

**Street light monitoring and Control using low cost microcontroller system**

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**A report submitted in partial fulfillment of the requirements for the degree of  
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**Faculty off Electrical Engineering**

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**June 2016**

I hereby declare that I have read through this report entitled “Street light monitoring and Control using low cost microcontroller system” and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)

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Date: 13 June 2016

I declare that this report entitled “Street light monitoring and Control using low cost microcontroller system” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Date: 13 June 2016

**To my beloved mother and father**

## Abstract

Nowadays, a rapid advancement in the field of area construction in which large number of streets are paved. As the number of streets increase a large amount of energy is required to provide light to the streets. Street lights is an essential thing in order to improve the human life quality. Life quality implies accidents prevention due the darkness, road safety and providing clear vision. In most of global streets, a traditional street lighting system is utilized to take control of the street lights switching during day (high intensity) or night (low intensity). This traditional system is widely used due to the simple and easy construction as well as the long time life of the system. Apart from that, with new era of technological growths, new smart lighting system has been used to control the street light switching. This project aims to develop Street light monitoring and Control using Arduino system which implement various intelligence options. The working principle of the system utilize LED lights and two sensors attached to each light, a LDR is implemented in the system to off the light during day time, however, during darkness, two sensors are employed to detect the presence of the vehicle and send the signal to Arduino to light up the corresponding light for 100% and two surrounding light by 50%. The objectives of the project have been successfully achieved by prototyping a smart street light system which intelligently control the light of the street and hence save cost and energy consumption.

## Table of contents

### Table of Contents

Abstract .....	v
Table of contents .....	vi
LIST OF FIGURES .....	viii
CHAPTER 1 .....	1
1. INTRODUCTION .....	1
1.1 Research Background.....	1
1.2 Problem Statement .....	2
1.3 Objectives .....	3
1.4 Scope.....	3
1.5 Expected outcomes .....	3
1.6 Report outline.....	4
CHAPTER 2 .....	5
2. LITERATURE REVIEW .....	5
2.1 Introduction .....	5
2.2 Theory and Basic Principles.....	6
2.2.1 Traditional Street Lighting System	6
2.2.2 Traditional Street Lighting System Advantages	13
2.3 Smart street lighting system.....	14
2.3.1 Smart Lighting system components	15
2.4 Review of previous works.....	28
2.5 Summary .....	29
CHAPTER 3 .....	30
3. METHODOLOGY .....	30
3.1 Description of the Work.....	30
3.2 List of Components.....	31
3.3 Block diagram.....	31

3.4 Software Implementation.....	32
3.5 Hardware Implementation and Setup.....	33
3.5.1 Ultrasonic Sensor.....	33
3.6 System Flow chart.....	36
CHAPTER 4 .....	37
4. RESULTS & DISCUSSION.....	38
4.1 Project Description.....	38
4.2 Complete Design of the Hardware.....	39
4.3 System working principle .....	41
CHAPTER 5 .....	42
5. CONCLUSION AND RECOMMENDATION.....	42
5.1 Conclusion .....	42
Recommendation and Future Work .....	42
References.....	43
Appendices.....	45
Appendix A: Project Gantt chart.....	45
Appendix B: Codes of Communication.....	46
Code of sensors .....	47
Appendix C: Design circuit .....	48

## LIST OF FIGURES

Figure 2.1 Traditional street lighting system circuit diagram	6
Figure 2.2 Light Dependent Resistor (LDR) with its symbol	7
Figure 2.3 typical shape of resistor with its symbol	8
Figure 2.4 CA3140 IC circuit diagram	9
Figure 2.5 Relay circuit configuration	10
Figure 2.6 Transistor circuit	11
Figure 2.7 Working principle of traditional street lighting system	12
Figure 2.8 Smart street lighting	14
Figure 2.9 Real time clock design	15
Figure 2.10 Light Dependent Resistor (LDR)	16
Figure 2.11 Infrared sensor	18
Figure 2.12 Timing Diagram	18
Figure 2.13 Arduino	19
Figure 2.14 Arduino board specifications	21
Figure 2.15 Smart System Lighting	27
Figure 3.1 Description of the proposed system	31
Figure 3.2 RFID Tag Scanner (PART 1) Block Diagram	32
Figure 3.3 System circuit design in proteus	32
Figure 3.4 System fabricated circuit	33
Figure 3.5 RFID reader Connection with Arduino	34
Figure 3.6 Resistance variation	35
Figure 3.7 The connection LDR with Arduino	36
Figure 3.8 System flow chart	37
Figure 4.1 Smart Street Lighting System (a) side view ,(b) upper view	39
Figure 4.2 Single light Design.	40
Figure 4.3 System working principle	41



