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Review Article

Benefits of utilizing intelligent streetlight monitoring systems

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Abstract
An important component of a city's infrastructure development is the installation of streetlights. In low light, it helps improve visibility of roadways, signage, streets, and people. Intelligent streetlight monitoring systems enable automatic streetlight lamp on/off based on demand.

Keywords: Smart Street Lighting System; Smart City; Sensor Network; Energy Efficiency; Intelligent Management.

I. INTRODUCTION
Large urban areas have seen substantial urbanization in recent years, which has increased interest in the concept of a "smart city." In an effort to better serve the world's expanding population, numerous technical and intelligent systems have been implemented as a result of urbanization. Street lighting is crucial in both urban and suburban settings. Urban lighting's main objective is to maintain economic activity throughout the evenings by improving visibility along streets and other thoroughfares used by cars and pedestrians. However, this project comes with a hefty price tag—roughly 13–14% of the annual power production worldwide. By 2027, 363 million bulbs will have been deployed worldwide [3]. In smart cities, street lighting amounts to little more than an upgraded energy-intensive system, and its infrastructure can be used to assess and improve important urban aspects. This can be done with cutting-edge methods and creative system interventions. Street lighting poles, also known as columns, can be transformed into intelligent and adaptable buildings by putting in place a sensor network and specific communication technologies [4]. The application of city safety regulations, traffic management, and environmental parameter monitoring are a few instances of this type of monitoring and management [5-7]. Due to the critical roles these needs have played in society, modern science and industry have placed a great deal of emphasis on them [6].

II. RELATED WORKS
The goal of the "Smart Lights with Smart Electricity in Public Places" project is to intelligently create and use power in public areas so that lights may adjust to their surroundings without compromising efficiency. Smart street lighting has several advantages over previous, less effective street lighting techniques. They are more adaptable and energy-efficient, and they may be used for a variety of purposes, such as traffic monitoring, emergency lighting, planned illumination, adaptive dimming, motion detection, and improving public safety and quality of life. Despite their short existence, smart street lighting systems are becoming more and more well-liked. With the decreasing cost of its components and increased awareness of the numerous benefits of smart street lighting systems, smart streetlights are expected to be installed in a growing number of locations globally [1]. As an essential component of smart city infrastructure, streetlights represent the evolution of a municipality. Although streetlights are essential for maintaining good visibility, traffic safety, and nighttime use of public spaces, they also add a substantial amount of electricity usage to the grid. Reducing the amount of power used for home and industrial purposes is a goal shared by governments worldwide. The Intelligent Street Lighting System, which uses LED lights, is a key idea in today's world of energy use. When a car approaches, this system turns on

the LED lights; when there isn't a car around, the lights are dimmed or turned off. In order to achieve energy efficiency and cost reduction, the main goal of this research study is to construct an intelligent street lighting system based on LED lights. Results from experiments show that energy savings over conventional streetlamp systems could reach 80%. Through terminal devices, the system also permits intelligent management and remote monitoring of urban street light conditions [2]. This system controls the intensity of the lights based on the density of the lane. It is also referred to as 'intelligent street lights' [10]. We suggest conducting this study with smart lighting. This gadget can sense motion from people and cars, as well as time settings and step dimming, which enables dynamic illumination and dimming. Additionally, this technology enables communication between devices. For example, if a car or pedestrian is spotted nearby, the nearby lighting will turn on. PIR, ultrasonic, and light sensors will all be included with this gadget. It is anticipated that when Internet of Things technology advances [12], it will aid in remote control and have an integrated system. The internet connects the control and monitoring system. The three parameters that need to be managed are the presence of people, cars, and lights. Web-based and Android applications can be used to monitor each of these elements. Drawing from the aforementioned research, this study aims to design a public streetlight system that integrates human sensors (PIR), light sensors, and ultrasonic sensors. A Data Control Unit (DCU) will be used to facilitate the control system. Every streetlamp in the system will be wirelessly connected to every other streetlamp, allowing for remote monitoring of the system's smart lighting features, such as whether to turn on or off the lights in response to traffic [11]. Roadways are made visible to two-, three-, and four-wheeled vehicles by public street lighting. For both safety and aesthetic reasons, most roadways have street lighting. The security function makes it easier for drivers to see at night. For drivers to reduce accidents and criminal activity, proper lighting is essential. The layout and design of the lighting have an impact on the evening appeal of the city and its streets. Uncontrolled electricity use in public street lighting lights leads to exorbitant costs. A design that efficiently utilizes and controls electrical energy is required. For electrical energy planning, the Internet of Things-based public street lighting system that uses solar panels as battery chargers may be used. Control is provided by the ESP8266 module, Wi-Fi is provided by a separate module, an electric switch is provided by the relay module for turning on and off public street lighting lights using the intelligent energy public street lighting application, and batteries are charged by solar panels. The system is equipped with ultrasonic sensors, LDR sensor monitoring, and a NodeMCU ESP8266 microprocessor. Light intensity is detected by the light sensor module. Officers can keep an eye on the procedure in real time with the use of the Smart Energy, Public Street Lighting app. This application will track street illumination in public spaces, evaluate data, and create a graph [13]. Two crucial benefits of smart cities are safety and energy efficiency. More specifically, there is a connection between energy conservation and city street lamps. As such, street lights are an essential component of smart cities. But the lack of smart features in today's street lighting makes them more dangerous and energy-intensive. This research proposes a fog computing-based smart street lamp (SSL) for smarter cities as a solution to these issues [14]. Using video image processing technologies, intelligent control of metropolitan lighting systems is possible [15]. In this work, I present "iLIGHT," an ICT-based smart lighting solution that can more effectively and economically address the lighting requirements of smart cities. The benefits and drawbacks of "iLIGHT" are also thoroughly covered. The findings of the analytics-based test showed that "iLIGHT" can cut power usage by over 30%. In addition, I have included an overview of the evaluated literature on the benefits and drawbacks of the lighting solutions utilized by smart cities. Additionally, I examined various use cases and average power consumptions for smart city indoor and outdoor lighting systems. Lastly, I've included details about what I intend to do in the future with the "iLIGHT" lighting system [16].

