# IoT Based Solar Smart Street Light Monitoring System

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***Abstract-*** *Street lights are very essential in urban and rural areas which facilitate better visibility for vehicle goers and walkers. But, it consumes a quiet large portion of electricity. Hence a prototype is designed which provides an energy efficient automatic street lighting system. The main objective is to design energy efficient street light for energy conservation in existing streetlight. In this project IOT based embedded system is designed to control the street light to automatically turn ON/OFF based on vehicle movement in the street. This system avoids street lights switched on even during day time which results in lot of electricity consumption. This project is designed using Arduino Uno microcontroller which is interfaced with sensors and IOT which facilitates control and monitoring of street lights. The system was programmed to automatically turn off during the hours of daylight and only operate during the night and heavy raining or bad weather. Many times we see that street lights are remain switched ON even during day time, this is lot of wastes of electricity while India is facing lack of electricity. In addition, this system detects the fault and measures concentrations of gases present in the atmosphere. Hence the developed prototype will be efficient in performance and cost effective.*

***Keywords***- Arduino, Air Quality Monitoring, Battery Monitoring, Energy Conservation, IOT (Internet of Things), Microcontroller, Solar Smart Streetlight.

## I. INTRODUCTION

In today's rapidly growing urban landscapes, the demand for efficient and sustainable infrastructure solutions is more pressing than ever. Traditional street lighting systems, powered by fossil fuels, are not only costly to maintain but also contribute to environmental degradation through carbon emissions. As a response to these challenges, the integration of solar energy and Internet of Things (IOT) technology presents a promising avenue for transforming urban lighting infrastructure into smart, sustainable systems. Our project model focuses on the development andimplementation of a solar smart street light system, augmented with an IOT-based battery monitoring system. This innovative approach combines the renewable energy capabilities of solar panels with the connectivity and intelligence of IOT technology to create a reliable, energy-efficient, and environmentally friendly lighting solution for urban environments. In Existing system, When the vehicles pass over the roadways especially at night, there is a stress applied by the moving vehicle on the piezo transducer.This converted digital signal transmitted to IOT-transmitter unit to be processed and wirelessly send to IOT-transceiver to take a decision for lighting LEDs of group-1 only or both group-1 & group-2 according to the traffic situation.Hence, our proposed project affords the ability to control the squandered energy in streetlights smartly.

Our proposed system describes that the wastage of electricity can be reduced, lifetime of the street lights gets enhanced because the lights do not stay ON during the whole night and also helps to increase safety measurement.The piezo electric sensor and solar panel are used for the power generation. The complete hardware will work based on this power source.This system measures concentrations of gases such as Methane using semiconductor sensors.The LDR sensor is used for the energy efficient purpose. At night time only street light will turn on. At day time it will be automatically turned off.The IR sensor is used based on the vehicles presence the street light will turn on. With the help of voltage and current sensors, we can detect that whether the street light is faulty or not.The industrial pollution monitoring includes ecological parameters like methane Gas and other poisonous sensor. The sensors data are giving to the arduino microcontroller for observe analyze the environmental situation.

## II. LITERATUREREVIEW

Inthetitle[1]IOT based Energy Efficient Smart Street Lighting Technique with Air Quality Monitoring proposed by S.N. Ali Kazmi, A. Ulasyar and M.F. Nadeem KhanThis paper presents an Internet of Things (IOT) based solar and piezoelectric powered street lighting system focusing on energy conservation, automation, air quality monitoring and detection of faulty streetlights. It presents a hybrid and dynamic IOT based approach for smart street lighting system (SSLS) along with real time online monitoring of air quality. The free energy generation from solar panels and piezoelectric transducers makes the proposed SSLS a standalone