# CHAPTER 1

## 1. INTRODUCTION

### 1.1 Research Background

A bulb is an electrical device which converts an electrical current crossing it into light energy. Lighting is very important need for people to provide them with visibility during dark times. Road lighting is essential requirement as well, in order to make any moving object in the road such as humans, vehicles or any other objects are visible so that any obstacles due the darkness avoided. With rapid technology growth where green issues have presented, many scientists and engineers are focusing in producing modern techniques to minimize the energy consumption, less environmental impacts equipment and maximize the equipment efficiency. Among various methods, smart system found to be the best method to be implemented in industrial and residential and commercial areas. Smart system can be defined as dependent system which can senses the variation in the environment with the help of sensors implantation and can response to modify the variations causes as desired.

Street light is very advantageous system which contributes to extend the people life quality during the darkness periods. Life quality includes the crime prevention and traffic safety on the street. The amount of energy street light consumes almost two percent of the world energy, also the street light is responsible for the yearly millions of Co<sub>2</sub> emission which more detrimental to environment and contribute largely to increase the global warming. Street lighting normally involves energy waste as well as lack of controllability and arrangements. It is remarkable idea to develop a smart system that can provide a well-organized control mechanism of the street lighting, hence reduce the energy consumption

The basic concept of Street light monitoring and Control using low cost microcontroller system is that, the system is implemented utilizing the latest technology light emitting diode. With the aid of sensors, the movement of vehicles or human can be detected. As the sensors detected the presence of human or vehicle the light intensity goes on in increasing for few seconds till the vehicle passes the light intensity decreased

## **1.2 Problem Statement**

Nowadays, with rapid advancements in technology and the globe is increasingly becoming more modernized. Day after day the number of roads and streets are increasing in accordance the intensive population growth, as well the large usage of vehicles. Apart from that the street lighting is very important in order to comfort the life quality of human as well as provide a vision across the street so that the accidents rate and traffic problems occurred on the street due to the darkness is narrowed out. Most of streets lighting system utilized nowadays are conventional and consume a big number of energy as well as produce environmental effects

However, by utilizing Street light monitoring and Control using low cost microcontroller system all these problems are minimized. A system that utilize the latest technology light emitting diode .As well as the system utilize various sensors so that the lighting system is operating according to the sensor detection .When the sensor detect the presence of vehicle the light intensity will increase for a certain time ,as the vehicle passed the light intensity goes back to normal .Moreover the system will utilize microcontroller driving mechanism for the system .Implementing such system contribute largely to reduce the energy consumption as well as the lighting system managed well .

### 1.3 Objectives

The goal of this project is to achieve these objectives:

- To develop a smart lighting system to reduce energy consumption
- To use latest technology light emitting diode (LED)
- To carry on the system implementation in single street

### 1.4 Scope

The scope of this project includes building a smart street lighting system to be implemented on the streets so that the energy consumption and street arrangement are improved. The basic construction of the system utilizes latest modern technology of LED, sensors and the microcontroller. The system demonstration is carried out utilizing Single Street. The key concept of the system is that the sensors will detect the presence of the vehicle or human so that the microcontroller will control the light intensity based on the sensor detection

### 1.5 Expected outcomes

Upon the completion of this project, it is expected to:

- Reduce the energy consumption to minimum rate
- Produce less impacts to environment
- Produce a well-organized street lighting system
- Overcome the shortcoming of conventional street lighting system drawbacks

## 1.6 Report outline

This report consists of five chapters which are presented as below:

Chapter 1: **Introduction**-This chapter presents and illustrates the aim of this project, discusses the problem fundamentals. As well as detail information about Street light monitoring and Control using low cost microcontroller system

Chapter 2: **Literature Review** - This chapter provides a detailed background of speed lighting system and taking in the consideration the fundamental concepts of smart lighting system. It also provides comparison study in other previous related work has been done in Street light monitoring and Control using low cost microcontroller system.

