SMART STREET LIGHT BY USING SOLAR SYSTEM AND GRID CONNECTION

An UndergraduateCAPSTONE Project
By

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Faculty of Engineering
American International University - Bangladesh

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A CAPSTONE Project submitted to the Faculty of Engineering, American International University - Bangladesh (AIUB) in partial fulfillment of the requirements for the degree of Bachelor of Science in theirmentioned respective programs.

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Fall Semester2022-2023,
January 2023

Faculty of Engineering
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DECLARATION

This is to certify that this project is our original work. No part of this work has been submitted elsewhere partially or fully for the award of any other degree or diploma. Any material reproduced in this project has been properly acknowledged.

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APPROVAL

The CAPSTONE Project titled SMART STREET LIGHT BY USING SOLAR SYSTEM AND GRID CONNECTION has been submitted to the following respected members of the Board of Examiners of the Faculty of Engineering in partial fulfillment of the requirements for the degree of Bachelor of Science in the respective programs mentioned below on **January 2023** by the following students and has been accepted as satisfactory.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

A smart street light is a piece of infrastructure that helps to mechanize the street. Smart Street lights are designed to save money by dimming when there are no cars passing. If there are no cars on the road, the Smart street light will turn off. Because of technological progress, people's lives are become less complicated and more convenient every day. Automation is the substitution of electronic and digital systems for human labor in manufacturing and other service industries. Automation is more advanced than mechanization in terms of industrialisation since it reduces the need for not just physical labor but also the mental and sensory labor that is normally performed by humans. As time goes on, automation becomes more and more integral to the global economy and our everyday lives. The use of automatic systems has surpassed that of manual ones. It has been demonstrated through this study that automatic control of streetlights can result in significant energy savings. Infrared sensors in the Smart street lights detect an oncoming vehicle, and when this happens, the lights in the block in front of the car automatically turn on, saving energy. The taillights turn off as soon as the car leaves their range. By doing so, it will be able to significantly reduce our energy consumption. Therefore, all lights are turned off when there are no cars on the road. Due to depleting fossil fuel reserves, attention has shifted to renewable sources of energy. The streetlights that are turned on at night and off in the morning use a tremendous amount of electricity. This converted the street lights to "smart street lights," which only come on when there are cars on the road in order to conserve energy. Sunlight can be captured and stored using solar panels for later use. Making use of electrical current is a popular technique. So, the surplus energy into the mains. From this vantage point, this project introduces the design of a solar charge controller and a solar-powered street light, both of which are powered solely by solar energy and feature LED bulbs, infrared (IR) sensors, a boost converter, and a battery. Due to its exclusive use of renewable energy, it may be argued that this initiative has helped keep costs down. When cars drive by, the lights turn on, and when the road is clear, they turn off automatically. Virtual and real-world trials of the technology have been successful.

Chapter 1

INTRODUCTION

1.1.Overture

Street light are very much needed thing of the streets, But there are traditional lights which are used in the roads. The Smart Street light has gained a lot of traction in recent years because of the huge amount off energy waste. Increased reliance on renewable energy as opposed to traditional fossil-based sources has been facilitated by technological advancements in this field. This paper presents a concept for utilizing renewable energy sources, specifically solar energy, to power a street lighting system, which has the potential to reduce strain on the existing power grid and advance our progress toward a smarter power grid. This project propose a system in which photovoltaic (PV) panels are attached to street lights, together with batteries and a charge controller, to store energy during the day and release it to light the streets at night. At night, when there is less pedestrian traffic, it is also important to conserve energy; for this reason, an upgraded system to incorporate a motion-sensing circuit that turns on the street lights only when they are actually needed. An additional component, the dust cleaning circuit, is installed in the PV panel to remove dust buildup anytime it occurs. This prevents the panel's efficiency from dropping below an acceptable level due to dust buildup. It was designed both the hardware with the former encompassing elements like the motion sensing circuit, the dust cleaning circuit, and the main circuit that links the street light to the PV panel, and the latter centering on the creation of the control algorithm that integrates and regulates the operation of all of the hardware components. [1] Solar irradiation, open circuit voltage, short circuit current, input and output power to the PV panel, and the condition of the dust cleaning device and the motion sensor were all monitored and recorded frequently at the rate of once per second to guarantee proper system operation. The provided solutions can be employed even if the street lighting system is not connected to the grid, as was the case with this project. The purpose of this work is to create a working model of a solar-powered, intelligent street lighting system that would rely on no grid electricity at all. Since it is also crucial to find ways to reduce the energy loss, the implemented IR sensor and solar panels.

Many countries are exploring renewable energy sources to replace traditional fossil fuels in light of the mounting climate change threat resulting from excessive carbon emissions. Although costs have been coming down, solar energy is still one of the more expensive sustainable energy options. When the benefits and drawbacks are weighed against the likelihood that solar panel prices will continue to drop, solar power emerges as a promising option. Solar energy's benefits include its potential for production in any country, its low environmental effect, and its status as a sustainable alternative to fossil fuels. The downsides include the fact that solar power can only be generated when the sun is out, that a large amount of land is required, and that some forms of solar technology necessitate extremely rare elements. And the rest of the energy will go to the grid.

1.2.Engineering Problem Statement

Many countries are exploring renewable energy sources to reduce the costs. For this reason, using solar and automated lamps solved the problem. Although costs have been coming down, solar energy is still one of the more expensive sustainable energy options. When the benefits and drawbacks are weighed against the likelihood that solar panel prices will continue to drop, solar power emerges as a promising option. Solar energy's benefits include its potential for production in any country, its low environmental effect, and its status as a sustainable alternative to fossil fuels. The downsides include the fact that solar power can only be generated when the sun is out, that a large amount of land is required, and that some forms of solar technology necessitate extremely rare elements. On the other hand, by using IR sensors in street light the lights are only turn on when there is vehicle. In that way energy is saving and also energy is stored.

1.3.Related Research Works

1.3.1. Earlier Research

1.3.1.1. IOT based smart highway management system

The term "smart Highway" refers to a novel vision for the roadways of the smart cities of the future. It is an innovative program that integrates fresh perspectives with novel approaches to making the most of the possibilities presented by technological advancements. Due to the rising number of traffic accidents and the prevalence of certain hotspots—such as intersections—road safety has emerged as a pressing issue in modern society.[1] Infrared (IR) sensors and Internet of Things (IoT) devices are used to identify the over speed and heavy load of the vehicle, together with the capture of the vehicle's license plate, in this project. The usage of roller barriers that can detect and stop potential accidents is another Project priority. Barrier stiffness includes both the flexible and semi-rigid properties. In addition to reducing risks and accidents, their unique mechanism makes them stand out among other forms of protection. Urethane's superior physical and mechanical qualities have made it the material of choice for many performance-driven applications in the modern day. The same is true for the role that a street light management system plays in the efficient administration of roads. The terms "smart highway" and "smart roads" refer to the various technological additions made to highways in order to better monitor road conditions, traffic flow, and vehicle speeds and loads.

1.3.1.2. Lux and current analysis on lab-scale smart grid system using Mamdani fuzzy logic controller

Keeping up with the growing demand for electricity will necessitate new, high-quality, low-cost methods of electrical distribution from the industry's leading providers. A control system that can automatically back up or synchronize the voltage of the renewable energy power network with that of the main grid is essential to the growth of this industry. With a fuzzy logic controller in place to manage the main network, solar panel network, and generator network, this study aims to provide a novel lux and current analysis for a smart grid system operating at the laboratory scale.[2] By modifying the main network's current and the LDR sensor's light intensity, the Mamdani fuzzy logic controller approach is utilized as the basis for establishing the solution to the control problem of the smart grid system. There are three categories for the current state of affairs: safe, warning, and trip. In the meanwhile, there are three categories for the amount of available light: dark, cloudy, and brilliant. When the load current is 0.4 A (safe) and the light intensity is 1,167 Lux, the findings show that the utility grid (PLN) is operational (dark). When the load current is 1.37 (warning) and the light intensity is 8,680 lux, the PLN + PV condition is on (bright). When the load current reaches 1.6 (trip) and the luminosity reaches 8,680, the generator status is on (bright). The results of the tests show that the system is capable of figuring out which source is the most efficient given the data it collects.

1.3.1.3. Design of a Cost Effective Smart Autonomous Power and Switch Controlled Led Street Light

A novel Smart Autonomous power and switch controlled Led Street Lighting System for Bangladesh is proposed and demonstrated in this study. The independent power and switching of these streetlights can have a significant impact on our electricity usage and minimize electricity waste in an era when streetlights are particularly vital for a city's infrastructure in densely populated areas. Typically, street lights are needed from dusk until dawn, but in many underdeveloped countries, including Bangladesh, the demand for electricity exceeds the supply from the National Grid between the hours of 17:00 and 20:00, when many people use their televisions, air conditioners, and other home appliances at their most. By storing solar energy during peak hours and employing energy-efficient automatic Streetlight switching based on light dependent resistors, a smart autonomous power and switch controlled street lighting system is proposed here. A Real time clock (RTC) and a temperature sensor are being installed to provide up-to-the-minute time and temperature information to passing motorists and pedestrians.[3] Therefore, with correct implementation, the proposed system will be able to serve as a conduit for a circuit that is both energy efficient and able to minimize the scarcity of power on the national grid, all while providing power at no cost and with a high degree of reliability at no cost.

1.3.1.4. Sensor-Based Predictive Modeling for Smart Lighting in Grid-Integrated Buildings

Based on research, it has been shown that if all California building lighting systems were retrofitted with dimming ballasts, 450 MW of regulation, 2.5 GW of non-spinning reserve, and 380 MW of contingency reserve could be obtained from the involvement of lighting loads in the energy market. In any case, keeping an eye on and modeling the demand for and supply of lighting in buildings will be crucial to ensuring participation. Therefore, wireless sensor and actuator networks have shown to have a significant potential for energy-efficient, individually-tailored lighting.[4] Real-time and extensive sensing are needed for closed-loop control of these lighting setups. The setup and activation costs for such systems can be high. Here, we detail a sensor-based intelligent lighting system for grid-integrated buildings of the future. The system relies on sparse sensing to forecast how light will be distributed inside a given space, with the goal of ensuring that lighting loads may fully participate in the energy market. We only used 1% as many sensors as state-of-the-art systems, which use one photosensor per light bulb. Small solar panels, fueled by natural light, were built into the sensor modules. By employing piecewise linear predictive models of indoor light, with discretization at the cluster level for sky conditions and sun positions, fewer sensors can be deployed. Forecasts of temperature, humidity, and cloud cover are used to estimate the amount of daylight available a day in advance. Our model accurately predicted the illuminance at seven tracked workstations 80.95% of the time using training data collected over the course of two weeks using both natural and artificial light sources at NASA Ames' sustainability base. We also found that our support vector regression model was 92% accurate at predicting the next day's daylight.

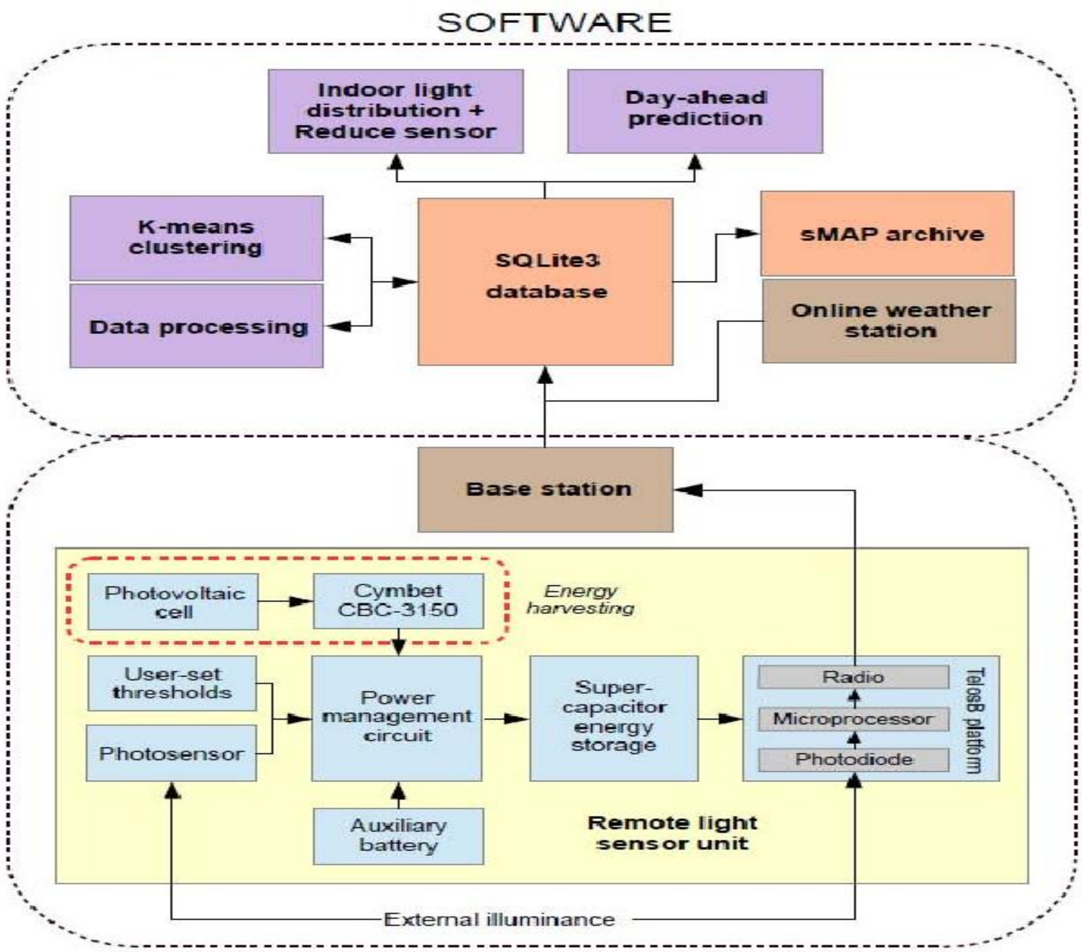


Figure 1.1: System architecture showing hardware and software components.[4]

1.3.2. Recent Research

Several works have been done for developing the street lighting system. Sometimes the lighting system have been changed or modified to make an easier system. In addition, sometimes the way of operation was changed to make an efficient system. The existing street lighting system which is use today, started with the replacement of vapor lamps or high-pressure vapor lamps by the LED which can save a lot of power. The associated research of the system showed a complete analysis of different traditional lamps; power consumed by them and features of new technology and their features to replace those traditional lamps. After some study regarding the difference of power consumption and efficiency and cost saving between various traditional bulbs and LED, the country has projected to replace the traditional lights.