infrastructure. It smartly maneuvers the streetlights based on the presence or absence of vehicles and sunlight via light dependent resistor (LDR) and infrared (IR) sensors. Moreover, an online detection system is used for detecting faulty streetlights with the help of voltage and current sensors. Depending upon number of vehicles passed during night, streetlights are operated at four different intensities i.e., from 20% to 50% with the step size of 10% in the absence of vehicles while operating at 100% intensity upon vehicle's arrival. This dimming operation not only enhances the life span of streetlights but also enables significant conservation of energy up to 84%. Besides, real time online air quality monitoring helps authorities to take suitable action whenever air quality index reaches an undesired level.In this title [2] 'Smart City: Recent Advances. In Intelligent Street Lighting Systems Based On IOT'. Proposed by Amjad Omar, Sara AlMaeeni, Hussain Attia, Maen Takruri, Ahmed Altunaiji,Mihai Sanduleanu, Raed Shubair, Moh'd Sami Ashhab, Maryam Al Ali, and Ghaya Al HebsiThis paper reviews the current trends in smart street lightingwith emphasis on the selection of the type of lamp and themethod of controlling the light intensity, as well as theapproach to connect the sensors together to remotely controlthe lights, record the weather conditions, and diagnose lamp failure remotely. A comparison between the different methods is provided. Compared to other review paper on smart street lighting, our paper compares the different systems of smart streetlighting including control mechanism and connectivity anddiscusses the current and future trends. The other review paper excluding mainly focus on one type of connectivityand one type of control system.This paper discusses the selection of light lamps. Discusses background work on smart street lighting explaining the different control techniques. Introduces the concept of networkedstreet lighting systems as well as its state-of-the-art. Discusses different light connectivity techniques. Summarizes the properties of the different lighting systems. Highlights the current and future trends in smart lighting systems.In this title [3] 'Solar Power Monitoring System Using IOT Syatem' proposed by Gaurav Khambalkar, Atharva Wasurkar, Ritesh Jibhakate, Suraj Dongare, Vijay Chikhalonde. The increasing demand for renewable energy has led to the development of solar power systems as an alternative source of electricity. However, the efficiency of these systems is greatly influenced by the environment in which they are installed. To address this challenge, an IOT-based solar power monitoring system was designed and implemented to monitor the performance of a solar power system in real-time. The system measures five critical parameters, namely, current, voltage, power, solar panel temperature, and light intensity, continuously. The system's hardware consists of a microcontroller unit (ESP32), current and voltage sensors, a temperature sensor, a light intensity sensor, and an LCD display. Additionally, the system is designed to communicate with both a mobile Blink application and a computer screen, providing realtime monitoring and data visualization. The data collected by the system is analyzed and used to optimize the performance of the solar power system. The system's software is programmed to generate alerts when any of the measured parameters falls below or exceeds the set threshold values. This ensures that the system is continuously monitored, and any issues are detected and addressed promptly, enhancing the efficiency of the solar power system. Overall, the IOT-based solar power monitoring system has proved to be an effective solution for real-time monitoring and optimization of solar power systems. The system's ability to measure critical parameters and provide alerts has improved the efficiency and reliability of the solar power system, making it a valuable addition to the renewable energy sector. In this title [4] 'An Internet of Things based Solar Power Monitoring System using Node MCU' proposed by Kaushalya Thopate, Swati Shilaskar, Shripad Bhatlawande. In this research paper, we propose a solar power monitoring system using Node-MCU, an open-source IOT platform. Our system collects, processes, and visualizes real-time data from solar panels, batteries, and other system components, providing comprehensive monitoring capabilities for solar power system owners. The system is designed to be cost-effective and scalable, making it suitable for both residential and commercial applications. Through our research, we demonstrate the feasibility and effectiveness of our solar power monitoring system using Node-MCU. The findings contribute to the field of renewable energy management by offering an innovative approach to monitor and optimize solar power systems, promoting the wider adoption of renewable energy sources for a sustainable future.In this title [5] 'IOT Based Solar Power Monitoring System' proposed by Maisagalla Gopal, T Chandra Prakash, N Venkata Ramakrishna, Bonthala Prabhanjan Yadav. Internet of Things (IOT). By using the IOT supervising solar energy can greatly enhance the performance, monitoring of the plant. It is a technique to keep track of the dust assembled on the solar panels to induce the maximum power for active utilization. The amount of output power of the solar panels depends on the radiation hit to the solar cell. All the panels are attached and the sensors are precisely connected to the central controller which supervise the panels and loads. Thus, user can view the current, voltage and sunlight.

## III. METHODOLOGY

Programmed to be an intelligent and automatic system, our solution is designed in a way such that the street lights automatically turn their states to glowing on and glowing off depending on the sunlight and the movement

detection. Along with the detection of sunlight, another feature that has been added is to control the intensity(the brightness) of the LED's by making use of the IR (Infrared Ray) motion sensors. These sensors are used to detect any motion whether it be a person or a vehicle, by sensing the heat radiations, and if a motion is detected, the brightness or the intensity of the lights automatically increases and in case if no motion is detected then the brightness either is dim or the lights returned off, depending on how the system is programmed by making used of the code and the values that are provided during the building of the source code**.**

**BLOCKDIAGRAM**

In this system, we use ARDUINOUNO microcontroller which acts as brain of the system, because the entire system program instruction stored in it.