Chapter 3: **Methodology**- This chapter presents the approaches and procedures used to build this project in sequence. As well as the project flow chart, provide specifications, components used and present the project flow

Chapter 4: **Result and discussion**- This chapter illustrates and analysis the result of this project and discusses the achieved results of the developed system.

Chapter 5: **Conclusion and recommendation**- This chapter provides a summary of the project. The strengths and advantages of the project will be discussed as well. Furthermore, some suggestions for future works will be offered.

## CHAPTER 2

### 2. LITERATURE REVIEW

#### 2.1 Introduction

Nowadays, with the intensive development in technological and industrial field in which the world becoming more modernized and sophisticated. Overtime, the number of streets are increasing as the number of population and new cities created increase. Street lighting is an important need to provide a clear vision to people during darkness times so that the any crime occurrence or road accidents is avoided. In developed countries, a sophisticated street lighting system is implemented where the light ON and OFF is controlled automatically by the detection of darkness. Apart from that, the need for smarter lighting system to reduce the energy consumption [1].

Smart lighting system is new lighting system that can be implemented in street lighting to reduce the energy consumption as well as organize the street lighting. The process of traditional street lighting system consume a large amount of energy since, the traditional system implies that the all the lights will be one at 100% intensity during darkness periods, however it is unnecessary the street light is ON all the time with 100% intensity even though there is no presence of vehicle or human. The smart lighting system is capable of providing control mechanism of the street light intensity. With the existence of Arduino a integrated control tool, the smart system utilize it to provide full controllability of the system .In the smart system, sensors will be installed to detect the presence of light as well as the presence of vehicle or human .Therefor, the light intensity will be controlled in accordance with the sensor detection .The advantageous feature of Street light monitoring and Control using low cost microcontroller system is the energy consumption is minimized as well as the street lights are managed well [2].

## 2.2 Theory and Basic Principles

This particular subtopic is specialized for studying the theoretical concept of the street lighting system. The system concept is discussed to visualize the working approach of the system. As well as the system fundamental components are studied along with their working principle and significant contribution in forming the street lighting system.

### 2.2.1 Traditional Street Lighting System

Traditional street light system is commonly used nowadays in most streets. The main goal of such system is to provide control mechanism of the street lights to save energy. The basic construction of the system is that it utilizes only light sensor to detect the presence of the light, hence automatically turn on or off the light. The working principle of the system implies that the street light will be off during the daytime while will be on at nighttime or in the presence of heavy clouds that cause darkness. In The presence of vehicle or pedestrians, the system will not response. The system main components are transistor and light dependent resistors (LDR) as the main components [3]. Figure 2.1 show the circuit diagram of traditional street lighting control

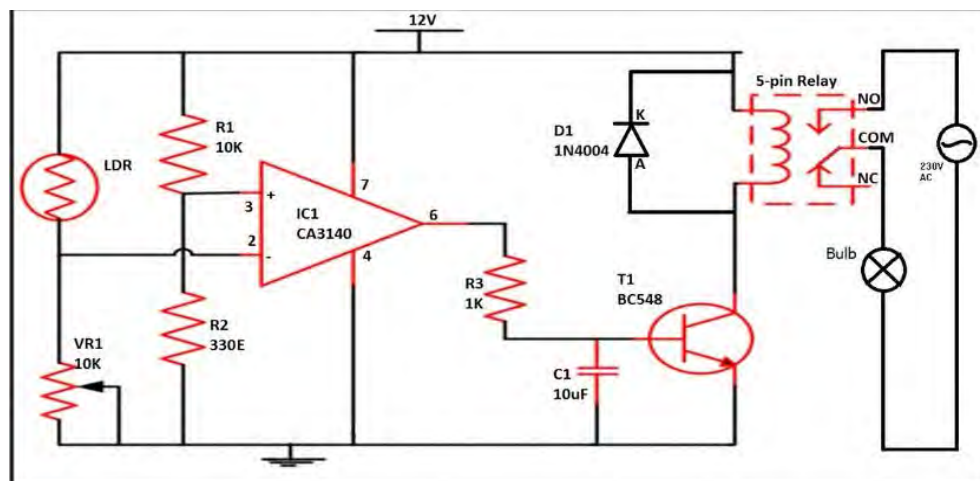


Figure 2.1 Traditional street lighting system circuit diagram

### 2.2.1.1 Traditional System Components

The implementation of the common conventional street lighting system is quite simple .it comprises set of fundamental components that integrate the system in order to control the light of the street automatically

