

# A Study on IoT based Smart Street Light Systems

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**Abstract**--Today's modern world people preferred to live the sophisticated life with all facilities. The science and technological developments are growing rapidly to meet the above requirements. With advanced innovations, Internet of Things (IoT) plays a major role to automate different areas like health monitoring, traffic management, agricultural irrigation, street lights, class rooms, etc.,. Currently we use manual system to operate the street lights, this leads to the enormous energy waste in all over the world and it should be changed. In this survey we studied about, how IoT is used to develop the street lights in the smart way for our modern era. It is an important fact to solve the energy crises and also to develop the street lights to the entire world. In addition, with the study on smart street lighting systems we analyzed and described different sensors and components which are used in IoT environment. All the components of this survey are frequently used and very modest but effective to make the unswerving intelligence systems.

**Keywords**--Smart street light systems, Internet of Things, Temperature sensor, Weather sensor, Raspberry Pi, Arduino UNO.

## I. INTRODUCTION

Internet of Things plays a most important role in our everyday life. It connects enormous devices to the internet and involves the use of various data points, all of which need to be secured. It has developed as a new paradigm for the upcoming of the Internet, making way for devices that can communicate together [22]. The five phases of evolution of the Internet is shown in Fig. 1. IoT is not only about collecting data generated from sensors, but also about analyzing it [6]. IoT infrastructure must be an open source, without ownership, meaning that anyone can develop, deploy and use it [16].

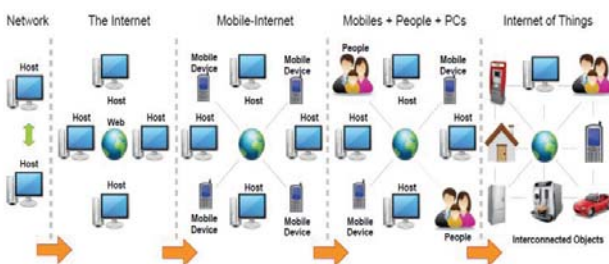


Fig. 1. Evolution of the Internet shown in five phases.

IoT is usually characterized by actual world minor things, extensively distributed, with restricted storage and processing capacity, which comprise apprehensions regarding consistency, presentation, safety and confidentiality [17]. IoT can link pervasive devices and conveniences with several networks to deliver effectual and protected facilities for complete applications anytime and anyplace [18]. The IoT is used in various applications like surveillance systems that analyze abnormalities in security, RFID tags in luggage, sensors in chemical industries, smart homes, military applications, healthcare, industrial management and diverse environments. The Fig. 2 shows comparative analysis of projected number of people and devices connected to IoT. The x-axis shows year and y-axis shows count in billions.

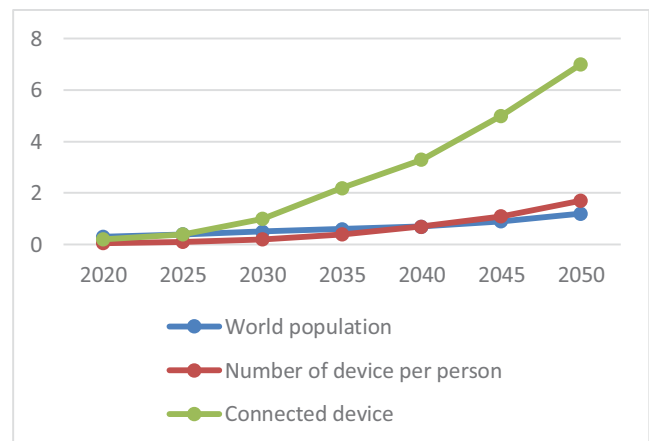


Fig. 2. Projected number of people and devices connected to IoT.

Predominantly, street lights play's the vital role in the urban areas where the main purpose is to improve the streets throughout shady periods of the daytime. Beforehand, the quantity of streets in the city's ad towns were very fewer but by the growth of urban areas, the quantity of streets growths quickly with high traffic concentration. This paper gives the finest resolution for electrical energy consumption. Here the labor-intensive operation of the illumination system is entirely abolished. The scenario of an IoT based smart street light system is shown in Fig. 3.

