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Design and Implementation of Smart Poles using Machine Learning and IOT

[1]Ramya Shree L, [2]Niharika B G, [3]Rakesh K S, [4]Madhu V, [5]Shivaprasad B K

[1-4]UG Student, Department of Electronics and Communication Engineering, PESITM, Shivamogga, Karnataka, India

[5]Assistant Professor, Department of Electronics and Communication Engineering, PESITM, Shivamogga, Karnataka, India

***Abstract* - In this age of change and technological growth, the traditional maintenance and control system for street lighting is still antiquated. For such ground-breaking online companies, the Internet of Things (IoT) evolution has been a helpful cornerstone. So, to support the upkeep and management of the street lighting system, we use this highly sought-after technology. The suggested approach makes it possible to maintain and manage street lighting and makes it simpler to keep an eye on and manage its operation. Street lights use a lot of energy every day that may be used for other essential purposes. Through the use of a Smart Pole System, this article seeks to overcome this problem. Various other modules, including LoRaWAN, GPRS, and a Smart Display to track the amount of air pollutants present, temperature, and humidity, have also been implemented on top of smart street lighting systems to create a "Smart Pole System," which goes beyond the auto-dimming and auto-turn on and off feature of the street lights.**

Keywords: Internet of Things, LoRaWAN, Solar, Smart Display, smart street lightening, smart pole system.

I. INTRODUCTION

The Internet of Things offers a platform to develop new ideas and extract knowledge from a massive amount of real-time data while also remotely managing, controlling, and monitoring a wide range of devices. In order to ensure optimal communication and information sharing and to create intelligent systems for the same, it entails placing sensors in common items and connecting them to the internet via appropriate protocols. The goal of this project is to develop an Internet of Things (IoT)-based application to efficiently monitor, control, and maintain streetlights. Since inadequate light causes the majority of accidents, street lights are currently the most crucial part of every city.

About 20 to 40 percent of the electricity produced is used for street lights, which use the majority of the electricity. Lighting issues, electricity theft, public safety, and excessive electricity use are the main issues here. Smart street lighting is seen as a crucial development for a smart city. The authors showed how increased air pollution from increased traffic congestion affects the health of those living close to and using roads. For a greenhouse system, a Netudino module is utilized to transmit moisture, temperature, sunshine, and humidity data to a server. The Smart Pole System that is proposed in this study, which entails installing numerous "smart" modules like environmental monitoring sensors, is the primary contribution of the work.

1.1 Literature Review

A Zigbee-based remote controlled system that provides a wireless Smart Street Lamp architecture has been suggested by certain academics. The data from the sensors, such as on/off control, power adjustment, and fault monitoring, is delivered to a control terminal, where it may be evaluated and street lighting that aren't working recognized. The authors in few papers recommended that the lights be switched on or off based on proximity, allowing for more efficient energy consumption. The authors in other few papers use a neural network to predict the energy demand for the street light system, in an attempt to reduce energy consumption. Street cameras are used for traffic monitoring and vehicle tracking via image processing.

1.2 Objectives

1. Create and deploy a smart street lighting system to save energy.
2. Install a smart RFID card-based vehicle charging station.
3. To create and implement a human safety mechanism in the event of an emergency.
4. Develop and implement an image processing technique for detecting car numbers.

1.3 Problem Statement

A city's street light is one of its largest costs. Because of the high cost, all sodium vapor lamps use more electricity. The money spent on the street light may be put to better use elsewhere in the country. Currently, a manual system is in use, in which the light is turned on and off manually, i.e., the light is turned on in the evening and turned off in the morning. As a result, there is a significant amount of energy wasted in the ON/OFF cycle.

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II. PROPOSED SYSTEM

The concept focuses on creating intelligent street lights that can do more than just light up the streets. The 24-hour surveillance camera keeps an eye on the street to ensure public safety. In case of an emergency or crime, pedestrians can use the panic button that is part of the smart street light system to alert the proper authorities. Finding cars that are speeding is made possible with the use of speed detecting capabilities. Lighting adaptation is used by the system. When necessary, the street lamp will be turned on by the control system. When no movement is detected nearby, the lights will dim. Pollution sensors will identify specific regions where the air quality is poor and notify the appropriate authorities when it becomes abnormally high, thereby promoting environmental preservation. Installing car charging stations on light poles will promote the use of electric vehicles and lower global warming. The system's primary parts include an LED lamp, a power sensor, a PIR sensor, an LDR, a high-resolution camera, a pollution sensor, and a charging port module. The system offers a web portal to monitor the information delivered to the server by the smart street lamp sensors and the camera feed. After predetermined intervals of time, the server also receives data from the pollution sensor. Since traffic congestion and local air quality are related, the data can be utilized to improve traffic routing.

