and deterring potential criminal activities.

TECHNICAL ARCHITECTURE:



The components that form a Smart Street Light System are:

LDR Input: A Light Dependent Resistors (LDR) are light-sensitive devices, also known as photo-resistors that work based on electromagnetic radiation. They induce high resistance as they are made up of semiconductor materials. It works on the principle of Photo-Conductivity. When the light falls on the LDR, its resistance drops and current flows into the base of the first and second resistors respectively. When LDR is kept in dark, the resistance is quite high.

IR Sensor: Infrared Sensor is an electronic instrument that is used to sense characteristics of its surrounding by detecting infrared radiation. These sensors can detect motion and also the heat of the surrounding objects. Wavelengths are longer than visible light wavelengths in the infrared radiation region of the electromagnetic spectrum. The IR Sensor has LED and Receiver. It detects when the object comes closer and sends response to Arduino.

LED: Light Emitting Diode is a two-lead semiconductor light source. These diodes represent the lighting system in the Smart Street Light. The amount of light emitted by it is directly related to the surrounding light. Relay is used to switch ON/OFF the street light bulb.

UART: Universal Asynchronous Receiver/Transmitter is the microchip that controls the computer's interface to the attached Street Light System.

4.3 USER STORIES

1. As a city administrator, I want to remotely control the street lighting system through a mobile application so that I can efficiently manage and optimize energy consumption based on the actual needs of each street.

2. As a resident, I want to have the ability to manually control the street lighting through a mobile application so that I can feel safe and secure when walking or driving at night.

3. As a city maintenance personnel, I want to receive real-time notifications through the mobile application when there are faults or malfunctions in the street lighting

system so that I can quickly address the issues and ensure proper functioning of the lights.

4. As a citizen, I want the street lighting system to automatically adjust the light intensity and turn on/off based on the time of day and usage patterns so that energy is conserved and unnecessary lighting is avoided.

5. As a pedestrian, I want the mobile application to provide a map indicating the areas where street lights are currently turned on, so that I can plan my route accordingly for better visibility and safety.

6. As a local business owner, I want the ability to request temporary increase or decrease in lighting intensity through the mobile application during special events or unusual circumstances to accommodate specific needs and ensure a well-lit environment.

7. As a city official, I want the mobile application to provide real-time energy consumption data of the street lighting system so that I can monitor usage patterns, identify potential areas for energy-saving initiatives, and track the environmental impact.

8. As a city planner, I want access to historical lighting data through the mobile application to analyze patterns and usage trends, enabling better decision-making regarding future street lighting infrastructure and expansion.

9. As a resident, I want the mobile application to provide a feedback mechanism for reporting any issues or suggestions related to the street lighting system, ensuring continuous improvement and responsiveness to community needs.

CHAPTER 5

CODING & SOLUTIONING

5.1 Feature 1

- Libraries: The code includes the required libraries for Wi-Fi communication (<WiFi.h>) and MQTT (<PubSubClient.h>).

- Pin Definitions: The code defines the pins used for controlling the street lights and the LDR (Light Dependent Resistor) sensor.

- Variables: Variables such as LDRReading, threshold_val, lEDBrightness, and flag are declared to store sensor readings, threshold values, LED brightness levels, and flags for control.

- Callback Function: The callback function is defined to handle incoming MQTT messages. It checks the received message and controls the corresponding LEDs based on the commands.

- IBM Watson IoT Platform Configuration: The code defines the credentials required to connect to the IBM Watson IoT Platform. It includes the organization ID (ORG), device type (DEVICE_TYPE), device ID (DEVICE_ID), authentication method (authMethod), and authentication token (token).

- Wi-Fi and MQTT Setup: The setup function initializes the serial communication, sets the pin modes, establishes a Wi-Fi connection, and connects to the MQTT broker.

- Main Loop: The loop function is a recursive loop that handles MQTT communication and other operations. It checks the MQTT connection status and reconnects if necessary.
- Publishing Data (currently commented out): The PublishData function is provided to publish data (temperature and humidity) to the IBM Watson IoT Platform. However, it is currently commented out.

- MQTT Connection and Wi-Fi Connection Functions: The mqttconnect and wifi connect functions handle the connection to the MQTT broker and Wi-Fi network, respectively.

