CHAPTER 1: INTRODUCTION

1.1 Background

Most street lighting systems in the environment are designed according to the old standards and they often do not take advantages of the latest technologies. The two possible ways out for this. First one is using LED as source of light with solar system and the second one is using an intelligent system to control and manage street lights automatically based on the intensity of light and the movement of the vehicle.

However, intelligent street lighting system did make a huge development in these days as many developments and research were done showing the interest in this topic in order to make the street lighting system consume less power because it is one of the largest energy expenses for a city, accounting for about 35-45% of a municipality's utility budget. Also, an intelligent street light has been improved by many developers to detect lamps damage which is very important thing to reduce traffic accidents and crimes in these days. (Cynthia, Raj & George, 2017)

An intelligent street lighting system is a system will be developed for the purpose of the energy saving, proper maintenance and autonomous operation for the streets by controlling and monitoring of lights using sensors and devices. According to the statistics that have been done on many cities, an intelligent street lighting control system can reduce municipal street lighting costs as much as 60%.

Meanwhile, there are many factors should be considered to design a great street lighting system such as provide public lighting at cost effective, night-time safety for road users, minimizing its effect on the environment, the reduction of crime. In this proposed project, the system will be designed and implemented by integrating the latest technologies of sensors and devices like solar panel, LDR sensor in order to provide advanced and intelligent management and control system of the street lighting which will result in energy saving, increasing lamps lifespan and lower cost of maintenance. Moreover, street lighting system runs using solar panels which are non-polluting source and eliminate external wiring and minimize risk of accidents and requires much less maintenance compared to conventional street lighting system.

1.2 Project Aim

To design and develop a Solar Powered Street Light control system that power ON and OFF the lights. The system will have a sensor to turn ON the lights only when a vehicle is passing the road as well as it uses GSM technology to send SMS to the municipal in case of lamp damage.

1.3 Project Objectives

a) To study and review existing street light systems that have been used recently which will assist in developing the proposed project.
b) To study and gain information about the use of components required for the designing such as Arduino, GSM modem, light emitting diode, relay driver, solar panel, solar regulator, Battery, Light dependent resistor, IR sensor.

c) To implement automatic solar street light system using electronic components on the broadband such as solar charge controller, LED, LDR and IR sensor.

d) To program the system that reflect the status of the street light in order to interface Arduino to a GSM SIM900 to send SMS that shows the light condition.

e) To test and troubleshoot all components used in the project such as damaged solar panels, battery, LED.

1.4 Problem Description

Currently electrical energy is widely used to power up many things such as home power, stations and lights. Hence, providing electrical energy might be expensive and difficult to achieve. Sometimes, saving the energy is the best solution to avoid high power consumption which result in wasting energy as well. Moreover, providing electrical energy adversely affect the environment since it causes pollution and emit hazard gas. This project will solve the problems faced in the existing system used to power ON street lights and they are as follow:

- Nowadays street lights are always ON at night which results in consuming lots of energy. Therefore, to minimize the utilization of electrical energy so street lights turn ON only if there is vehicle presence.
- Sometimes the lights are OFF on the street because of delaying or some electrical issue has occurred which may result in a car accident. So, this project will solve this problem by using the sensor that switches ON the light automatically when the

vheical passing the street as well as if there is any light has a problem on the street, it will send a message to the mobile phone to inform that that the light has problem.

- Using solar energy instead of gas to generate electricity because electrical energy which is provided for street lights through cables made from copper which is very expensive as well as generating electrical energy itself is costly. Moreover, the maintenance required for machines and cable makes it even more expensive.
- Electrical energy is one of the non-renewable energy source that is produced by burning coal and crude oil or other fossil fuels which results in releasing toxic fumes and gases harmful for human body and affects adversely to the environment thus resulting in global warming, Abnormal weather patterns, acid rain and Increased intensity of natural disasters.

1.5 Project Feasibility

This project requires many components which might be available in Oman or might not. According to the research done to provide project components to implement solar powered street light control system using GSM Technology. It was found that the most components will be available in Oman. However, few components like solar panel must be purchased online and it may take time to reach. The total cost required to implement this project is between 70-120 OMR. Moreover, the most important thing is to research about the literature reviews through internet. The purpose of the literature review is studying, analyzing and comparing of previous projects which are related to the project proposed.

1.6 Project Scope

The main scope of the project is to provide intelligent management and control of lighting systems in order to provide incredible solution to reduce the use of electrical energy and minimize the electrical wastage. Hence, this will allow to use saved power in the villages, towns, etc. The concept of intelligent street light system can be enhanced by integrating it with the solar panel, which converts the sunlight into electrical energy which can be used to feed the streets. Also, this system can be used in various other application like for providing lighting in campuses, industries and parking lots of huge shopping malls.

1.7 Project Methodology

As it is mentioned before, a smart street light system should be understood well by obtaining the required data for this project. Hence, different literatures related to the

proposed project should be critically analysed to gain information about different methodology and the purpose of each component used in the project which will help to know the limitation and difficulties previous projects had to overcome them in the proposed project. After identifying suitable components based on their specification, the system will be designed based on LDR sensor, solar panel, LED, Arduino UNO microcontroller. Solar panel absorbs solar radiation during the daytime in order to convert it into electrical energy which is finally stored in the battery. Then, the rechargeable battery provides an energy supply to the microcontroller which will be programmed as a pulse width modulation connected to LDR, which sense the light intensity. When LDR sensor detects darkness, the relay switch will be ready to turn ON the light as it activates by LDR sensor. Hence, when IR sensor detects the movement of vehicle, the battery will offer the energy to LED which emits visible light at certain direction. On the other hand, when the light falls on LDR sensor, it sends the commands to the microcontroller to switch OFF the light. Also, GSM module is used to send short message service that contains the lamp number that gets damaged.

1.8 Project Challenges

The honors challenge of this project is implementing automatic solar street light system using many components connected together such as Arduino, GSM modem, light emitting diode, relay driver, solar panel, solar regulator, Battery, Light dependent resistor, IR sensor as implementing circuit is very complex and very hard whereby the connection must be accurate and precise. Another challenge is programming street light control system, which is also not easy as the code should be written very accurately to get the required operation from each component.

1.9 The Motivation for the Project

This idea is coming up when it has been observed that most of existing street lights are old types of light like Fluorescent lamp, Mercury vapor, Incandescent light, High pressure sodium and these types of lights consume more power than LED. Also, street lights are operated without using solar energy and switching ON the lights even there in no vehicle cause the wastage of energy and a lot of harmful gas as well as sometimes they are OFF because of damage and manual switching (late) which may cause traffic accident and crimes. Hence, providing automatic street light control and fault detection system based on new technology or advancement is one of most important in the present situation. As a telecommunication engineer, this project is an incredible opportunity to be familiar on

how GSM modem works and how to link it with computing machine to perform different tasks as well as understanding the concept of GSM and solar energy.

1.10 Project Outline

This proposed project will be divided into three chapters. The first chapter is the introduction which contains brief information about the project and its benefits, challenges, problems and solution to the problem. The second chapter is literature review which is one of the most important parts of the report as many studies will be carried out to compare between them in order to enhance and make the project better and more creative. The third chapter is pre-design and analysis that shows the block diagram and flow chart of the project and the components used to implement the project as well as the project costing. Finally, the conclusion reflects the whole project and the future work shows how to enhance the project in future by adding more features and advancement.

1.11 Summary

This chapter provides clear overview of the project idea, aim and objectives. Also, the problem description demonstrates the reasons behind implementing the project. The chapter also covers the scope which shows the working involved in the project and the challenges that may face while doing technical project. Moreover, it contains the feasibility, methodology, motivation and project outline.

