

IOT BASED SMART STREETLIGHT SYSTEM

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Technology degree in
Information Technology

By

TANIYA VERMA (Reg.No - 39120127)



DEPARTMENT OF INFORMATION TECHNOLOGY

SCHOOL OF COMPUTING

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade “A” by NAAC | 12B Status by UGC | Approved by AICTE
JEPPIAAR NAGAR, RAJIV GANDHI SALAI,
CHENNAI – 600119**

MAY- 2023



SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC | 12B Status by UGC | Approved by AICTE

www.sathyabama.ac.in

DEPARTMENT OF INFORMATION TECHNOLOGY

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **Taniya Verma (Reg. No - 39120127)** who carried out the Project Phase-2 entitled **"IOT Based Smart Streetlight System"** under my supervision from January 2023 to May 2023.

Internal Guide
Dr. R M Gomathi, M. Tech, Ph. D.

Head of the Department
Dr. R. SUBHASHINI, M.E., Ph.D.

Submitted for Viva voce Examination held on _____

Internal Examiner

External Examiner

DECLARATION

I, **Taniya Verma (Reg. No- 39120127)**, hereby declare that the Project Phase-2 Report entitled “**IOT Based Smart Streetlight System**” done by me under the guidance of **Dr. R M Gomathi, M. Tech, Ph. D.** is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology degree in **Information Technology**.



Taniya Verma

DATE:

PLACE: Chennai

SIGNATURE OF THE CANDIDATE

ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to **Board of Management** of **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr. T. SASIKALA, M.E., Ph.D., Dean**, School of Computing, **Dr. R. SUBHASHINI, M.E., Ph.D. Head** of the Department of Information Technology for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide **Dr. R M Gomathi, M. Tech, Ph.D.**, for her valuable guidance, suggestions, and constant encouragement paved way for the successful completion of my phase-2 project work.

I wish to express my gratitude and thanks to all Teaching and Non-teaching staff members of the **Department of Information Technology** who were helpful in many ways for the completion of the project.

ABSTRACT

A streetlight, light pole, lamp pole, lamppost, streetlamp, light standard, or lamp standard is a raised source of light on the edge of a road or path. When urban electric power distribution became ubiquitous in developed countries in the 20th century, lights for urban streets followed. Streetlights serve the purpose of security, act as safeguard against road accidents, people feel more safer in areas well lit areas and the crime is also not very prevalent in areas with large number of streetlight. Streetlights have become a necessity in modern world, as there is such a wide utilization of energy by streetlights, we need to come up with ways so that the consumption of energy can be reduced. The streetlights installed currently are mostly outdated and are inefficient. Therefore, there is a pressing need to install streetlights that are efficient and inexpensive. In this article, a smart IoT based smart street light system is proposed to satisfy the goal of saving energy through coordinated movements such as infrared (IR) and human detection (PIR). And LDR sensors are also used to detect the presence of light in the space, if there is low light intensity in the outside environment, lights will be turned on. When no one is in the space, the lights will be in dimmed mode or switched off otherwise all lights and are turned to high-light mode. Moreover, setting changes in brightness of LED lights can be directly controlled by microcontroller via IoT. And an app is also created that will connected to the smart lighting system in case if anything gets faulty and there is a need to control the lights manually then that can be done through the app. This approach is very efficient in energy conservation and easy to implement.

TABLE OF CONTENTS

CHAPTER No.	TITLE	PAGE No
	ABSTRACT	iv
	LIST OF FIGURES	vii
	LIST OF ABBREVIATIONS	viii
1.	INTRODUCTION	
	1.1 Internet of Things	9
	1.2 Sensors	10
	1.3 Detection of Human Activity	11
	1.4 Detection of Light	12
	1.5 Objectives	13
	1.6 Scope	13
2.	SYSTEM ANALYSIS	
	2.1 Existing System	14
	2.2 Proposed System	14
	2.3 Literature Survey	15
	2.4 Inferences From Literature Survey	18
	2.5 Open Problems of Existing System	19
3.	REQUIREMENT ANALYSIS	
	3.1 Feasibility Study	20
	3.2 Software Requirements	21
	3.3 Hardware Requirements	23

4.	DESCRIPTION OF PROPOSED SYSTEM	
4.1	Description	30
4.2	Design Architecture	30
4.4	Module Description	32
5.	RESULTS AND DISCUSSION	35
6.	CONCLUSION	
6.1	Conclusion	38
6.2	Future Enhancements	38
	REFERENCES	39
	APPENDIX	
	A. SOURCE CODE	40
	B. SCREENSHOTS	41
	C. RESEARCH PAPER	42

LIST OF FIGURE

Figure No.	Figure Name	Page No.
3.1	Arduino IDE	23
4.1	System Architecture	31
4.2	Workflow Diagram	32
5.1	Smart Streetlight	35
5.2	Activity Detected and No Light in the Environment	36
5.3	Light Detection	36
5.4	Light Dims as No Activity Detected	37

LIST OF ABBREVIATIONS

ACRONYM	DESCRIPTION
IOT	Internet of Things
PIR	Passive Infrared
LDR	Light Dependent Resistor
LED	Light Emitting Diode
IDE	Integrated Development Environment
UART	Universal Asynchronous Receiver/Transmitter

CHAPTER – 1

INTRODUCTION

Smart streetlight is considered as a backbone of future. It will play a major role energy conservation in smart cities. Smart streetlight system is an interconnected network smart lights which are equipped with lamp controller, sensors, and cameras. A smart light automatically controls the lights based on the brightness, darkness, weather conditions, movement of objects in its vicinity. Thereby, saving a considerable amount of energy and maintenance cost. Smart streetlight may also contain real time data monitoring system which will allow operator to control various functionalities of the streetlights as well as give the insight of the real time data. The technology behind smart streetlights can vary depending on its features and requirements, but typically, it involves a combination of cameras and sensors. When implemented on standard streetlights, these devices can detect movement that enables dynamic lighting and dimming. It also allows neighboring fixtures to communicate with each other. If a pedestrian or car is detected, all surrounding lights will brighten until movement is no longer captured.

1.1 INTERNET OF THINGS

The Internet of Things (IoT) is a term used to describe a network of physical devices, vehicles, home appliances, and other objects that are connected to the internet and can collect and exchange data. This technology has rapidly grown in recent years, and it has become an essential aspect of the digital world. The devices connected to the IoT can range from simple sensors to complex machines, and they can communicate with each other, share information, and provide data that can be analyzed and used to make decisions. One of the primary benefits of the IoT is the ability to collect data from a vast range of sources. These sources can include sensors that monitor environmental conditions such as temperature, humidity, and air quality, or machines that track the performance of industrial equipment. The data collected can then be analyzed using advanced algorithms and machine learning techniques to gain insights and improve efficiency. For example, in agriculture, farmers can use sensors to monitor soil conditions and weather patterns to optimize irrigation and fertilization, which can increase crop

yields and reduce water usage. Another significant benefit of the IoT is the ability to automate processes and improve safety. Connected devices can be programmed to perform specific actions automatically, reducing the need for human intervention and increasing efficiency. For example, in manufacturing, machines can be programmed to detect faults and notify maintenance teams before they result in downtime. Similarly, in the transportation industry, connected vehicles can communicate with each other and with infrastructure to reduce the risk of accidents and optimize traffic flow. The IoT has also led to the development of new business models and revenue streams. Companies can use data collected from connected devices to provide new services and products, such as predictive maintenance or real-time tracking of shipments. Additionally, the IoT has enabled the creation of new markets, such as the smart home industry, where connected devices can be used to control lighting, heating, and security systems.

However, the widespread adoption of the IoT also poses significant challenges, such as privacy and security concerns. With so many devices connected to the internet, there is a risk that data can be intercepted, manipulated, or stolen, which can have severe consequences. Additionally, there are concerns around the ethical use of data, particularly in areas such as healthcare, where sensitive information is often collected. In conclusion, the Internet of Things has the potential to transform the way we live and work, by providing new insights, automating processes, and improving safety. However, to fully realize these benefits, it is essential to address the challenges posed by the widespread adoption of this technology, such as privacy and security concerns. With the right policies and regulations in place, the IoT can help to create a more connected, efficient, and sustainable world.

1.2 SENSORS

Sensors are an essential component of the Internet of Things (IoT) ecosystem. They are used to collect data from the physical world and transmit it to connected devices or the cloud for analysis. There are many types of sensors used in IoT applications, including temperature sensors, humidity sensors, motion sensors, light sensors, pressure sensors, and more. These sensors can be used to

monitor environmental conditions, detect changes in motion or vibration, measure the amount of light in a room, or track the location of an object. One of the critical benefits of sensors in IoT applications is their ability to provide real-time data. By collecting data continuously, sensors can detect changes in the environment or the behavior of machines or devices, which can be used to trigger actions or alerts. For example, a temperature sensor in a warehouse can detect a sudden increase in temperature, indicating a fire, and trigger an alarm or automatically shut down equipment to prevent further damage.

Another benefit of sensors in IoT applications is their ability to operate autonomously. Sensors can be installed in remote or hazardous locations, such as oil rigs or nuclear power plants, and transmit data wirelessly to a central monitoring system. This reduces the need for human intervention and improves safety by providing early warning of potential hazards. However, selecting the right sensor for an IoT application can be challenging. Factors such as accuracy, reliability, and power consumption must be considered when choosing a sensor. Additionally, sensors must be compatible with the communication protocols used in the IoT ecosystem to ensure that data can be transmitted efficiently. In conclusion, sensors are a critical component of the Internet of Things and play a vital role in collecting data from the physical world. They provide real-time data and can operate autonomously, making them useful in a wide range of applications. However, selecting the right sensor for an IoT application requires careful consideration of factors such as accuracy, reliability, and power consumption. As the IoT continues to grow, sensors will become increasingly important in providing insights and improving efficiency in many industries.

1.3 DETECTION OF HUMAN ACTIVITY

A PIR (Passive Infrared) sensor is a type of motion sensor that is commonly used in smart streetlights to detect human activity. The PIR sensor detects changes in infrared radiation, which is emitted by all living objects. When a person walks past the sensor, their body temperature radiates heat, which is detected by the PIR sensor. The PIR sensor is designed to detect changes in the infrared radiation within its field of view. It consists of two halves, each of which detects the

infrared radiation from one half of the field of view. When a person walks past the sensor, they will be detected by one half of the sensor, which will trigger the light to turn on. Once the PIR sensor detects motion, it sends a signal to the controller of the smart streetlight, which then activates the light. The controller may also be programmed to adjust the brightness of the light based on the amount of ambient light present. The PIR sensor is a popular choice for smart streetlights because it is highly reliable and energy efficient. The sensor only activates the light when it detects motion, which reduces energy consumption and lowers operating costs. Additionally, because the PIR sensor only detects changes in infrared radiation, it is not affected by ambient light, making it suitable for use in a wide range of lighting conditions.