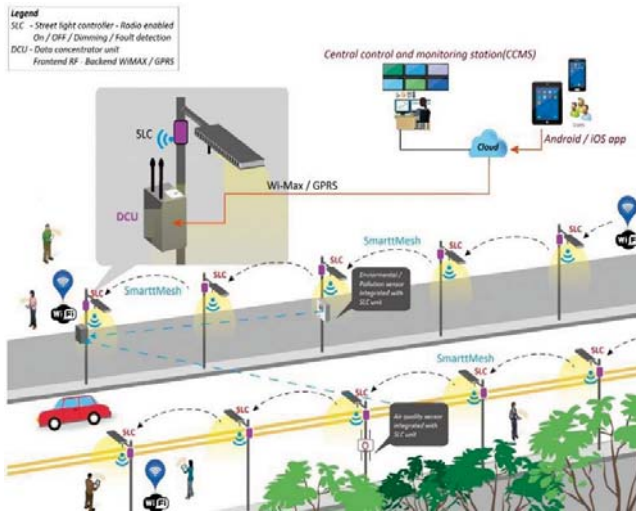


Fig. 3. Scenario of an IoT based smart street light system(Reprinted from [16]).

The energy consumption in entire world is increasing at the fastest rates owed to population and financial development and the availability of energy sources remains woefully constrained [1]. The recent manual streetlight system has numerous problems like conservation problems, connectivity problems and control problem[6]. These difficulties can be determined by IoT technology. In order to project a better lighting system on street we need focus on some features such as dark-period safety for communal affiliates and those we use the roads.

## II. MOTIVATION AND BACKGROUND

Smart Street Light System is a manageable and strong idea, which is utilized to switch ON/OFF of the street lights robotically. Manual works are completely eradicated. Whenever the sunlight is decreased lights were automatically switched ON. The lights are switched OFF by monitoring the luminous level of sunlight in the self-regulating manner. This work is performed by an LDR sensor which monitors the light absolutely like our eyes. The system itself spots whether there is a necessity for light or not. When the progress of darkness is increased to a destined level then street lights were automatically switched ON, otherwise it gets OFF. The main compensations of this system are cost reduction which is connected to power conservation and managing by integrating an automobile recognition process. The automated regular report enables the nursing of the more traffic areas and embodies the tackles to improve traffic overcrowding. The lifespan of HPS and LED lamp are shown in Fig. 4.

The community street lights can be planned to encounter the desires of persons of entire ages, along with folks age-relevant hallucination losses, the study comprises finest supervision performs and lessons cultured from metropolises wherever LED street

illumination has mounted. This description plans overall references about street lighting, in addition to methodological provisions for spare LED equipped on present dignitary ends. It offers traditions to exploit on the further assistances of LED technology, such as the custom of control systems for lowering, changing color, alternative events, and the usage of decorative hue lights for use in technique outcome, residence making and occurrences scheduling in occupational boroughs. It also proposes customs in which metropolises can go outside street lighting to reflect all public and private open-air lighting in a wide-ranging method.

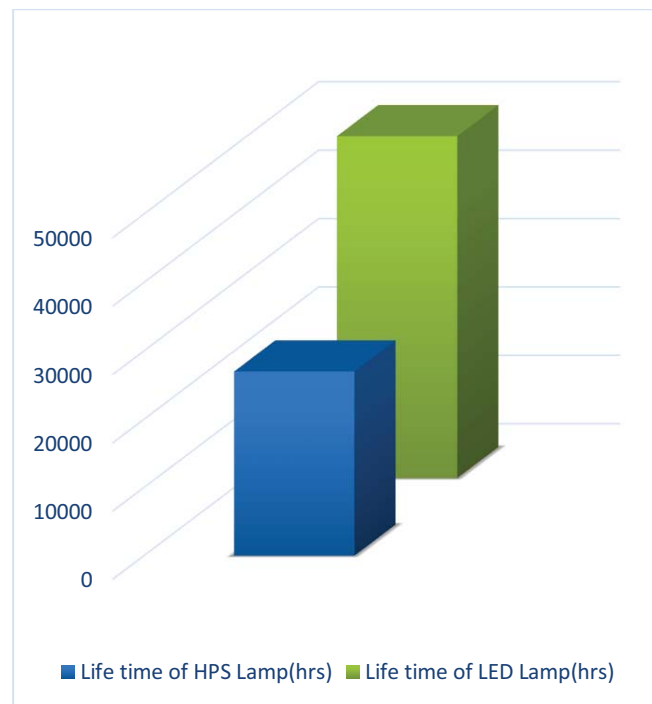


Fig. 4. Lifespan of HPS and LED lamps.