1.3.2.1. An IoT Based Application for Monitoring Smart Grid Assimilating Tracking System

The Internet of Things, or IoT, is predicated on the idea that the Internet is used everywhere in the world to make ordinary things possible. In this work, this shows how Internet of Things may be used to better track and distribute power from solar facilities. In the IoT, things are managed remotely over an existing network. For dual-axis tracking, the most fundamental components are a servo motor, a Light Dependent Resistor (LDR), and an Arduino.[5] Maximum power point tracking controllers are employed for this purpose. combined with a means of storing said energy and an inverter for converting DC to AC for transmission and distribution. Rainy and foggy weather conditions necessitate the use of the temperature sensor to measure the temperature, as this is when the system's maximum output can be accurately determined. in a digital display that indicates the proposed system's temperature, relative humidity, DC voltage, current, and AC voltage and current. The proposed solution makes use of the Thing Speak server to present solar energy use data online. Through constant monitoring, so it can be seen how much and how efficiently solar power is being used each day. Power, efficiency, precision, humidity, voltage, and current may all be analyzed using this. The effects of using solar energy and electrical problems are analyzed. Since this is, in every respect, a prototype, it was unable to display the distribution. As such, a load has been implemented for distribution, and current and voltage sensors will be deployed to keep an eye on things via the Internet of Things.

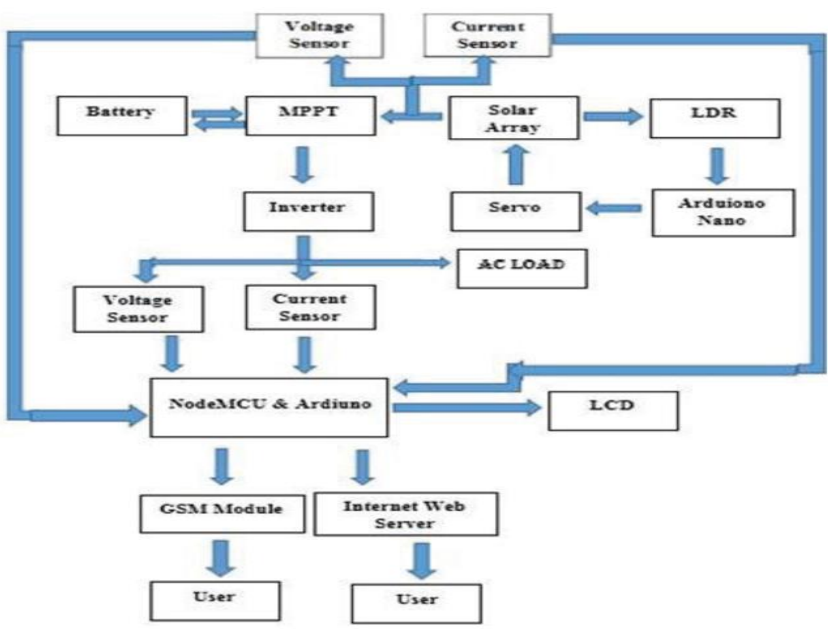


Figure 1.2 Proposed Block Diagram [5]

1.3.2.2. A Smart Street Lighting System Using Solar Energy

The primary objective of this study is to plan and carry out cutting-edge embedded system development for energy-efficient street lighting. Nowadays, people are so rushed that they forget to do simple things like turn off lights they aren't using. Under the current setup, streetlights are turned on in the evening before sunset and turned off the next morning once daylight has sufficiently illuminated the streets. This article provides the most effective method for preventing the waste of electrical power. In addition, no human intervention in the lighting system is required at all. In this research, two types of sensors—a Light Dependent Resistor (LDR) sensor for determining whether it is day or night, and an infrared (ir) sensor for determining whether or not there is motion on the street—are employed. With C as the language of choice for writing the microcontroller's software, the PIC16F72 serves as the "brain" of the street lighting system. The system's prototype has been developed and deployed successfully.

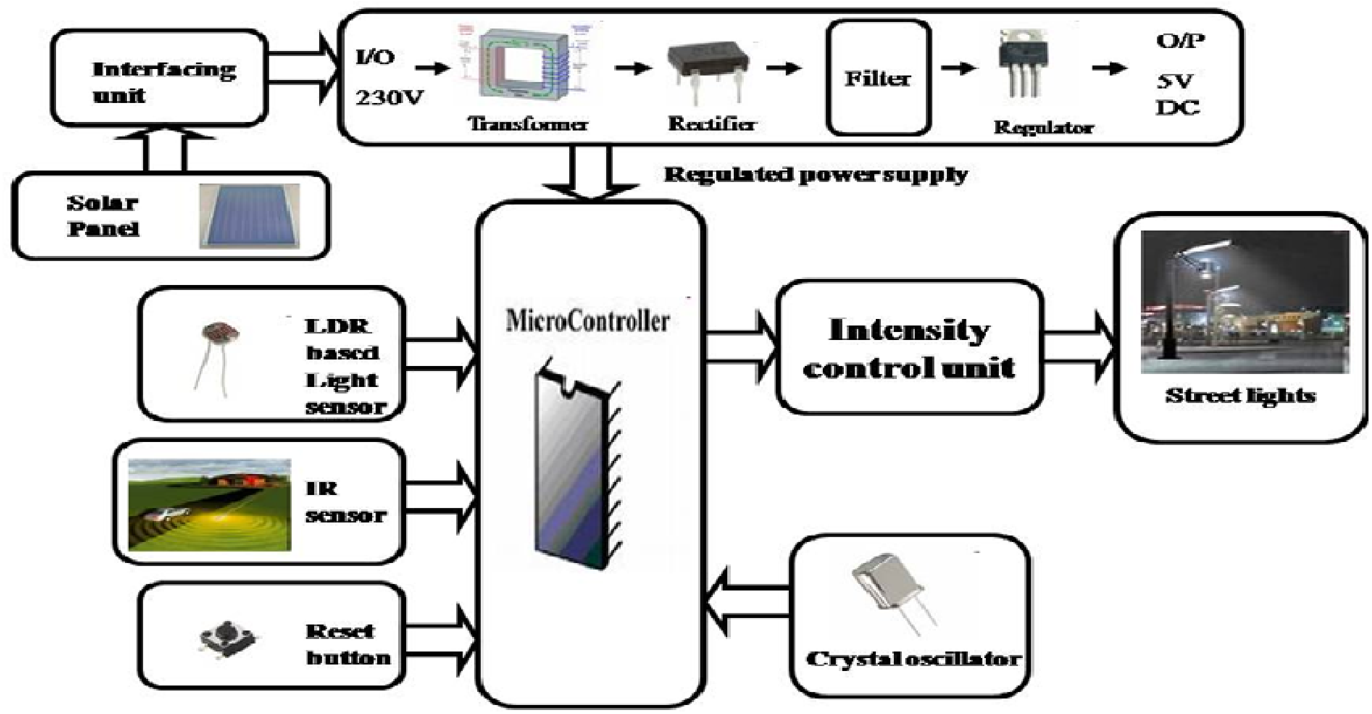


Fig: 2. Block Diagram of Automatic Street Lighting System

Figure 1.3: Block Diagram of Automatic Street Lighting System [6]

1.3.2.3. Smart Street Light Based on IR Sensor

A smart street light is a piece of infrastructure that helps to mechanize the street. Smart Street lights are designed to save money by dimming when there are no cars passing.[7] When it detects traffic, the Smart

Street light will turn on; otherwise, it will remain off. Because of technological progress, people's lives are become less complicated and more convenient every day. Automation is the substitution of electronic and digital systems for human labor in manufacturing and other service industries. Automation is more advanced than mechanization in terms of industrialization since it reduces the need for not just physical labor but also the mental and sensory labor that is normally performed by humans.

1.3.2.4. Smart Street Light Management System with Automatic Brightness Adjustment Using Bolt IoT Platform

This article details the implementation of a Bolt IoT platform-based streetlight management system. The goal of this project is to conserve energy by cutting down on unnecessary electricity use and labor.[8] Light Emitting Diodes (LED) are used in the plan because they are energy-efficient and, as directional light sources, they emit light in a precise location, making the streetlights more effective. LED lights with light-dependent resistors (LDRs) allow for dimming. When IR sensors on one side of the road detect a large volume and rapid movement of traffic, they send a signal to turn on the LEDs on the next designated stretch of road. The performance of the suggested work is superior than that of the current methods.

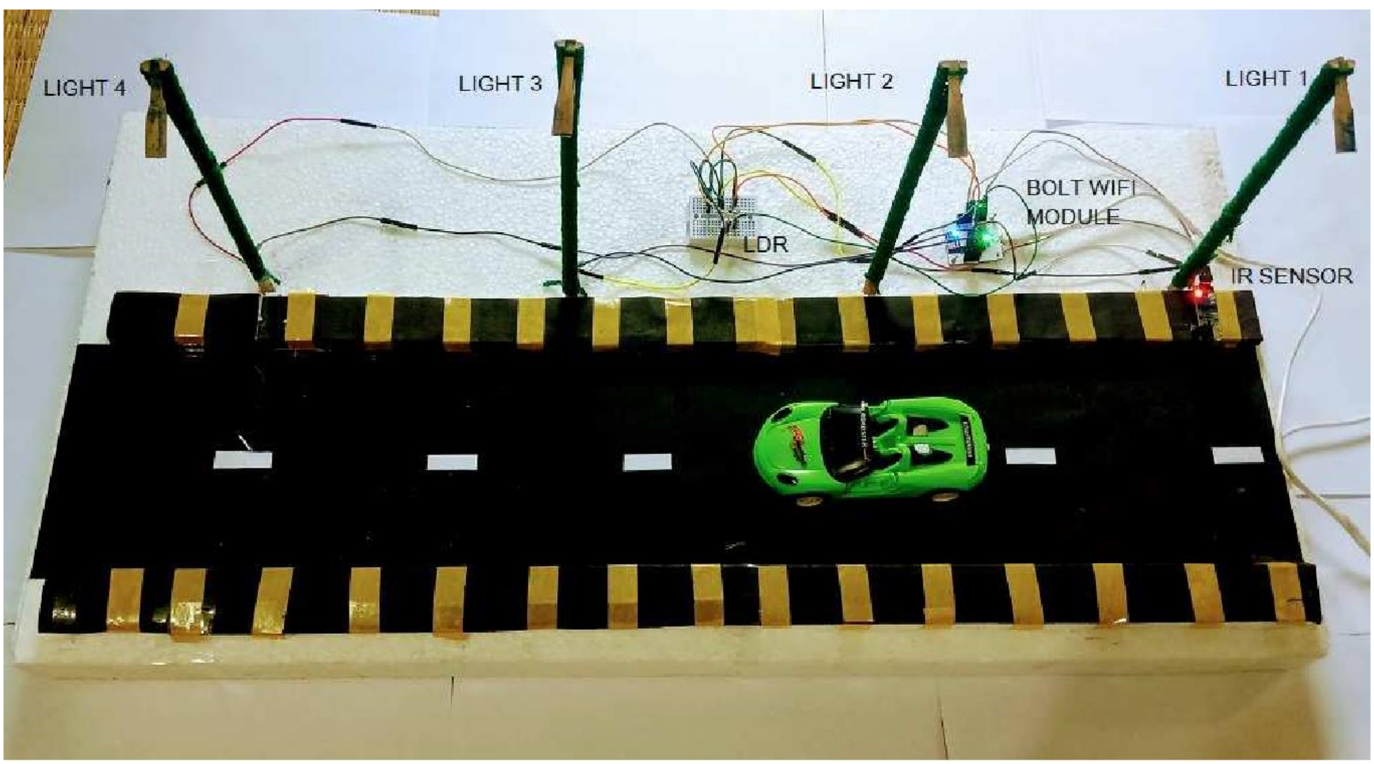


Figure 1.4: Prototype of the Proposed System [8]

1.4. Critical Engineering Specialist Knowledge

One of the greatest benefits of producing your own electricity is participating in Net Metering or Net Billing, which is made possible by connecting solar panels together to create larger arrays for direct connection to the local power grid. In the event that your solar PV system generates more electricity than you need on a sunny day, you can send the excess to the utility grid, thus turning your electric meter backwards.[23] When this occurs, you can expect credits from your utility company equal to the amount of electricity generated by your PV system and fed into the grid. If anymore use more electricity than you produce during the billing period, you will be charged the standard rate for the "net quantity" of electricity used. However, if you produce more solar energy than you need in a given month, you will receive credit for the "net amount" of power created, which might be a monthly bill credit or a positive repayment to you or the account holder.