CHAPTER 2: LITERATURE REVIEW

A literature review is a text of a scholarly paper, which includes the current knowledge such as substantive findings, as well as theoretical and methodological contributions to a particular topic. In this chapter, the critical analysis is based on seven different literatures review on intelligent street lighting system which was implemented and tested with different methodology. The literature review provides a description, summary, and critical evaluation of the previous projects that are related to the proposed project in order to know the limitation and difficulties previous projects had to overcome them in the proposed project.

2.1 Literature Review of Academic papers

A previous paper based on an automatic street light control, fault detection and traffic density control was implemented by (Harshitha et al.,2017). This system was divided into two parts, the first part being street light and the second part the traffic light. Moreover, several hardware components have been used to implement this project such LDR's, IR Sensors, ATmega328 microcontroller, GSM modem, and DC fan. At the beginning, four LDR sensors, one IR sensor and an exhaust fan were placed in street lights where one LDR sensor detects the intensity of light and three LDR sensors were used to detect fault condition of each lamp, along with an exhaust fan used to absorb the polluted gases from the vehicles. Hence, when LDR detects light, the street lights turn OFF, whereby street lights turn ON whenever LDR sense darkness and IR sensor detects the vehicle movement. Moreover, GSM modem was used to send the message to the computer by interfacing the microcontroller with it through serial communication when the lamp gets damaged. In the second part of this project, 4X1 key pad was used to select traffic signal for ambulance unit and encoder transmitted serial data at 443MHZ carrier frequency with help of the RF transmitter, whereby RF receiver demodulates received data and transmit this serial data to decoder unit. Moreover, control unit was used to read data from decoder and control the traffic light depends on it as well as traffic lights runs at predefined time interval. However, the Period of time of traffic light 1 and traffic light 2 depended on the traffic density information that fetched from Arduino Uno microcontroller. The results obtained from this paper show that the street lights glow with low intensity of light during nighttime, and glow with maximum intensity of light only when the movement of vehicle is detected. To conclude, this automatic street light control system with fault detection is

environmentally friendly, cost effective, and the easiest and safest way to save energy as it can save more than 40% of electrical energy according to statistical data. It also detects lamps faults using new advancement of sensors will help to do effective maintenance in a short time. However, Some drawbacks of this system are as follow; the lighting system does not used solar panel, which it is very useful component to save energy and reduce harmful gasses as it absorbs sun light to generate electricity as well as the traffic lights was implemented with only green and red colour which can be dangerous and cause a lot of accidents, while using the red, yellow and green traffic light is the standard traffic light around the world, it is much safer as the yellow light would give time for driver to slow down and stop which would avoid accidents from happening.

In contrast with the proposed system designed by authors (Meghana, 2017), the authors (Harshitha et al.,2017) used GSM model to send SMS to the computer when the lamp gets damaged, while the author (Meghana, 2017) used a buzzer that produces auditable beep which is a very suitable way to inform the users. Also, the system proposed by (Harshitha et al.,2017) turns on the lights only when IR sensor detects the movement of vehicle during nighttime while the system proposed by (Meghana, 2017) turns on the lights during night regardless if there is a car on the road or not as it does not have an IR sensor. On the other hand, the main drawback of (Harshitha et al.,2017) system compared to the system of the author (Meghana, 2017), is that (Harshitha et al.,2017) system does not use solar panel which is very important part of street lighting system that targets energy saving as it reduces the use of electrical power.

The paper by (Meghana, 2017) proposed an automatic street light control and damage detection system. This system uses many components such as LDR sensor, solar panel, relay, super capacitor and buzzer. For lighting the street light, solar panel absorbs sunlight to generate electricity where the electrical energy is stored in super capacitor. In the first part of this system, the relay connects to street lamps and functions as a switch to turn ON/OFF the light, whereby LDR sensor is used to detect the intensity of light. Hence, whenever there is no light, the street light will turn ON, and will turn OFF when there is light. Moreover, the second part of this system is lamp damage detection where a buzzer which produces audible beep is connected to a switch, and street lamps are connected to output of ray. Hence, when there is no load or when there is a mismatch in the voltage, the relay sets off which makes the buzzer produce a chirping noise. The results demonstrate that lighting system was able to switch ON the street lights during night

automatically and switch OFF the street lights during the daytime. It also shows that if one particular light is damaged, the buzzer will produce am auditable beep. To conclude, it is clear that this project solves of today's important problems like saving energy and the proper disposal of incandescent lamps. Moreover, the implementation of lamp fault detection system with help of new technology or advancement helps to reduce crimes and traffic accidents, as well as help the pedestrians walk more safely without any damaged lights without any damaged lights going unnoticed by residents or officials. However, the drawback in this system is that the authors should use GSM module instead of using buzzer which in not an appropriate way to inform the users that there is lamp damage.

Figure 2.1: Automatic switching ON of the street lights during night. (Meghana, 2017)

Figure 2.2: Automatic switching OFF of the street lights during day. (Meghana, 2017)

In contrast to the paper of other authors (Kavitha et al., 2016), (Meghana, 2017) system has its advantages over the system proposed by (Kavitha et al., 2016) as it detects the lamp damage, and its super capacitors can accept and deliver charge much faster than rechargeable batteries and tolerate more charge and discharge cycles than rechargeable batteries that were used in (Kavitha et al., 2016) system. On the other hand, the drawbacks of (Meghana, 2017) system compared to the author (Kavitha et al., 2016) system, are that (Meghana, 2017) system turns ON the lights at same intensity of light during nighttime, whereby the system proposed by (Kavitha et al., 2016) is better in saving energy as microcontroller is engaged to provide different intensities of lights at different times of the night using PWM technique.

In addition, another previous literature was carried out by (Kavitha et al., 2016) based on solar powered LED street lighting with auto intensity control. This paper presents a smart street lighting system to minimize the electrical energy wastage using solar panel, LDR, LED, PIC microcontroller, current sensor, and temperature sensor. The circuit consists of a battery charge controller circuit charged by the solar panel. The battery provides an

energy supply to the microcontroller connected to LDR which gives low or high signal depending on the intensity of light. Hence, when MOSFET gets a high signal from microcontroller, the LED will turn OFF. However, when microcontroller gives a low signal to the MOSFET, the LED will turn ON. The circuit also consists of a measurement circuit used to measure photovoltaic power and the amount of sunlight obtained. The temperature is sensed by the temperature sensor, and the current by the current sensor, and voltage is noted by the potential divider circuit. Moreover, A LCD was used to display all the output parameters such as intensity of light voltage, temperature, and current of solar panel. The result comprises the successful operation of the intelligent street lighting system using solar panel. When the illumination is more than 50 lux, the lamps are automatically turn OFF, whereby when it is less than 50 lux, the lamps automatically turn ON as shown in Figure 2.3. The values of current, voltage, temperature and illumination are noted from the LCD successfully as shown in Figure 2.3

Table 2.1: Observation on different status of LED. (Kavitha et al., 2016)

Sl. no.	**Current (A)**	**Voltage (V)**	**Illumination (lux)**	**Tempera-ture (ºC)**	**Status of LED**
1	0.012	0	69.2	22	OFF
2	0.011	0	53.5	22	ON but Dim
3	0.01	0	46.7	22	ON and Slightly bright
4	0.011	0	3	23	ON and glowing brightly