## III. SYSTEMATIC ANALYSIS OF RELATED WORKS

To study about the smart street light system, we have to take an analysis on different aspects anticipated by other researchers. This is a description which is related to the work done on Smart Street Light with various components and by using different algorithms. This was developed and implemented by different aspects in several platforms.

Saifuzzanman et al. takes about the Energy crises is the major problem in our modern environment [1]. On developing the rural area, electricity is the major need. This paper proposes that smart system which can make decision for the bright control. LDR sensor is used to identify the power of the light and the street lights are controlled by IR sensor. Here solar cell is used as a battery. The notable part of this project is to sustain the traffic and also watch the entire system over the internet using surveillance camera is fixed on the street light lamps. B. Abinaya et al. proposed a smart and

weather adaptive lighting in the street light based on the reduction of the light street lights are controlled with the smart embedded system [2]. The ON/OFF of the street lights are accessed through internet. The actions performed on the roads are tracked by a camera which placed on top of the street lights and footages are saved in the server. In-case of any emergency or danger the panic button is placed on the pole, when any person caught danger can press this panic button which raises an alarm to the nearby police station. The manual operation is completely eliminated to ensure the safety and to prevent the energy wastage the system.

Smart street light using IoT by Lakshmana et al. proposed in his project that the solar energy is used for a smart street light to save the electricity in the urban areas in the easy way [3]. Energy is gained by photovoltaic and given to the LEDs of the street lights. The energy source from the photovoltaic is stored in the rechargeable battery and whenever the sun light is not received by the detector, the LEDs will automatically turn ON. PIR sensor is placed is used to the light intensity. Smart street lighting system by M. Kokilavani et al. presented in this paper is focuses on light intensity and also controls moving object nearby the light. Photo electric sensor and light sensor are used in this system [4]. Using artificial energy source, the entire smart system designed can operated. Human being and light intensity of a particular area are sensed by PIR sensor and LDR sensors. The data transmitted to the EB section through the wireless connection.

Designing of Street lighting system based on IoT for smart city by Parkash et al. The proposed system of this paper provides the solution for energy saving [5]. For recognizing a vehicle, the combination of IR receiver and IR transmitter are used. The microcontroller receives the data from the sensor to switch ON and any vehicle or object moves away then the light come to be switched OFF and accessed through the internet. Development of a smart street light system by Fathima et al. is to control the street light [6]. This paper proposes that using the IoT the energy conservation and man power is reduced and the saved energy can utilize efficiency for other purpose. The traditional HID lamps are replaced by LED to save more amount of energy. the calibrated digital signal output of the temperature and humidity are sensed by DHT11 sensor. Programmed Arduino board is used to provide the required intensity of the light at various time.

Development of Urban IoT system by Andrea et al. mainly focused to sustenance the smart vision of city, it aims at abusing the furthest innovative technology to support the added values for the management of city and for the citizens [7]. It provides wide-ranging survey of the enable technology protocol for an inner-city IoT. Designing of cost-effective Street Light System by Akshay Balachandran et al. shows the way of implementation with embedded system focused on the necessity of the automated street light system and [8]. Here IR sensor is replaced by the piezo electric sensor to detect the object's motion on the road. The brain to control the process is microcontroller msp230. It gives the solution to control the light intensity and also the movement on the road. Light

sensor and photoelectric electric sensor are used as a sensing device. Here this system uses piezo electric sensor to detect the movement on the road.

Sharath Patil et al. proposes in the paper, automatic street light control system that the automatic switch in this system is relay, it releases the manual work at-most 100% [9]. The Light dependent sensor works as our eye does. To illuminate the status of human use, light intensity sensors like Zigbee, PIR sensor, LDR sensor are used. To avoid the wastage of energy by glowing street lights in the unwanted area, ON/OFF status of the street lights are intimated to nearby EB section. Artificial energy source called solar and with the battery backup the whole system is operated. By the wireless communication turn ON/OFF of the street light controlled by data received from the Zigbee.