1.5. Stakeholders

Even while utility distribution systems might be envisioned as lasting for 30 years, in practice they frequently outlive that estimate. Therefore, in the near future and in most locations, the design of PV systems under a high-penetration scenario must be consistent with reliable operation of a grid infrastructure that will be little modified from current practice. It may not be cost-effective to force individual PV installations to pay for the expense of upgrading the distribution network. However, it is reasonable to assume that most new systems will not be net-metered under flat rate structures, and instead will be subject to time-of-use, demand, and other charges, with the result that they may be paid less for any energy they produce in excess. Methods are explored in this section for integrating a large amount of PV into the existing distribution network without degrading or compromising PV system value or utility system reliability.[14] Invasive PV systems may compromise grid stability and control. Steps can be done to alleviate the impact of high penetration of distributed energy sources on the distribution infrastructure even as utilities contemplate replacement of the old infrastructure with new hardware and controllers specifically designed to allow two-way power flows. This procedure requires improved means of communication but assumes the maintenance of the distribution system's priciest components.

1.6. Objectives

The program aims to provide inverters/controllers for grid-connected solar for street light systems that do one of the following:

1.6.1. Primary Objectives

- Innovations in energy management, energy storage, smart appliances, and utility portals that do not include solar power.
- Communicate via auxiliary equipment (portals) with bidirectional communications needed to track, manage, and maximize the worth of energy generated by PV systems.

1.6.2. Secondary Objectives

- Include power control and conversion features, as well as energy management elements, to enable long-term energy storage.
- feature integration with energy management and storage infrastructure,
- The evolution of smart home connects to the controller/inverter and operates it. technology, utility web portals, and related technologies.

1.7. Organization of Book Chapters

Chapter-2: Project Management

In this Chapter, the project Gantt chart has designed in this project management chapter. Then, analysis the different related issues as such strength of this project, weakness and opportunities. Which Norm practice is has taken while doing the project along with all the individual responsibility were mentioned in this section.

Chapter-3: Methodology and Modeling

In this methodology chapter, the proposed designed with block diagram were explained. 3D model with demonstration and the simulation and hardware result was shown as well subsequently.

Chapter-4: Implementation of Project

In this the modified chapter, the proposed model will be described with details and other working mechanism. The description of primary used components was discussed.

Chapter-5: Results Analysis & Critical Design Review At last a result comparison was shown between simulation and hardware result.

Chapter-6: Conclusion

Summary of the findings were discussed along with the novelty of this project and the limitations which were faced in this project. Future aspects and many impacts were mentioned as well.

Chapter 2

PROJECT MANAGEMENT

2.1. Introduction

Project management is a common method used to assure the success of a project. When it comes to project management, it's critical to have a clear picture of the objectives of the project, the resources this project needs, and achieve it. This chapter is all about getting down to business. The purpose of project management is to plan and execute a project in such a way that its stated goals and deliverables are met. Additionally, it includes the identification and control of potential risks, along with a thorough budgeting process and cross-organizational communication. Project schedules can benefit from using the Gantt chart. Money can be saved on the project's equipment by manipulating the data. Managing a project is a critical managerial ability. Planning, scheduling, and regulating actions to achieve a certain goal within a given time and budget are all part of the process. By completing initiatives that contribute to project aims, many businesses can meet the objectives. In most cases, projects have a specific start and end date, a specific number of participants, a specific number of resources, and a specific budget. This is planned and monitored by the group leader and adjusted just as needed.

2.2. S.W.O.T. Analysis

A project's opportunities and threats, as well as its strengths and weaknesses, can be analyzed using the SWOT framework. Using a functional approach, the internal analysis pinpoints the projects' strengths across the board (finance, management, infrastructure, procurement, production, distribution, marketing, reputational factors, and innovation) as well as its weaknesses (the same) and opportunities for growth (the same). Finding the source of competitive advantage requires a thorough internal study. In doing so, it identifies areas for investment in developing resources that will keep a team motivated. Potential advantages and disadvantages in the sector are uncovered through research on the surrounding environment, including the competition, the industry, and the broader economy. Analysis of the capabilities and assets of each competitor constitutes the competitive landscape. Competition, new entrants, suppliers, customers, and product substitution are analyzed as part of the industry's external environment using the five Forces Model.

Political, economic, sociological, technological, environmental, demographic, ethical, and regulatory repercussions are examined in the context of the external environment.[30] The objective of doing a Strengths, Weaknesses, Opportunities, and Threats (SWOT) study is to inform a company's strategy development considering its specific context. In this using SWOT analysis, the strength and weaknesses are found.

Figure 2.1 S.W.O. T Analysis [30]

2.2.1. Strengths

- Well proven technology for small lighting services, no need for cable laying
- No need for network deployment and maintenance.
- No need for network deployment and maintenance. High bit rate
- No need for network deployment and maintenance.
- Possible fee only for gateways to control center connectivity

2.2.2. Weaknesses

- Single service network. Maintenance required. Vulnerability to failures. Low bit-rate.
- Lighting infrastructure not used for other services.
- Fee for all streetlights

- Possible coverage gaps.
- Maintenance of batteries is costly.
- Lighting infrastructure not used for other services.

2.2.3. Opportunities

- Private network Possibility to support possible coverage gaps. other services and High latency gain revenues.

2.2.4. Threats

- A network operated by a third party.
- Downtime and repairs to the network. As a result of its obsolescence.
- There is no dimmer that responds to changes in brightness
- Potentially escalating low encoding speed pay as you go

2.3. Schedule Management

Project activities and tasks are organized using a schedule management structure, which uses time variables to do so. Outlines what has to be done for the project's completion to be on time and within the budget. Implementing a schedule management system is crucial to getting a project off the ground, tracking its progress, and ensuring that it is completed on time.

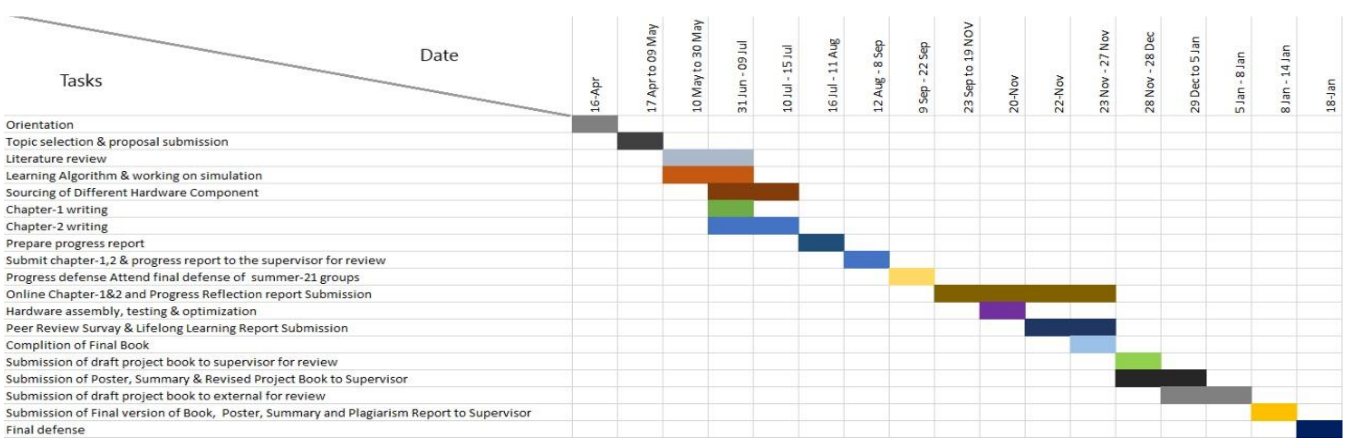


Figure 2.1: Gantt chart

2.4.Cost Analysis

The total cost analysis of both object detection and authentication devices is shown here. Here, the estimated price and the buying price of the components are shown.

SL No	Cost Description	Unit Price (Taka)	Quantity	Total (Taka)
1	ARDUINO UNO R3	1100	1	1100
2	Uni-T UT33B+ Digital Multimeter	1190	1	1190
3	IR INFRARED OBSTACLE AVOIDANCE SENSOR MODULE	88	6	528
4	JUMPER WIRE 40 PCS SET	95	6	570
5	Solar Panel Controller	240	1	240
6	WHITE LED	5	6	30
7	KILOOHM (KΩ) 1/4W RESISTORS	1	5	5
8	DC MALE POWER JACK PLUG CONNECTOR	20	1	20
9	BATTERY 3.7V	195	1	195
10	KOOCU V900 PRECISION SOLDERING IRON	550	1	550
11	SOLDERING IRON STAND	75	1	75
12	DC-DC STEP UP BOOST CONVERTER MODULE MT3608	120	1	120
13	Solar Cell 6v to 9v 300mA	540	2	1080
14	Glue Gun	300	1	300
15	Glue Gun Stick	18	3	54
16	PVC Board	250	2	500
17	PVC Pipe	40	6	240
18	GENUINE SMALL SUN 18650	195	2	390

	BATTERY 3.7V 3800MAH			
19	18650 BATTERY HOLDER 2S WITH WIRE and connector	120	1	120

Total	7307

Now according to the standard deviation formula equation,

N=19

Sum, Σ X: Online price (BDT) + Final expenditure price (BDT)

= 7307

Variance = $\sigma^2 = \frac{1}{N}\sum(xi-\mu)^2 \quad \frac{+\cdots+}{} = \frac{7307}{14-1}$ =1141.15

Standard deviation = $\sqrt{Variance}$ $= \sqrt{405.94}$ = 20.14

2.5.P.E.S.T. Analysis

To assess a project's current situation, future prospects, and strategic course of action, the PEST analysis is an invaluable tool.[31] Businesses and other organizations often do market analyses by considering political, economic, social, and technological (PEST) issues. A PESTLE analysis takes into account other aspects, such as those related to the law and the environment.

Figure 2.2: P.E.S.T analysis

2.6.Professional Responsibilities

2.6.1. Political Analysis

The analysis of political structures, institutions, ideas, and behaviors, and most importantly, the political processes through which they are constantly formed and changed, is made accessible and engaging in Political Analysis. This project won't require approval from the government to carry out its initiative. This project can be implemented without any restrictions.

2.6.2. Economic Analysis

Cost-benefit analysis is the core of the economic analysis. First, it uses economic viability to rate projects, so that funds can be distributed more efficiently. The purpose of this study is to evaluate a project's contribution to society. It is reasonable and cost-effective, and this project's initiative is to be accessible to everyone. The researchers need to keep the budget in mind throughout the implementation process.

2.6.3. Social Analysis

Analyzing stakeholder perspectives and priorities, and involving as many relevant stakeholders as possible in the development process, are all components of social analysis. This analysis is conducted in the context of the socio-cultural, institutional, historical, and political environment of Bank-financed operations. It’s a team project and its target market may be affected by certain societal trends, behaviors, or attitudes

2.6.4. Technological Analysis

Dynamic vehicle has been featured in cars for aiding driver awareness of their surroundings and providing warnings to take preventative action in the event of a collision. Recently, technology has advanced to the point where it can act on behalf of a driver to avoid potentially disastrous situations including head-on crashes, backing into obstacles or traffic, or veering out of a delineated lane. The decisions made when driving, riding, and walking have a direct impact on public safety. However, modern automobiles can assist. Automobile safety is nowadays a great concern. So, the app-based authentication system now applies to most the smart vehicles to provide security.

2.6.5. Norms of Engineering Practice

This entire project had a lifetime that it went through from start to finish. This project's lifecycle was divided into four parts, as indicated Definition, Planning, Execution, and Termination.

2.6.5.1 Definition

The project was defined at this stage after examining the project history, necessity, and acceptability, as well as considering the feasibilities. First, aspects such as how this initiative would help people, how suitable it was for the globe, and who would be the stakeholders were reviewed. The availability of necessary equipment, the project's cost, and numerous dangers were all examined. The project was started when all of these analyses were completed.

2.6.5.2 Project Planning

A detailed project plan was established at this phase. Milestones and timetables for the project have been specified. Chores were assigned, and a plan was devised to guarantee that each task was performed on time. Several internal and external project difficulties were taken into consideration, and as a result, preparations were made. The resources were estimated, and the project participants were identified.