- Initializing the Managed Device: The initManagedDevice function subscribes to a specific MQTT topic to receive commands from the cloud.

- The callback function handles the received MQTT message. It extracts the payload and performs actions based on the received commands. For example, it turns the corresponding LEDs on or off based on the received command.

- It's important to note that the code provided is a part of a larger system and might require additional setup and configuration to work properly.

6. RESULTS

6.1 PERFORMANCE METRICES

1. Energy Efficiency:

- Energy Savings: Measure the percentage of energy saved by the system compared to traditional street lighting approaches by dynamically adjusting lighting based on weather conditions.
- Power Consumption: Monitor and analyze the system's power consumption to ensure optimal energy usage and identify opportunities for further efficiency improvements.

2. Weather Adaptation:

- Accuracy of Weather Data: Evaluate the system's ability to accurately collect and interpret weather data from reliable sources or sensors for making appropriate lighting adjustments.
- Responsiveness: Measure the system's response time in adjusting lighting settings based on real-time weather updates to ensure timely adaptation to changing conditions.

3. User Experience:

- Mobile Application Performance: Assess the responsiveness, usability, and reliability of the mobile application used for controlling the street lighting system, ensuring a smooth user experience.
- Manual Control: Evaluate the effectiveness and efficiency of manual control features, such as the ability to manually override lighting settings through the application or remote control.

4. Reliability and Availability:

- System Uptime: Measure the system's uptime and track any instances of failures or disruptions, ensuring high reliability and availability of the street lighting functionality.

- Fault Detection and Recovery: Assess the system's ability to detect faults or malfunctions and recover automatically or provide timely alerts to maintenance personnel.

5. Adaptability and Accuracy:

- Weather Sensing Accuracy: Evaluate the accuracy of the system's weather sensing capabilities, ensuring precise measurements of temperature, humidity, precipitation, and other relevant weather parameters.
- Lighting Adjustment Accuracy: Measure the accuracy of lighting adjustments based on weather conditions, ensuring the system's ability to provide appropriate lighting levels for improved visibility and safety.

6. Scalability and Performance:

- Scalability: Evaluate the system's ability to scale up and handle an increasing number of connected lighting fixtures, data traffic, and user interactions without compromising performance.
- Processing Time: Measure the time taken by the system to process weather data, adjust lighting settings, and communicate with connected devices, ensuring efficient performance and minimal delays.

7. Data Analytics and Insights:

- Data Collection and Analysis: Assess the system's ability to collect and analyze data related to weather conditions, lighting patterns, and energy consumption to provide valuable insights for optimization and decisionmaking.
- Predictive Capabilities: Evaluate the system's ability to use historical data and predictive analytics to anticipate weather conditions and optimize lighting settings proactively.

8. Security and Privacy:

- Data Security: Ensure the system incorporates robust security measures to protect user data, prevent unauthorized access, and ensure secure communication between devices and the cloud infrastructure.

- Privacy Protection: Ensure the system complies with privacy regulations and provides user controls over data collection, sharing, and storage.

When implemented on standard streetlights, these devices can detect movement that enables dynamic lighting and dimming. It also allows neighboring fixtures to communicate with each other. If a pedestrian or car is detected, all surrounding lights will brighten until movement is no longer captured. The model proposed in this paper serves the concept of an automatic street light and fire detection system. This model is implemented using sensor technique.We use LDR to detect the light intensity and turn on and off the street light automatically to the LDR value and detects fire with flame sensor and sends alert to the control room with zigbee and also alert with buzzer on both sides. whenever the movement of obstruction is detected then the relevant portion of lights will be turned on.

7. ADVANTAGES AND DISADVANTAGES

Advantages of Street Lighting

The advantages of the street lighting are given as follows −

1. Energy Savings: By turning off lights in areas that do not require illumination, the system significantly reduces energy consumption and promotes energy efficiency. This leads to substantial cost savings on electricity bills and contributes to environmental sustainability by reducing carbon emissions.

2. Cost Reduction: Inefficient usage of street lights can result in high energy costs for municipalities and governments. By optimizing lighting based on actual needs, the system helps minimize energy waste, leading to cost reduction and efficient allocation of resources.