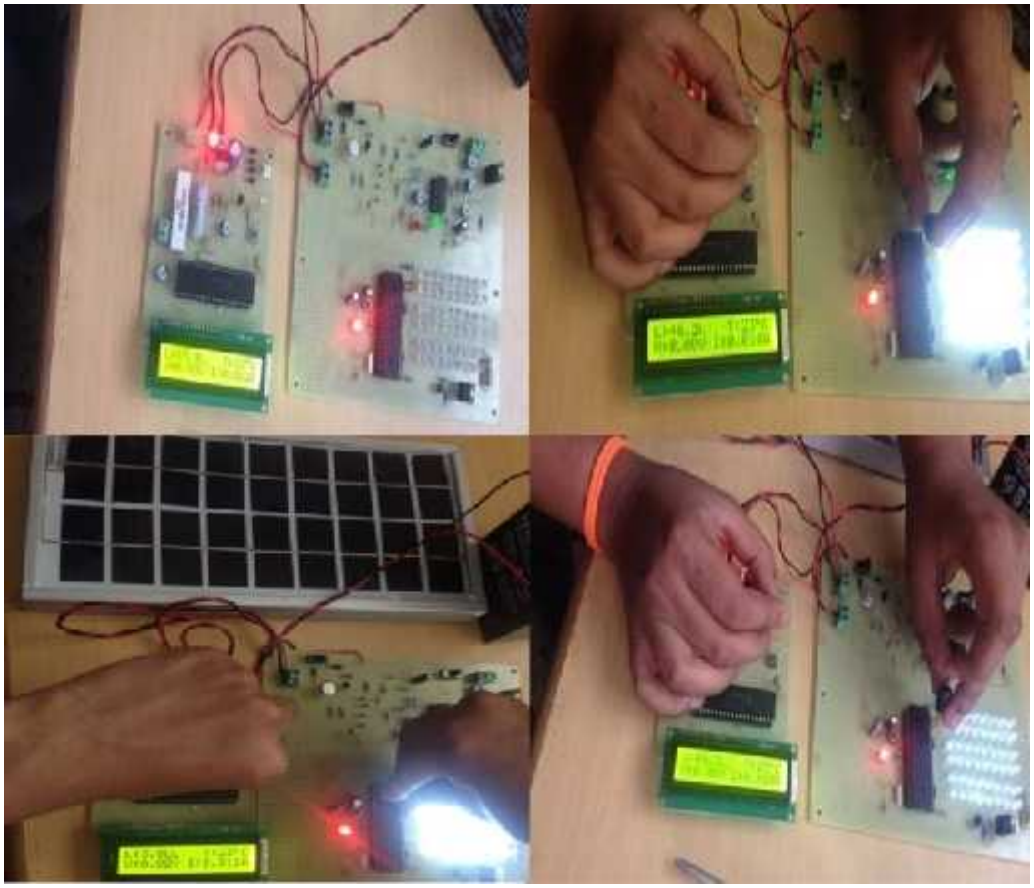


Figure 2.3: Different illumination. (Kavitha et al., 2016)

To conclude, this paper elucidates the intelligent designing of street light system as it works efficiently to turn ON/OFF street light at different intensities of light at different times of the night, which is a great idea to control of dimming that is usually prone to error and leads to the wastage of electrical energy. On the other hand, the drawback of this system that the lighting system does not detect lamp damage, which is very important part of intelligent street light to reduce crimes and traffic accidents, as well as help the pedestrians walk more safely without any damaged lights going unnoticed by residents or officials.

The paper of other authors (Fathima & Vinoth, 2016) proposed intelligent fault identification in led lighting and security system using GSM. This system was programmed by Arduino Uno R3 and uses many components such as light emitting diode, PIR sensor, LED sensor, and ZigBee. Firstly, two Arduino UNO R3 are used to execute this project. The first Arduino UNO work as a lamp station to monitor the lamps and motion status, while second Arduino work as GSM unit. The lamp station is placed at each lamp consisting of three lamps and various sensors including six LDR sensors and a PIR

sensor. Three LDR sensors are used to detect the light intensity falling on it and three LDR sensors detect damage of lamp, while the PIR sensor to sense motion. The lights are wirelessly monitored and controlled by GSM module. The monitoring station consists of a serial Universal Asynchronous Receiver Transmitter interface which gets data about lamps status from the GSM module. The transmission system consists of a GSM network and ZigBee module. Moreover, GSM module is used to send SMS whenever lamp gets damaged, whereby ZigBee is used as a wireless personal area network from the lamp station to the monitoring station. The results demonstrate that lighting system was able to detect lamp fault and send messages through a GSM unit to a virtual terminal as shown in Figure 2.4, and that the LED turns ON when PIR sensor detects any motion and sends message through GSM unit to virtual terminal. To conclude, this system was designed to provide intelligent controlling management and maintenance of lamps system that aims to save energy, provide autonomous operation and easy lamp maintenance for the streets with help of a GSM modem and sensors. However, the drawbacks that has been observed in this project are that the system does not include solar panel use, which is one of the most important component to save energy. Also, the project could be better if the GSM sends messages to the mobile phone instead of a computer as the mobile phone is a small portable device that can be easily taken everywhere, and it is usually on hand.

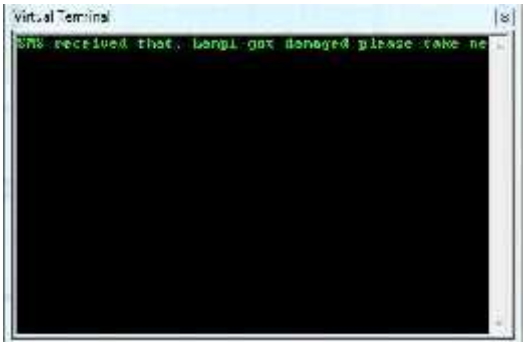


Figure 2.4: SMS send through serial port when lamp get damaged. (Fathima & Vinoth, 2016)

To compare with the method used by the authors (Sakhare & Angal, 2015), both system used the components like PIR sensor, LDR sensor, LED and GSM module. Moreover, the system designed by (Fathima & Vinoth, 2016) is better in the usage of GSM model as it sends message to the computer when the lamps get damaged, whereby (Sakhare & Angal, 2015) system displayed the message on the LCD with help of the ZigBee. Also, (Fathima & Vinoth, 2016) system works only on intelligent mode as it is not use lamp control GUI to set on/off time of lamps whereby, (Sakhare & Angal, 2015) system works

on three different modes which are; the peak mode, day mode and intelligent mode, such methods are not good methods of saving energy.

Another previous paper has been done by (Sakhare & Angal, 2015) based on the intelligent lighting system with fault detection was programmed using LPC2138 NXP ARM Microcontroller with the help of ZigBee network used to provide smart management of lamps by transferring data to and from monitoring station. This system can operate in three modes that allowing additional energy savings. Periods for the day mode and the peak mode were selected from the lamp control graphical user interface as the period is not fixed or predefined and can be changed according the seasons and traffic road, whereby the lamps were operated using LDR and PIR sensors in the intelligent mode. The monitoring station of intelligent lighting system consists of a GSM module and lamp control station GUI with a UART interface that receive the information about the lamp status provided by ZigBee network. Furthermore, lamp control GUI was used to provide on time and off time reports of each lamp and set the time for each lamp, whereby GSM module was used to send a Short Message Service (SMS) that contains the number of the damaged lamp in order to simplify the lamps maintenance. Moreover, the lamp station was designed with three lamps and two light dependent resistors (LDR) were used on each lamp, one was used to detect the lamp damage and the another one was used to sense the intensity of light. In addition, passive infra-red (PIR) sensor was used to detect human body or vehicle, whereby the Xbee module was used to send the information to the monitoring station. The system was successfully tested, as it shows that whenever the lamp gets damaged, the LCD displayed “lamp damage” as well as whenever the human body is detected, the LCD displayed “Movement detected”. Moreover, lamp control GUI selected the time and generated the report of lamp 3 successfully, as it shows off time and on time. To conclude, the system was mainly designed to save energy with help of ZigBee, PIR and LDR sensors, and provide intelligent management of the lamp as a GSM module sends the message whenever the lamp gets damaged to make lamps maintenance easier. This system could be better if it operates only in intelligent mode because there is no need for the peak mode and the day mode. Also, this system does not use solar panel to reduce the use of electrical power which causes a lot of harmful gases.

