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Automatic Street Light Control and Management System Using Solar Energy

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Abstract: ***Electricity waste is a major issue in today's world. The excessive use of electricity by the street lights is one of the main factors in this situation. This undertaking depends on brilliant checking of the streetlamp which will help in lessening the energy utilization issue. In this section, we will make use of a microcontroller, LDR sensor, and IR sensor and solar powered battery pack to automatically turn on and off the street lights whenever they are needed to save power and extend their lifespan. It is suggested that this arrangement could save up to 50% of the energy that is currently used. In comparison to the conventional street lights, this appears to be more cost-effective, sustainable, and efficient.***
Keywords: Microcontroller, LDR sensor, IR sensor, solar energy and street light

I. INTRODUCTION

This system focuses on the development of a smart street lighting system using IoT technology. The aim is to reduce energy consumption and wastage of power by implementing a system that can monitor and control the street lights based on traffic flow and lighting conditions. The system uses sensors such as LDR and PIF to detect light and human presence, which is transmitted wirelessly to the controller. This data is used to turn on/off or dim the street lights accordingly. The proposed system offers a solution for efficient monitoring and control of street lights, resulting in significant energy savings.[1]

The "Street Light Monitoring and Control System" is designed to maintain automatic street lights and reduce power consumption. Light and current sensors report problems to a centralized system with GSM support. Useful data is stored in a database to generate charts for power consumption, total burning hours, and fault detection. Effective street lighting increases road safety, improves quality of life, and deters crime. Similar projects include smart street lighting and automatic street light control systems.[2]

A smart street light monitoring system is proposed in this system that automates the operation of electronic devices using a microcontroller, Wi-Fi module, and relay. This system is a step towards a smart world where IoT is the way of communication between all electronic devices, leading to efficient energy utilization and lesser need for human intervention. IoT technology allows for information sharing between connected devices and offers major advantages compared to manual operation. This system can be used to operate street lights based on certain conditions, improving energy efficiency and reducing maintenance costs. Other research papers in this area include "Smart Street Lighting System for Energy Efficiency with Traffic Monitoring and Control" and "Automatic Street Light Control System Using LDR and RTC."[3]

Here, the authors focus on how Internet of Things (IoT) can be used to develop smart street lighting systems, which can help in solving energy crises and improve street lighting around the world. They discuss various sensors and components used in IoT environment, which can create intelligent systems. The paper also highlights the importance of IoT in our daily lives and its usage in different applications such as healthcare, industrial management, and smart homes. The study aims to provide the best solution for electrical energy consumption in street lighting.[4]

This paper presents an IoT-based smart street light system that reduces electricity wastage and manpower by using an LDR sensor to switch the lights on and off based on ambient intensity. The system uses a low-cost Wi-Fi module to control the switching and allows real-time access to the ON/OFF status of the lights from anywhere. The system is implemented using a NodeMcu board and has achieved better performance compared to existing systems. The system also includes power conditioning and control measures to reduce energy consumption.[5]

Automatic street light control and fault detection system with cloud storage uses IoT technology to automatically control and detect faults in street lamps. The system senses the light or dark environment using LDR sensors and switches the street lights on or off accordingly. It also sends SMS to ward members and servicemen in case of faulty conditions and stores the sensor values in a cloud server, accessible anywhere and anytime. This technology reduces energy consumption, maintenance costs, and manual errors, making it an efficient solution for street lighting systems.[6]

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Autonomous street light systems require no external wiring or manual operation, automatically turning on/off when needed. Motion detection sensors help to increase light intensity and conserve energy when there is no activity. With increasing demand for energy-efficient solutions, smart street lighting systems can reduce power consumption and serve as the foundation for IoT applications. Modern street lighting systems are being challenged to perform more and reduce waste, making it necessary to improve consumption with Smart Street Light while ensuring public safety. Smart streetlights can also be used for detecting flooding in the streets.[7]

IOT based smart LED street lighting system aims to reduce energy consumption and costs by automating street lights through sensor technology. This system detects objects and adjusts light levels accordingly, reducing wastage and carbon dioxide emissions. The system also illuminates pedestrian paths, increasing safety. Real-time updates can be accessed through IOT, allowing for efficient monitoring and issue resolution.[8]

This system is on Smart Street Lighting System using IoT for energy savings and monitoring of street lights. The proposed system eliminates manual operation and utilizes wireless technologies, sensors, and a microcontroller to control LED lighting based on traffic flow and presence of people. Energy savings are achieved through automatic switching ON/OFF and dimming of lights. This system can operate using solar energy and has huge potential for reducing energy consumption in cities.[9]