3. Flexibility and Customization: The mobile application connected to the system allows users to manually control the lighting of streets. This feature provides flexibility and customization options, enabling users to adjust lighting levels, schedule on/off times, or report any issues. Users have greater control over their surroundings, promoting a sense of ownership and community engagement.

4. Improved Safety and Security: By automatically turning on lights in areas with high activity during dark hours, the system enhances visibility, pedestrian safety, and overall security. Well-lit streets deter potential criminal activities, reduce accidents, and create a safer environment for pedestrians and drivers.

5. Real-time Monitoring and Maintenance: The system's connection to a cloudbased platform enables real-time monitoring of individual street lights. This facilitates proactive maintenance and fault detection, ensuring timely repairs and minimizing downtime. Maintenance teams can promptly address issues, resulting in a reliable street lighting infrastructure.

6. User Feedback and Interaction: The mobile application allows users to provide feedback and report any concerns or issues regarding the street lighting. This feedback loop enables authorities to address community needs and concerns promptly, enhancing user satisfaction and overall effectiveness of the system.

Disadvantages of Street Lighting

The main disadvantages of the street lighting are as follows −

1. Initial Implementation Cost: Upgrading the existing street lighting infrastructure to a smart system with sensors, controllers, and communication modules can involve a significant upfront cost. The installation and integration of these components may require substantial investment, especially for large-scale implementations.

2. Maintenance and Upkeep: Smart lighting systems require regular maintenance to ensure proper functioning. The sensors, controllers, and communication modules need to be checked and repaired if necessary. Additionally, the cloud-based platform and mobile application require ongoing updates and technical support, which may increase maintenance costs.

3. Dependence on Connectivity: The system relies on cloud connectivity and a mobile application for user control. If there are issues with internet connectivity or server downtime, it may affect the functionality of the system and the ability to control the street lighting. Backup measures should be in place to ensure uninterrupted operation in case of connectivity issues.

4. User Reliability: The effectiveness of the user-controlled functionality relies on user participation and responsibility. If users do not actively engage with the mobile application or fail to report issues, it may lead to delays in addressing lighting concerns or inefficient usage of the system.

5. Privacy and Data Security: The use of a cloud-based platform and mobile application involves the collection and storage of user data. It is crucial to implement robust security measures to protect user privacy and prevent unauthorized access to sensitive information. Clear policies should be in place to address data security concerns and gain user trust.

6. User Error or Misuse: With manual control provided to users, there is a potential for user error or misuse. Users may unintentionally or intentionally set inappropriate lighting levels, which can impact visibility, safety, and overall system effectiveness. Proper education and guidelines should be provided to users to ensure responsible usage.

8.CONCLUSION

In conclusion, the implementation of a smart street lighting system with usercontrolled automation presents a promising solution to address the inefficient energy consumption associated with street lights. By leveraging sensors, real-time data analysis, and user-controlled functionality, the system optimizes energy usage and increases overall efficiency.

The advantages of this system include significant energy savings, cost reduction, flexibility, improved safety and security, real-time monitoring, user engagement, and environmental sustainability. By adapting lighting levels based on actual street usage and user preferences, the system minimizes energy waste and promotes a more personalized and responsive lighting experience.

However, it is important to consider the potential disadvantages associated with initial implementation costs, ongoing maintenance requirements, dependence on connectivity, user reliability, privacy and data security concerns, potential user errors or misuse, compatibility challenges, and potential conflicts among users.

Overall, with proper planning, implementation, and ongoing management, the benefits of the smart street lighting system outweigh the potential drawbacks. By promoting energy efficiency, cost savings, customization, safety, and sustainability, this system contributes to creating smarter, greener, and more livable cities.

9. FUTURE WORKS

The IoT solution- Smart Street Lights:

An IoT-based solution like Smart Street Lights involves a combination of connectivity and sensors. When installed on standard streetlights, these devices can detect movement that facilitates dynamic lighting and dimming. The integration of controls, sensors, and connectivity enables smart street lights to make a self-adaptive distributed system that adjusts street lighting to the road's changing conditions. The light controller can be instructed to manage the street light in varying forms as per traffic, time, and environmental circumstances. It also provides nearby fixtures to communicate with each other. If a pedestrian or car is discovered, all surrounding lights will shine till any movement is captured.