III. BENEFITS OF UTILIZING INTELLIGENT STREETLIGHT MONITORING SYSTEMS

1. Facilitate Smart Parking

Park Smart and other intelligent parking systems can be integrated with smart street light monitoring systems. The integration makes it possible to identify parking spots and gives vehicles directions to free spaces. It lessens security concerns, mismanagement, traffic congestion, and accidents. When it detects an emergency, the system can send out notifications. Examples of crises include sudden harsh weather, crowd detection, potential criminal activity, active shooters, and many more. It is possible to install an overhead system since it requires less money to implement. Installing sensors to identify parking spaces on or within streetlights is made possible by integrating the two systems. The intelligent overhead system anticipates parking problems brought on by improperly parked cars and quickly identifies obstacles in the bus, bike, or garage lanes. The mobile network is then used to transmit the measured data to the control center. The control center determines the occupancy of parking spaces based on sensor data. It notifies traffic enforcement agencies of illegally parked cars and helps drivers locate parking places. Smart streetlight monitoring systems can also assist in understanding how various lanes and public transportation are used through vehicle identification. As a result, real-time traffic optimization and adjustment become feasible. Thus, it lessens traffic and air pollution.

2. Crime Reduction

One of the main objectives of the stakeholders, including the government, is to reduce crime. As a result, the use of smart street light monitoring systems is becoming more widespread. The fact that it permits improved public safety and security is among the primary justifications. It aids in the creation of a network canopy that facilitates more data processing. Thus, a more intelligent system that guarantees public safety can be put into place. To give an example, it gives passengers and drivers better view. Additionally, drivers can receive notifications that lower the likelihood of accidents through innovative procedures. In the event of an emergency or safety problem, the system can also change the hue of the LEDs. Smart light monitoring devices are also quite useful in offices and residences. The primary purpose is to identify a person's existence. Consequently, it modifies the hue or brightness in each area that a person enters. Using a smartphone to turn things on and off is also a simple task.

3. Energy Conservation

It is evident that switching from conventional street lighting systems to smart streetlight monitoring systems is necessary owing to increased traffic flow and population. Traditional street lights require manual handling, which is one of the causes. Even turning off a large number of street lights at night to save electricity becomes challenging. This cutting-edge device uses Internet of Things (IoT) connectivity to gather, assess, monitor, and transmit data in real time to project managers, civil engineers, and city planners. It enables them to make greater use of actionable data for development, like improving the infrastructure for lighting. The street lights go out when there is no movement. It also lowers energy consumption in this way. Furthermore, energy consumption is 90% lower with LEDs than with conventional incandescent bulbs when utilizing cutting-edge lighting technology. LEDs, on the other hand, last longer and require less money for maintenance and replacement. The quantity can then be easily applied to various development initiatives, like enhancing urban infrastructure.

4. Reduce Light Pollution

Light pollution is becoming a bigger problem, interfering with astronomical research, upsetting ecosystems, washing out stars at night, wasting energy, and even having negative health impacts. Melatonin synthesis falls during the night as a result of increased light. This leads to many health problems such as exhaustion, tension, lack of sleep, headaches, and irregular circadian cycles. Light pollution is mostly caused by streetlights. With the use of smart technology, lights can be turned off automatically throughout the day and at night when no one is walking or driving on the street. These problems are resolved by putting in place a smart streetlight monitoring system.

5. Easy Maintenance

Every lamp inside the intelligent streetlight surveillance system possesses a unique ID. It makes it simple for us to locate them. Facility managers monitor drive circuits and power consumption in addition to remotely controlling the system. They keep an eye on the status of the lamps, so in the event of any problem—such as a light fuse or breakdown—quick and affordable fixes are applied. Even the light can change from being bright to being dim, depending on how strong the moonlight is. It even modifies its status in response to varying weather conditions, such as rain. Additionally, it helps extend the life of LEDs, which means less maintenance is needed [17].

Conclusion

This study has shown us how the benefits of employing the street light control system stack up against more conventional approaches. The smart lighting system has been the basis for the reviews of numerous articles.

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