2.6.5.3 Project Execution

The project and its accompanying duties have been finished at this time. A rough design of the complete project was made at first. The design simulations have been finished. To acquire the best possible result, the simulation was performed several times with calibrations in between. The various components of the projects were then implemented, and everything was finally put together. The received results were then analyzed. Simultaneously with the implementation, the project's documentation was being completed. The project's progress was submitted to supervisors in the midst of the project, and they provided input. The project supervisor kept a close eye on the whole execution process and made any necessary changes or developments.

2.6.5.4 Project completion

This stage marked the completion of the project. The project's requisite documentation, which had already been completed, was submitted. The concept was summarized, a poster was created, and the project was finally presented.

2.7. Individual Responsibilities and Function as Effective Team Member

Because this is a Capstone project, it requires a team effort. That's why the project work was distributed among the group members.

Table 3.2 Individual Contributions in Project Leading

Name	ID No	Responsibility
Fatin Istiak Rahman	19-39841-1	Project lead
Fatema Zannatul Mawya	19-39987-1	Theoretical study, Literature review, Book writing, Design ISM band antenna, Antenna location, MATLAB Code
Tashfia, Fairuz	19-39447-1	Software lead

2.8.Management Principles and Economic Models

Economic models are simplifications of the real world that help us study and anticipate economic activity. To simplify a complex, real-world scenario is a primary goal of modeling. A well-constructed model can help an analyst get insight into the problem at hand. A good model should be easy to comprehend while still being sophisticated enough to account for relevant details. Economists often talk about theories instead of models. The difference between a theory and a model, in the strict sense, is that the former is more theoretical, while the latter is more practical or empirical. To verify hypotheses, models are frequently employed. However, we shall treat the two terms as synonyms throughout this course.

2.9.Summary

All necessary tools for this endeavor can be seen up there. To effectively organize and manage the project, various factors were considered from the beginning, including software simulation, strategic planning, scheduling, cost analysis, prototype design, social impact, organizing individual responsibilities, maintaining multidisciplinary components, cost analysis and studying the project lifecycle. The strategic planning provided insight into the inner workings of the project and aided comprehension of its innovation, future scope, and constraints. A cost analysis provides an overview of the initial costs required and aids in the creation of a prototype budget. Distribution of responsibilities based on an individual's area of competence promotes efficiency, and as a result, the project was completed on time and to the satisfaction of all stakeholders.

Chapter 3

METHODOLOGY AND MODELING

3.1.Introduction

There would be no city with functioning street lights. Nearly every intersection has a street light to dispel the nighttime gloom. They offer protection and traffic control services. It serves as a warning system for impending danger. Goals for Utilization: There are just too many lights on the streets to count. Because of the illumination provided by street lights, drivers and pedestrians are safer. Additionally, individuals can quickly determine if there are any potentially hazardous objects on the road, protecting them from unfinished buildings and obstructed streets. It serves a functional purpose, but it also improves the aesthetics of the city. When there were fewer streetlights, they were simpler to manage. But as time has progressed, not only has the volume of traffic increased, but so has the number of streets. As a result, keeping tabs on and regulating the lights is a hassle. They can't be managed manually using the individual street switches. It's a time- and energy-guzzling procedure that's futile to try to carry out. It's also a hassle to keep track of when street lights should be turned on and off, which results in unnecessary energy consumption. The result is the mechanization of lighting. The goal is to discover methods of enhancing product efficiency while simultaneously decreasing energy use.

3.2.Block Diagram and Working Principle

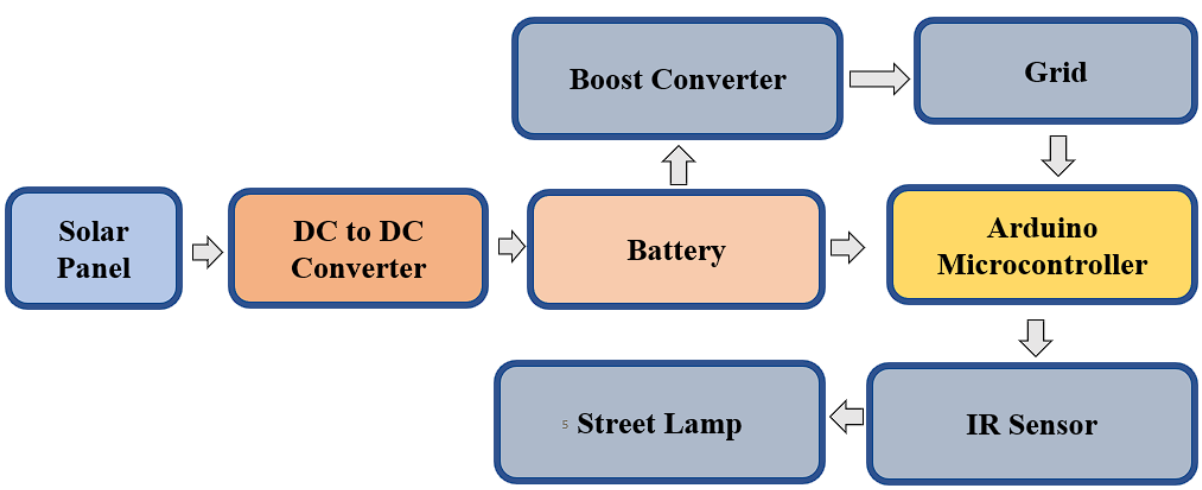


Figure 3.1: Block Diagram

The widely available ATmega328 chip is the basis of the Arduino Uno microcontroller board. The Arduino's brain, the microcontroller, communicates with connected devices to gather data and issue commands. This board is an Arduino Uno. Uses the Arduino software for programming. The Arduino Uno comes with a plethora of capabilities, such as pulse-width-modulation (PWM) pins, external and internal interrupts, timers, and more. The Arduino Uno board, as depicted in figure 1.1, includes a USB interface that can be inserted into any standard USB port, allowing it to communicate with a wide variety of current electronic gadgets. This device has a clock speed of 16 MHz, making its use very quick, and 32 KB of memory allocation, allowing it to store the code efficiently. Furthermore, it is useful for debugging and troubleshooting, and it has a voltage regulator built in, so you can manage the amount of power being used. You can power it from an external source of up to 12V and have the built-in voltage regulator drop the voltage to 5V or 3.3V, or you can plug it into any USB port and not need an additional power source. An external power supply can be plugged into one of the ports, and there are also 5V and 3.3V power pins, as well as a ground pin. The USB port can be avoided by means of an ICSP connector. In addition to this, it serves as a re-bootloader for broken chips and an interface for the Arduino as a serial device. When fresh firmware needs to be installed on a microcontroller, a bootloader can do it without the use of an external programmer. The Arduino microcontroller may be reset with the device's RESET pushbutton, simplifying a variety of tasks. From Figure 3.1, we can see that it includes 14 digital pins and 6 analog pins, all of which can be used to directly link sensors or other electronic equipment. After receiving data from numerous sensors, the Arduino Uno microcontroller is capable of sensing the ambient situation. It may affect its environment by manipulation of things like lights, motors, etc. Through a solar panel power is consumed and using a rectifier the power was converted from DC to AC power. Then the power is given in the Controller Arduino. The Arduino gets its run power through Grid power system and solar panel. Again, it delivers that power in the road light and motion sensor. The lights on and off by those motion sensor when objects come near that.

3.3.Modeling

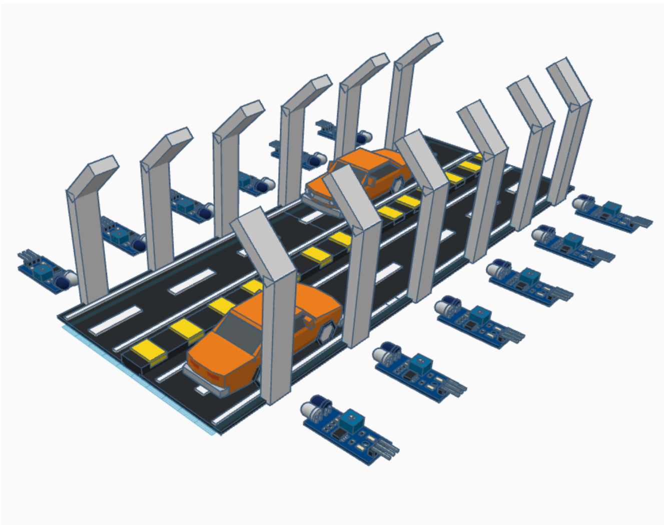


Figure 3.2: First angle of 3D

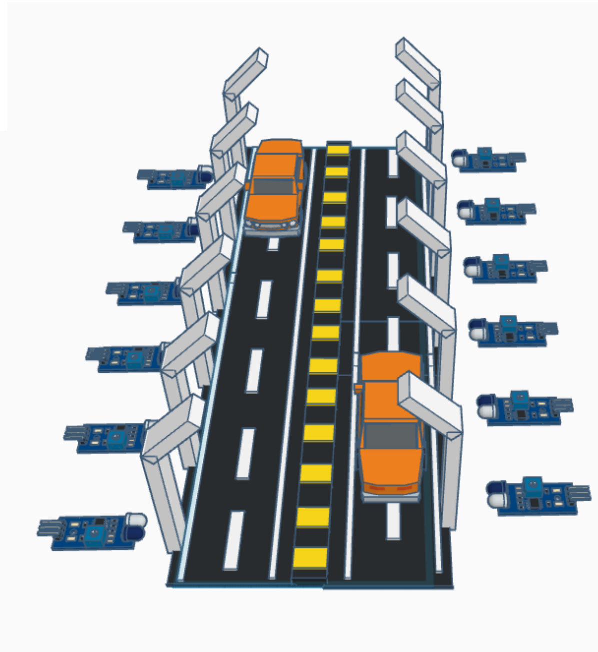


Figure 3.3: Second angle of 3D

Figure 3.4: Third angle of 3D

A 3D model was made using fusion 360 software to depict and demonstrated the project. When the project will be implemented it will look alike the 3D model.

3.4. Flowchart of Arduino

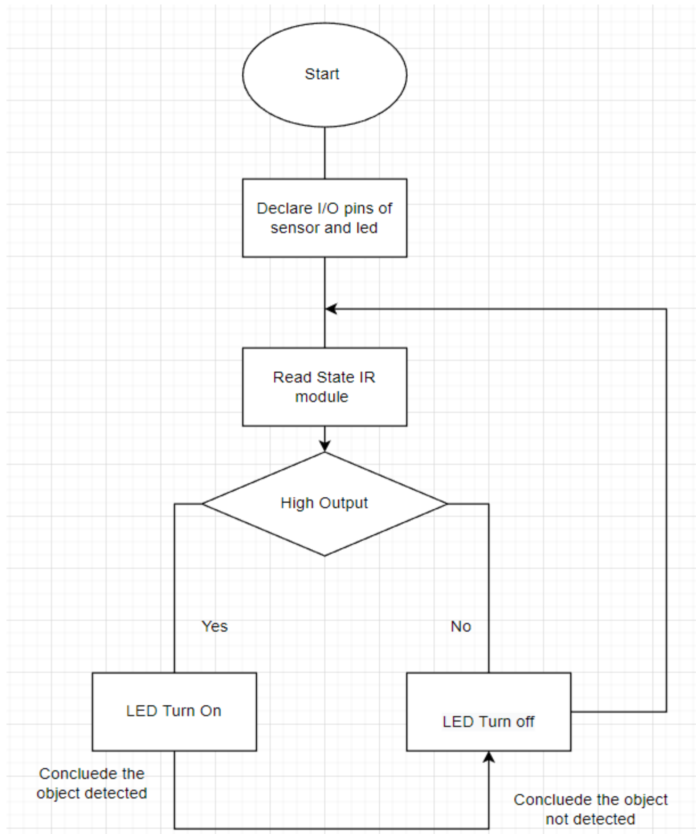


Figure 3.5: Flowchart of Arduino

3.5. Summary

All necessary tools for this endeavor can be seen up there. Understanding the structure and mechanism of our dream project is made easier by the equipment's operating principle and their features as stated before. The provided pin diagrams allow for a high-level understanding of the apparatus to be gained. We have gone over the list of gear and their respective costs above. The necessary tools can be purchased at a low cost from any one of several nearby electronic retail outlets. They are long-lasting and reliable, and their tools are up to the task of carrying out our project. We have displayed both the software we used to program the project and the estimated costs associated with implementing it. The next chapter provides a thorough study of the system, including all of the circuit diagrams and block diagrams that will be needed to put the project into prototype or actual implementation, as well as the necessary equipment power needs.

Chapter 4

PROJECT IMPLEMENTATION

4.1. Introduction

The goal of the project was to make the street lighting system more intuitive and user-friendly while also reducing the number of people needed to maintain it. There are four key ways in which our project contributes to this objective. Controlled by hand, with This method of street illumination is made possible with the use of sensors and mobile SMS; if a problem is detected, we are notified via text message. In this chapter, we will cover the feature of timing-based switching in depth together with the other major elements. In this section, we'll delve deeper into the project mechanism and go over the steps required to put it into action on an AC line. Multiple potential domains of application for this project are discussed here. We'll also talk about how much room there is for adaptation, so that it can be utilized in a wide variety of contexts. In this chapter, we'll talk about the project's overall outcome.