Yao-Chung Chang and D Ying-Hsun Lai explains campus edge computing network using IoT. They speak that a campus affords many advanced tenders in smarter way, such as abundant education, smart energy, and safekeeping facilities to campus employers through many IoT devices [10]. The landscape of platform integrates with campus courses service, controlling the connection between two resources, mobile wireless networks, and other computing services. To examine the network, neural network learning processes are hired and an entire network resource sharing service is used to operate the network node. Furthermore, the learning processes will be customized as the bidirectional IoT communication to avoid insufficient reservoir with various IoTs service and data streams in the general campus network service superiority. The tentative results illustrate that the future mechanism that the edge computing diminishes the cloud loading and forecasts and alters the delivers of the all network can capably reservoir and preserves load stability.

A wireless street light system with GUI was designed and developed by B.K. Subramanyam et al., it converted a vital for the folks to work throughout night and returning homes to the night-time and also rising the amount of corruptions occurred during thenight times [11]. This is established by proper execution of the solar based lighting system on the streets. The charges are reduced by using the solar panel. By using LDR and IR sensors time could be saved and also can reduce the huge individual power. By plotting a specific GUI in the PC, the street lights are governed. Zigbee is the technology is used control street lights.

J.Arthi et al. designing and implementing the advanced evolution in IoT for energy conservation of street light, the best resolution for saving the electrical power is automation on street lights [12]. Here, the manual operation of the lighting system is completely abolished. By using sensor street light illumination can be modified at minimum electrical energy consumption. If any object is detected on street, then street light's luminous level will be increased, else they stay in the blurry mode. During night, real time updates of street processing and observe the changes occur in the street. This paper gives the advantages like reduction in heat

discharges, influence consumption, conservation and replacement costs.

Snehal Bhosale et al. proposes that Street light play's the major role in road safety which is a vital feature for the contemporary atmosphere [13]. A high quantity of power is spent by street lights. It is essential to save the power as much as we can. The electricity cost remains to increase as the wastage of energy increases. It has become very crucial for conserving power. Street light monitoring and controlling is a mechanized system designed to expand the competence on switching of street lights. This development states a new technique for solving the problem for street light control method. By using wireless communication base server controls the street lights by just sending a notification for it. It consists of a client-server application. The principal intention behind this project is to conserve energy.

Deepak Kapgate et al. proposed a system which regulates lights on street conferring to the procedure for Sun-up and Sundown and also for light concentration [14]. This system runs in controlled method. In this method, PC monitor terminal is used to control the streetlights. Additionally, this system is not only for monitoring and controlling the streetlights, it also observes the real-time data and mixes a humidity and temperature. This system broadly useful in all the places and furnished with the high-power relay output which want sensible controller such as electricity divisions, schools and streets.

S.H.Jeong et al. describes a streetlights system based on Zigbee technology which controls and detects the streetlight's status which is mounted along with load. By this system's control command lights are switched ON/OFF [15]. Its information on local status is also monitored by control system via communication channel. ON/OFF status, information about safety, etc., are detected data. Various communication media and communication protocols are used to deliver the control instruction and status information. Wireless or Power lines are generally used as a communication media. This system saves maintenance time and costs with an improvement of safety level.

#### IV. VARIOUS COMPONENTS USED IN IoT

##### 4.1. Microcontroller

A microcontroller may be concerned as a free-standing system with a memory, peripherals and processor. The peripherals, automobiles, appliances and telephones are mostly used microcontrollers and also all the computer systems were embedded in other machineries, so it can be used as the embedded system.

###### 4.1.1. Raspberry Pi

A Raspberry Pi shown in Fig. 3a can deliver all the forecast potential that implicit, at a low-power expenditure level. It is an affinity (debit) card-sized computer modeled by the BBC Micro for educational purposes.

###### 4.1.2. PIC microcontroller

Peripheral Interface Controller shown in Fig. 3b is a firm microcomputer developed to control the performance of embedded system like peddling machines, robots, therapeutic devices, portable radios, office machines, home-based purposes, motor vehicles and several additional devices. Microchip Technology assembled a specialized microcontroller (family of chips) in Chandler, Arizona.

###### 4.1.3. Arduino UNO

The Arduino UNO shown in Fig. 3c is Microchip ATmega328P based on an unsecured source microcontroller board. The board is furnished with a bunch of analog and digital I/O (input or output) pins that may be communicated to various shields (evolution boards) and further circuits. The original STK500 protocol is used to interface.