This system is of an IoT-based Smart Street Light System that aims to conserve energy by reducing electricity wastage and manpower. The system uses an LDR sensor to switch the street lights on and off based on ambient intensity levels. A low-cost Wi-Fi module, ESP8266, is used for switching and real-time monitoring can be done from anywhere through the internet. The system achieves better performance compared to existing systems and can be operated in auto or manual mode. The proposed system uses wireless technology to transfer data from the street light controller to the base station.[10]

II. LITERATURE REVIEW

This is a technical paper on the development of a smart street light energy saving control system. The aim is to reduce energy consumption and increase the lifespan of the lamps. The system operates by maintaining the street lighting intensity at 40% of maximum intensity if no vehicles pass through a certain road. When an infrared sensor detects movement of a vehicle, the street lights will be switched to 100% intensity. A light-dependent resistor (LDR) is used to detect day/night, and all the street lights will be in the OFF state during the day. The Arduino microcontroller is used to control the system, and the current sensor is used as the current detector for the LED lamp. The system also includes an LDR sensor to detect the proper operation of the street light. If any of the street lights are not working properly, the same is displayed on an LCD. The system has shown great energy savings and has the potential to be upgraded with more functions to become more user-friendly and commercialized. The paper highlights the importance of saving energy in the present scenario where the demand for electricity is increasing, and energy production is not able to keep up with demand. [1]

The article is discussing a proposed plan for a street light monitoring and control system that aims to improve street lighting maintenance and reduce energy consumption. The system involves placing light sensors in all street light circuits that are responsible for automatic switching on and off. Current sensors are placed at every light pole to report problem status to the centralized system with the help of a GSM module. The system also collects useful information from each street light at the end of each day to derive charts that contain information like power consumption, burning hours, interruptions, power consumption vs. power supplied, and fault detection details. The proposed system aims to achieve individual faults repaired within a few working hours instead of taking days or months, as is the case in the current system where a staff actually goes on "light patrols" six to eight times a year to check for faulty street lights. The article also discusses some related works on automatic street lights control systems using microcontrollers and sensors. [2]

In this research paper the study of automatic control and fault detection on street lamps is done with the help of arduino program. The street lighting system is one of the largest energy expenses for a city a smart street light controlling and monitoring system can reduce the street lighting cost. Nowadays the street lamps are operated or fixed annually. But the street light control and fault detection with cloud storage system operates the street lamps on/off and find the fault in the street lamps automatically. The LDR (light dependent resistor) is used to check the weather condition for the street lamp on/off. If the weather is bright system identifies it as the day time and if it’s dark it’s a night time. When the lights are on but some faulty lights are not glowing, the system find the light is not glowing. So some fault occurs in the light we can able to know through the LDR values. So the system send alert message to the ward member or service man. [3] The given system is worked with a street light circuit and it is monitored with the help of SIM800A module which is sequentially tracked by the mobile phone or laptop. This system can be comfortable for controlling individual street light control, monitoring and fault detection by any smartphone or laptop.

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This information is going to be collected from each street light whether it is on or off and also the condition of light that it is working or not is received with the help of GSM module. This data is collected from street light about their on/off conditions and healthy status (light is working or not working) to address within the system and connected to the web servers. So basically this system presents the status of light that it is on/off and any king of fault occurred during the turning on process is determined. This data is collected by the web server and send to the service man. [4]

This paper describes the system that controls the illumination of light. It saves energy and achieves higher efficiency which helps in building, smart city, solar panel the solar energy will be converted into electrical energy hence power consumption will be very low. It will have the ability to automatically switch ON lights when sunlight goes below the visible region and automatically switch OFF lights when sunlight comes. It also has the ability to calculate and automatically recognize presence movement of people/ vehicles/ animals with the help of microcontroller, it will guarantee that the light system will operates in a very exact manner. With the help of new technology, they have also fitted dept sensors to serve streets which are flooding. [5]

This paper analysis on different aspect anticipated by other researches, this is a description which is related to the work done on smart street light with various components and by using different algorithms. LDR sensors is used to identify the power of the light and the street lights are controlled by IR sensor, here solar cells are used as batteries. Various components used in this are Microcontroller, Wi fi module esp8266, sensors, photoelectric sensor, IDR sensor, raspberry pie, CCTV, ultrasonic sensor, proximity sensors, humidity sensor, LED, rechargeable battery, solar panel. The energy cries occur in the cities maybe reduced by 50%-60% of electricity is saved and these energies can be used in other important places. [6]