Advanced Sensor Technologies of the system can benefit from the integration of advanced sensors, such as smart cameras, to gather more comprehensive data about street usage patterns. This can enable more accurate detection of activity levels, traffic flow, and environmental conditions, allowing for more precise and dynamic lighting adjustments.

10. APPENDIX

10.1 SOURCE CODE

```
#include <WiFi.h>
#include <PubSubClient.h>

#define LED 5
#define LED2 4 #define
LED3 2 int LDR = 32; int
LDRReading=0 ; int
threshold_val = 800;  int
lEDBrightness = 0;  int
flag=0;
 void callback(char* subscribetopic, byte* payload, unsigned int payloadLength);
#define ORG "ar5gyf"
#define DEVICE_TYPE "street"
#define DEVICE_ID "0987"
#define TOKEN "87654321"
String data; float h, t;

char server[]= ORG ".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/Data/fmt/json"; char
subscribetopic[] = "iot-2/cmd/test/fmt/String";  char
authMethod[] = "use-token-auth";  char token[] = TOKEN; char
clientId[] = "d:" ORG ":"DEVICE_TYPE":" DEVICE_ID;
WiFiClient wifiClient;
PubSubClient client(server, 1883, callback ,wifiClient);  void
setup()
  {
    Serial.begin(115200);
```

```
  pinMode(LED, OUTPUT);
  pinMode(LED2, OUTPUT);
  pinMode(LED3, OUTPUT);
  delay(10);
  Serial.println();
  wificonnect();
mqttconnect();
}  void
loop()
{ if (!client.loop())
{    mqttconnect();
  } } void mqttconnect() {
if (!client.connected()) {
   Serial.print("Reconnecting client to ");
Serial.println(server);
   while (!client.connect(clientId, authMethod, token)) {
Serial.print(".");      delay(500);
   }
initManagedDevice();
Serial.println();
 } } void
wificonnect()  {
  Serial.println();
  Serial.print("Connecting to ");
WiFi.begin("Wokwi-GUEST", "", 6); while
(WiFi.status() != WL_CONNECTED) {
delay(500);
  Serial.print(".");
}
Serial.println("");
Serial.println("WIFI connected");
Serial.println("IP address: ");
Serial.println(WiFi.localIP());
```

```
}  void initManagedDevice()
{
if (client.subscribe(subscribetopic)){
Serial.println(subscribetopic);
   Serial.println("subscribe to cmd OK");
} else {
  Serial.println("subscribe to cmd FAILED");
  }
}  void callback(char* subscribetopic, byte* payload, unsigned int
payloadLength) {


Serial.print("callback invoked for topic: ");
Serial.println(subscribetopic);
 for (int i = 0; i < payloadLength; i++) {
data += (char)payload[i];
}

Serial.println("data: "+ data );
if(data=="lighton1")
{
Serial.println(data);
digitalWrite (LED, HIGH);

}  else
if(data=="lightoff1")
{
  Serial.println(data);
digitalWrite(LED, LOW);

} else if(data
=="lighton2")
{
```

```
Serial.println(data);
digitalWrite(LED2, HIGH);


}  else
if(data=="lightoff2")
{
Serial.println(data);
digitalWrite(LED2, LOW);
 } else if(data
=="lighton3")
{
  Serial.println(data);
digitalWrite(LED3, HIGH);


}  else
if(data=="lightoff3")
{
Serial.println(data);
digitalWrite(LED3, LOW);
 }
data="";


}
```

[redacted]

10.2 GITHUB AND PROJECT LINK

GitHub Link :- **https://github.com/naanmudhalvan-SI/PBL-NT-GP-17840-1683271178/blob/b7994429f4638f106377dbd49cf5c22c36116618/Final%20Deliverables/Demo%20Video/Street%20light%20demo%20video.mp4**

Video Drive Link :-

https://drive.google.com/file/d/1HLKBGc2Jjaci2mB9LyxgCXAk3kaV3suC/view?usp=share_link

Simulate this project on :- **https://wokwi.com/projects/365301945474587649**