According to (Priyanka & Baskaran, 2015), another pervious literature was made on solar powered street lights. In this proposed project, they designed control of a solar led street lighting system based on climatic conditions and object movements to save energy. They

used an LDR sensor, IR sensor, solar panel, LED, Battery, charge controller and Microcontroller (PIC16F877A). In this proposed system, an LDR sensor was used to sense the light and darkness in order to make the system switch ON the light only in the nighttime when IR sensor detects the movement of vehicle. Moreover, the Solar panel was designed using MATLAB/ /Simulink model to recharge the battery using sunlight as energy source, whereby the charge controller was used to control the battery charging and discharging. At the beginning, the Solar panel absorbs solar radiation during the daytime in order to convert it into electrical energy, which is finally stored in the battery. When LDR sensor detects darkness, the ON/OFF switch will be ready to turn ON the light as it activates by LDR sensor. Hence, when IR sensor detects the movement of vehicle, the battery will offer the energy to LED which emits visible light at certain direction as shown in Figure 2.5. On the other hand, when the light falls on LDR sensor, it sends the commands to the microcontroller to switch OFF the light as shown in Figure 2.6.

Figure 2.5: turn ON street lights during day. (Priyanka & Baskaran, 2015)

Figure 2.6 turn OFF street lights. (Priyanka & Baskaran, 2015)

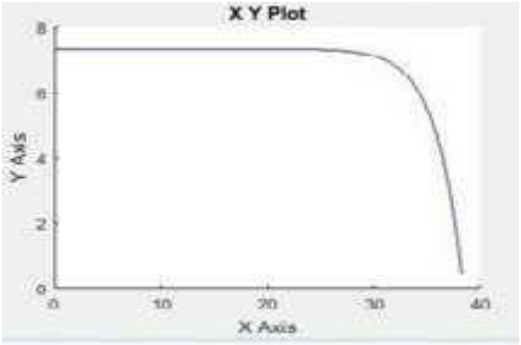


Figure 2.7: The V-I characteristics curve shows that the current increses with respect to the voltage durning the daytime whereby the current gradually decrese when the solar energy reduces during the evening time. (Priyanka & Baskaran, 2015)

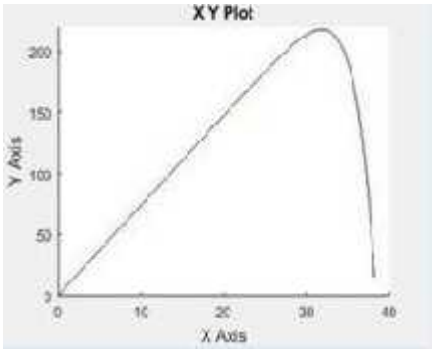


Figure 2.8: The P-V characteristics curve shows that the power increases with respect voltage. The solar panel power reaches the maximum power in the afternoon and slowly decrease with the constant voltage in the evening time. (Priyanka & Baskaran, 2015)

To conclude, the streetlight system was successfully controlled by microcontroller successfully, as it sends comments to the microcontroller depending on the light intensity in order to switch ON/OFF the lights automatically. This system aimed to save the energy as well as prevent unnecessary wastage of energy which occurs from the manual switching of street lights. This can be done by designing a smart lighting system that switch ON after sensing the movement and density of vehicles as well as replace current street lights by LED ones. By comparing with normal street light, one lamp is turned ON for 3650 hours yearly and has an average energy consumption of 200 W per year. However, the lamp used 20-30 W per year as 95% of energy was consumed by the LEDs in this system. Hence, this system has succeeded in saving energy by 66-71%.

On the other hand, previous literature on lighting system based on a ZigBee network of devices and sensor shows that the author (Sakhare & Angal, 2015) has used some components which were used by authors (Priyanka & Baskaran, 2015) such as a light emitting diode, presence sensor, LDR sensor. However, the designing of lighting system was better and more efficient in this paper as the author used solar panel to recharge the battery to supply the power during the daytime which makes the energy cost independent from the prices of power supply. On the other hand, the advantages of (Sakhare & Angal, 2015) over this paper (Priyanka & Baskaran, 2015) that (Sakhare & Angal, 2015), proposed system used lamp control GUI which shows total power consumption, total working time, system faults and maximum consecutive off or on time for each lamp as well as this system detects lamp damage which is very important thing to reduce traffic accidents and crimes in these days.

Other authors (Husin et al., 2012) used another method for controlling and monitoring street lights as they proposed an automatic street lighting system for energy efficiency based on appropriate lighting levels control. This system consists of many components such as set of the light emitting diode (LED), LDR sensor, rain sensor and laser sensor, while it was programmed using microcontroller. In this proposed system, the controlling and managing of the system was based on five different levels of street light brightness, depending on light intensity, number of vehicle and weather conditions. Hence, the system was programmed to turn OFF the light during daylight hours and only operate during the nighttime and heavy raining or bad weather, as LDR sensor was used to detect the light intensity, and rain sensor measured the raining density level, while laser sensor detects the vehicle presence to determine traffic density. Moreover, the status of the voltage,

power consumption, raining, number of vehicle and daytime or nighttime displayed on the LCD. The result was divided into three sections as follows; power consumption for different type of lamps, power consumption on different road type and power consumption for different condition type.

- In power consumption on different road type, five levels of power consumption for different road types was recorded and summarized based on the different conditions detected by different sensors such as LDR sensor, rain sensor and laser sensor are stated in Table 2.2

Table 2.2: results for input and output based on five different conditions. (Husin et al., 2012)

Condition	INPUT			OUTPUT			
	Dark Sensor	Water Sensor	Laser Sensor	LED Lamps	Liquid Crystal Display (LCD)	Voltage (V)	Power Consumption (Watt)
1	Low	Off	High	Level 1	Night/ Not Rainy/ No vehicles	0.0	0.000
2	Low	Off	Low	Level 3	Night/ Not Rainy/ Vehicles	3.0	0.045
3	Low	On	High	Level 2	Night/ Rainy/ No vehicles	1.0	0.015
4	Low	On	Low (if vehicles <= 5)	Level 4	Night/ Rainy/ Number of Vehicles	4.0	0.060
5	Low	On	Low (if vehicles > 5)	Level 5	Night/ Rainy/ Number of Vehicles	5.0	0.071

- In simulation of power consumption on different condition, three different road types using five different conditions as stated in Table 2.2 has been simulated from 7.00 pm to 7.00 am as shown in below Figures.