In conclusion, the PIR sensor detects human activity in smart streetlights by detecting changes in infrared radiation. When a person walks past the sensor, their body temperature radiates heat, which is detected by the PIR sensor. This triggers the light to turn on, and the brightness may be adjusted based on the amount of ambient light present. The PIR sensor is a reliable and energy-efficient option for smart street

1.4 DETECTION OF LIGHT

In a smart streetlight system, LDR (Light-Dependent Resistor) sensors are used to detect the ambient light levels and control the brightness of the streetlights accordingly. LDR sensors are passive components that change their resistance based on the intensity of light falling on them. When the ambient light levels are low, the resistance of the LDR sensor increases, and when the ambient light levels are high, the resistance of the LDR sensor decreases.

The LDR sensor is connected to a microcontroller, which receives the resistance value from the sensor and uses this information to adjust the brightness of the streetlights. If the ambient light levels are low, the microcontroller will increase the brightness of the streetlights to ensure adequate visibility for drivers and pedestrians. If the ambient light levels are high, the microcontroller will decrease the brightness of the streetlights to conserve energy.

In addition to controlling the brightness of the streetlights, the LDR sensor can also be used to detect faults in the lighting system. For example, if a streetlight

fails to turn on at night, it may be due to a faulty LDR sensor, which is not detecting the ambient light levels properly. By monitoring the resistance of the LDR sensor, the smart streetlight system can detect such faults and alert maintenance personnel to rectify them.

Overall, the use of LDR sensors in smart streetlight systems helps to improve energy efficiency, reduce maintenance costs, and enhance the safety of drivers and pedestrians by ensuring adequate lighting levels on the streets.

1.5 OBJECTIVES

The objectives of the project are:

1. Enhance energy efficiency: Smart streetlights can adjust their brightness based on the ambient light levels, traffic density, and pedestrian activity, reducing energy consumption and lowering operational costs.
2. Improve public safety: By ensuring adequate lighting levels on the streets, smart streetlights can enhance the visibility of drivers and pedestrians, reducing the risk of accidents and crimes.
3. Reduce maintenance costs: Smart streetlights can detect faults and failures in the lighting system and alert maintenance personnel, enabling quick and efficient repairs and minimizing downtime.

1.6 SCOPE

The scope of my project is to develop a IoT based smart streetlight system which can detect human activity and light detection. The streetlights are switched on and off if human or any objects moves in front the lights and if there is no light in the environment.

And if there is no light that if there is darkness in the environment and there is no detection of movement of human or moving objects in the vicinity of the streetlights, the lights are turned dimmed so that it does not the consume much energy and hence can save energy efficiently.

CHAPTER – 2

SYSTEM ANALYSIS

2.1 EXISTING SYSTEM

The existing system of streetlights typically consists of a network of traditional streetlights that are connected to the power grid and operated by a central control system. The streetlights are usually turned on and off manually or using a timer, with fixed brightness levels that are not adjusted based on ambient light levels or other factors. The traditional streetlight system has several limitations, including:

1. High energy consumption: Traditional streetlights consume a significant amount of energy, leading to high operational costs and carbon emissions.
2. Limited control: The brightness levels of traditional streetlights are fixed, and there is limited control over their operation and maintenance.
3. High maintenance costs: Traditional streetlights require regular maintenance and replacement of bulbs, leading to high maintenance costs and downtime.
4. Poor visibility: Traditional streetlights may not provide adequate visibility for drivers and pedestrians, leading to safety risks.
5. Lack of connectivity: Traditional streetlights are not connected to the internet or other wireless networks, limiting their potential to collect and share data.

Overall, the existing system of streetlights is inefficient and outdated, and there is a need for more advanced and sustainable solutions such as smart streetlights.

2.2 PROPOSED SYSTEM

A proposed system of smart streetlights involves the use of advanced technologies such as sensors, wireless communication, and data analytics to create a more efficient, sustainable, and safe street lighting system. Here are some of the key features and components of a smart streetlight system:

1. LED lights: LED lights are highly energy-efficient and have a longer lifespan

than traditional bulbs, reducing maintenance costs and carbon emissions.

2. Light sensors: Light sensors such as LDR (Light-Dependent Resistor) sensors can detect the ambient light levels and adjust the brightness of the streetlights accordingly, saving energy and enhancing visibility.
3. Motion sensors: Motion sensors such as PIR (Passive Infrared) sensors can detect the presence of pedestrians and vehicles and adjust the brightness of the streetlights, improving safety and reducing energy consumption.

2.3 LITERATURE SURVEY

From this paper, it can be inferred that the article discusses the use of the Internet of Things (IoT) in the context of smart cities. The authors likely explore how IoT technologies can be utilized to improve various aspects of urban living, such as transportation, energy management, and public safety. The article was published in the IEEE Internet of Things Journal in February 2014, indicating it is an early but still relevant source on the topic.[1]

Smart streetlight poles are used as carriers for the omnipresent electricity Internet of Things and smart city development trends and building techniques. The quick growth of the modern city and the pervasive influence of the Internet of Things (UIoT), as well as the rising need for different kinds of sensors and monitoring devices in urban infrastructure, are all discussed in this paper by Fenqing Du and Xing De Huang. At the same time, however, the amount of usable urban space has been somewhat reduced. It is one of the main causes for the emergence of smart poles in recent years, which integrate a variety of features such as illumination, monitoring, and security. Three stages of the evolution of street light poles are described in this paper. At last, it compares the actual situation in Shanghai and puts forwards a more efficient and flexible ways for Shanghai Electrical company to be involved fully and understand the importance of smart streetlight system in smart city and IoT construction.[2]

According to Shih Chang Hsia's research, a high-power (60V/1A) single-chip driver might be used to dim LEDs with the TSMC high-voltage process. Analog, power driver, and digitally controlled circuits with blending design methods

make up the main circuit. Using just two switches, the electronic lowering can change the luminance of LEDs. The user may choose between controlling the switches in automatic or manual mode. The chip has been placed with all digital control circuitry. As a result, it's not necessary to use a microprocessor to dim LEDs; instead, this chip's extremely cost-effective architecture can save interface components. The dimming approaches employ current mode instead of PWM (Pulse Width Modulation) to eliminate flickering and maintain high-stable LED lights. Up to 16 stages are used in the multi-level current approach to regulate LED illumination. The step accuracy for a smart lighting system is 6.25%. This method uses variable consistent current regulation to improve lighting efficiency, lower noise emissions, and extend the lifespan of LEDs in smart lighting systems.[3]

In this paper the highlight how a street lighting management platform is made up of three major components smart streetlights, network infrastructure and administration and the control system, this document has three distinct sections real-time lighting management which is achieved by manually setting up or scheduling of real facts such as smart street-lighting system information which detects environmental parameters and streams of real-time ip camera captures is also offered and an api for previous data inquiry is given also including storage for videos, this papers proposed system consists mostly of the following components a web based user interface, management platform and an edge orchestrator. Also, with accelerated growth of smart lights comes the quick creation of a management platform that can handle computing networking and storage resources as well as the numerous demands made by lamps as a result it is critical to design a massively scalable platform with simple transition quick deployment and increased resource utilization this article used container-based virtualized deploying technologies to achieve quick deployment and scalability.[4]

Simulcity designing communications in smart and modern cities, the authors have presented their perspectives on communication networks and the way they have become a vital component in the creation of smart cities they also discuss how the information flowing via thousands of devices and sensors should be managed to ensure that appropriate quality, and security assurances. This article puts forward the simulcity tool which aids in the developement of a smart cities

intricately integrated and converging network system.[5]

This paper discusses base station (BS) sleeping strategy in the hybrid energy-powered cellular network on the IoT platform, how base strategy works for on grid energy saving in cellular which have Hybrid energy supplies. An algorithm is deployed which changes the sleeping state of a Base station based on the real traffic it is receiving, and solar energy is suggested to improve on-grid energy savings.[6]

Remote Computer Room Energy Conservation and Management for Telecom Operators. The authors of this work suggest an IoT-based energy-efficient, energy saving management platform for telecom operators' using distant computer rooms through IoT technology. First is the idea of an Internet of Things-based management platform for RCRs. The ET algorithm is then devised, which is a straightforward yet efficient approach. The ET algorithm attempts to reduce the energy used by air conditioners, which make up close to 40% of total consumption, without resulting in large investment costs, hence enhancing the RCRS's overall effectiveness in saving energy.[7]

Next-Generation IoT Devices: Energy Harvesting, Wireless Connectivity, and Sustainable Eco-Friendly Manufacturing Potential solutions for resolving the fundamental problems with creating sustainable IoT devices are provided by authors of this work. Their work focuses on creating next-generation IoT devices with consideration for sustainable power method, environmentally friendly manufacturing method, and wireless connectivity. The number of IoT systems is growing very quickly because to the numerous and diversified uses of IoT applications in wearable technology, industrial automation, and smart cities. They also emphasize the underlying technologies of next-generation IoT and give an overview of hardware-related research trends as well as practical use cases of developing IoT systems. They demonstrate environmentally friendly IoT device production using energy collection and wireless power transmission.[8]

The article "Energy-Saving and Management of Telecom Operators'

Remote Computer Rooms Using IoT Technology" published in IEEE Access in September 2020 discusses the use of IoT technology for energy efficiency and management in telecom operators' remote computer rooms. The authors explore how IoT devices and sensors can be deployed to monitor and manage energy consumption, temperature, and other environmental factors, leading to reduced energy costs and improved performance. The article focuses specifically on the energy-saving and management strategies for remote computer rooms used by telecom operators, providing insights into the unique challenges and opportunities of this context. As it was published in a recent volume of IEEE Access, the article represents current research in IoT-based energy management for telecom operators' remote computer rooms, and is likely to be a valuable resource for researchers and practitioners interested in improving energy efficiency and management in this area.[9]

The article titled "Energy-Saving and Management of Telecom Operators' Remote Computer Rooms Using IoT Technology" published in IEEE Access in September 2020 discusses the use of IoT technology to improve energy efficiency and management in telecom operators' remote computer rooms. The authors likely explore how IoT devices and sensors can be deployed to monitor and manage energy consumption, temperature, and other environmental factors in these computer rooms, leading to reduced energy costs and improved performance. The article appears to focus on the energy-saving and management strategies for remote computer rooms specifically used by telecom operators, suggesting that the authors may provide insights into the unique challenges and opportunities of this context. The authors may discuss the potential benefits of IoT-based energy management, such as improved data collection and analysis, real-time monitoring, and proactive maintenance.[10]

2.4 INFERENCES FROM LITERATURE SURVEY

It is possible to see from the aforementioned material that significant study has been done on this subject and that many instances have been put forth. Of course, each of the aforementioned methods has advantages and disadvantages.

Even though some of the work utilizes the contemporary mix period and provides greater precision, it is still some distance from what is desired. In recent years, there has been great deal of research into activity detection and light detection. The streetlights are developed in such that they can utilize less energy.

2.5 OPEN PROBLEMS IN EXISTING SYSTEM

Traditional streetlights have been the primary lighting solution for public areas such as streets, parks, and parking lots for decades. However, as society advances towards more sustainable and efficient practices, traditional streetlights have been increasingly recognized as outdated and problematic. There are several problems associated with traditional streetlights, including high energy consumption, high maintenance costs, and limited flexibility. While traditional streetlights have served us well in the past, they come with several problems that cannot be ignored in today's world. High energy consumption, high maintenance costs, and limited flexibility are just a few of the issues associated with traditional streetlights that must be addressed as we move towards more sustainable and efficient lighting solutions.