Basically, streetlights are an essential part of our infrastructure, but they consume a lot of energy and cost a lot of money to operate. The existing system relies on manual operation, which can lead to energy waste if people forget to turn off the lights during daylight hours. To address these issues, the smart LED street lighting system proposes a solution that uses advanced technology to automate the streetlights and reduce energy consumption. The system makes use of sensors and the Internet of Things (IoT) to detect when the lights are needed and adjust their illumination accordingly. Two types of sensors are used in the system: an infrared (IR) sensor and a light-dependent resistor (LDR) sensor. The IR sensor detects the presence of vehicles or pedestrians on the road, and the LDR sensor detects the amount of ambient light in the environment. By combining these sensors, the system can determine when to turn on and off the lights and adjust their brightness levels. The system is controlled by an Arduino node mcu (ESP8266) microcontroller and a mobile application called "bylnk." The microcontroller receives data from the sensors and uses it to control the LED lights. The bylnk application allows users to monitor the system's status in real-time, making it easier to detect and fix any issues that may arise. Overall, the smart LED street lighting system aims to save energy, reduce costs, and improve safety by providing a more efficient and automated solution for street lighting. [7]

This paper is about automating the operation of street lights on a campus or in a certain area using a microcontroller and a relay to control the lights wirelessly instead of manually. The microcontroller used is the ESP8266 (NodeMCU), which has an inbuilt Wi-Fi module that connects to a network, allowing for wireless operation of the street lights. The goal of this project is to create a "smart world" where all electronic devices are connected and can communicate with each other through the Internet of Things (IoT) technology. This saves energy and reduces the need for human intervention. The paper discusses the advantages of using IoT technology to connect electronic devices, such as the ability to remotely control them from anywhere with an internet connection. This makes it easier to operate connected devices compared to manually operating them. The proposed system involves connecting an additional switch mechanism to the existing switch in series, which can connect to the internet and receive commands from a user. The new switch is the microcontroller, which can be controlled wirelessly with a smartphone, making the entire system smart and no longer requiring manual operation from the physical location of the switch. The paper also discusses the working principle of IoT, which involves connecting every device required to be operated through IoT to each other and to the internet. This allows for communication between the devices and allows for easy control of the devices through a smart device connected to the same network. Overall, this paper demonstrates a step towards digitizing routine tasks and having more control over them through IoT technology. [8]

III. METHODOLOGY

A method of dynamic control is supported by the Smart Street light control system. As per the proposed model, as a matter of some importance, when it becomes dull, every one of the streetlamps naturally switch on with low power. At the point when a vehicle cruises by, a block of streetlamps shines with the focused energy and on the grounds that the vehicle pushes ahead, the ensuing block of lights begins sparkling with extreme focus where the past block diminishes its power.

A. *Existing Framework*

The assiduity of street lighting frameworks is developing fleetly and going to complex with fast fire development of assiduity and cities. In the current field of electronics and electrically related technologies, important considerations include robotization, power consumption, and cost effectiveness. To control and keep up with complex street lighting frameworks all the more financially, vivid street light control frameworks are created. Using a variety of technologies, these systems are developed to control and reduce the energy consumption of a city's public lighting system. HID lights are used during the being work. Since the HID is currently utilized in municipal streetlights that are based on the gas discharge principle, the discharge path is broken and the intensity cannot be controlled by any voltage reduction system. HID lights are a type of electrical gas-discharge beacon that use an electric bow between tungsten electrodes in a fused quartz or fused alumina bow tube that is transparent or translucent. Gas and essence mariners abound in this tube. The gas works with the bow's unique strike. The essence mariners forming tube is heated and evaporated when the bow is started, resulting in a significant increase in light intensity and a decrease in power consumption. Extreme focus release lights are a sort of bow reference point. Negative aspects of the current system:

1) High-intensity discharge (HID) lamps use more power.
2) HID lamps have a shorter lifespan in comparison.
3) Not all outdoor applications are suitable for HID lamps.
4) Splendor of the lights in the back view mirrors which causes an issue for drivers before your vehicle.