4.2. Required Tools and Components

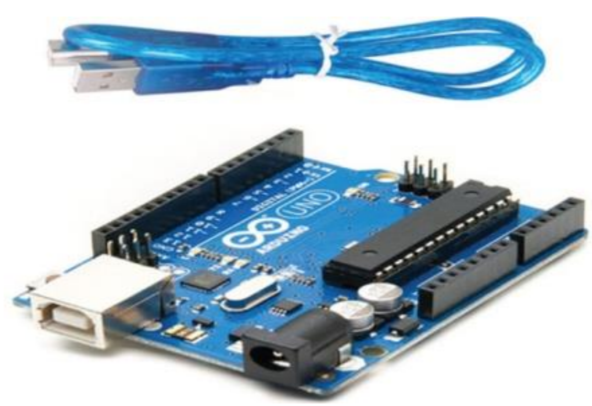


Figure 4.0: Arduino Uno [30]

The ATmega328P is the basis for the Arduino Uno microcontroller board (datasheet). The board includes a USB port, a power jack, an ICSP header, a reset button, and 14 digital I/O pins (6 of which can be used as PWM outputs). It also features 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a 16 MHz crystal oscillator (CCXO), and a power connector. It has everything you need to get started with the microcontroller; all you have to do is plug it into a computer through USB or supply power using an AC-to-DC adapter or battery. You can experiment with your Uno without too much fear of breaking it; if the worst comes to the worst, you can simply get a new chip for a few dollars and start over.

In honor of the first public release of the Arduino Software (IDE), the version number "Uno" was chosen. There have been many revisions of the Arduino platform since its inception with the Uno board and the 1.0 release of the Arduino Software (IDE). For a comprehensive list of current, historical, and obsolete boards, see the Arduino index of boards. The Uno board is the first in a series of USB Arduino boards and serves as the platform's reference model.

Figure 4.1: IR sensor [31]

Anti-Collision Infrared Technology There is an infrared transmitter and receiver in the IR Sensor Module (Active Low). The IR waves emitted by the transmitter will be picked up by the receiver tube once they have been reflected back from the object being communicated. A green indicator LED lights up and processing is handled by the on-board comparator circuitry.The module's tail has a 3-pin interface with Vcc, GND, and an OUTPUT pin. As long as the voltage is between 3.3 and 5V, it will function properly. When an obstruction or reflection is detected, a digital signal is sent out via the output pin (a low-level signal). The effective distance range is from 2cm to 80cm, and it may be fine-tuned using the on-board preset.

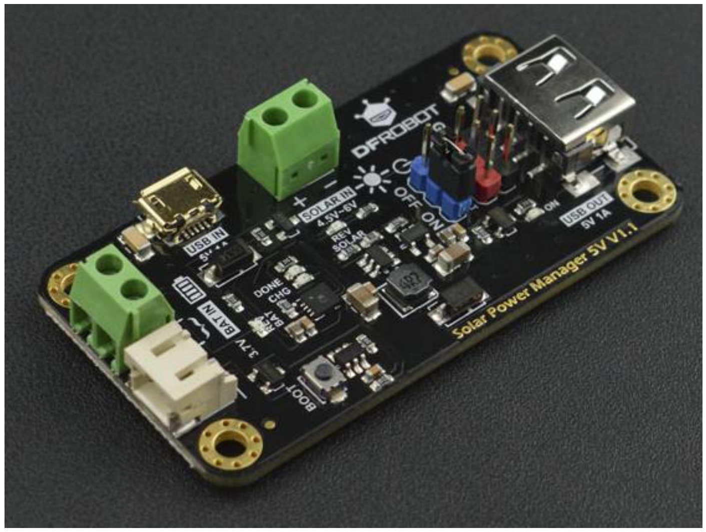


Figure 4.2: Solar Power Manager 5V [32]

This tiny, high-efficiency solar power management module is specifically intended for use with 5V solar panels and is known as the Solar Power Manager 5V. It has a mechanism called MPPT (Maximum Power Point Tracking) that allows the solar panel to operate at peak efficiency. The module can supply a charging current of up to 900mA to a 3.7V Li battery when connected to a USB charger or a solar panel. Low-power and solar-powered applications can all benefit from the ON/OFF controlled DC-DC converters that provide 5V at 1A. In addition to bolstering the dependability and security of your solar installations, the module includes many battery, solar panel, and output protection features.

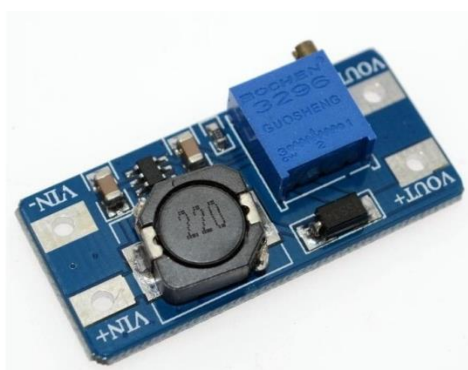


Figure 4.3:MT3608 2A Max DC-DC Step Up Booster Power Module [33]

This low-priced module, the MT3608 2A Max DC-DC Step Up Power Module Booster Power Module, can increase a 2 to 24V input voltage to a 5 to 28V output at up to 2A. Since the module can't output more power than it receives, DC-DC boost converters raise the input voltage while simultaneously lowering the current. Depending on the input/output voltage settings, this boost converter can provide a continuous current of up to 1.5A, with 1A available in most cases. The output voltage range is from 5.0 to 28V. The input voltage must be less than the output voltage, as expected of a boost converter. Instead of using electrolytic capacitors, which can leak and cause the device to age prematurely, low ESR bulk ceramic capacitors are used. If the MT3608 converter IC is overloaded, it will automatically shut down to prevent damage.

4.3. Implemented Models

4.3.1. Simulation Model

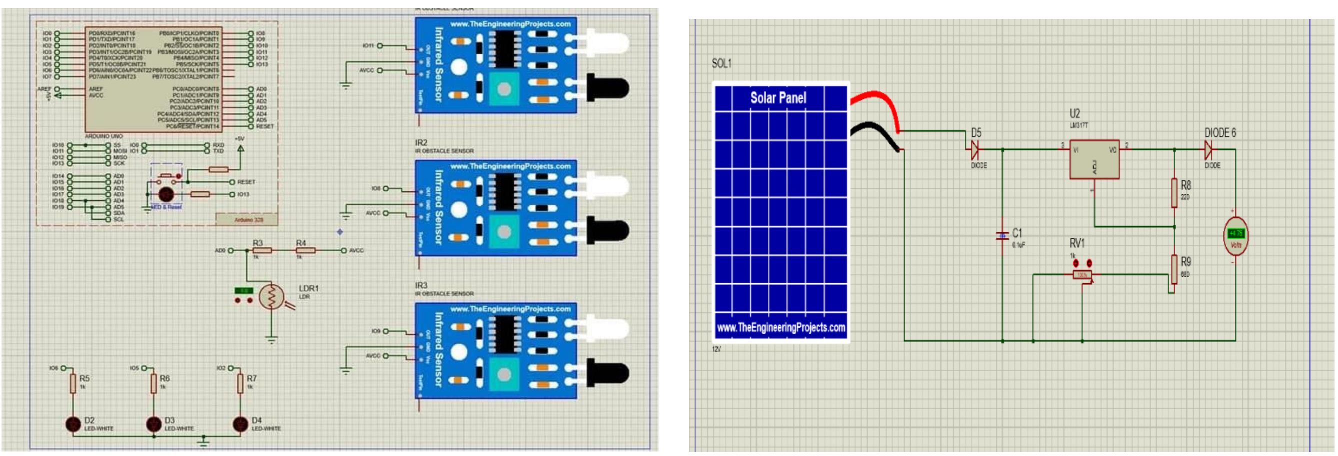


Figure 4.4: Proteus Simulation

4.3.2. Hardware Model

Figure 4.5: Equipments

At first all the necessary equipments were gathered together. A road was build in a PCV bord before implementing the IR sensor and the probes.

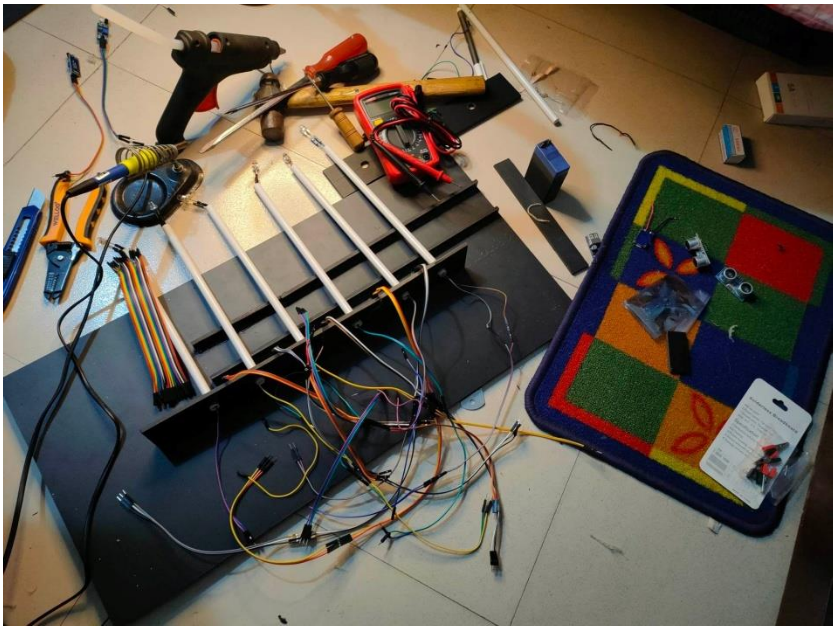


Figure 4.6: Preparing the Probes

After An infrastructure was build. The probes were situated serially in the road. Then the probes were situated. The lights were coneected with the IR sensors through the Arduino. The Arduino Is Programmed to co-relate the Arduino and the IR sensor.

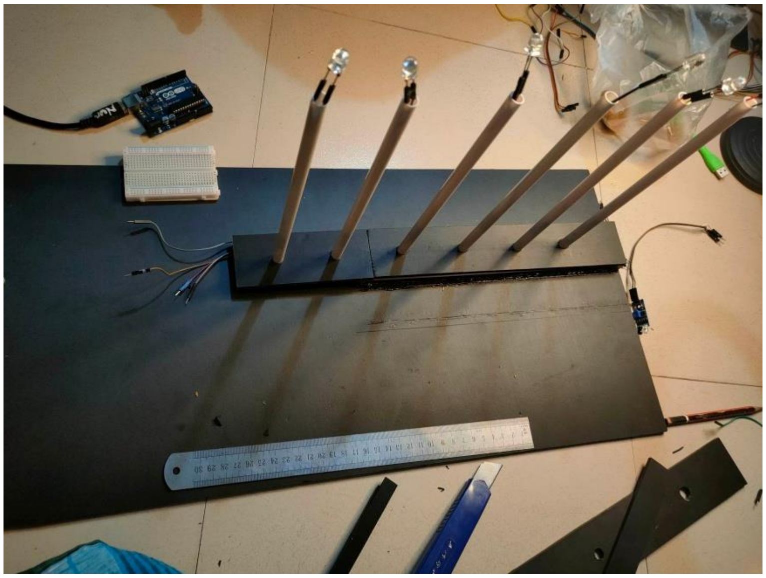


Figure 4.7: Properly situated

After all the probes was situated and all the wire were organized. Then the road would look like this.

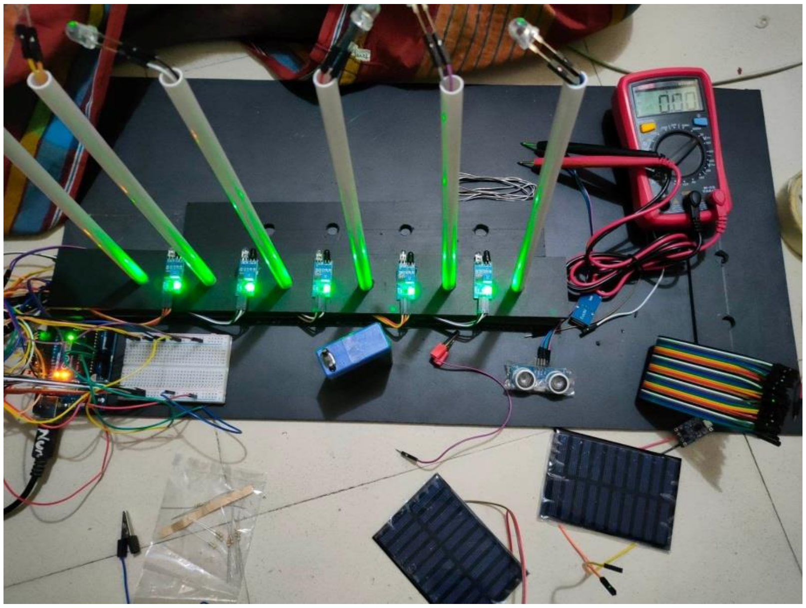


Figure 4.8: Situated in the IR sensor

All the Probes was connected. All the IR sensor was situated besides beside the probes. The IR sensor was connected though the arduino and a programming was done to control the probes through the IR sensor.