###### 4.1.4. Wi-Fi Module ESP8266

A microcontroller can access to Wi-Fi network by giving an autonomous SOC (Wi-Fi Module ESP8266) shown in Fig. 3d with coherent TCP/IP protocol stack. For providing an application or discharging every Wi-Fi networking operations from one to alternative application processor, the ESP8266 capable is used. With an AT instruction set microcode each ESP8266 modules were pre-assembled. The ESP8266 module is terrifically worthwhile board with an enormous, and ever flourishing, community.

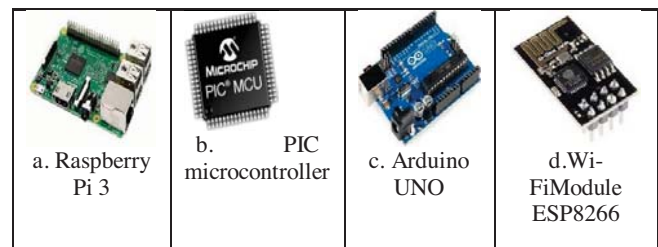


Fig. 5. Various microcontrollers used in smart street light systems.

##### 4.2. Sensors

For a prolonged time, different kinds of sensors have been used in various industries and organizations but the IoT (Internet of Things) innovation of has taken the growth of sensors to the extreme level [17]. Using different sensors, IoT provides various type of data and intelligence. They serve to collect data, push data and share data with an entire network of combined devices.

###### 4.2.1. LDR Sensor

An LDR (Light Dependent Resistor) shown in Fig. 4a is also called a photoresistor. These devices are light dependent. The resistance will be decreases, when the light drops on the LDR, now the resistance level is low. If LDR is placed in the dark region, then the resistance increases here its resistance level is high.

###### 4.2.2. Temperature sensor

A quantity of heat energy is measured using a device called Temperature Sensor shown in Fig. 4b. It allows to diagnose a natural action in temperature from a specific source and transforms the data for a device or user.



#### 4.2.3. Proximity sensor

A proximity sensor shown in Fig.4c senses occurrence of an adjacent object, or properties of that object, and translates it into signal which can be simply read by user or an electronic device without getting in contact with them.

#### 4.2.4. Photoelectric sensor

Photoelectric sensor shown in Fig.4d is made by light-sensitive parts and uses a beam of light to sense the occurrence of an object. It is an idyllic alternative of inductive sensors.

#### 4.2.5. Ultrasonic sensor

Ultrasonic sensors shown in Fig.4e are also used to sense the occurrence or to compute the distance of targets similar to sonar or radar. This makes a consistent resolution for harsh and demanding conditions.

#### 4.2.6. Infrared sensor

An infrared sensor shown in Fig.4f is a sensor which the convinced characteristics of its neighbors are sensed either by releasing or spotting infrared radiation. Accomplishment of computing the heat which is discharged by an object.

#### 4.2.7. PIR sensor

A motion detector shown in Fig.4g is a device which is used to sense the physical movement (motion) in an assumed area and it converts motion into a signal. Motion detective sensor theatres a major role in the refuge industry.

#### 4.2.8. Optical sensor

A sensor which senses the number of light rays and translate it into electrical motion which can be effortlessly readable by user or an electronic instrument/device is called optical sensor shown in Fig.4h.

#### 4.2.9. Pressure sensor

A pressure sensor shown in Fig.4i is used to senses a pressure and translates it into an electronic signal. Here, the quantity depends upon the level of pressure applied.

#### 4.2.10. Humidity sensor

A humidity sensor in Fig. 4j is used to sense both air temperature and moisture. While viewing for relief, Relative humidity becomes an imperative factor.

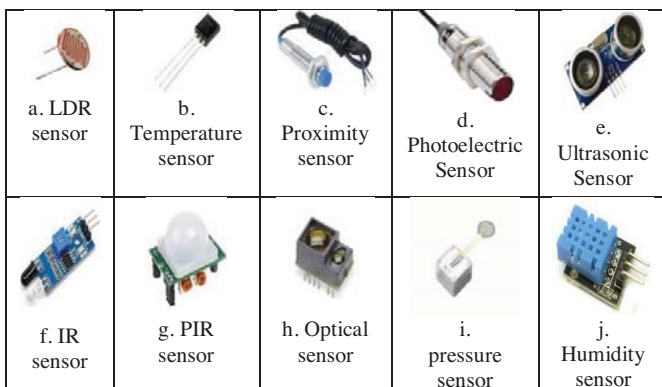


Fig. 6. Various sensors used in smart street light systems.