Drawbacks

- High energy consumption: Traditional streetlights consume a significant amount of energy, leading to high operational costs and carbon emissions.
- Limited control: The brightness levels of traditional streetlights are fixed, and there is limited control over their operation and maintenance.
- High maintenance costs: Traditional streetlights require regular maintenance and replacement of bulbs, leading to high maintenance costs and downtime.
- Poor visibility: Traditional streetlights may not provide adequate visibility for drivers and pedestrians, leading to safety risks.
- Lack of connectivity: Traditional streetlights are not connected to the internet or other wireless networks, limiting their potential to collect data.

CHAPTER 3

REQUIREMENT ANALYSIS

3.1 FEASIBILITY STUDY

Feasibility studies aim to objectively and rationally uncover the strengths and weaknesses of the existing business or proposed venture, opportunities and threats as presented by the environment, the resources required to carry through, and ultimately the prospects for success. In its simplest term, the two criteria to judge feasibility are cost required and value to be attained. As such, a well-designed feasibility study should

Provide a historical background of the business or project, description of the product or service, accounting statements, details of the operations and management, marketing research and policies, financial data, legal requirements, and tax obligations.

3.1.1 TECHNICAL FEASIBILITY

This study is carried out to check the technical feasibility, that is, the technical requirements of the system. Any system developed must not have a high demand on the available technical resources.

3.1.2 ECONOMIC FEASIBILITY

The assessment is based on an outline design of system requirements in terms of Input, Processes, Output, Fields, Programs, and Procedures. This can be quantified in terms of volumes of data, trends, frequency of updating, etc. in order to estimate whether the new system will perform adequately or not.

3.1.3 OPERATIONAL FEASIBILITY

The aspect of study is to check the level of acceptance of the system by the user. This includes the process of training the user to use the system efficiently. The user must not feel threatened by the system, instead must accept it as a necessity.

3.2 SOFTWARE REQUIREMENT

The software requirements document is the specification of the system. It should include both a definition and a specification of requirements. It is a set of what the system should do rather than how it should do it.

The software requirements provide a basis for creating the software requirements specification. It is useful in estimating cost, planning team activities, performing tasks and tracking the teams and tracking the team's progress throughout the development activity.

- Windows 10 OS 64-bit (or above)
- Arduino IDE

3.2.1 WINDOWS 10 OR ABOVE

Windows 10 and above are the latest versions of the Microsoft Windows operating system. These versions of Windows offer several improvements and new features compared to their predecessors, including enhanced security, improved performance, and more advanced user interface options.

One of the most significant improvements in Windows 10 and above is the enhanced security features. These include Windows Hello, which provides biometric authentication using facial recognition, fingerprint scanning, or iris scanning. This adds an extra layer of security to devices and helps prevent unauthorized access. Windows 10 also includes built-in antivirus and malware protection, which helps protect against malicious attacks.

Windows 10 and above also offer improved performance compared to previous versions of Windows. This is due to several factors, including better memory management, faster boot times, and improved multitasking capabilities. In addition, Windows 10 and above have better support for modern hardware, such as solid-state drives (SSDs), which can significantly improve system performance.

Another significant improvement in Windows 10 and above is the user interface. The Start menu has been redesigned to include a customizable layout with live tiles, which provide real-time updates from apps. The Action Center provides a quick and easy way to access notifications, settings, and other features. Additionally, Windows 10 and above include support for virtual desktops, which allow users to create multiple desktops for different tasks, improving productivity and organization.

3.2.2 ARDUINO IDE

Arduino IDE (Integrated Development Environment) is an open-source software platform that allows users to create, develop, and upload code to Arduino microcontrollers. It is a user-friendly, cross-platform application that simplifies the programming process for beginners and advanced users alike.

One of the key features of Arduino IDE is its simplicity. The platform is designed to be intuitive and easy to use, which means that users can get started with minimal programming experience. The interface is clean and straightforward, with a single window that contains all the necessary tools for writing and uploading code. The platform also includes several helpful features such as syntax highlighting, auto-complete, and error checking, which can help users catch and correct mistakes before uploading their code. Another significant advantage of Arduino IDE is its cross-platform compatibility. The platform is available on Windows, Mac OS X, and Linux, which means that users can develop and upload code from a wide range of devices. Moreover, Arduino IDE is open-source, which means that the source code is freely available for anyone to modify and improve. This has led to a vast community of users who have created and shared their own libraries, code snippets, and tutorials, making it easier for beginners to learn and develop their skills. Arduino IDE is also an excellent platform for prototyping and experimentation. The platform supports a wide range of Arduino boards, including the popular Arduino Uno, Mega, and Nano. This makes it easy for users to experiment with different hardware configurations and components, such as sensors, actuators, and displays. The platform also includes a serial monitor, which allows users to monitor and debug their code as it runs on the board.

One of the unique features of Arduino IDE is its ability to work seamlessly with the Arduino ecosystem. The platform supports a vast library of pre-written code snippets and libraries, which can be easily imported into a user's project. This means that users can quickly add functionality to their projects without having to write complex code from scratch. Additionally, Arduino IDE is compatible with a wide range of third-party tools and services, such as cloud-based storage and analytics, which can further enhance the functionality and usefulness of Arduino projects.

In conclusion, Arduino IDE is a powerful and versatile platform for developing, prototyping, and experimenting with Arduino projects. Its user-friendly interface, cross-platform compatibility, and vast library of pre-written code and libraries make it an excellent choice for beginners and advanced users alike. Whether you're looking to build a simple LED display or a complex IoT project, Arduino IDE is a great tool for bringing your ideas to life.

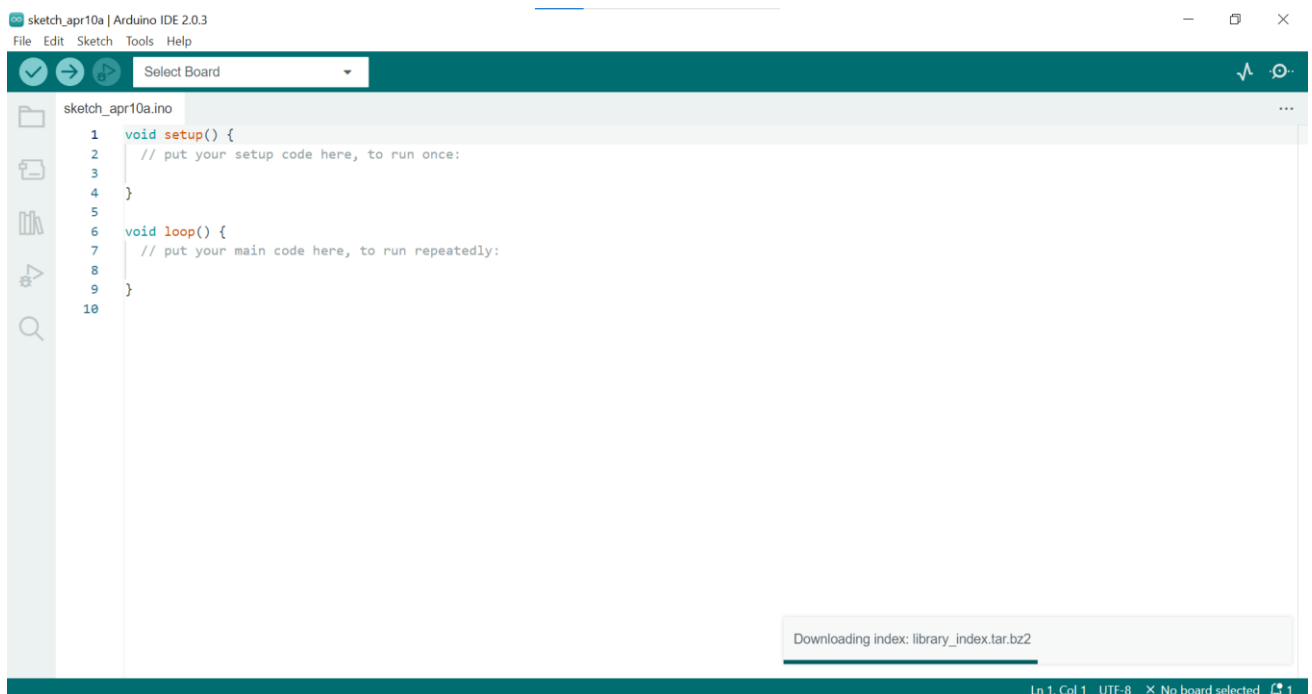


Fig 3.1 Arduino IDE

3.3 HARDWARE REQUIREMENT

The hardware requirements may serve as the basis for a contract for the implementation of the system and should therefore be a complete and consistent specification of the whole system. They are used by software engineers as the starting point for the system design. It shows what the system does and not how it should be implemented.

- Microcontroller Arduino UNO
- PIR sensor
- LDR sensor
- LED lights
- Jumper cables

3.3.1 ARDUINO UNO

Arduino Uno is a popular microcontroller board that is widely used by hobbyists, makers, and engineers to build a wide range of electronic projects. It is based on the Atmega328P microcontroller, which is capable of running at up to 16 MHz and has 32KB of flash memory and 2KB of SRAM. Here is a more detailed look at some of the key features and capabilities of the Arduino Uno. One of the key advantages of the Arduino Uno is its ease of use. The board is designed to be user-friendly, even for beginners with little or no experience in electronics or programming. The board comes with pre-installed software, called the bootloader, which allows users to easily upload code to the board using a USB cable. This means that users can quickly get started with programming the board and building their own projects. The Arduino Uno also has a wide range of input and output pins, which can be used to interface with various sensors, actuators, and other electronic components. The board has 14 digital input/output pins, six of which can be used as PWM (Pulse Width Modulation) outputs, and six analog input pins. In addition, the board has several other pins for power, ground, and serial communication.

Another significant advantage of the Arduino Uno is its versatility. The board can be used to build a wide range of projects, from simple LED displays to complex robotic systems. The wide range of input and output pins means that users can connect a variety of sensors, such as temperature sensors, motion

sensors, and light sensors, to the board. The board can also be used to control a variety of actuators, such as motors, servos, and LEDs. The Arduino Uno is also highly customizable. Users can write their own programs in the Arduino programming language, which is based on C/C++. The language is easy to learn and provides a good balance between simplicity and flexibility. Additionally, the Arduino community has developed a wide range of libraries and code examples, which can be used to add functionality quickly and easily to projects.

One of the unique features of the Arduino Uno is its ability to communicate with other devices. The board has a built-in UART (Universal Asynchronous Receiver/Transmitter) communication interface, which allows it to communicate with other devices using serial communication. This means that users can connect the board to other devices, such as sensors or displays, and exchange data. The board also has a USB interface, which allows it to communicate with a computer or other USB-enabled devices. The Arduino Uno is also highly affordable. The board is available for a relatively low cost, making it accessible to a wide range of users. Additionally, the open-source nature of the Arduino platform means that users can modify and customize the board to meet their specific needs.

In conclusion, the Arduino Uno is a versatile and user-friendly microcontroller board that can be used to build a wide range of electronic projects. Its ease of use, wide range of input and output pins, and affordability make it an excellent choice for beginners and advanced users alike. Additionally, the ability to write custom programs in the Arduino programming language and the availability of a vast library of code examples and libraries make it a powerful and flexible tool for building electronic projects.