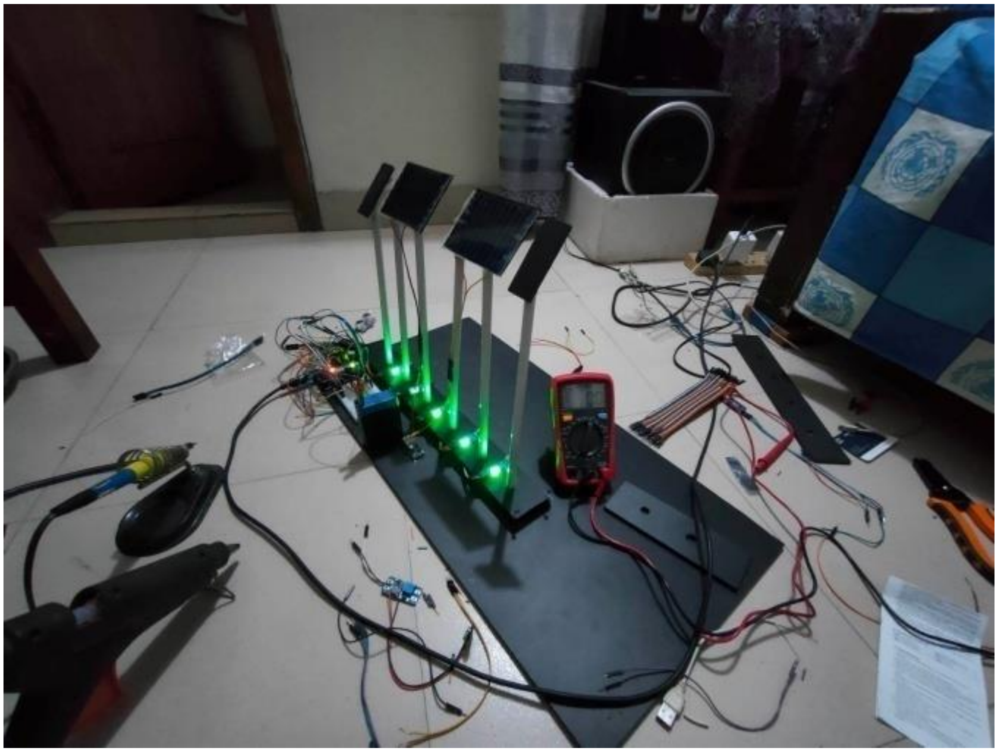


Figure 4.9: Solar situation

After All the probes was situated and programmed with the IR sensor. The solar panels were situated Above the probes.

4.4.Summary

The software and hardware architecture were designed, and then the working circuit diagram was implemented on the breadboard/project board. In this case, the input voltage is created by the power source. The microcontroller is clearly visible. Charge controller output adjusts for both load and battery. LEDs displaying battery voltage and load are also functioning normally. In this case, we were able to simply adjust the power of the load via an android app run from a mobile device.

Chapter 5

RESULTS ANALYSIS & CRITICAL DESIGN REVIEW

5.1.Introduction

the cost of the project's components and where they come in the previous chapter. This chapter will cover the entire system, from the prototype stage to the actual deployment. We'll talk about system models and systems, too. The system's power supply, block diagrams, and other such analytical and illustrative details. We need to adhere to some circuit diagrams and block diagrams in order to finish this project successfully. It is easy to grasp the role of each piece of equipment and how the project operates thanks to the detailed explanations provided in this chapter's project overview. How the streetlights are managed has been explained, as depicted in the system diagram. In this chapter, we'll go deeper into these topics.

5.2.Results Analysis

5.2.1. Simulated Results

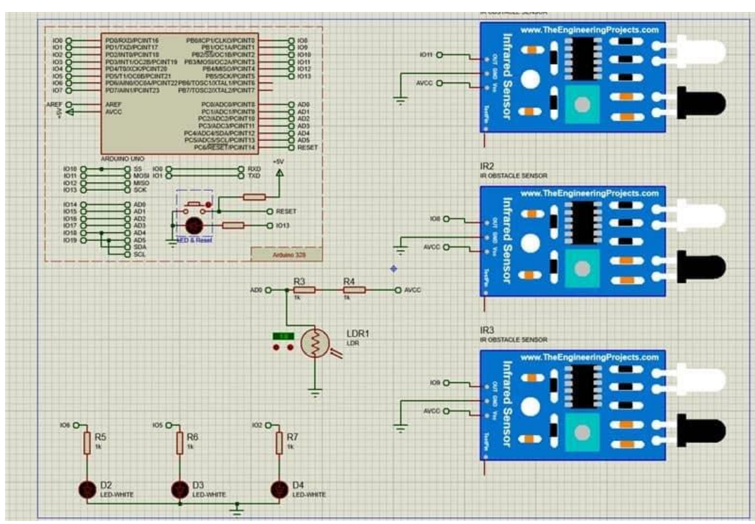


Figure 5.0: Proteus Simulation

Before implementing the hardware model. A brief Simulation was done in proteus software to check the validity of the hardware mode. A few IR Sensors were attached with the Arduino Uno to Run The project and check the distance of the IR sensor working Model.

5.2.2. Hardware Results

Figure 5.1: Hardware Implementation

- Typical -80dBm sensitivity
- Up to +4dBm RF transmit power
- Low Power 1.8V Operation ,1.8 to 3.6V I/O
- PIO control
- UART interface with programmable baud rate
- With integrated antenna
- With edge connector

Maximum power point trackers (MPPTs) are electronic DC-to-DC converters that find the sweet spot between the voltages produced by a solar array (PV panels) and those stored in a battery bank or supplied by the utility grid. What they do, in a nutshell, is take the solar panels' higher voltage DC output (and a charge batteries at a lower voltage than is produced by wind generators) The PPT is a high-frequency direct current to direct current (DC to DC) converter. In order to perfectly match the solar panels and batteries, they transform the direct current (DC) input from the panels to high frequency alternating current (AC) and then back to DC at a different voltage and current. MPPTs produce extremely high-pitched sounds, typically between 20 and 80 kHz. High frequency circuits have the benefit of being able to use compact, high-efficiency components and transformers. To function, the power point tracker (and other DC to DC converters) convert the DC input current to AC, route it through a transformer, correct it back to DC, and then route it to the output regulator. Most DC-to-DC converters rely solely on electronics for this process, with no significant intelligence involved beyond that required to regulate the output voltage. Since the battery voltage and ambient light and temperature conditions fluctuate continuously throughout the day, solar panel charge controllers require a great deal more intelligence.

Figure taken from Maui Solar Software's PV-Design Pro software. The maximal strength appears as a strong peak in the top right corner. An MPPT controller "scans" for that precise point, then performs the voltage/current conversion necessary to meet the battery's precise requirements. Depending on the time of day and the weather, the peak can be found in a variety of different locations.

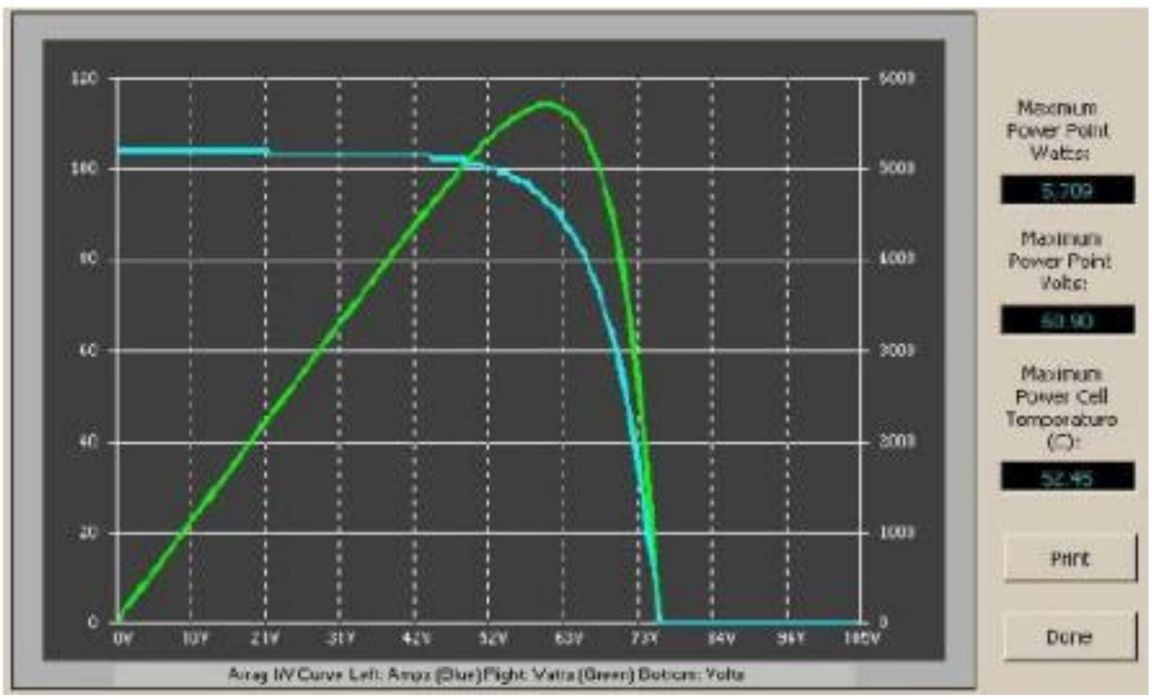


Figure 5.2: Controller set points

The maximum power point is not the same as the STC (Standard Test Conditions) rating, hence an MPPT is used to keep track of it. In really cold weather, a 120-watt panel can produce more like 130 or more watts of power because its output increases with decreasing temperature. But if that PowerPoint isn't recorded, the information will be gone. On the other hand, in really hot weather, electricity decreases as the temperature rises. Because of this, its efficiency drops in the summer.

The site's viability can be determined by examining the following during the surveying process:

- The slant of the ground or roof, and the overall area or surface area available;
- Structure and roof material
- Potential wire runs, battery placements, and inverter installations;

5.3. Comparison of Results

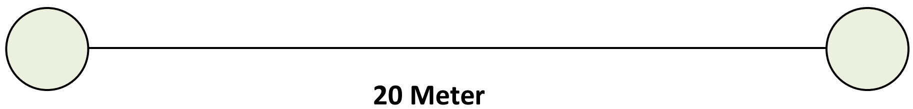


Figure 5.2: Distance From one light to another pole is 20 meter

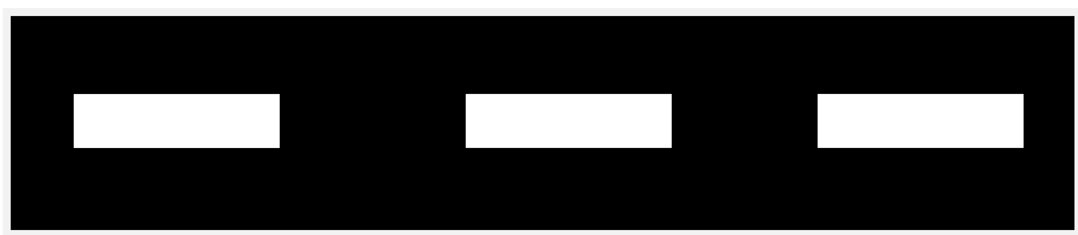


Figure 5.3: The road where the project will imply

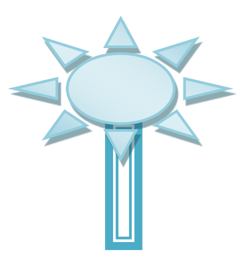


Figure 5.4: Bulb in the Street

Solar panel measurements for 1KM Road and 1bus stand.

Loom Solar 375 Watts Solar Panel
Output power: 375w
Product Dimensions- 197 x 99 x 3.5 cm
Bus stand roof area: 1000 x 400 cm

Total solar: 12 pis per bus stand

Total power we get: 4500 watts.

Street light: After Every 20M

Total required for 1KM distance:
50Pis LED
Light model: Philips CE 75W LED Street Light
Total power needed 3750 W

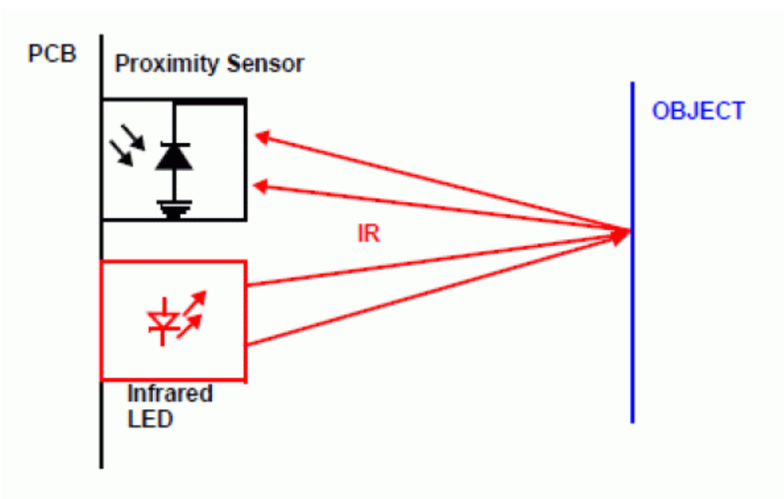


Figure 5.5:IR sensor mechanism

Typical readings from an infrared sensor tend to change as the ambient light level does. The light waves pick up on whatever is nearby and reflects that information back to the sensor. The microwaves can't compete with their short wavelengths. In addition to tracking movement, these devices may assess an object's thermal output. Depending on the conditions, the maximum distance that most IR thermometers can measure is about 100 feet (30 meters).