### 2.2.1.2 Light-Dependent Resistor (LDR)

Light Dependent Resistor (LDR) or a photo resistor is a light variable resistor. Its resistance is inversely proportional to the light intensity, as the light intensity increases, the LDR resistance decrease and vice versa. LDR is created utilizing a high strength semiconductor. In darkness period, it can possess very high resistance reaching a mega ohms ( $(M\Omega)$ ), but in the light, it can have a very low resistance not more than hundred ohms .The working concept of LDR is, whenever it exposed to lights that exceeds a specified frequency, photons resolved by the semiconductor produce bound electrons enough power to go into the conduction cycle [4]

In the street lighting system, the using LDR is beneficial where; it can provide a simple control mechanism for the street light system. In the time of darkness or when there is no light, the resistance of LDR is very high so that the street light will turn on, but in the presence of light or in brightness, the LDR resistance is very, hence the street light is off. Figure 2.2 show the type of Light Dependent Resistor (LDR)

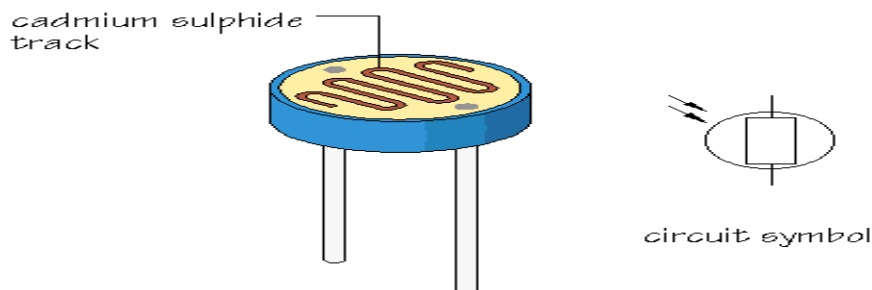


Figure 2.2 Light Dependent Resistor (LDR) with its symbol

**2.2.1.3 Resistor**

A resistor is a passive electrical element which has two terminals can be utilized as electrical resistance in the electrical circuit. Usually the main purpose of the resistor is to act as the current limiting component. It is utilized to provide protection to desired part of an electric circuit from an excessive current .For street lighting system in particular, various resistor used in order to manage the current flow in the circuit and prevent some part of the circuit from receiving high current .There are two type of resistor, fixed value resistor in which the value is constant and unchangeable or variable resistor where there resistance value can be varied as desired [5].Figure 2.3 shows the typical shape of electrical resistor along with its electrical symbol.



Figure 2.3 typical shape of resistor with its symbol



### 2.2.1.4 Operational Amplifier (CA3140IC)

CA3140 can be referred as Operational Amplifier utilizing MOSFET as an inputs and Bipolar as an output. This Op Amp comprises the features of PMOS transistors and high voltage bipolar transistors. It possesses gate prevented MOSFETs (PMOS) transistors in the input design to produce very high input resistance roughly around  $1.5T$  Ohms. The IC utilizes very less input current as low as  $10pA$  to alter the output state, high or low. The IC possesses very fast changes and high speed of characteristics. The output phase of the IC utilizes bipolar transistors and involves formed inprevention against damage from load port short circuit to either supply rails or to ground [6]. In the case of street lighting system, The CA3140 works as a comparator and gives fast response & high speed. Figure 2.4 shows the circuit diagram of CA3140 utilized in traditional street lighting system.