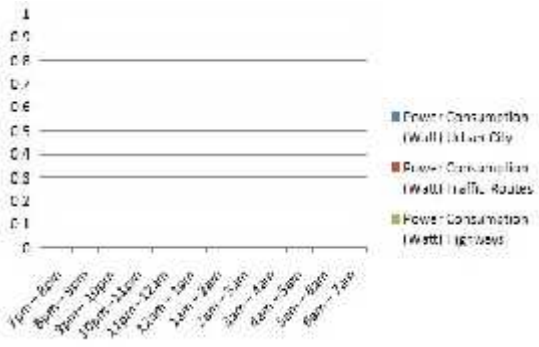


Figure 2.9: Power consumption for each hour at the urban city, traffic routes and highways according to their road type based on condition 1. (Husin et al., 2012)

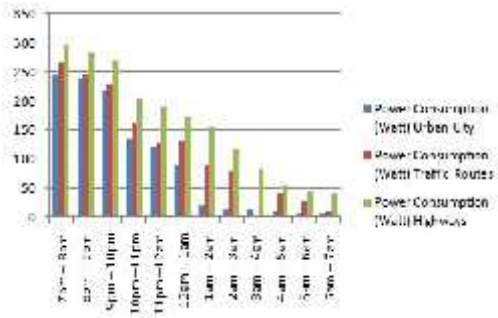


Figure 2.10: Power consumption for each hour at the urban city, traffic routes and highways according to their road type based on condition 2. (Husin et al., 2012)

Hour	Power Consumption (Watt)		
	Urban City	Traffic Routes	Highways
7pm – 8pm	82.5	88.5	99.0
8pm – 9pm	82.5	83.25	84.5
9pm – 10pm	72.0	76.0	80.0
10pm – 11pm	45.0	54.0	67.5
11pm – 12am	42.5	42.8	63.0
12am – 1am	30.0	33.4	57.8
1am – 2am	7.5	26.9	51.3
2am – 3am	4.9	15.0	39.8
3am – 4am	4.1	13.1	28.1
4am – 5am	3.2	9.4	18.0
5am – 6am	2.3	6.7	14.7
6am – 7am	1.9	4.8	13.1

Figure 2.11: Power consumption for each hour at the urban city, traffic routes and highways according to their road type based on condition 3. (Husin et al., 2012)

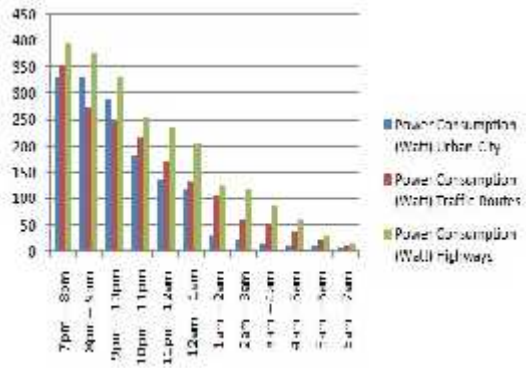


Figure 2.12: Power consumption for each hour at the urban city, traffic routes and highways according to their road type based on condition 4. (Husin et al., 2012)

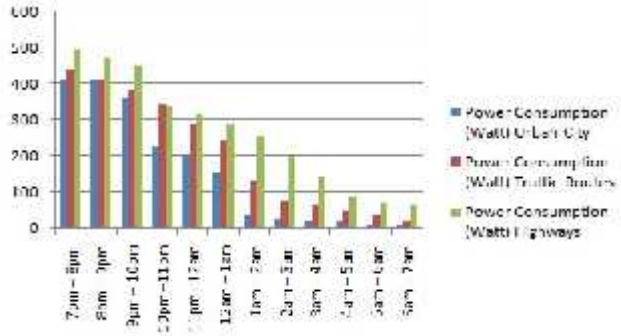


Figure 2.13: Power consumption for each hour at the urban city, traffic routes and highways according to their road type based on condition 5. (Husin et al., 2012)

- In Comparative of Power Consumption for Different Type of Lamp

The power consumption performance was evaluated for LED lamp and high-pressure sodium as shown in Table 2.3. The evaluation was conducted on three different road types in three different installation areas. It is clear from the results that LED lamp consumed less power compared to pressure lamp sodium for all three road types and an Urban City has minimum power consumption at 971.56W.

Table 2.3: the different of power consumption using high pressure sodium lamp and led lamp. (Husin et al., 2012)

Installation Area	Road Type	Power Consumption in 12 Hours using High Pressure Sodium Lamp (Watt)	Average Power Consumption in 12 Hours using LED Lamps (Watt)
Urban City	Two lanes (both ways)	4775.5	971.56
Traffic Routes	Multilane (both ways)	5520.0	1216.37
Highways	Three lanes (both ways)	8400.0	1592.44

To conclude, this proposed automatic street lighting system showed the difference between high pressure sodium lamps and LED lamps as it observed in the table. Also, this paper shows that the street lighting system should be designed according to the installation area. Moreover, this lighting system will reduce the power consumption by 77%-81 as it is using LDR sensor, laser sensor and LED lamps, Moreover, the advantages of using LED module instead of high pressure sodium are as follows; the lifetime, better illumination and low power consumption, less maintenance cost. Also, this project is one of the best street lighting system project compared to other projects as it is designed to control the lights in five different conditions as mentioned in the table. The only drawback in this system that it does not detects lamp faults.

2.2 Compression between (Fathima & Vinoth, 2016) project and the proposed project

Furthermore, when comparing between the proposed project and the (Fathima & Vinoth, 2016) project, both projects used components such LED, GSM module, LDR sensor and Arduino UNO. The proposed project is better than (Fathima & Vinoth, 2016) as the proposed system used a GSM module SIM808, where (Fathima & Vinoth, 2016) used GSM modem SIM300 which is upgraded with an Improved quad band version named as SIM808 to improve the range of reception and solve problems in the GSM modem SIM300.Also, the proposed system sends the message to the mobile phone instead of a computer as the mobile phone is a small portable device that easily taken everywhere and it is usually in hand, while the system of (Fathima & Vinoth, 2016) displayed the message on the computer. Moreover, the system of (Fathima & Vinoth, 2016) did not use solar panel to reduce the use of electrical power which causes a lot of harmful gases, while solar panel will be used in the proposed project.

2.3 All Pervious Literatures with the proposed project Review

Table 2.4: All Pervious Literature Review with the proposed project (Self, 2017)

Project	(Harshitha et al.,2017)	(Meghana, 2017)	(Kavitha et al., 2016)	(Fathima & Vinoth, 2016)	(Sakhare & Angal, 2015)	(Priyanka & Baskaran, 2015)	(Husin et al., 2012)	**Proposed Project**
Solar System	✗	✓	✓	✗	✗	✓	✗	✓
LDR sensor	✓	✓	✓	✓	✓	✓	✓	✓
Vehicle Movement Detection (Presence sensor)	✓	✗	✗	✓	✓	✓	✗	✓
Lamp Fault Detection	✗	✓	✗	✓	✓	✗	✗	✓

LED								

2.4 Summary

This chapter discusses and shows different academic journals that related to solar power street light control system in order to gain knowledge about the whole project and avoid the limitation of them. Moreover, it explains the methodology, components, results weakness and strengths of each paper and compare between them. By comparing between them, it will help to decide the best components and technologies to achieve high performance of the project with low cost and make the project more beneficial as much as possible for the community.

CHAPTER 3: DATA ANALYSIS/ PRE-DESIGN

This chapter is an initial startup of the design where the block diagram and flow chart will be provided with explanation as well as the definition and function of each component will be used in the proposed project will be explained clearly. Choosing the best design for any project is not an easy task as the designer should look at many aspects like saving money, saving energy, and not using a system that would affect the environment in a harmful way.