3.3.2 PIR Sensor

A PIR (Passive Infrared) sensor is an electronic device that detects motion by measuring changes in the infrared radiation levels emitted by objects in its field of view. It is a type of motion sensor that is commonly used in security systems, lighting systems, and home automation applications. The sensor consists of a pyroelectric sensor, which generates an electrical signal when exposed to changes in infrared radiation levels, and a processing circuit that interprets the signal and

triggers an output signal if motion is detected. One of the main advantages of PIR sensors is their high sensitivity and accuracy. They can detect even small movements within their field of view, making them ideal for use in security systems and motion-activated lighting systems. They are also able to distinguish between the heat signature of a human and that of other objects, such as pets or moving objects, reducing the likelihood of false alarms. PIR sensors are also easy to install and use. They can be mounted on a wall or ceiling and connected to a control circuit using simple wiring. Most PIR sensors come with adjustable sensitivity and timing settings, allowing users to customize their operation according to their specific needs.

Another advantage of PIR sensors is their low power consumption. They consume very little power, making them ideal for battery-powered applications. They are also relatively inexpensive, making them accessible to a wide range of users. However, there are some limitations to PIR sensors. They are only able to detect motion within their field of view, which can be limited depending on the sensor's placement and orientation. They are also less effective in environments where there are extreme temperature variations or where there are objects that emit infrared radiation, such as heating or cooling systems. In conclusion, PIR sensors are a reliable and efficient way to detect motion in a wide range of applications. Their high sensitivity and accuracy, low power consumption, and ease of use make them a popular choice for security systems, lighting systems, and home automation applications. While they do have some limitations, they are still an effective tool for detecting motion and improving the security and functionality of electronic systems.

3.3.3 LDR Sensor

An LDR (Light Dependent Resistor) sensor is an electronic device that measures the amount of light falling on its surface and changes its resistance accordingly. It is a type of sensor commonly used in light-sensitive applications such as automatic streetlights, outdoor lighting systems, and camera light meters. LDR sensors are made of semiconductor materials that have a high resistance in the dark and a low resistance in the light. The resistance of the sensor varies with the intensity of the light falling on it, which allows it to be used as a light-sensitive switch or as a component in a light measuring circuit.

One of the main advantages of LDR sensors is their simplicity and ease of use. They are easy to install and require very little maintenance, making them ideal for use in outdoor applications. They are also relatively inexpensive and readily available, making them accessible to a wide range of users. LDR sensors are also highly accurate and responsive to changes in light levels. They can detect even small changes in light intensity, making them useful for applications where precise control of lighting levels is required.

However, there are also some limitations to LDR sensors. They are less effective in situations where the light source is not constant or where there are rapid changes in light levels. They are also less sensitive to changes in color or wavelength of light, which can limit their usefulness in certain applications.

In conclusion, LDR sensors are a useful and versatile tool for measuring light levels in a wide range of applications. Their simplicity, accuracy, and ease of use make them a popular choice for outdoor lighting systems, camera light meters, and other light-sensitive applications. While they do have some limitations, they are still an effective and reliable way to measure light levels and improve the functionality of electronic systems.

3.3.4 LED LIGHTS

LED lights, or light-emitting diodes, have revolutionized the lighting industry since their development in the 1960s. These small, energy-efficient light sources have quickly gained popularity in homes, businesses, and public spaces around the world. One of the main advantages of LED lights is their energy efficiency - they use up to 80% less energy than traditional incandescent bulbs and can last up to 25 times longer. This makes them a popular choice for those looking to reduce their energy bills and minimize their carbon footprint.

In addition to their energy efficiency, LED lights also offer a range of other benefits. They are available in a variety of colors and can be easily customized to fit any space or occasion. They are also highly durable and resistant to shock, vibration, and extreme temperatures, making them ideal for use in outdoor lighting, signage, and traffic signals. Furthermore, LED lights produce very little heat, reducing the risk of fire hazards and making them safer to use in enclosed spaces.

LED lights also offer a number of benefits over traditional incandescent bulbs in terms of their environmental impact. They contain no hazardous materials such as mercury and are fully recyclable, reducing their impact on landfills and the environment. Additionally, LED lights emit significantly less carbon dioxide and other greenhouse gases during their lifetime, making them a more sustainable option for those looking to reduce their carbon footprint. Despite their many benefits, there are some drawbacks to LED lights that should be considered. One potential concern is their cost - LED lights can be more expensive than traditional bulbs, although their long lifespan and energy efficiency make up for this in the long run. Additionally, some people have reported that LED lights can cause headaches or eyestrain, although this is generally only an issue with poorly designed or improperly installed fixtures. Overall, LED lights have quickly become a popular choice for those looking to reduce their energy bills and minimize their impact on the environment. With their energy efficiency, durability, and versatility, LED lights offer a range of benefits over traditional incandescent bulbs, making them a smart choice for any lighting application.

3.3.5 JUMPER CABLES

Jumper wires are a type of electrical wire used to create connections between electronic components on a circuit board or breadboard. They are typically made of thin, flexible wires with a solid core, and are available in a variety of lengths and colors.

Jumper wires are used to make temporary or permanent connections between electronic components, such as resistors, capacitors, and integrated circuits. They are particularly useful for prototyping and testing electronic circuits, as they allow for quick and easy modifications and adjustments. Jumper wires are typically inserted into the holes of a breadboard, which is a reusable platform for building and testing electronic circuits. Breadboards have rows and columns of holes that are connected internally in a specific pattern, allowing for easy and organized circuit building. To use jumper wires on a breadboard, simply insert one end of the wire into the desired hole and the other end into another hole to make a connection. Jumper wires can be used to connect components in series or parallel

and can also be used to create branching connections.

Jumper wires are available in a variety of sizes, from just a few inches to several feet in length. They are also available in different colors, which can help to keep track of different connections in a complex circuit.

Overall, jumper wires are an essential tool for anyone working with electronic circuits. They are easy to use, versatile, and can help to speed up the prototyping and testing process. Whether you're a hobbyist or a professional, jumper wires are a valuable addition to any electronics toolkit.

CHAPTER 4

DESCRIPTION OF PROPOSED SYSTEM

4.1 DESCRIPTION

A proposed smart streetlight system would utilize both PIR (Passive Infrared) sensors and LDR (Light Dependent Resistor) sensors to create an efficient and reliable lighting system.

The PIR sensors would detect the presence of people or vehicles within the streetlight's field of view and trigger the streetlight to turn on, providing illumination for increased safety and visibility. This would reduce unnecessary energy consumption by only turning on the lights when needed, rather than keeping them on constantly.

Meanwhile, the LDR sensors would monitor the ambient light levels and adjust the brightness of the streetlights accordingly. During daylight hours, the LDR sensors would detect the high levels of ambient light and dim the streetlights or turn them off completely, further reducing energy consumption. As the sun sets and light levels decrease, the LDR sensors would increase the brightness of the streetlights to maintain adequate visibility and safety.

4.2 DESIGN ARCHITECTURE

4.2.1 GENERAL

Design is meaningful engineering representation of something that is to be built. Software design is a process design is the perfect way to accurately translate requirements in to a finished software product. Design creates a representation or model, provides detail about software data structure, architecture, interfaces and components that are necessary to implement a system.

4.2.2 SYSTEM ARCHITECTURE

The system architecture of a smart streetlight that uses PIR sensors to detect movement and LDR sensors to detect light is composed of several key components.

Firstly, the PIR sensors are placed strategically on each streetlight pole, covering a specific area or zone. These sensors are connected to a microcontroller, which processes the signals from the PIR sensors and determines whether to turn on or off the streetlights based on the movement detected.

Secondly, the LDR sensors are also placed on each streetlight pole, measuring the ambient light levels in the surrounding area. These sensors are also connected to the microcontroller, which adjusts the brightness of the streetlights based on the light levels detected by the LDR sensors. The microcontroller is the central component of the system architecture, responsible for processing the signals from the PIR and LDR sensors and controlling the streetlights. It is typically an Arduino or similar microcontroller board, which is programmed with the necessary algorithms to detect movement and adjust lighting levels based on ambient light levels.

Overall, the system architecture of a smart streetlight that uses PIR sensors to detect movement and LDR sensors to detect light is a robust and efficient solution for urban lighting. By using energy only when needed and adjusting lighting levels based on ambient light levels and presence of people or vehicles, this system can significantly reduce energy consumption while promoting safety and security for both pedestrians and motorists.

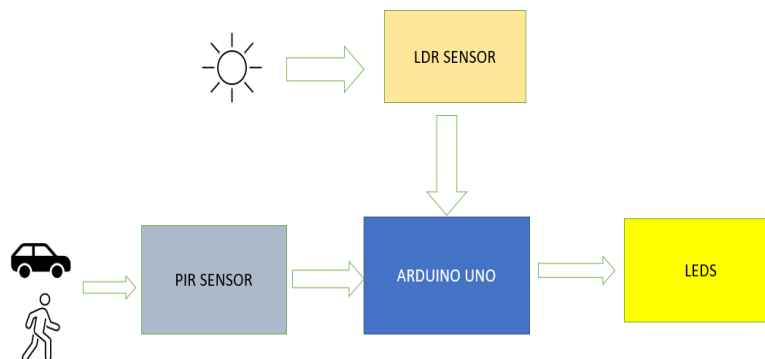


Fig 4.1 System Architecture

4.2.3 WORKFLOW DIAGRAM

A workflow diagram is a visual representation of a series of steps or processes involved in completing a task or achieving a goal. It is a diagrammatic representation of a workflow that illustrates the flow of tasks or activities involved in a project or process.

The diagram typically includes a series of boxes or rectangles, each representing a task or step in the workflow, and arrows or lines connecting the boxes to show the sequence of steps. Some diagrams also include decision points or diamonds, which represent points in the workflow where a decision needs to be made based on specific conditions.