#### 4.3. Other Components

##### 4.3.1. CCTV

Closed Circuit Television shown in Fig. 5a is a television system and its signals are not visibly distributed but are observed, mainly for surveillance, investigation and security purposes.

##### 4.3.2. LED

A Light Emitting Diode shown in Fig. 5b is a light source that releases light when current drifts through it. It recombines an electron in the semiconductor with electron holes, liberating power in the mode of photons.

##### 4.3.3. Solar panel

A Solar panel shown in Fig. 5c intended to engage the sun's emissions as a basis of dynamism for producing power.

##### 4.3.4. Relay

A relay shown in Fig. 5d is a gadget that is activated by a current. Relays are used in numerous applications because of their extended life, relative easiness, and the consistency level is proven.

##### 4.3.5. Rechargeable battery

A rechargeable battery shown in Fig. 5e is a kind of electrical battery and recharged several times, as divergent to a throwaway or primary battery, which is provided entirely charged and discarded later use.

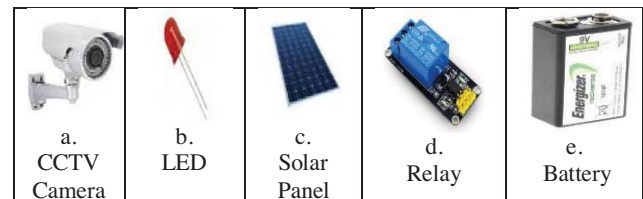


Fig. 7. Various components used in smart street light systems

#### V. COMPARATIVE ANALYSIS OF SMART STREET LIGHT SYSTEMS

In Table 1, it shows comparison and an analysis of various smart street light systems. Using the power efficient lamp with the progressive lighting method is one of the alternate approaches for cost reduction. The progressive technologies such as light emitting diode (LED), are described as the one of the reductions in energy ingesting comparable to the further outmoded, High Pressure Sodium lights (HPS). The system which uses LDR sensors to detect the ambient light and also to detect the fault in the lights. Pedestrian movement of vehicles are detected by motion sensors which is installed in parallel series. Thus, it demonstrates to be ineffective because sensor subsidize for rapid range exposure.

Table. 1 Comparative analysis of IoT based smart street light systems

<i>Papers</i>	<i>Components</i>	<i>Merits</i>	<i>Demerits</i>
F. Dheena et al. [6] (2017)	LDR Sensor, DHT11 Sensor, Arduino Nano.	Reduce manual work, saves more energy	Initial cost and maintenance are high.
Sayali Arkade et al. [24](2016)	PIR sensors, skin sensors, Raspberry Pi.	Saves energy and works in both domestic & industrial applications	More maintenance cost
Parkash et al. [5] (2016)	LDR sensor, IR Sensor, Current Sensor, Raspberry Pi.	Maintenance Cost Reduction, Wireless Communication.	More Energy Consumption, Initial cost expense.
Sagar Deo et al. [17] (2014)	Zigbee Comm. protocol	Reduce manual work, save energy	More Complex Design
Sharath Patil et al. [9] (2015)	Pollution detecting sensors, Temperature, Weather station, Arduino Uno.	Improve energy Efficiency, Minimize cost	Difficult to Design, it works in autonomous way
M. Kokilavani and A. Malathi [4] (2017)	IR sensor, LDR sensor, Raspberry Pi 3	Manual work is reduced, Low cost	Limited coverage.

## VI. CONCLUSIONS

In this survey, we analyze that IoT has groomed rapidly with our day to day life. Smart Street light System is one of the major parts which uses IoT concepts. Smart Street Lighting System clearly tackles the major problems like Energy wastage, Crime detection, disposal of incandescent lamps, maintenance cost etc. This system ensures traffic safety and the security to the people which can stop from women annoyance, burglaries and further intimidations. The Energy crisis occurs in the cities may be reduced because 50 to 60 percent of electricity is saved and these

energies were used in other important purposes. This system is entirely adaptable to the requirements of users and creates a safe environment. This approach requires minimum hardware with simple software. To control street light decisions where taken by the system, it is possible to avoid negligence factors by human operatives. It will also be helpful in making our city as the Smart City.

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