3.1 Block Diagram of the proposed system

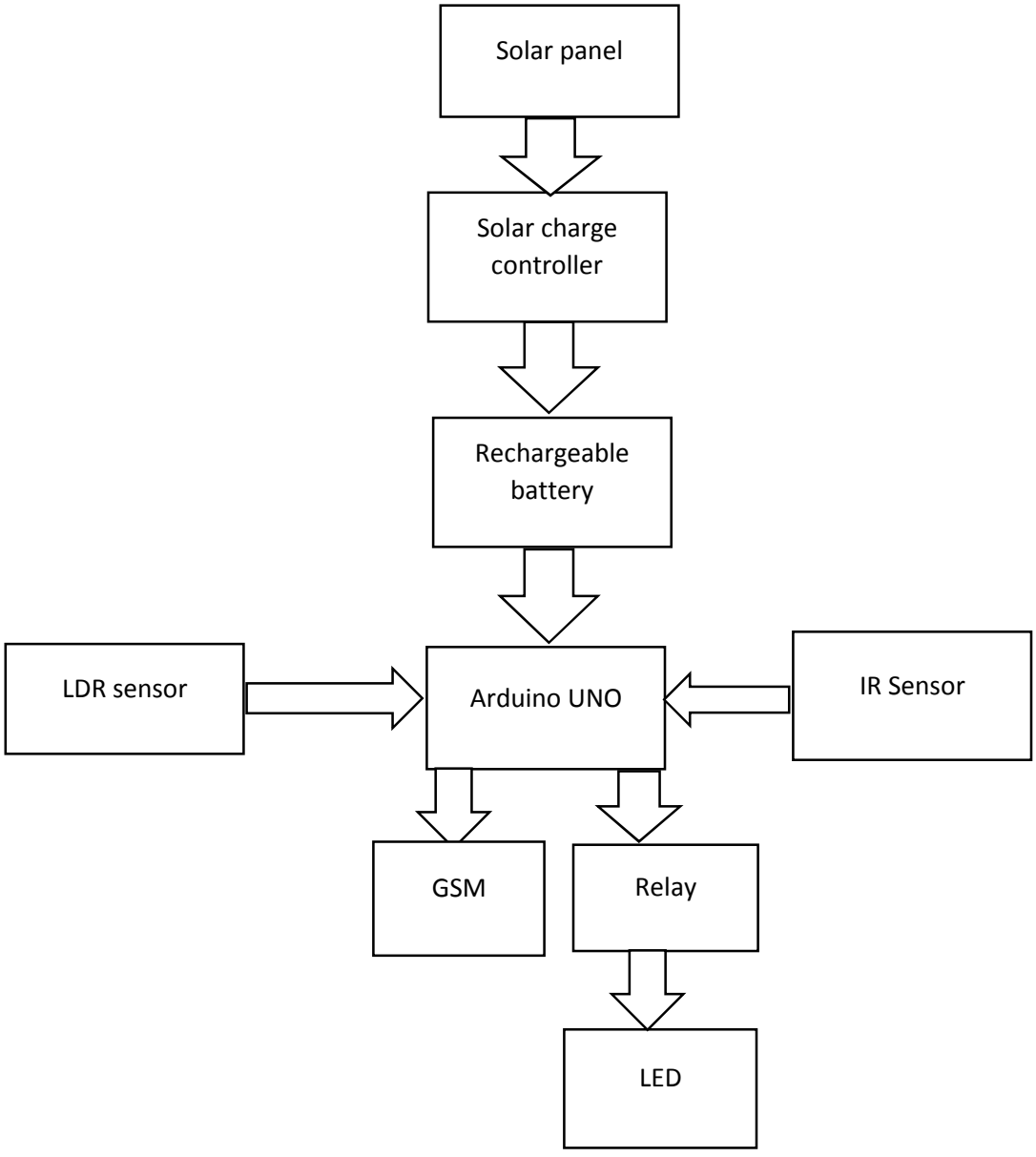


Figure 3.1: Block Diagram of the system proposed. (Self, 2017)

First, during day time, solar radiation is absorbed using the solar panels. This is done to convert solar energy into electrical energy, which will then be stored in the battery. When darkness is detected using the LDR sensor, the ON&OFF switch will be prepared to turn the light ON which is activated using the LDR sensor. Therefore, when the movement of vehicles is detected using the IR sensor, energy will be supplied to the LED from the battery which results in the LED emitting visible light at specified direction. The LDR sensor on the other hand, when light falls on it, commands are sent to the microcontroller in order to switch OFF the light. Also, when any lamps get damaged, the system will send message to the mobile phone with serial number of damage lamp.

3.2 Flow Chart for auto mode operation

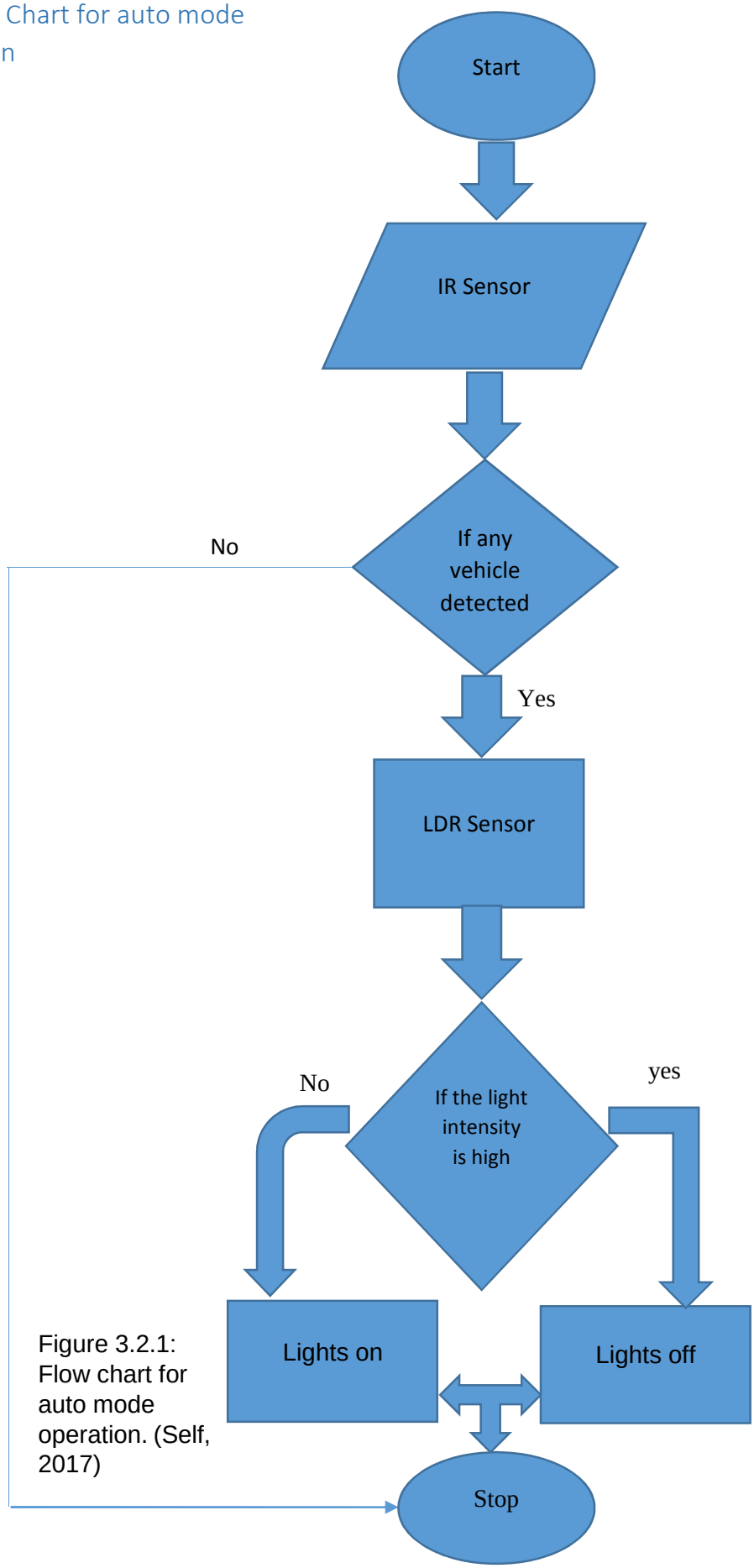


Figure 3.2.1: Flow chart for auto mode operation. (Self, 2017)

3.2.1 Algorithm

Step 1: Start

Step 2: IR sensor check whether there is vehicle movement on the road or not

Step 3: If IR sensor detects vehicle movement, go to step 4. Otherwise, go to step 7

Step 4: LDR sensor check whether there is light or not

Step 5: If LDR sensor detects darkness, go to step 6. Otherwise, go to step 7

Step 6: Turn ON street light

Step 7: Turn OFF street light

Step 8: Stop

The flow chart explains the operation of automatic street light. when the IR sensor detects the movement of a vehicle and LDR sensor detects light, the system turns ON the lights. On the other hand, when LDR sensor detects light, the system turns OFF the lights even there is a vehicle on the road.