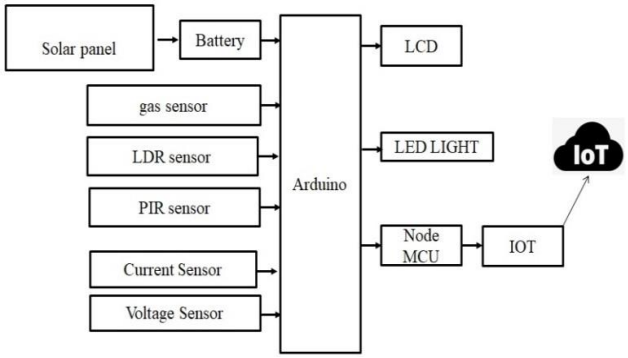


**Fig.1 block diagram**

**The design basically includes three working modes:**

**OFF mode-**When there is enough natural light in the surrounding i.e. during the daytime, the entire system is switched off and the batteries are charging.

**Active mode-**When the natural light drops below a certain level the system automatically turns on and the motion sensors are powered.

**ON mode-**On the presence of pedestrians, the sensors turns on which in turn switches on the LED lights These lights turns off after a period of time.

The details of the hardware and software required for this project are given below

**Hardware Requirements**

Powersupply+5V dc
Solar Panel
Arduino Uno
Node MCU
Battery
Gas sensor
LDR sensor
IR sensor
Current Sensor
Voltage Sensor
LCD
LED
IOT

**Software Requirements**

Embedded C
Arduino software IDE
ThinkSpeak(cloud)

## IV. HARDWARE DESCRIPTION

**ARDUINO UNO**

The Arduino Uno is a low cost, flexible, and easy to use programmable open source microcontroller board.This board can be interfaced with other Arduino boards, Arduino shields, Rasperry Pi boards. They can control Relays, Leds, Servos, and Motors as an output**.**

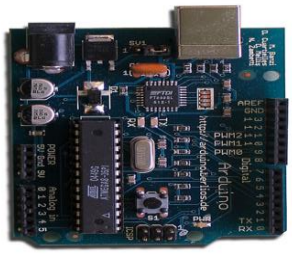

**Fig.2 Arduino Uno**

**POWER SUPPLY**

The power supply section is the important one. It should deliver constant output regulated power supply for successful working of the project. The primary of this transformer is connected in to main supply through onand off switch& fuse for protecting from overload and short circuit protection.

**NODE MCU**

Node MCU is a low-cost open source IOT platform ESP32 (32-bit MCU).In this ESP module it has a build in Wi-Fi module.It is used for the purpose of Transmitter and Receiver communication**.**

**Fig.3 Node MCU**

**GAS SENSOR**

This is a MQ 135 Air Quality/Gas Detector Sensor Module for Arduino.If you are want to make a device that is used to detect Ammonia, Sulphide, and Benzene steam, also sensitive to smoke and harmful gases from the desired distance, then this sensor is needed.

**Fig.4 Gas Sensor**

**IR SENSOR**

An IR (Infrared) sensor detects the presence or absence of objects by emitting and receiving infrared radiation. When an object is present in the sensor's field of view, it reflects or emits infrared radiation, which is then detected by the sensor. This triggers the sensor to produce an output signal indicating the presence of the object.

**Fig.5 IR Sensor**

**LDR SENSOR**

Photo resistor is made of a high resistance semiconductor. In the dark, a photo resistor can have a resistance as high as several mega ohm (MΩ), while in the light, a photo resistor can have a resistance as low as a few hundred ohms.

**Fig.6 LDR Sensor**

**CURRENT SENSOR**

A device that is used to detect & also change current to assessable output voltage is known as a current sensor.This output voltage is simply proportional to the current flow throughout the measured path.

**Fig.7 Current sensor**

**VOLTAGE SENSOR**

Voltage Sensor is a precise low cost sensor for measuring voltage. It is based on principle of resistive voltage divider design.It can make the red terminal connector input voltage to 5 times smaller.

**Fig.8 Voltage sensor**

**SOLAR PANEL**

Solar Panels are also called as PV (Photovoltaic) panels shown in figure 3 are used to convert the light energy from the sun. Solar panels are made up of many independent solar cells which are formed by combining the elements like silicon, phosphorus and boron layers. These panels absorb the photons from sunlight and collaborate with the electrons which are present in the panels and generate electricity

**Fig.9 Solar panel**

**LCD**

LCD screen is an electronic display module which uses liquid crystal to produce a visible image and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. A 16x2LCD means it can display 16 characters per line and there are 2 such lines.