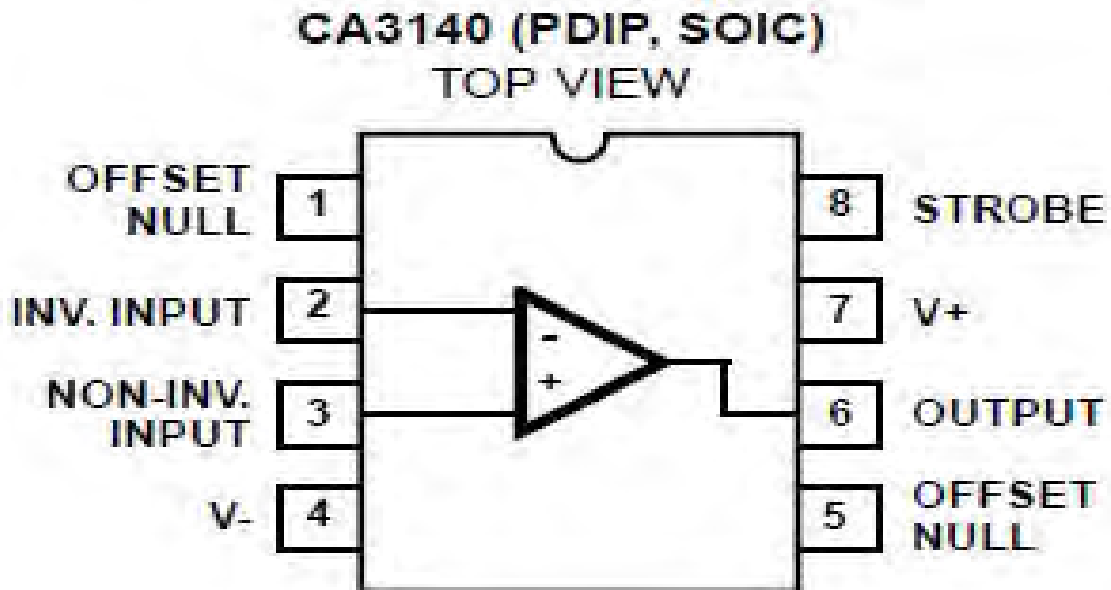


Figure 2.4 CA3140 IC circuit diagram

### 2.2.1.5 Relay

Relay can be defined as an electrical switch which utilize electromagnetic to operate as switch in mechanical way. The main purpose of relays is to be used to control a circuit utilizing low power signal with completely electrical isolation between control and controlled circuit. Also it can be used to control various circuits utilizing one control signal. In the past relays usage was intensively on telegraph as well as in telephone and early computer in order to achieve logical operations .The usage of relays also can utilized in electrical motor control in which relay can control moving parts instead using semiconductors which require switching. Lastly, relays can be used to protect electrical circuits against overload as well as fault occurrence [7]. There different type of relay with 3 or 4 pins ports, in the case of street lighting system a 5 pins relay is used which provide a simple way for LED to indicate the presence of current in the relay coil. Figure 2.5 shows the simple circuit of relay.



**2, 5 - Relay Coil connection**

**1 - Common**

**3 - NO 4 - NC**

Figure 2.5 Relay circuit configuration

### 2.2.1.6 Transistor

A transistor can be defined as semiconductor device that can be utilized to enlarge switching signal. In its basic construction utilizes a set semiconductor material, in order to be implemented in circuit must contains at least three terminals. The existence of such device contribute largely to minimize the size of the equipment. Transistors can be used as switch to turn on or off a circuit as desired. The basic operation of transistor includes an input power fed into a transistor terminal can alter the power through the other terminal; hence transistor can be used as amplification device to produce higher output power than the input. The most advantageous features of transistor that, it contribute significantly to produce a smaller and cheaper equipment [8]. In traditional street lighting system, transistor utilized for switching purpose. It is biased so that it remains on if there is signal at its base, otherwise it is always off. Figure 2.6 shows the circuit of transistor.