3.3 Project Components

3.3.1 Microcontroller (Arduino UNO)

It is an open source physical platform based on the ATmega328 microcontroller chip and Integrated Development Environment to write and upload codes to the microcontroller. The UNO is the most used and documented board of the whole Arduino family. It has 14 digital input/output pins.6 of them used as PWM outputs whereby 6 used as analog inputs.it contains a USB connection, 16 MHz ceramic resonator, a power jack, an ICSP header, 32 KB Flash memory and stronger reset circuit. Hence, it is clear that it contains everything to support microcontroller. In this project, the microcontroller will be connected to many components like LDR sensor, IR sensor, solar panel, rechargeable battery in order to program these components to perform different tasks. (Arduino, 2017)

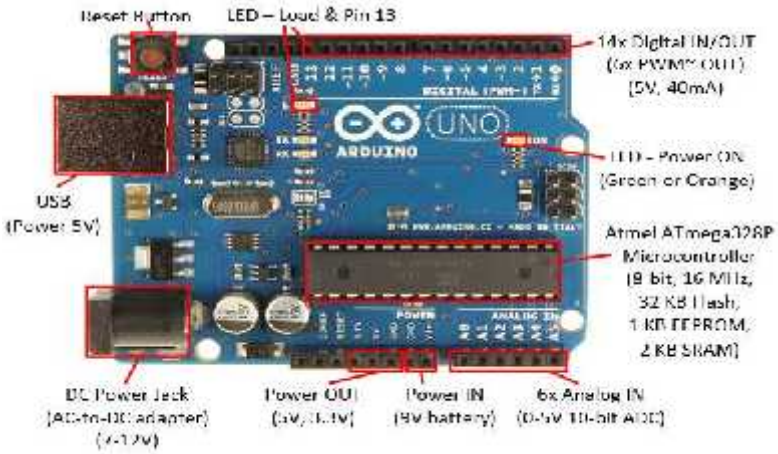


Figure 3.1: Arduino UNO. (Anon, 2016)

3.3.2 GSM Modem

it is special type of modem which operates with any SIM card and it is widely used to establish communication between GSM and mobile device or a computing machine because of its low cost, low power consumption long wireless communication channel and it does not need high data rate. A computer can use the GSM modem to communicate over the mobile network by connect it to the GSM modem. GSM modems can be a dedicated modem device with a serial, Bluetooth or USB connection as well as it can be mobile phone that provides GSM modem capabilities. A GSM modem offers an interface that allows to send and receive messages over the modem interface. There are a lot of GSM modules such as SIM300, SIM800, SIM808 and SIM900.Moreover, GSM modem SIM808 supports GSM/GPRS Quad-Band network and combines GPS technology for satellite navigation and the proposed project is used this modem to interface with Arduino Uno in order to send SMS whenever the lamp gets damage. (Simcom, 2017)

Figure 3.2: GSM Modem (mybotic, 2016)

3.3.3 Light Emitting Diode

It is a p–n junction diode that emits light when electric current passes through. it uses electroluminescence and semiconductors to create lights and it is requires only 30mv-60mv to operate. LEDs are typically less than 1 mm. as it made of very thin layer of fairly heavily doped semiconductor material. electrons are able to recombine with electron holes within the device and releasing energy in the photons form whenever an appropriate voltage is applied to the lead. This is called electroluminescence effect and the light color (corresponding to the energy of the photon) is determined by the semiconductor energy band gap. LEDs should have connected with resistor in series to protect it from passing excessive current. In this proposed project, LED will be used to emits the street lights. (Priyanka & Baskaran, 2015)

3.3.4 Solar Panel

It is electronic device which absorbs the sunlight as source of energy to convert the light into electricity. Solar panels are made of collection of photovoltaic cells or crystalline silicon solar cell. The photovoltaic cells can produce electricity even on a cloudy day which means they do not need direct sunlight to work. solar panels are mainly used to charge a rechargeable battery which powers LED lamp or fluorescent during the night. In the proposed project, solar panel is used as power source to recharge the battery during the daytime in order to turn ON the street lights in the nighttime and minimizes the battery capacity. (The Economic Times, 2018)

Figure 3.3: 25W poly Matrix solar panel (Solar Wholesaler, 2017)

3.3.5 Solar Regulator

It is small box consisting of solid state circuitry that regulates the amount of charge coming from a solar panel in order to extend battery life and avoid overcharging or power surges which may damage a battery or appliance. It is also called solar charge controller. The solar regulator is placed between solar panel setup and battery. It is very important charge

controller since the voltage is supplied from solar panels will fluctuate which means it is not suitable for charging batteries or power appliances directly. In the proposed project, solar regulator is used to control the power going into battery from solar panel. (Energymatters, 2017)

Figure 3.4: Solar charge controller (Dhresource, 2016)

3.3.6 Rechargeable battery

Volt 1.2Ah sealed lead acid rechargeable battery is the most common general purpose battery. There are many advantages in this type of battery such as low cost, less maintenance, fully rechargeable and usable in Any Orientation, robust, recyclable, no memory effect, Leak proof and Optimized for discharge up to 20 hours. It is mainly used to recharge the battery for many applications such as alarm panels, Electronic Toy-Cars, Emergency Lights, Rechargeable Flashlights, UPS, Fans. In the proposed project, the rechargeable battery is used to store electrical energy provided by solar panel. (Zbattery, 2017)

3.3.7 Infrared sensor

It is electronic device that used to sense certain characteristics of it its surrounding by either detecting and/or emitting infrared radiation. It can measure the heat of an object and detect the motion. It consists of IR transmitter and IR receiver. Infrared Transmitter is a light emitting diode (LED) which transmits infrared radiations whereby Infrared receivers detect the radiation from an IR transmitter. Infrared waves are not visible to the human eye. IR sensors are available with various ranges depending on application. The infrared

region is almost from 0.75 to 1000µm. This sensor is very small, low cost, low power and easy to use. In this proposed project, the task of this sensor is detecting the movement of vehicle which will cause either switch ON/OFF street light. (Jayant, 2015)

Figure 3.5: IR transmit LED (Electronicshub, 2015)

Figure 3.6: IR Receiver (Electronicshub, 2015)

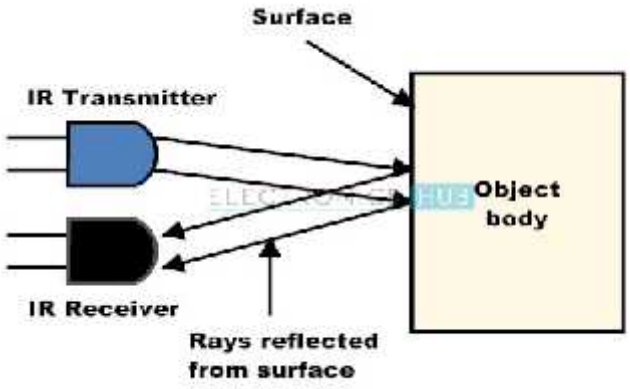


Figure 3.7: Working principle of IR sensor (Electronicshub, 2015)