**Fig. 10 16XLCD**

**IOT**

The Internet of Things (IOT) is the network of physical devices, vehicles, buildings and other items embedded with electronics, software, sensors, actuators and network connectivity that enable these objects to collect and exchange data. Data is updated to a specific site or a social network by which the user can able to access the data.

**Fig.11 IOT board**

**FEATURESOFIOT**

Power Supply DC +12v 1Amp
Auto data updating 30sec
Digital Output port Pins +5VDC
Provided with 3links they are

1. Data updating to a specific website
2. Device controlling website
3. Data updating to a social network

## V. SOFTWARE DESCRIPTION

**EMBEDDEDC**

Embedded Cis most popular programming language in software field for developing electronic gadgets. Each processor used in electronic system is associated with embedded software. Embedded C programming plays a key role in performing specific function by the processor. All these devices are working based on microcontrollers that are programmed by embedded C.

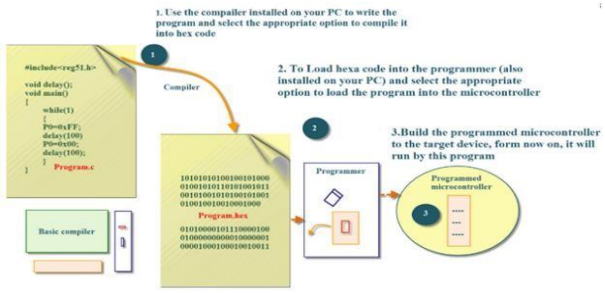


**Fig.12 Embedded C format**

In embedded system programming C code is preferred over other language. Due to the following reasons
Easy to understand
High Reliability
Portability
Scalability

**ARDUINOSOFTWAREIDE**

The Arduino Integrated Development Environment or Arduino Software (IDE) - contains atext editor for writing code, a message area, a text console, a tool bar with buttons for common functions and a series of menus. It connects to the Arduino and Genuine hardware to upload programs and communicate with them.

**THINGSPEAK**

ThingSpeak is an open-source Internet of Things (IOT) platform that allows users to collect, analyze, and visualize data from sensors or devices in real-time. It provides a cloud-based infrastructure for storing and managing IoT data, as well as tools for data analysis, visualization, and integration with other applications.

## VI.VERIFICATION AND RESULTS

Energy Efficiency The integration of solar panels and LED lighting technology significantly reduces energy consumption compared to traditional street lighting systems, leading to substantial cost savings and environmental benefits.Reliability: The IoT-based battery monitoring system ensures the reliable operation of street lights by continuously monitoring battery health and performance. This proactive approach minimizes downtime and improves overall system reliability. Optimized Maintenance: Real-time monitoring and remote diagnostics capabilities streamline maintenance efforts by enabling prompt identification and resolution of issues. This leads to reduced maintenance costs and improved operational efficiency. Environmental Impact: The use of renewable solar energy reduces carbon emissions and reliance on fossil fuels, contributing to environmental sustainability and mitigating the effects of climate change.

Overall, the project results validate the effectiveness and practicality of integrating solar energy, IoT technology, and battery monitoring systems to create smarter, more sustainable urban lighting infrastructure. These findings underscore the project's significance in addressing contemporary challenges in urban development and energy management.

**OFF MODE** When there is enough natural light in the surrounding i.e. during the daytime, the entire system is switched off and the batteries are charging.

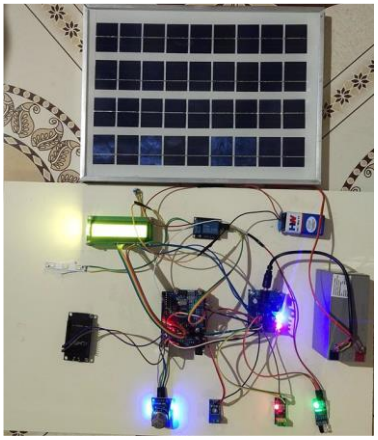

**Fig. 13 Project Prototype while OFF**

**ON MODE** On the presence of pedestrians, the sensors turns on which in turn switches on the LED lights These lights turns off after a period of time.

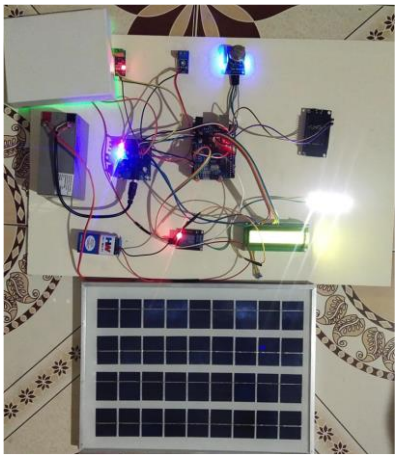

**Fig. 14 Project Prototype while ON**

**READINGS OF GAS, CURRENT AND VOLTAGE SENORS OUTPUT**


**Fig. 15 Current and voltage reading**


**Fig. 16LDR reading**

**SOFTWARE OUTPUT**

All the readings are shown in the chart using ThingSpeak cloud.