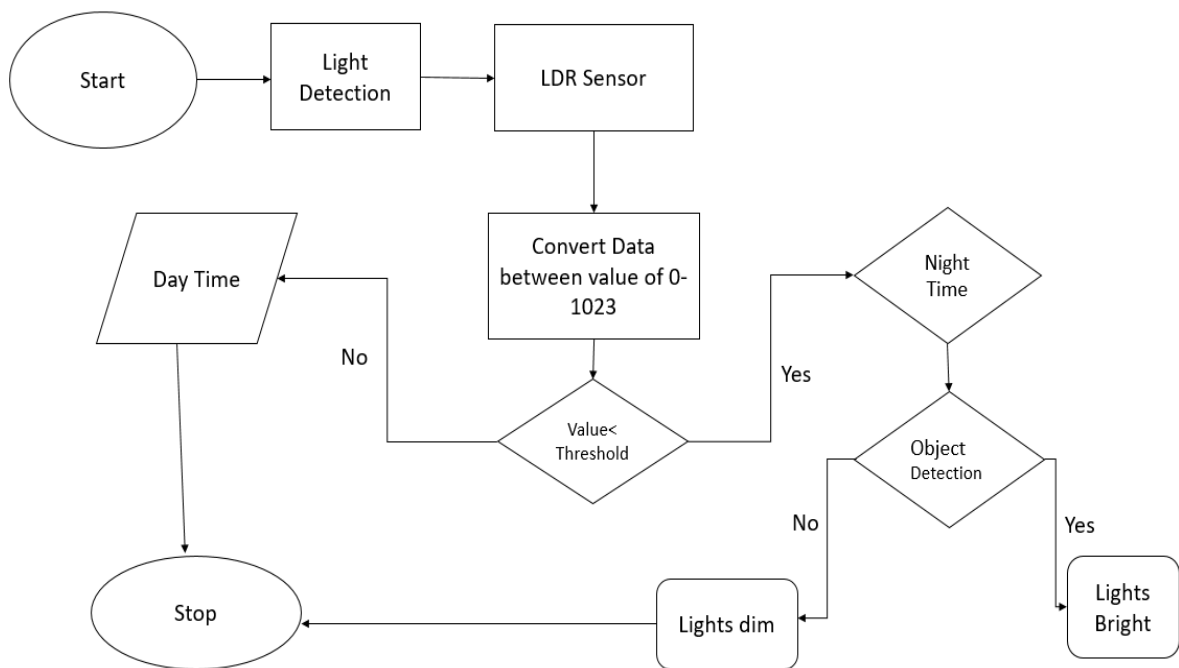


Fig 4.2 Workflow Diagram

4.4 MODULE DESCRIPTION

4.4.1 DETECTION OF LIGHT BY LDR SENSOR

An LDR (Light Dependent Resistor) sensor is a device that changes its

electrical resistance based on the intensity of light that falls on it. This property makes it useful in a variety of applications where detection of light is needed. Here's how an LDR sensor works:

When light falls on the LDR sensor, the photons in the light excite the electrons in the sensor material, causing them to move from the valence band to the conduction band. This movement of electrons reduces the resistance of the sensor. The greater the intensity of light, the more electrons are excited, and the lower the resistance of the sensor. To detect light using an LDR sensor, you need to create a simple circuit that measures the resistance of the sensor. This can be done by connecting the LDR sensor in series with a resistor and a voltage source. The voltage across the LDR and the resistor can then be measured, and the resistance of the LDR can be calculated using Ohm's law ($V=IR$). By measuring the resistance of the LDR at different light intensities, you can create a calibration curve that relates the resistance of the LDR to the intensity of light. This calibration curve can then be used to convert the resistance of the LDR into a measure of light intensity. Overall, the detection of light using an LDR sensor is a simple and effective technique that finds its use in various applications, such as streetlights, solar cells, and automatic night lights.

4.4.2 MOTION DETECTION BY PIR SENSOR

PIR (Passive Infrared) sensors are commonly used to detect motion in a variety of applications, including security systems, automatic doors, and lighting controls. Here's how a PIR sensor works:

PIR sensors are designed to detect changes in the infrared radiation emitted by objects in their field of view. They consist of a pyroelectric sensor that generates an electrical signal when it detects infrared radiation. When a person or an object moves within the field of view of the PIR sensor, the temperature of the object changes, and it emits infrared radiation. The PIR sensor detects these changes in the infrared radiation and generates an electrical signal. The electrical signal generated by the PIR sensor is then processed by a circuit that analyzes the signal and determines if it indicates motion. If motion is detected, the circuit triggers an output signal, which can be used to activate an alarm, turn on a light, or

perform other actions.

One of the advantages of PIR sensors is that they are passive devices that do not emit any radiation themselves, making them suitable for applications where low power consumption and safety are important. They are also sensitive to changes in infrared radiation, which means they can detect small movements and are less prone to false alarms than other motion sensors.

4.4.3 WORKING OF ARDUINO UNO

Arduino is a microcontroller-based platform that can be programmed to interface with a variety of sensors, including LDR and PIR sensors. Here's how Arduino works with LDR and PIR sensors: LDR Sensor: To interface an LDR sensor with an Arduino, you need to create a simple circuit that measures the resistance of the LDR and converts it into a voltage that can be read by the Arduino's analog-to-digital converter (ADC). This can be done by connecting the LDR sensor in series with a resistor and a voltage source and connecting the junction between the LDR and the resistor to an analog input pin of the Arduino. The Arduino can then read the voltage across the LDR and the resistor and use it to determine the resistance of the LDR, which can be calibrated to measure the intensity of light.

PIR Sensor: To interface a PIR sensor with an Arduino, you need to connect the PIR sensor's output signal to a digital input pin of the Arduino. The PIR sensor generates a digital signal that goes high when motion is detected and low when no motion is detected. The Arduino can read this signal and trigger an action when motion is detected, such as turning on a light or sounding an alarm.

Both LDR and PIR sensors can be used with the Arduino's built-in programming language, which is based on the C and C++ programming languages. The Arduino platform also provides a variety of libraries that simplify the process of working with sensors, including libraries for interfacing with LDR and PIR sensors.

CHAPTER 5

RESULTS AND DISCUSSION

Here is what we did, we have created system consisting of a microcontroller i.e., Arduino Uno which is programmed in such a way that it controls the streetlights based on environmental factors such as Human Activity detection, Object detection and Light intensity of the environment. This system contains a PIR sensor which detects the motion activity in the environment PIR sensors are designed to detect changes in the infrared radiation emitted by objects in their field of view. They consist of a pyroelectric sensor that generates an electrical signal when it detects infrared radiation. LDR sensor is connected to system which detects the light intensity of the environment. When light falls on the LDR sensor, the photons in the light excite the electrons in the sensor material, causing them to move from the valence band to the conduction band. This movement of electrons reduces the resistance of the sensor. The greater the intensity of light, the more electrons are excited, and the lower the resistance of the sensor.

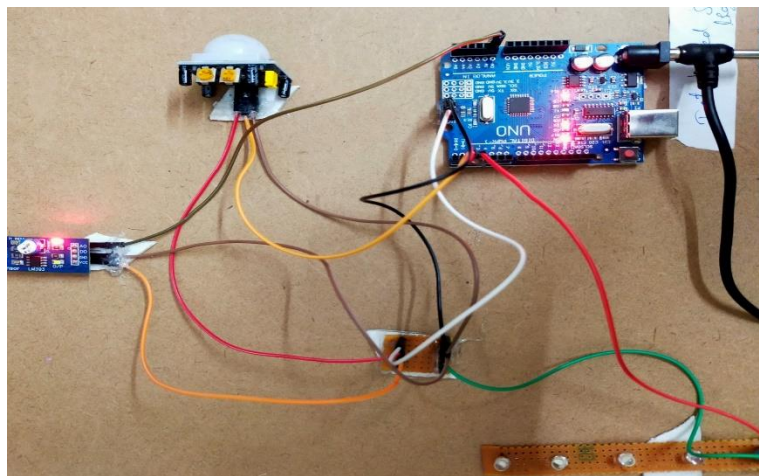


Fig 5.1 Smart Streetlight System

When any activity is detected by pir sensor, the light intensity of the environment is checked if it darker then the lights are turned on to full brightness mode.

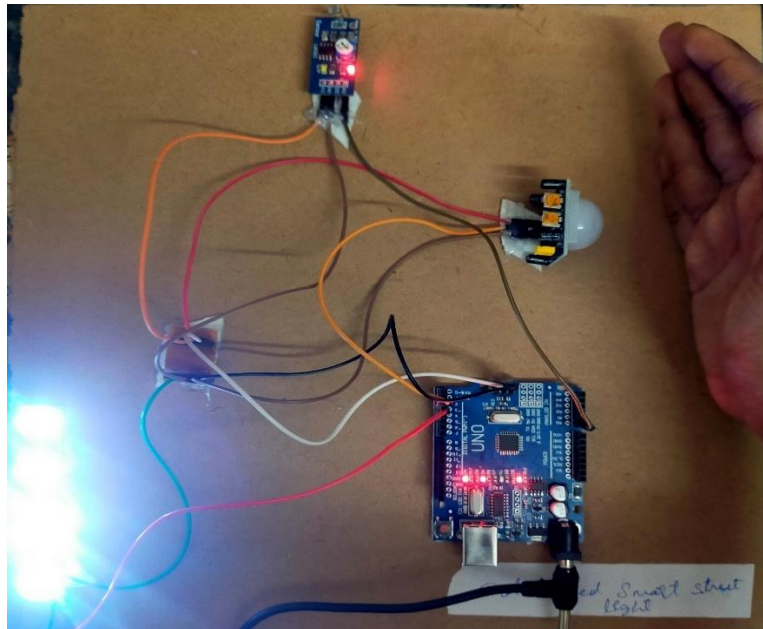


Fig 5.2 Activity Detected and Low Intensity of Light

The other scenario is when the motion is detected by the pir sensor, and it is bright outside in the environment so there is no need of the streetlight hence the streetlights are turned on conserving the energy.

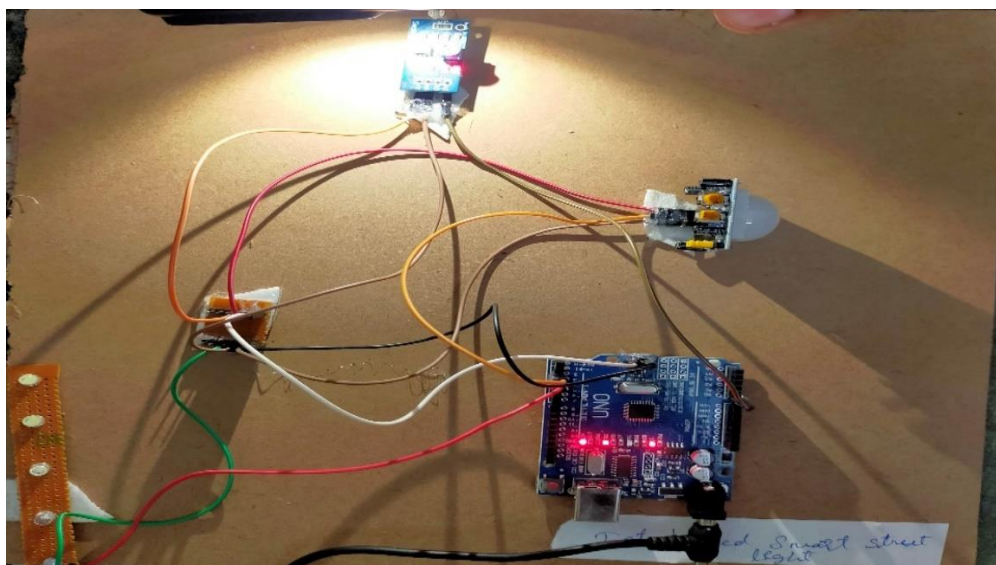


Fig 5.3 Light Detected in the Environment

And there is last case also when the streetlights are turned dimmer, this case occurs when there is no movement or activity detected in the environment and there is darkness in the environment. In case there is no need for streetlights to

be turned to full brightness as there is no presence of activity so it will be a waste of energy, hence in the system where our main focus is to conserve energy we turn the lights to be dim.