III. METHODOLOGY

The circuit uses the Raspberry Pi4 microcontroller, which runs the Raspbian operating system and has an integrated WiFi module to help with message production and passing. The infrared (IR) light that objects emit is measured by a passive infrared (PIR) sensor. It utilizes the Pyroelectric effect, which aids in the detection of human movement. This will be programmed using the Python programming language. Huge databases will be stored on the cloud according to certain areas, and the admin will receive notifications. To facilitate fast charging and convenient charging, electric cars require a supporting infrastructure. The specified charging current is calculated using two-way communication between the car and the charger and is based on the maximum current offered by the charger coupled with the most current the vehicle is capable of taking in.

The video feed should be processed almost instantly because of the constant flow of data. Since the number plate would be a rectangle with a set aspect ratio, a straightforward image processing technique is employed to extract the number plate based on its aspect ratio and minimum size. If given adequate information, a CNN can be used to extract the license plates. The admin and staff will have access to a web interface at the admin end that will be utilized to receive communications from the cloud.

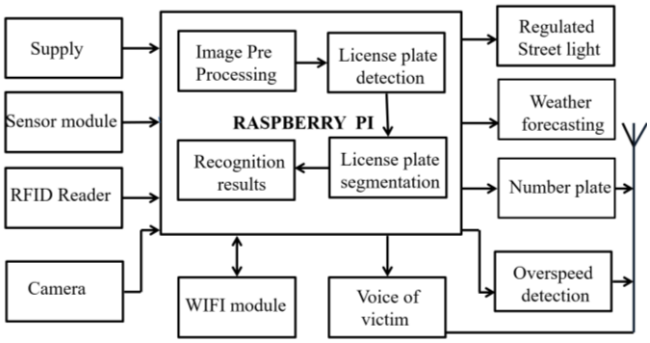

Figure 1: Block diagram of smart pole system

IV. RESULTS

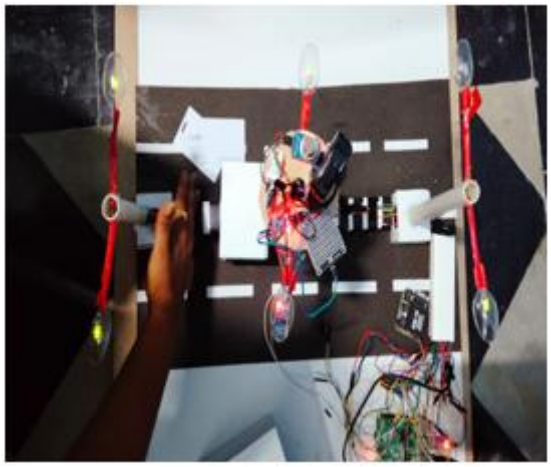

Figure 2: Prototype of the IOT based smart pole system

IV. CONCLUSION

The government may have been severely burdened by the lack of maintenance attention given to the street lights, causing delays and costs to surpass expectations. Streetlight manual control can cause maintenance to be put off. The "Smart Pole System" being presented would show to significantly cut energy consumption as well as offer a number of other beneficial features and smart features to the public. Due to the use of adaptive dimming, only 30% of total energy was consumed. For the purpose of detecting crimes, the technology also automatically recognizes a vehicle's license plate. The car will be monitored on the map if the license plate is on a blacklist. For the purpose of identifying over speeding vehicles, speed detection is offered. The device can be used to monitor the smart street light system. Inform the authorities of a systemic failure. It also measures the amount of pollution in a specific area, and if the level exceeds a certain point, it notifies the relevant authorities.

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AUTHORS BIOGRAPHY

Ramya Shree L, UG Student, Department of Electronics and Communication Engineering, PESITM, Shivamogga, Karnataka, India.

Niharika B G, UG Student, Department of Electronics and Communication Engineering, PESITM, Shivamogga, Karnataka, India.

Rakesh K S, UG Student, Department of Electronics and Communication Engineering, PESITM, Shivamogga, Karnataka, India.

Madhu V, UG Student, Department of Electronics and Communication Engineering, PESITM, Shivamogga, Karnataka, India.

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