B. *Proposed System*

A smart road light system has been created by replacing HID lights with LEDs because they are unreliable and expensive. Because of robotization, power utilization and cost adequacy inside the current field of hardware and electrical associated advancements, the assiduity of street lighting frameworks is developing fleetly and getting excessively complicated with the fast fire development of assiduity and cities. Different kinds of road light control systems are developed to control and maintain complex road lighting systems more economically. These frameworks are created to decrease the energy utilization of a public lighting framework utilizing different innovations which use IR movement identifiers to distinguish the vehicle or person on foot development after which the streetlamp starts to expand its force. The streetlight, which was glowing brightly at first, gradually decreases in brightness as the vehicle moves.

Road light control systems of various kinds have been developed in an effort to cut down on energy consumption in public lighting systems. Streetlight intensity is increased when these systems detect vehicle or pedestrian movement using IR motion detectors. The intensity of the previous streetlight increases as vehicles or pedestrians move along the street
is automatically reduced, resulting in a lighting system that is both more effective and dynamic. Also a 12 volt solar panel is added to the system to make it totally independent. This panel absorbs the solar energy from the sun and charges a battery of 11.1 volts. This battery pack then supplies power to the system making it fully automated. A solar regulator is also used to regulate the flow of electricity between the solar panel and the battery. Its primary function is to prevent overcharging and over-discharging of the batteries, ensuring they are charged and discharged within safe limits. It monitors the voltage and current coming from the solar panels and regulates the charging process to maintain the batteries at their optimal voltage levels. When the batteries reach a certain charge level, the charge controller reduces or stops the flow of electricity from the solar panels to prevent overcharging.

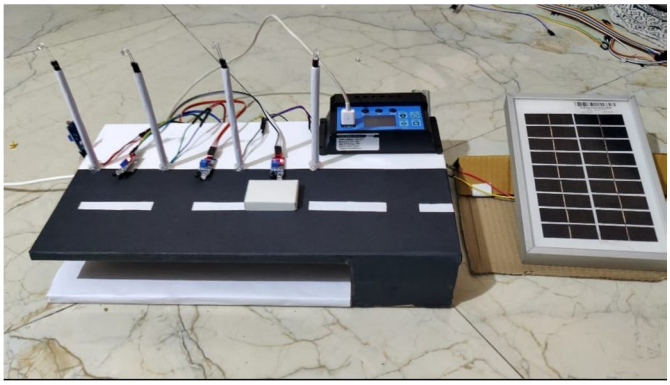


Fig 1

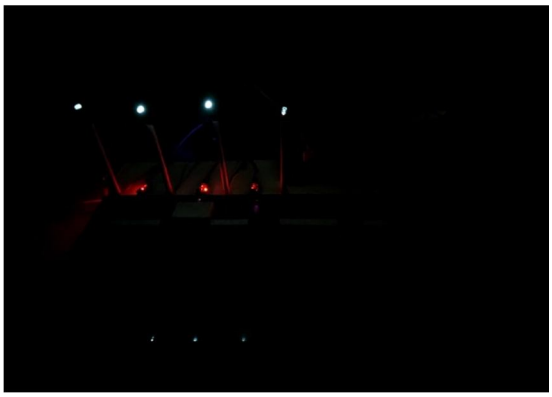


Fig 2

C. Equations

1) Efficiency = (Light output / Energy input) x 100%

2) Energy (in kWh) = Power (in kW) x Time (in hours)

3) Voltage drop = Current x Resistance

External Brightness	LED Intensity
62	514
54	534
51	542
210	119
211	117

Table 1: External brightness (LDR value) vs LED Intensity

Feature	Description
Energy Efficiency	Ability to conserve energy when not in use
Dimming	Ability to adjust light output based on need
Wireless Connectivity	Ability to connect to wireless networks
Smart Controls	Ability to adjust light output based on environmental factors
Remote Monitoring	Ability to monitor system remotely
Environmental Sensors	Ability to collect and report environmental data
Cost	Price per unit, maintenance cost, and installation cost