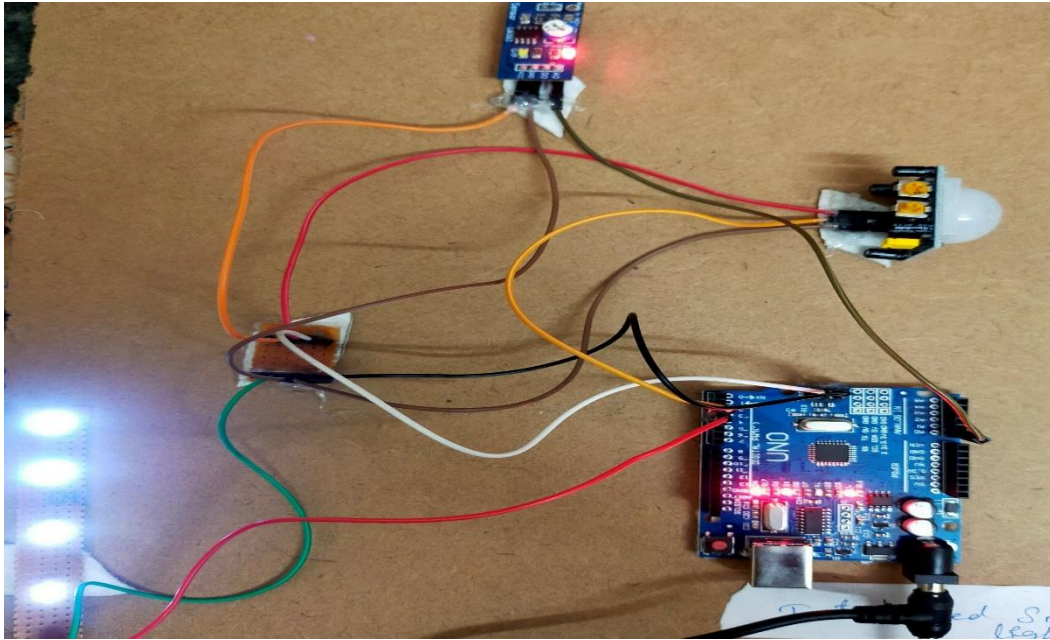


Fig 5.4 Light Dim as No Activity Detected

CHAPTER 6

CONCLUSION

6.1 CONCLUSION

In conclusion, a smart streetlight system based on PIR sensor and LDR sensor can offer several benefits. The PIR sensor can detect the presence of people or vehicles, and the LDR sensor can measure the ambient light levels. By combining the two sensors, the system can automatically adjust the brightness of the streetlights based on the surrounding environment and the presence of people or vehicles. This system can lead to significant energy savings, as the streetlights will only operate at full brightness when necessary. It can also reduce light pollution and improve safety by providing better lighting when people or vehicles are present.

However, the implementation of such a system would require careful planning and consideration of factors such as sensor placement, communication protocols, and power management. Additionally, maintenance and repair of the system would need to be considered to ensure reliable operation. Overall, a smart streetlight system based on PIR sensor and LDR sensor has the potential to be a cost-effective and sustainable solution for public lighting.

6.2 FUTURE ENHANCEMENTS

The smart streetlight system has come a long way from being a traditional high energy consuming infrastructure to a smart interconnected cost saving, energy friendly infrastructure but there are still improvements which can be implemented to make this system more efficient, energy saving and smart.

The system can be further enhanced like:

- To control the dimness of the light based on the illumination of the environment
- MQTT protocol can be also implemented in these smart streetlight so that it can communicate with other smart streetlights efficiently.
- Alarms can be sent off if any component goes faulty, this will help in speedy recovery of the system.

REFERENCES

- [1] Andrea Zanella, Nicola Bui, Angelo Castellani, Lorenzo Vangelista, Michele Zorzi, "Internet of Things for smart cities" in IEEE Internet of Things Journal (Volume: 1, Issue: 1, February 2014)
- [2] Fengqing Du; Xingde Huang; Aiqiang Pan; Xiaoman Qi; Zhiya Niu, "Development trends and construction strategies of smart city and the ubiquitous power Internet of Things with smart streetlight pole as carrier" at CIRED 2020 Berlin Workshop (CIRED 2020) Year: 2020, Volume: 2020, Conference Paper, Publisher: IET
- [3] Shih-Chang Hsia, Ming-Hwa Sheu; Jyun-Jia Ciou, Cost-Effective LED Dimming Driver with Single Chip Design for Smart Lighting System in IEEE, Volume 8, 2020
- [4] An Implementation of High Efficient Smart Street Light Management System for Smart City by Yu-Sheng Yang, Shih-Hsiung Lee, Guan-Sheng Chen, Chu-Sing Yang in IEEE, Volume 8, 2020
- [5] Indoor Lighting In Proceedings of 2016 IEEE International Conference on Computing, Communication and Automation (ICCUA), Aug. 13
- [6] David Gomez-Cuadrado, Miguel A. Rodriguez-Hernandez, Angel Gomez-Sacristan SimulCity: Planning Communications in Smart Cities IEEE Access (Volume: 7), April 2019
- [7] Frequency Support Through LED Street Lighting in Small Non-Synchronous Power Systems" IEEE Transactions on Industry Applications (Early Access), 23 November 2022
- [8] Heng Wang; Zhenzhen Zhao, Jianhua Qu; Guangyin, Xu Xiaodong Cheng, Jilai Ying;, "Base Station Sleeping Strategy for On-Grid Energy Saving in Cellular Networks with Hybrid Energy Supplies in IoT Environment" Collaboration for Internet of Things IEEE Access (Volume: 6), 16 August 2018
- [9] Liang Zhao, Jiahui Zeng, Shaocheng Qu, Qiaoying Zhao "Energy-Saving and Management of Telecom Operators' Remote Computer Rooms Using IoT Technology" IEEE Access (Volume: 8) 08 September 2020
- [10] Yasaman Ghasempour, Hamed Rahmani; Darshan Shetty; Mahmoud Wagih; "Next-Generation IoT Devices: Sustainable Eco-Friendly Manufacturing, Energy Harvesting, and Wireless Connectivity", IEEE Journal of Microwaves (Volume: 3, Issue: 1, January 2023)

APPENDIX

A. SOURCE CODE

```
int ldrPin = A0;
int motionPin = 2;
int ledPin = 3;

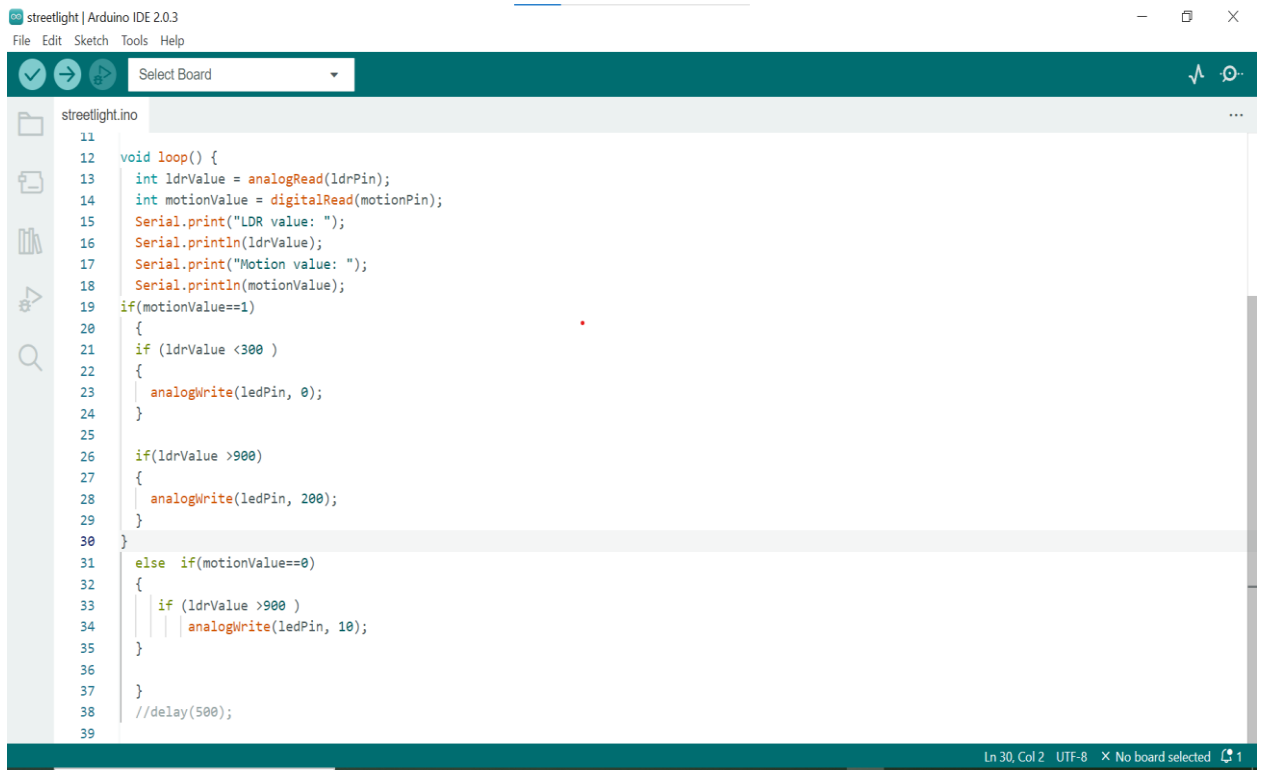
void setup() {
  pinMode(motionPin, INPUT);
  pinMode(ldrPin, INPUT);
  pinMode(ledPin, OUTPUT);
  Serial.begin(9600);
}

void loop() {
  int ldrValue = analogRead(ldrPin);
  int motionValue = digitalRead(motionPin);
  Serial.print("LDR value: ");
  Serial.println(ldrValue);
  Serial.print("Motion value: ");
  Serial.println(motionValue);
  if(motionValue==1)
  {
    if (ldrValue <300 )
    {
      analogWrite(ledPin, 0);
    }

    if(ldrValue >900)
    {
      analogWrite(ledPin, 200);
    }
  }
  else if(motionValue==0)
  {
    if (ldrValue >900 )
      analogWrite(ledPin, 10);
  }

  }
  //delay(500);
```

B. SCREENSHOTS



```
11
12 void loop() {
13   int ldrValue = analogRead(ldrPin);
14   int motionValue = digitalRead(motionPin);
15   Serial.print("LDR value: ");
16   Serial.println(ldrValue);
17   Serial.print("Motion value: ");
18   Serial.println(motionValue);
19   if(motionValue==1)
20   {
21     if (ldrValue <300 )
22     {
23       analogWrite(ledPin, 0);
24     }
25
26     if(ldrValue >900)
27     {
28       analogWrite(ledPin, 200);
29     }
30   }
31   else if(motionValue==0)
32   {
33     if (ldrValue >900 )
34     {
35       analogWrite(ledPin, 10);
36     }
37   }
38   //delay(500);
39 }
```

Ln 30, Col 2 UTF-8 X No board selected 1

DESIGN AND IMPLEMENTATION OF IOT BASED SMART STREETLIGHT SYSTEM

Taniya Verma
Department of IT
Sathyabama Institute of Science and Technology
Chennai, India
vermataniya901@gmail.com

Gomathi R M
Department of IT
Sathyabama Institute of Science and Technology
Chennai, India
gomathi.it@sathyabama.ac.in

Abstract—The streetlights installed currently are mostly outdated and are inefficient. Therefore, there is a pressing need to install streetlights that are efficient and inexpensive. In this article, a smart IoT based smart street light system is proposed to satisfy the goal of saving energy through coordinated movements such as infrared (IR) and human detection (PIR). And LDR sensors are also used to detect the presence of light in the space, if there is low light intensity in the outside environment, lights will be turned on. When no one is in the space, the lights will be in dimmed mode or switched off otherwise all lights and are turned to high-light mode. Moreover, setting changes in brightness of LED lights can be directly controlled by microcontroller via IoT. And an app is also created that will connected to the smart lighting system in case if anything gets faulty and there is a need to control the lights manually then that can be done through the app. This approach is very efficient in energy conservation and easy to implement.