3.3.8 Light Dependent Resistor

It Is light sensitive device and its resistance varies according to the amount of light falling on it. It is often used in light sensing circuit to detect the presence or absence of light as it is very cheap and easy to use. Is also called photoresistor, photocell and photoconductor. The resistance of LDR sensor decreases with increasing intensity of light whereby the resistance of LDR will increase when there is no light or in the time of darkness. In the proposed project, LDR sensor is used to sense the amount of light as the street light turns ON/OFF depends on sensing output of LDR sensor. Whenever there is no light (nighttime) the street light will turn ON whereby the street light will turn OFF when there is light. (Harshitha et al.,2017)

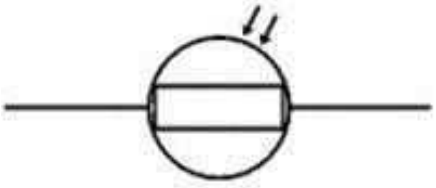


Figure 3.8: LDR Circuit Symbol (Abhishek, 2015)

Figure 3.9: LDR-Sensor (Abhishek, 2015)

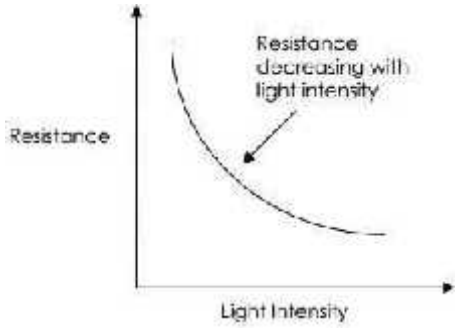


Figure 3.10: Typical LDR resistance vs. light intensity graph (Abhishek, 2015)

3.3.9 Relay Driver

Relays are electromagnetic switches that are controlled by another switch, such as a computer or a horn switch. They allow a small current flow circuit to control a higher current circuit. The heart of a relay is an electromagnet (a coil of wire that becomes a temporary magnet when electricity flows through it). Relays can work either as amplifiers (converting small currents into larger ones) or as switches (turning things ON and OFF). They have unique properties such high current capacity, ability to withstand ESD and drive circuit isolation which make them more robust than solid-state. In this project, relay is used as a switch to switch ON/OFF the street light. (Meghana, 2017)

Figure 3.11: Relay Driver (Wikipedia, 2016)

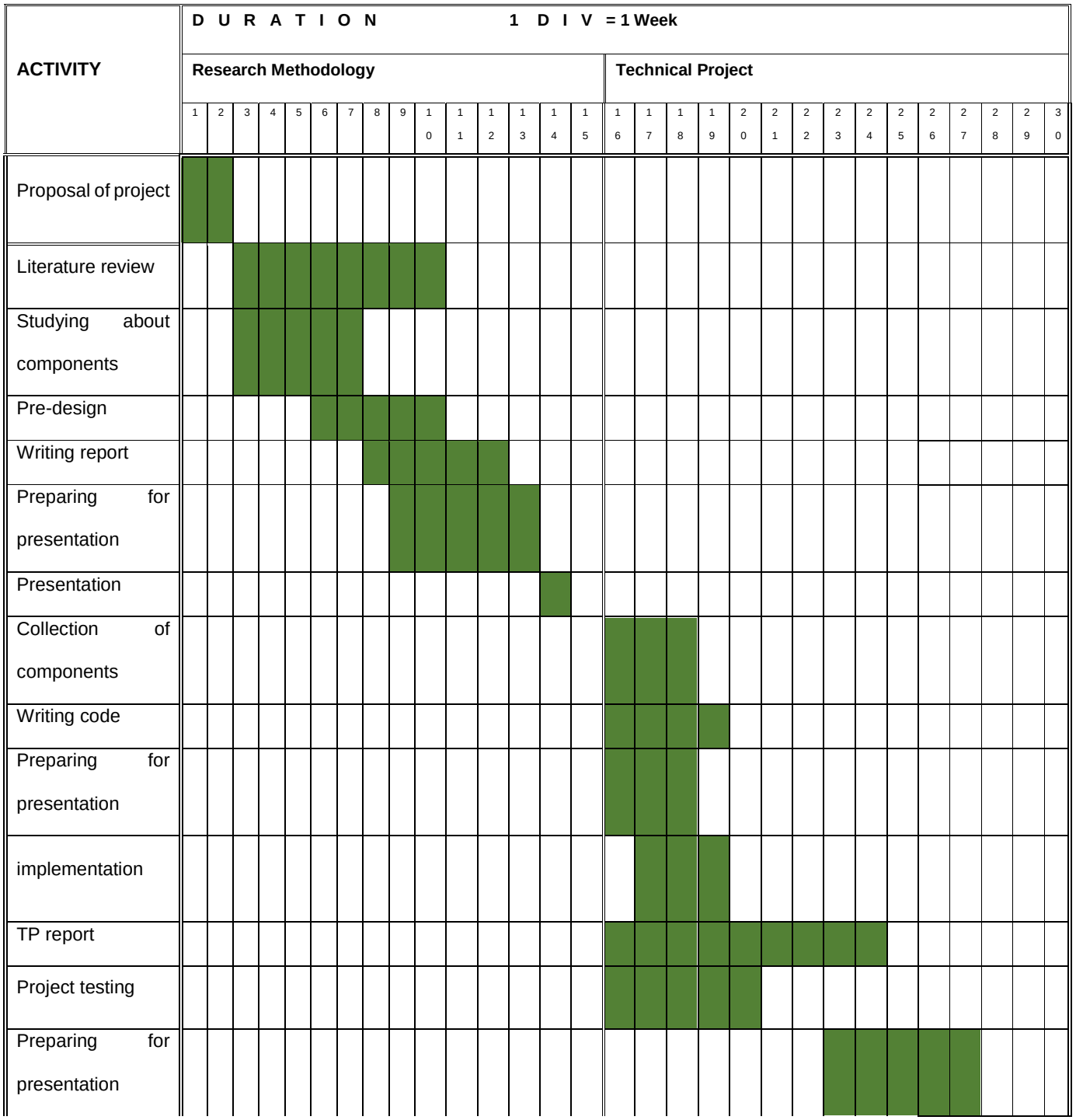
3.4 Project costing

The table below shows the cost of each component used in the project whereby the total cost of all components used in the project is 97.7 Omani Rials.

Table 3.1: Project Costing (Self, 2018)

Component Name	**Number of components required**	**Price (Rial Omani)**
Arduino UNO	2	4*2=8
GSM Modem	1	22
Solar Panel	1	8
Solar Regulator	1	4
Rechargeable Battery 12 v, 2.3 A	1	6
Rechargeable Battery 12 v, 1.2 A	1	4
Light Emitting Diode	6	6×0.1=600 baisa
Infrared Sensor	6	6×1.5=9
Light Dependent Resistor	1	0.1=100 baisa
Relay Driver	6	5×1=6
Other materials used in prototype	-	30

3.5 Project plan for research methodology and technical project phases.



Report submitting																												

3.6 Summary

This chapter covered the pre-design block diagram, flow chart of an automatic street light control project. In addition, it discusses how the project will work by providing the purpose of each component used in the project. Moreover, the definition and cost of each component used in the project with their specifications are explained clear