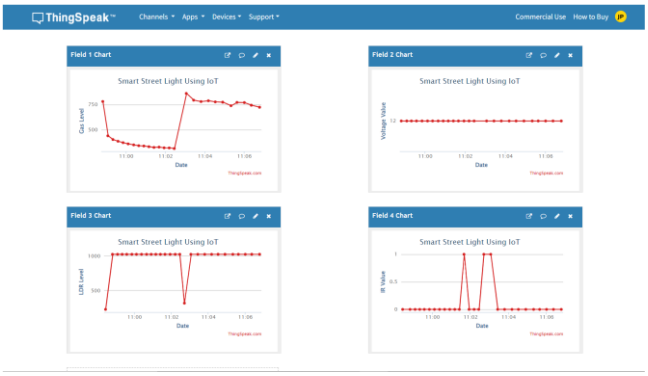


**Fig. 16 Simulation Output**

## VII. CONCLUSION

The integration of solar smart street lights with an IoT-based battery monitoring system offers a sustainable and efficient solution for urban lighting infrastructure. This project addresses the pressing need for energy conservation and effective management of resources in urban environments. By harnessing solar energy and utilizing IoT technology for battery monitoring and control, the system ensures reliable and environmentally friendly illumination while minimizing operational costs and maintenance efforts. Furthermore, the project provides valuable insights into the practical application of Air quality index and battery's voltage and current levels. Overall, this project not only serves as a significant contribution to academic research but also holds immense potential for real-world implementation, making it a compelling choice for the society.

## REFERENCES

[1] S.N. Ali Kazmi, A. Ulasyar and M.F. Nadeem Khan. 'IOT based Energy Efficient Smart Street Lighting Technique with Air Quality Monitoring'. 2020 14th International Conference on Open Source Systems and Technologies (ICOSST), 2020, pp. 1-6

[2] Amjad Omar, Sara AlMaeeni, Hussain Attia, Maen Takruri, Ahmed Altunaiji,Mihai Sanduleanu, Raed Shubair, Moh'd Sami Ashhab, Maryam Al Ali, and Ghaya Al Hebsi. 'Smart City: Recent Advances In Intelligent Street Lighting Systems Based On IOT'. Dept of Electrical, Electronics and communications Engineering, American University of Ras AL Khaimah Issued: 2022

[3] Gaurav Khambalkar, Atharva Wasurkar, Ritesh Jibhakate, Suraj Dongare, Vijay Chikhalonde. 'Solar Power Monitoring System Using IOT System'. International Journal Of Creative Research Thoughts (IJCRT) Issue: 2023

[4] Kaushalya Vaibhav Thopate, Swati Shilaskar, Shripad Bhatlawande. 'An Internet of Things based Solar Power Monitoring System using Node MCU'. International Journal on Recent and Innovation Trends in Computing and Communication Issue: 2023

[5] Maisagalla Gopal, T Chandra Prakash, N Venkata Ramakrishna, Bonthala Prabhanjan Yadav. 'IOT Based Solar Power Monitoring System'. Institute Of Physics (IOP) Issue: 2020

[6] Ayush Kumar Tiwari, Aman Goyal, Akshita Sharma, Pragya Tewari. ''Smart Pollution Monitoring System''. International Journal of Scientific Research & Engineering Trends (IJSRET) Issue: 2021

[7] Preethi Sekar, Priya Sabde, Ganesh Patil. ''IoT-based Solar Energy Monitoring''. International Journal of Scientific Research & Engineering Trends (IJSRET) Issue: 2022

[8] G. Jia, G. Han, A. Li, and J. Du, ''SSL:Smart street lamp based on fog computing for smarter cities''. IEEE Transactions on Industrial Informatics, vol. 14, no. 11, pp. 4995-5004, 2018.

[9] R. Abinaya, V. Varsha, and K. Hariharan, "An intelligent street light system based on piezoelectric sensor networks''. in 2017 4th International Conference on Electronics and Communication Systems (ICECS), 2017: IEEE, pp. 138-142

[10] S.R. Parekar and M.M. Dongre, "An intelligent system for monitoring and controlling of street light using GSM technology'', 2015 International Conference on Information Processing (ICIP), 2015, pp.604-609.