Table 2: Features and their description of the system

IV. RESULT

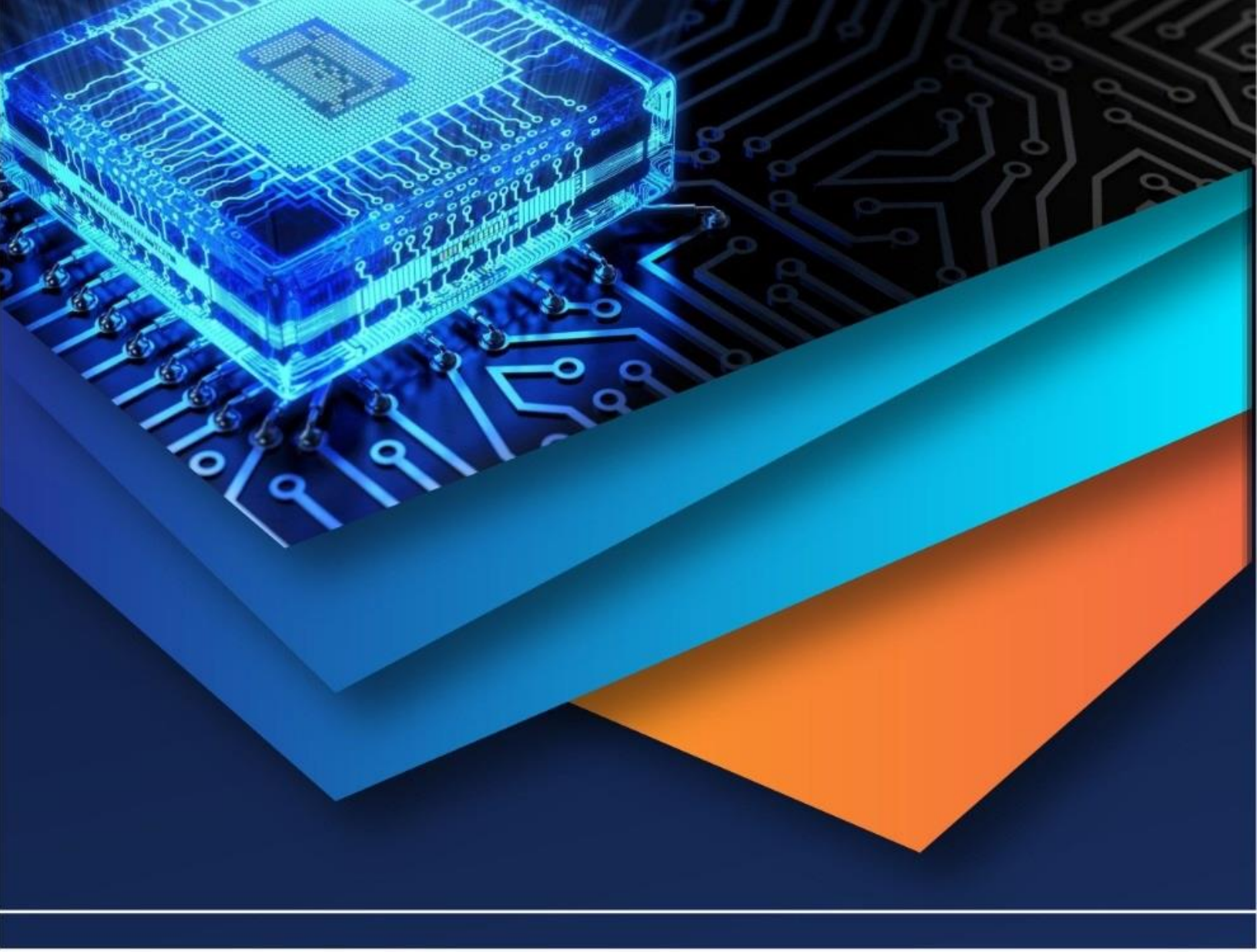
The LDR detects sunlight, which causes the lights to turn on or off. As it detects any object, the circuit's IR sensor controls the light's intensity. The system is powered by a set of batteries which are recharged by solar energy, connection is always established. The lights turn on or off based on LDR sensor responding to day or night. 40% of maximum intensity if no vehicles are passing through the road and turning them to 100% intensity if a vehicle is detected by the IR sensor.

V. CONCLUSION

This project proposes the creation of a smart monitoring system that can cut down on energy consumption to address the issue of street lights wasting electricity. A microcontroller, LDR sensor, IR sensor and a battery pack recharged by solar energy are all included in the proposed system to automatically regulate when street lights should be turned on and off, resulting in lower power consumption and longer lamp life. It is anticipated that the system will be more cost-effective, sustainable, and efficient while simultaneously saving up to fifty percent of the energy that traditional street lights use. Using sensors and microcontrollers to automatically control street lights has been shown in previous studies to help save energy. The goal of the proposed system is to speed up repairs for individual faults, reduce delays that could last for days or months, reduce energy consumption, and improve maintenance of street lighting.

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