Keywords— *Internet of Things (IOT), smart lights, embedded systems, energy conservation*

1.INTRODUCTION

Smart streetlight is considered as a backbone of future. It will play a major role energy conservation in smart cities. Smart streetlight system is an interconnected network smart lights which are equipped with lamp controller, sensors, and cameras. A smart light automatically controls the lights based on the brightness, darkness,

weather conditions, movement of objects in its vicinity. Thereby, saving a considerable amount of energy and maintenance cost. Smart streetlight may also contain real time data monitoring system which will allow operator to control various functionalities of the streetlights as well as give the insight of the real time data.

2.LITERATURE SURVEY

This segment discusses about how IoT can be implemented in different and heterogeneous end system, and enable it to be seamless and transparent, while also providing the access to many IoT devices. They focus mainly on a futuristic IoT system that is still a broad category are characterized by special domains of application.

Smart streetlight poles are used as carriers for the omnipresent electricity Internet of Things and smart city development trends and building techniques. The quick growth of the modern city and the pervasive influence of the Internet of Things (UIoT), as well as the rising need for different kinds of sensors and monitoring devices in urban infrastructure, are all discussed in this paper by Fenqing Du and Xing De Huang. At the same time, however, the amount of usable urban space has been somewhat reduced. It is one of the main causes for the emergence of smart poles in recent years, which integrate a variety of features such as illumination, monitoring, and security. Three stages of the evolution of street light poles are described in this paper. At last, it compares the actual situation in Shanghai and puts forwards a more efficient and flexible ways for Shanghai Electrical company to be involved fully and understand the

importance of smart streetlight system in smart city and IoT construction.

According to Shih Chang Hsia's research, a high-power (60V/1A) single-chip driver might be used to dim LEDs with the TSMC high-voltage process. Analog, power driver, and digitally controlled circuits with blending design methods make up the main circuit. Using just two switches, the electronic lowering can change the luminance of LEDs. The user may choose between controlling the switches in automatic or manual mode. The chip has been placed with all digital control circuitry. As a result, it's not necessary to use a microprocessor to dim LEDs; instead, this chip's extremely cost-effective architecture can save interface components. The dimming approaches employ current mode instead of PWM (Pulse Width Modulation) to eliminate flickering and maintain high-stable LED lights. Up to 16 stages are used in the multi-level current approach to regulate LED illumination. The step accuracy for a smart lighting system is 6.25%. This method uses variable consistent current regulation to improve lighting efficiency, lower noise emissions, and extend the lifespan of LEDs in smart lighting systems.

In this paper the highlight how a street lighting management platform is made up of three major components smart streetlights, network infrastructure and administration and the control system, this document has three distinct sections real-time lighting management which is achieved by manually setting up or scheduling of real facts such as smart street-lighting system information which detects environmental parameters and streams of real-time ip camera captures is also offered and an api for previous data inquiry is given also including storage for videos, this papers proposed system consists mostly of the following components a web based user interface, management platform and an edge orchestrator. Also, with accelerated growth of smart lights comes the quick creation of a management platform that can handle computing networking and storage resources as well as the numerous demands made by lamps as a result it is critical to design a massively scalable platform with simple transition quick deployment and increased resource utilization this article used container-based virtualized deploying technologies to achieve quick deployment and scalability.

Simulcity designing communications in smart and modern cities, the authors have presented their perspectives on communication networks and the way they have become a vital component in the creation of smart cities they also discuss how the information flowing via thousands of devices and sensors should be managed to ensure that appropriate quality, and security assurances. This article puts forward the simulcity tool which aids in the developement of a smart cities intricately integrated and converging network system.

Led street lighting for rapid frequency support in tiny non-synchronous power systems, Sergio Bruno, Giovanni Giancarlo Cosimo iurlaro and Massimo la scala highlight how led streetlighting systems are broad control resources that may be governed via local or via remotely controlled signals in a smart grid scenario, this research investigates the feasibility of regulating the power consumption of led street lighting to offer frequency support in systems with low total inertia in comparison to stimulation of non-synchronous power networks tests are carried out on a small Italian island using genuine led streetlamps the techniques of synthetic inertia and quick frequency response are both tried and debated.

This paper discusses base station (BS) sleeping strategy in the hybrid energy-powered cellular network on the IoT platform, how base strategy works for on grid energy saving in cellular which have Hybrid energy supplies. An algorithm is deployed which changes the sleeping state of a Base station based on the real traffic it is receiving, and solar energy is suggested to improve on-grid energy savings.

Remote Computer Room Energy Conservation and Management for Telecom Operators. The authors of this work suggest an IoT-based energy-efficient, energy saving management platform for telecom operators' using distant computer rooms through IoT technology. First is the idea of an Internet of Things-based management platform for RCRs. The ET algorithm is then devised, which is a straightforward yet efficient approach. The ET algorithm attempts to reduce the energy used by air conditioners, which make up close to 40% of total consumption, without resulting in large investment costs, hence enhancing the RCRS's overall effectiveness in saving energy.

Next-Generation IoT Devices: Energy Harvesting, Wireless Connectivity, and Sustainable Eco-Friendly Manufacturing Potential solutions for resolving the fundamental problems with creating sustainable IoT devices are provided by authors of this work. Their work focuses on creating next-generation IoT devices with consideration for sustainable power method, environmental friendly manufacturing method, and wireless connectivity. The number of IoT systems is growing very quickly because to the numerous and diversified uses of IoT applications in wearable technology, industrial automation, and smart cities. They also emphasise the underlying technologies of next-generation IoT and give an overview of hardware-related research trends as well as practical use cases of developing IoT systems. They demonstrate environmentally friendly IoT device production through the use of energy collection and wireless power transmission.

3.METHODOLOGY

3.1 Hardware components

3.1.1 Arduino Uno

In 2010, Arduino.cc produced the Arduino Uno, it is a microcontroller board based on the Microchip Atmega328P. The board features several analogue and digital input/output pins that have been interfaced to a number of expansion boards and other devices. A type B USB cable is used to program the board using the Arduino IDE (Integrated Development Environment). A USB cord or an external 9V battery can power it. A voltage between 7 and 20 volts is acceptable.



Fig - 1 Arduino UNO

3.1.2 Infrared Sensor

Infrared sensors are an electronic devices that senses and detects the infrared radiation in its neighboring environment. It was created based on an accidental discovery made by an astronomer called William Herchel in 1800. Herchel while conducting an experiment to measure the temperature of each color of light which were

separated after travelling through a prism. It led to a new discovery of infrared radiation which are not visible to human eyes and anything which produces heat also emits infrared radiation.



Fig -2 IR Sensors

3.1.3 LDR Sensor

LDR sensors also known as Photoresistors are light dependent devices that are used to sense illuminance present in environment. Its value is inversely dependent on the light intensity of the room. For example, if there is darkness in the environment it will show a high resistance value, while if its brightness in the environment it shows resistance of lower value. LDRs have sensitivity to the wavelength of the fallen light. LDRs are quite commercially used in different applications. LDRs made up of lead and cadmium are banned over safety concerns.



Fig - 3 LDR Sensors

3.1.4 Breadboard

A breadboard is a device that is used to make semi-permanent electronic circuits. Breadboards are reusable components as they do not need soldering. For this reason, breadboards are also quite popular with students and in technological education.

Compared to old circuits, modern breadboards showcase high resistance as well as high capacitance. Breadboard require a signaling of

10MHz to work and not everything below that frequency will work. Breadboards are quite popular with students and technical people.

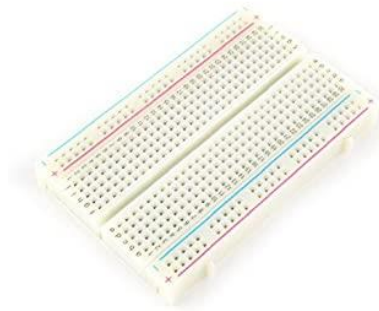


Fig-4 Breadboard

3.1.5 Jumper Wires

A jumper wire also known as jump wire or Dupont wire is an electrical cable that is used to connect circuits in a breadboard or any other kind of test circuits. It is mainly used to avoid the need of soldering in a circuit. The end of a jumper wire is used to connect the circuit and it can have one end or both ends as pins which can be inserted in a breadboard to make a connection.



Fig-5 Jumper Wires

3.2 Software Components Used

3.2.1 Arduino UNO IDE

The Arduino Uno is an open-source microprocessor based on the Microchip ATmega328P microcontroller that was first made available in 2010. The board features a set of input/output (input/digital and analogue) pins that can interact with other expansion boards and other devices. The board features 6 analogue I/O pins, 14 digital I/O pins, six of which may output PWM, and it can be programmed using the Arduino IDE via a type B USB connector. The Arduino can receive external power of 9 volts, and it can also handle voltages of 7 to 20 volts.

The IDE application can be used in operating system such as Windows, Mac OS X and Linux. It supports the programming languages C and C++. The programming in Arduino uno IDE is called sketching and it is saved with '.ino' extension.

3.2.2 Blynk

With the aid of Blynk, you can simply develop smartphone applications that communicate with microcontrollers and powerful computers like the Raspberry Pi.

The Blynk platform's main objective is to develop extremely simple applications that can communicate with your Arduino. It's simple to create an application using blynk. Using Blynk, you can easily control a LED or a motor with almost no amount of programming from your phone. Blynk is not only a simple software for little things; it can be scaled for usage by both industry and amateurs.

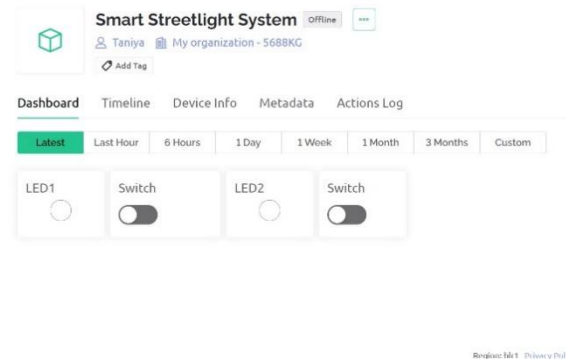


Fig- 6. Template for Blynk

4.SYSTEM OVERVIEW

The Block diagram represents system of Arduino uno based smart streetlight system. It contains smart lights, sensors to detect the motion and light. The system is connected to a power supply to power the microcontroller (Arduino uno), the purpose of the microcontroller is to control the switching off and on of streetlights based on detection of motion and light in the surrounding environment through the sensors in the system. The Blynk connected to the microcontroller gives the complete access to the sensors and the microcontroller. In case of some faults in the sensors if there working of somehow of compromised, the Blynk app connected to system can help in monitoring the sensors and turning the lights on and off manually. The Blynk app is used for both user and developer.