5.4 Summary

Rising energy consumption and ecological and financial worries about fossil fuels have contributed to a surge in the use of renewable energy sources to meet this demand. With its zero-fuel cost, zero maintenance costs (because to the lack of moving parts), and ease of installation, photovoltaic (PV) is one of the most promising renewable energy sources. Keep solar collectors/panels aimed directly at the sun throughout the day with the help of a solar tracker, which is used to maximize the energy production of solar panels and solar receivers. Because of this, widespread development of smart home systems powered by renewable energy is urgently required. The extra power will be transferred to the grid.

Chapter 6

CONCLUSION

6.1.Summary of Findings

Off-grid users of solar energy platforms have been studied extensively for insights into remote monitoring, control, and determination of energy use for proper billing. This paper, therefore, offers an intelligent system for using solar energy to the street lights and also add extra energy to the grid. The current project makes use of small-scale technologies to provide electricity close to the end users it enables appropriate monitoring of the intelligent solar system via an Arduino microcontroller, and also guarantees proper uses of renewable energy.

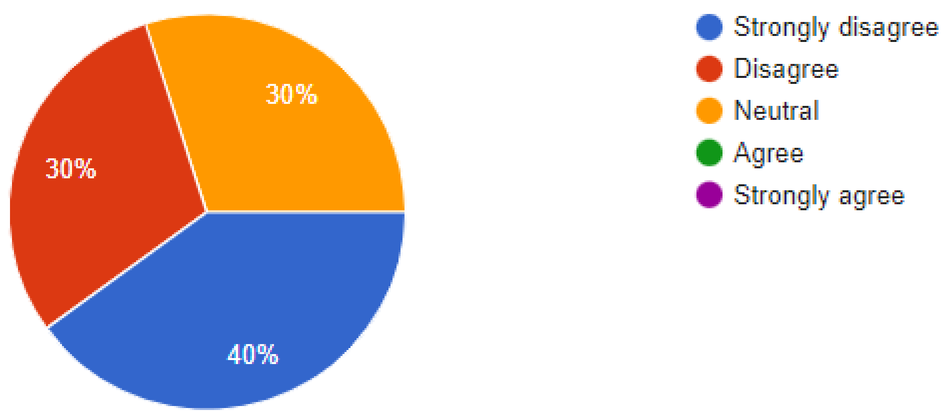
6.2.Novelty of the work

Solar energy may be used in a variety of ways to provide us with clean, sustainable power for our homes and businesses. Photovoltaic (PV) solar panels harness the sun's energy and turn it into usable electricity. Then, the power from this source green energy source that can power our home or company. The charge controller is the brains of the solar power system, and its job is to keep the battery safe. Solar energy systems have a low environmental impact and require little upkeep, but they are expensive to manufacture and have a poor energy conversion efficiency. Since solar panels still have a low conversion efficiency, a solar charge controller that can get the most electricity out of each panel can help keep the system's price down. Most of the population of our country resides in rural areas, which are still unconnected to the national grid. The current power grids cannot meet the demand for electricity. It follows that solar panels and wind turbines are the most viable alternatives to traditional energy production methods. The adoption of solar energy systems is rising rapidly in both rural and urban locations. Even Nevertheless, the standard method of employing a solar power charge controller has not changed. It's still run by hand for now. There is a simple approach to set up an automated system where we may regulate the charges incurred by using our mobile phone as the primary controller.

6.3. Cultural and Societal Factors and Impacts

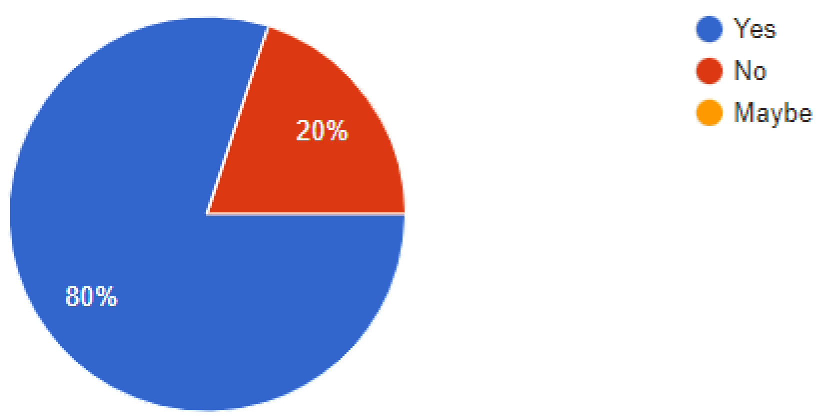
Maintenance cost for this project is reasonable?

10 responses



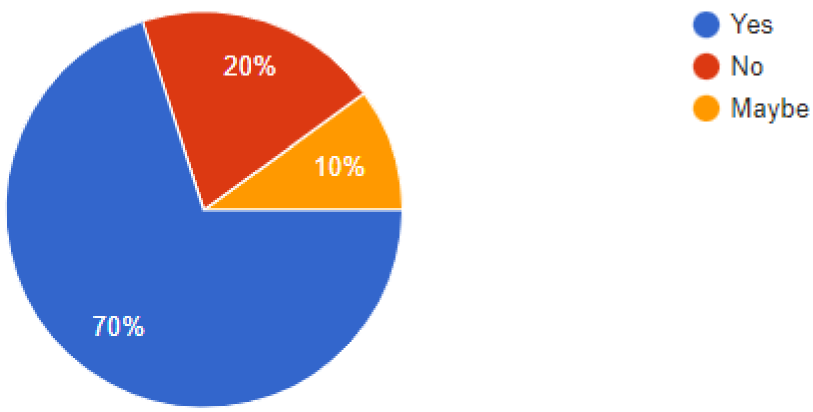
Do you think solar light needs direct sunlight?

10 responses



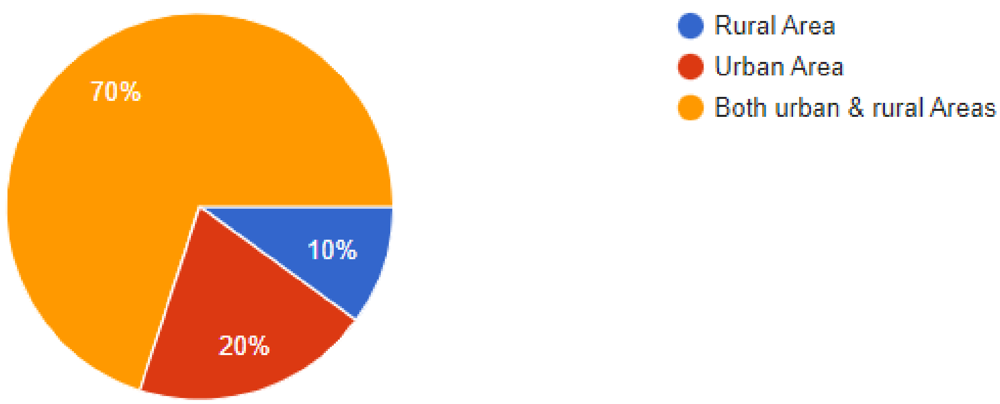
Do you think this project is helpful for people?

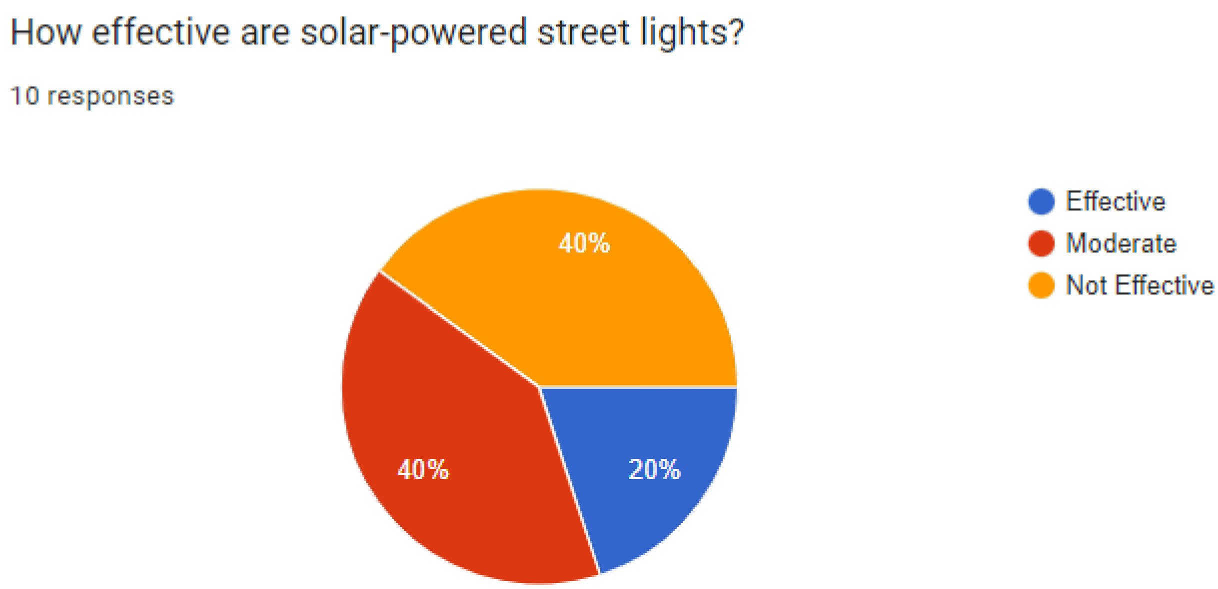
10 responses



Smart Road light is preferable for

10 responses





6.4.Engineering Solution in accordance with professional practices

Over the past two decades, as advancements in electronics have allowed for more convenient home automation, the notion of the "Smart Home" has gained popularity. People have been experimenting with automatic control of their home appliances in an effort to realize the ideals of the "smart house." With Rapid advances in mobile communication coupled with falling prices have made it possible for us to remotely operate our household appliances. However, people are looking for any and all means to satisfy the ever-increasing need for electricity. Innovations in power generation technology are being developed. To the best of my knowledge, solar energy is the most effective. This technology has been evolving and new applications are always being discovered. The idea of integrating a solar charge controller into an existing household appliance system is relatively novel, yet both disciplines have already seen a number of significant advancements. To prevent damage to the rechargeable battery, Deba [21] developed a solar-powered system. Another[2] charge controller method he developed was intended to improve efficiency and featured a visual representation of the controller's current state. To keep solar batteries from being destroyed, increase their efficiency, and use them in their own home system, Marufa [23] proposed a concept for a smart Charge controller for a solar battery charging station.

6.5. Limitations of the Work

- For our prototype, we opted for a 12V solar rechargeable battery rather than a PV panel and associated battery.

- Although we assumed a constant voltage to manage the charge, more research is required to confirm these assumptions.

- Most smart devices' default Bluetooth range is 10 meters (33 feet). Anything outside of that range will not be able to operate the household appliances.

- The software running on this platform is exclusive to the Android operating system.

- The system must be adaptable to allow for the use of different wireless technologies, such as Zigbee, Wi-Fi, and the Internet.

- Unfortunately, we lacked a high-current source and were unable to put the prototype through its paces, but we did do simulations to ensure its viability.

6.6.Future Scopes

The purpose of our project was to create a prototype of an intelligent charge controller with the capability of adjusting the power of household appliances using an Android tablet. We can refine and perfect this technology in the future to make a marketable product. Production 12V and 2A are used to create the prototype. For an industrial application, we may tailor the design for high voltage and current. Using a Bluetooth connection, we were able to operate it from our phones. In the future, we may rely on the Global Positioning System (GPS) for its extensive range of connectivity. By using GPS we can locate where the faulty light is. It has huge potential for industrial and commercial use if we can overcome all the obstacles we discussed previously.

6.7. Social, Economic, Cultural and Environmental Aspects

6.7.1. Sustainability

In most cases, the system can absorb all the solar power that is generated since there is a high enough demand for electricity. Production cuts happen only in extreme cases where there is an excess of supply over demand in a certain location due to excessive penetration. Operators of the grid supply the necessary net load from traditional nonrenewable sources. When it comes to balancing energy supply with demand while adhering to power system limits and keeping costs to a minimum, intermittent solar power is a problem due to its uncertainty, fluctuation, and site specificity. Their reliance on the weather is significant since their maximum generation limit varies over time (variability) and is not known with absolute precision (uncertainty).[36] High penetration necessitates adaptability on the part of grid operators due to the unpredictability of weather, who must respond rapidly to shifting circumstances and production patterns by deploying additional energy to maintain a stable voltage and frequency. If this isn't done, power outages and shortages could occur. Forecasting and meeting load presents a problem, necessitating enabling technology and tactics to preserve grid equilibrium. The weather can be predicted with a certain degree of accuracy these days. As the sun goes down, solar energy production drops, but the demand continues to be high. The net load curve, often known as the duck curve, shows how challenging it may be to balance and govern a system with a lot of users plugged into it. The ramp gradient is expected to grow as more electricity comes from solar energy, putting more stress on conventional generators during ramping. Furthermore, the duck curve demonstrates the possibility for overgeneration at reasonably high PV generation, which is especially concerning when taking into account the technological and institutional limits on power system functioning. If there isn't enough demand to make use of it, grid operators may have to restrict solar energy output at times of peak production, resulting in economic loss for solar generators. Not all of the energy generated by PV can meet demand without increasing grid flexibility.