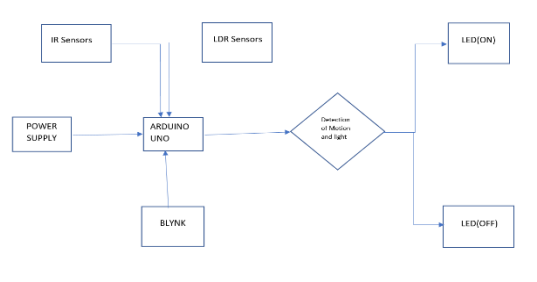


Fig - 7 System Architecture

4.1 A master controller

It acts as a brain of the system, Arduino uno sends data to and fro between slave nodes and web application for constant monitoring and visual display of the data.



Fig- 8 Flow Diagram of System

4.2A Slave Node

Each led lamp is connected to the master controller and sensors to receive the relevant data about the status of the device. Based on the data sent by sensors to master controller, the slave node receives the instructions to perform the relevant task.

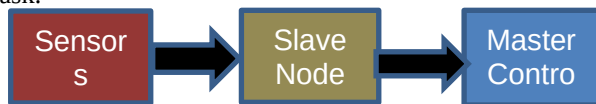


Fig-9 Flow Diagram of System

4.3 Web Application

The data from sensors is sent to microcontroller which in turns sends the data to the web application for constant monitoring and visualization of the data as well controlling the devices connected to the system.

4.4 Software Used

The software component used in the system is Arduino IDE, which makes it possible to write the code to implement the functioning of the microcontroller and sensors.

```

1 int ldrPin = A2;
2 int irPin = 3;
3 int led = 8;
4
5 void setup() {
6
7   Serial.begin(9600);
8   pinMode(led, OUTPUT);
9 }
10
11 void loop(){
12
13   int data = analogRead(ldrPin);
14   Serial.println("");
15   Serial.print("Light Sensor ");
16   Serial.print("value = ");
17   Serial.print(data);
18   delay(1000);
19
20   if(digitalRead(irPin) == LOW){
21     Serial.println("HIGHER");
22     digitalWrite(led,HIGH);
23     delay(1000);
24   }
25   else{
26     Serial.println("LOW");
27   }
28 }
  
```

```

19
20 void loop(){
21
22   int data = analogRead(ldrPin);
23   Serial.println("");
24   Serial.print("Light Sensor ");
25   Serial.print("value = ");
26   Serial.print(data);
27   delay(1000);
28
29   if(digitalRead(irPin) == LOW){
30     Serial.println("HIGHER");
31     digitalWrite(led,HIGH);
32     delay(1000);
33   }
34   else{
35     Serial.println("LOW");
36   }
37 }
  
```

Fig-10 Snippet of Arduino IDE code

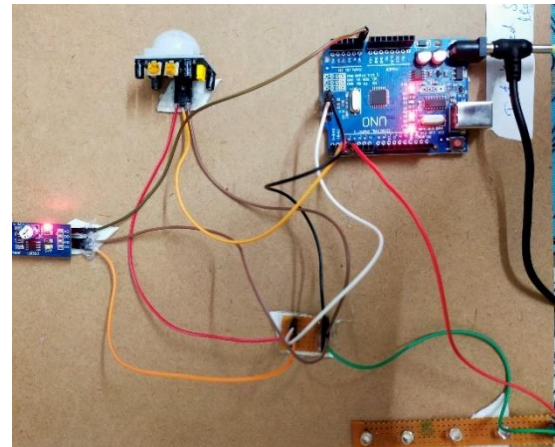


Fig- 11 Circuit Design for the system

5.RESULTS AND DISCUSSION

The system for IoT based smart streetlights comprises mainly of a microcontroller Arduino Uno, IR sensor, LDR sensor and LED lights. The IR sensor detects the motions of the object, LDR sensor detects the light intensity of the environment.

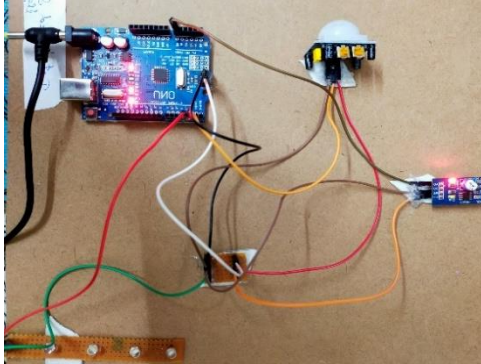


Fig- 12 IoT based smart streetlight system

The LEDs in the smart streetlight are programmed to function according to the motion and light intensity, hence when there is motion detected in the environment and there is darkness, the LEDs turn to full brightness. This allows the any passerby to have a better view of the roads.

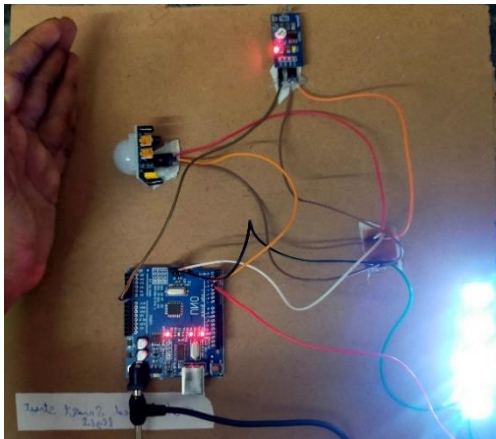


Fig- 11 Motion Detected by the IR sensor

When there is darkness in the environment and there is motion detected the LEDs turn to be in dim mode saving the energy, LEDs are dim so that it can be safer and as soon there is any motion detected it turns bright.

6.CONCLUSION

The traditional light system consumes a lot of energy, but the IoT based smart streetlight system suggested

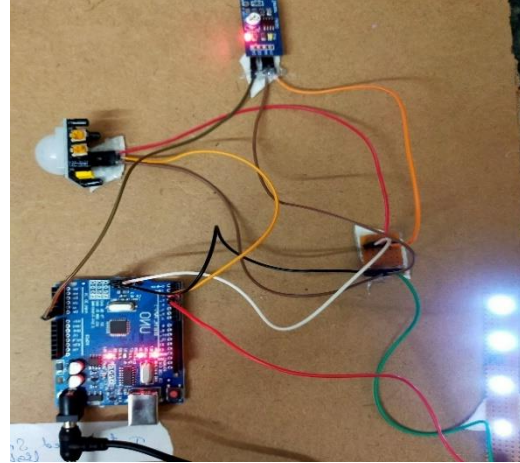


Fig- 11 No motion detected and darkness

There is no need of streetlight when there is already brightness in the environment hence in smart streetlight system also the lights are turned off, hence there is no utilization of energy.

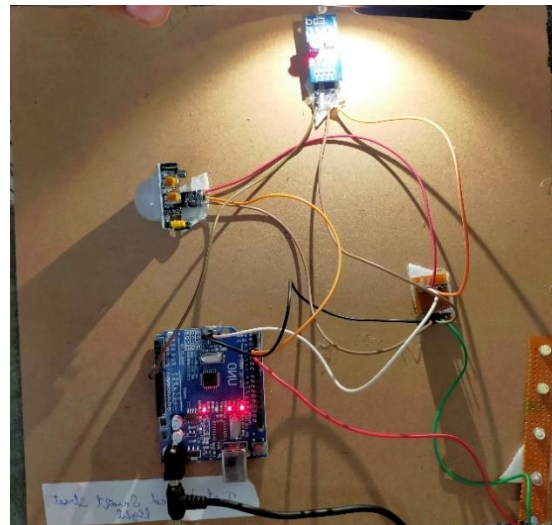


Fig- 11 Light detected by the LDR sensor

is an efficient way to control and monitor streetlight hence saving energy as the streetlights switches on and off based on motion detection and illumination detection. The dimness of the LEDs can also be controlled in this system such that there isn't always darkness in not presence of people. LEDs will be dimmed and when there is some detection of movement and as well as darkness in the environment the LEDs can be switched to full brightness. And in case of any fault, we can control the system through web application as well.

The system can be further enhanced like:

- To control the dimness of the light based on the illumination of the environment
- MQTT protocol can be also implemented in these smart streetlight so that it can communicate with other smart streetlights efficiently.
- Alarms can be sent off if any component goes faulty, this will help in speedy recovery of the system. The

smart streetlight can be developed in such a way that if it detects any criminal activity, it may trigger an alarm to alarm to authority.

This opportunity to work upon this research paper was provided was Sathyabama University. This was a great learning opportunity for me. And I would also like to express my gratitude to my mentor Dr R M Gomathi for her continuous guidance.

REFERENCES

1. Andrea Zanella, Nicola Bui, Angelo Castellani, Lorenzo Vangelista, Michele Zorzi, "Internet of Things for smart cities" in IEEE Internet of Things Journal (Volume: 1, Issue: 1, February 2014)
2. Fengqing Du; Xingde Huang; Aiqiang Pan; Xiaoman Qi; Zhiya Niu, "Development trends and construction strategies of smart city and the ubiquitous power Internet of Things with smart streetlight pole as carrier" at CIRED 2020 Berlin Workshop (CIRED 2020) Year: 2020, Volume: 2020, Conference Paper, Publisher: IET
3. Shih-Chang Hsia, Ming-Hwa Sheu; Jyun-Jia Ciou, Cost-Effective LED Dimming Driver with Single Chip Design for Smart Lighting System in IEEE, Volume 8, 2020
4. An Implementation of High Efficient Smart Street Light Management System for Smart City by Yu-Sheng Yang, Shih-Hsiung Lee, Guan-Sheng Chen, Chu-Sing Yang in IEEE, Volume 8, 2020
5. Indoor Lighting In Proceedings of 2016 IEEE International Conference on Computing, Communication and Automation (ICCUBE), Aug. 13
6. David Gomez-Cuadrado, Miguel A. Rodriguez-Hernandez, Angel Gomez-Sacristan SimulCity: Planning Communications in Smart Cities IEEE Access (Volume: 7), April 2019
7. Frequency Support Through LED Street Lighting in Small Non-Synchronous Power Systems" IEEE Transactions on Industry Applications (Early Access), 23 November 2022
8. Heng Wang; Zhenzhen Zhao, Jianhua Qu; Guangyin, Xu Xiaodong Cheng, Jilai Ying;, "Base Station Sleeping Strategy for On-Grid Energy Saving in Cellular Networks with Hybrid Energy Supplies in IoT Environment" Collaboration for Internet of Things IEEE Access (Volume: 6), 16 August 2018
9. Liang Zhao, Jiahui Zeng, Shaocheng Qu, Qiaoying Zhao "Energy-Saving and Management of Telecom Operators' Remote Computer Rooms Using IoT Technology" IEEE Access (Volume: 8) 08 September 2020
10. Yasaman Ghasempour, Hamed Rahmani; Darshan Shetty; Mahmoud Wagih; "Next-Generation IoT Devices: Sustainable Eco-Friendly Manufacturing, Energy Harvesting, and Wireless Connectivity", IEEE Journal of Microwaves (Volume: 3, Issue: 1, January 2023)