6.7.2. Economic and Cultural Factors

The purpose of this work was to offer a smart load management method for residential use that could be powered by a locally distributed generation of solar PV array. Prioritized loads totaling 1 kilowatt were switched using wireless switches based on atmospheric feedback from weather prediction systems. Batteries are used to directly power dc loads.

storage is immediately charged by Smart dc PV array during daytime and efficiently used during nighttime; this increases the overall efficiency of the system, which is especially helpful when solar energy is unavailable due to overcast skies or the time of day. This paper's purpose is to defend the effectiveness of dc appliances in reducing conversion losses between dc and alternating current and dc. The experimental data has been used as a driver for the generalized equations for solar PV and battery size. In order to avoid a complete shutdown of the system, a method was devised that utilizes priority load to safeguard data at night without interfering with backup procedures. It was shown that the proposed smart scheme is helpful in controlling the various dc and ac loads coupled with priority switching and suitable sizing of storage and PV array, leading to the cheaper solution for household loads.

6.8. Conclusion

From a sizing perspective, it is crucial to conduct a thorough evaluation of the available solar energy resources, as this will allow for more accurate predictions of the solar module or array's output and will aid in the selection of the most suitable PV technology for the PV power system. The solar radiation that hits the solar array's plane is being measured here. It is important to comprehend the value of both the direct and diffuse components of solar radiation. Solar radiation around the world includes both direct and indirect rays.

REFERENCES

[1] Rajan, P., Sivabalan, D. K. F., & Patham, S. (2016). EMBEDDED BASED HOME AUTOMATION. International Journal of Scientific Research and Modern Education (IJSRME), I, 77–84.

[2] Sonawane, N. K., Waghchavare, P. D., & Patel, K. A. (2014). Bluetooth Based Device Automation System Using Cell phone. *International Journal of Computer Applications & Information Technology*, *7*, 135–141.

[3] Wu, N.-S. L. L.-C. F. C.-L. (2002). An integrated, flexible, and Internet-based control architecture for home automation system in the internet era". Proceedings ICRA `02. *IEEE International Conference on Robotics and Automation*, *2*, 1101–1106.

[4] Sriskanthan, N., & Karand, T. (2002). Bluetooth Based Home Automation System". *Journal of Microprocessors and Microsystems*, *26*, 281–289.

[5] Al-Ali, A. R., & Al-Rousan, M. (2004). Java-Based Home Automation System". *IEEE Transaction on Consumer Electronics*, *50*(2).

[6] "Carrying the Torch for London's Last Gas Lamps". NPR.org.

[7] Thomson, J. (2003). *Scot who lit the world: The story of William Murdoch, inventor of gas lighting*.

[8] Las fernandinas. (2010). In *Esa Sevilla*.

[9] "Brush Arc Lighting". Archived from the original on 24 July 2008.

[10] Fotios, S. A., & Cheal, C. (2011). Predicting lamp spectrum effects at mesopic levels. Part 1: Spatial brightness. *Lighting Research & Technology (London, England: 2001)*, *43*(2), 143–157. https://doi.org/10.1177/1477153510393932

[11] Jivani, M. N. (2014). GSM based home automation system using app-inventor for android mobile phone. *International Journal of Advanced Research in Electrical Electronics and Instrumentation Engineering*, *03*(09), 12121–12128. https://doi.org/10.15662/ijareeie.2014.0309042

[12] Brandon Vigliarolo. "Smart thermostat swarms are straining the US grid". *www.theregister.com*. Retrieved 2022-08-17.

[13] R.A. Ramlee, M.H. Leong, R.S. Singh, M.M. Ismail, M.A. Othman, H.A.Sulaiman, M.H. Misran, M.A. Said, "Bluetooth Remote Home Automation System Using Android Application" Vol. 2, pp. 149-153.

[14] Roger A. Messenger, Jerry Ventre, Photovoltaic System Engineering, 3rd edition, CRC press, 2005, p 73,74.

[15] [2].Y.K.Tan, T.P.Huynh, Z.Wang, "Smart Personal Sensor Network Control for Energy Saving in DC Grid Powered LED Lighting System",IEEE Transaction of Smart Grid , Volume 4 Issue 2 pp 669-676.

[16] Omkar Rudrawar, Siddharth Daga, Janak Raj Chadha and P.S. Kulkami, “ Smart Street light system with light intensity control using Power electronics”. IEEE conference 2018 Technologies for Smart-City Energy Security and Power (ICESP), 28-30 March 2018.

[17] Jorge Higuera“Smart Lighting System”, IEEE sensors Journal,Vol.15,No.2,May 2015. Andrea Zanella and Lorenzo Vangelista “ Internet of Things for Smart Cities”,IEEE Internet of Things Journal,Vol.1,No.1,Febrauary 2014.

[18] Lee, J.; Baik, S.; Lee, C. Building an Integrated Service Management Platform for Ubiquitous Cities. Computer 2011, 44, 56–63.

[19] Li, Z.; Chen, C.; Wang, K. Cloud Computing for Agent-Based Urban Transportation Systems. IEEE Intell. Syst. 2011, 26, 73–79.

[20] Mitton, N.; Papavassiliou, S.; Puliafito, A.; Trivedi, K.S. Combining Cloud and sensors in a smart city environment. EURASIP J. Wirel. Commun. Netw. 2012, 2012, doi:10.1186/1687-1499-2012-247.

[21] Bonomi.Milito,R..Zhu, J.; Addepalli, S. Fog Computing a nd Its Role in the Internet of Things. Proceedings of the First Edition of the MCC Workshop on Mobile Proceedings of the First Edition of the MCC Workshop on Mobile Cloud Computing (MCC’12), Helsinki, Finland, 13–17 August 2012; pp. 13–16.

[22] [H. A. Attia, A. Omar, and M. Takruri, “Design of Decentralized Street LED Light Dimming System,” Des. Decentralized Str. LED Light Dimming Syst., 2016.

[23] D. R. Khade and R. A. Metri, “Intensity Controller of LED Street Lights,” 2017.

[24] P. V. K. Bhangdiya, “Low Power Consumption of LED Street Light Based on Smart Control System,” pp. 619–622, 2016.

[25] A. Gupta and S. Gupta, “Design of Automatic Intensity Varying Smart Street Lighting System,” IOP Conf. Ser. Mater. Sci. Eng., vol. 225, p. 012126, 2017.

[26] A. Toubal, B. Bengherbia, M. OuldZmirli, and M. Maazouz, “Energy efficient street lighting control system using wireless sensor networks,” 2016 8th Int. Conf. Model. Identif. Control, pp. 919–924, 2016.

[27] N. Khatavkar, A. A. Naik and B. Kadam, "Energy efficient street light controller for smart cities," 2017 International conference on Microelectronic Devices, Circuits and Systems (ICMDCS), Vellore, 2017, pp. 1-6.

[28] [6] Hengyu Wu, Minli Tang and Guo Huang, "Design of multi-functional street light control system based on AT89S52 single-chip microcomputer," The 2nd International Conference on Industrial Mechatronics and Automation, Wuhan, 2010, pp. 134-137.

[29] X. Shentu, W. Li, L. Sun and S. Gong, "A new streetlight monitoring system based on wireless sensor networks," The 2nd International Conference on Information Science and Engineering, Hangzhou, 2010, pp. 6394-6397.

[30] Priyasree, Radhi & H Kauser, Rafiya& E, vinitha&Gangatharan, N. (2012). "Automatic Street Light Intensity Control and Road Safety Module Using Embedded System," International Conference on Computing and Control Engineering (ICCCE 2012), At Coimbatore Institute of Information Technology, 2012.

[31] "Intelligent Street Lighting System Using Gsm" International Journal of Engineering Science Invention ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726Volume 2 Issue 3 March. 2013

[32] E. Adetiba, V. O. Matthews, A. A. Awelewa, I. A. Samuel and J. A. Badejo, "Automatic electrical appliances control panel based on infrared and Wi-Fi: A framework for electrical energy conservation," Int. J. Sci. Eng. Res., vol. 2, no. 7, pp. 1-7, July.2011.

[33] S. A. E. Mohamed, "Smart street lighting control and monitoring system for electrical power saving by using VANET," Int. J. Commun. Network Syst. Sci., vol. 6, pp. 351-360, 2013.

[34] A. S. Jalan, "A survey on automatic street lightning system on indian streets using Arduino," Int. J. Innovative Res. Sci. Eng. Technol., vol. 6, no. 3, pp. 4139-4144, 2017.

[35] G. Benet, F. Blanes, J.E. Simó and P. Pérez, "Using infrared sensors for distance measurement in mobile robots," Rob. Auton. Syst., vol. 40, no. 4, pp. 255-266, 2002.

[36] L. Louis, "Working principle of arduino and using it as a tool for study and research," Int. J. Control Autom. Commun. Syst., vol.1, no.2, pp. 21-29, 2016.

[37] A. Jalan, G. Hoge, S. Banaitkar and S. Adam, "Campus automation using arduino", Int. J. Adv. Res. ElectrElectron. Instrum. Eng., vol. 6, no. 6, pp. 4635- 4642, 2017.

[38] H. Satyaseel, G. Sahu, M. Agarwal and J. Priya, "Light intensity monitoring & automation of street light control by Iot," Int. J. Innovations Adv. Comput. Sci., vol. 6, no. 10, pp. 34-40, 2017.

[39] D. Yılmaz and G. Kılıçoğlu, "Resistance to change and ways of reducing resistance in educational organizations," Int. Assoc. Social Sci. Res., vol. 1, pp. 14-21, 2013.

[40] S. Escolar, J. Carretero, M. Marinescu and S. Chessa, "Estimating energy savings in smart street lighting by using an adaptive control system," Int. J. Distrib. Sens. Networks, vol. 10, no. 5, pp. 1-17, 2014.

[41] R. Banerjee, " Solar tracking system," Int. J. Sci. Res. Publ., vol. 5, no. 3, pp. 1-7, 2015.

Appendix A

Arduino Code

```
int SensorPin = 5;
int OutputPin = 10;
int SensorPin2 = 4;
int OutputPin2 = 11;
int SensorPin3 = 6;
int OutputPin3 = 8;
int SensorPin4 = 3;
int OutputPin4 = 9;
int SensorPin5 = 2;
int OutputPin5 = 7;
void setup() {
pinMode(OutputPin, OUTPUT);
pinMode(SensorPin, INPUT);
pinMode(OutputPin2, OUTPUT);
pinMode(SensorPin2, INPUT);
pinMode(OutputPin3, OUTPUT);
pinMode(SensorPin3, INPUT);
pinMode(OutputPin4, OUTPUT);
pinMode(SensorPin4, INPUT);
pinMode(OutputPin5, OUTPUT);
pinMode(SensorPin5, INPUT);
  Serial.begin(9600);
}
```

```
void loop() {
  int SensorValue = digitalRead(SensorPin);
  int SensorValue2 = digitalRead(SensorPin2);
  int SensorValue3 = digitalRead(SensorPin3);
  int SensorValue4 = digitalRead(SensorPin4);
  int SensorValue5 = digitalRead(SensorPin5);
  Serial.println(SensorValue);
  Serial.println(SensorValue2);
  Serial.println(SensorValue3);
  Serial.println(SensorValue4);
  Serial.println(SensorValue5);
   delay(100);
   if (SensorValue==LOW)
  { // LOW MEANS Object Detected
    digitalWrite(OutputPin, HIGH);
  }
  else
  {
    digitalWrite(OutputPin, LOW);
    delay(000);
  }
   if (SensorValue2==LOW)
  { // LOW MEANS Object Detected
    digitalWrite(OutputPin2, HIGH);
  }
  else
```

```
{
  digitalWrite(OutputPin2, LOW);
  delay(000);
}
 if (SensorValue3==LOW)
{ // LOW MEANS Object Detected
  digitalWrite(OutputPin3, HIGH);
}
else
{
  digitalWrite(OutputPin3, LOW);
  delay(000);
}
 if (SensorValue4==LOW)
{ // LOW MEANS Object Detected
  digitalWrite(OutputPin4, HIGH);
}
else
{
  digitalWrite(OutputPin4, LOW);
  delay(000);
}
 if (SensorValue5==LOW)
{ // LOW MEANS Object Detected
  digitalWrite(OutputPin5, HIGH);
}
```

```
  else
  {
    digitalWrite(OutputPin5, LOW);
    delay(000);
  }
}
```

Appendix B

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