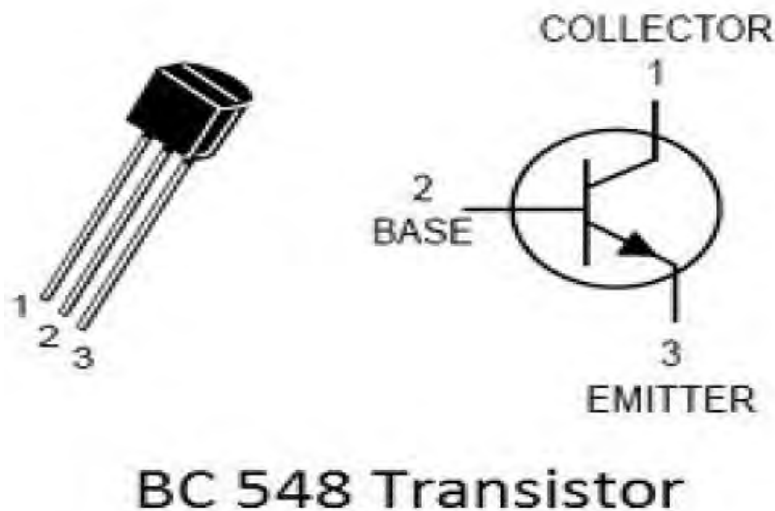


Figure 2.6 Transistor circuit

### 2.2.1.7 Working principle of Traditional Street Lighting System

The working principle of the designed traditional street lighting system circuit is quite simple, where the designed circuit will be incorporated the bulb street light .As the main component of the system is the LDR which a high sensitivity device so that as for the day time ,the LDR will sense the light ,hence comprise low resistance .Low resistance is low voltage fed into the relay so that the output of the relay is low which connected to the transistor and will be off, hence the light is off. While at night time, LDR by its property will experience a high resistance. Therefore, voltage is inputted into the relay which will produce high output to the transistor and make on state, hence the light bulb is on [9]. Figure 2.7 shows the diagram of working principle of traditional street lighting system.

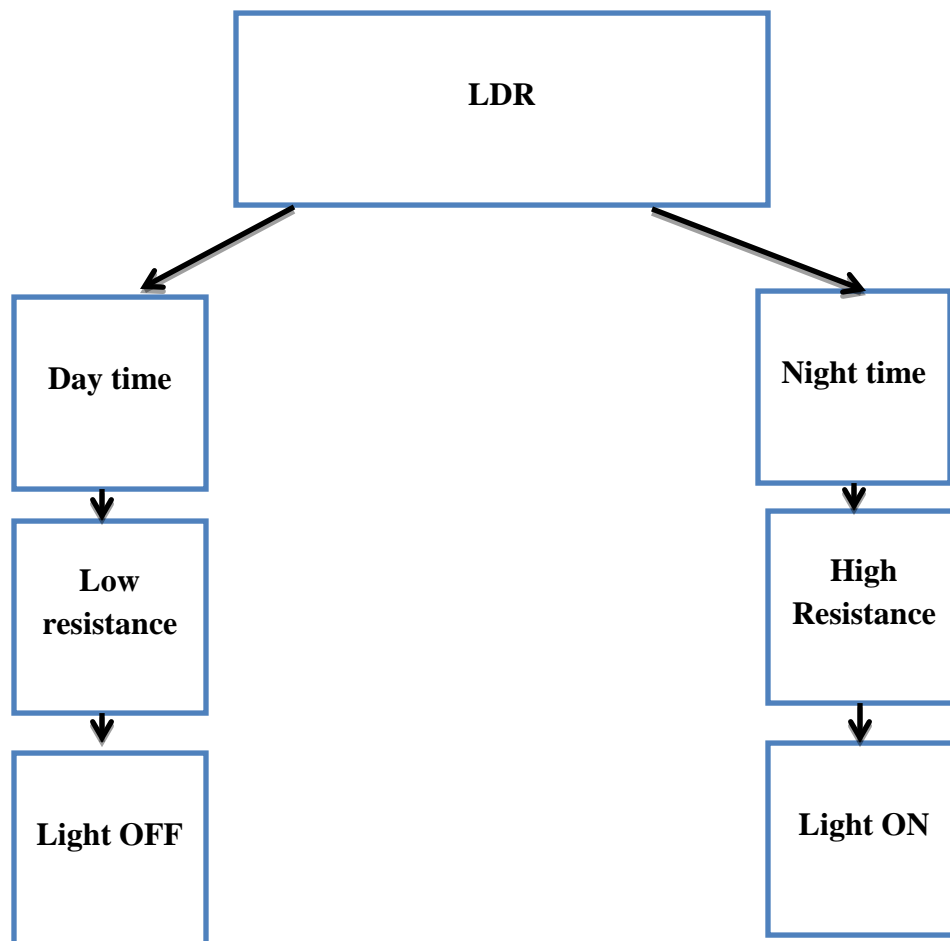


Figure 2.7 Working principle of traditional street lighting system

### 2.2.2 Traditional Street Lighting System Advantages

Traditional street lighting system is widely deployed and implemented in most of streets in the globe. The simplicity of this system make more remarkable to be used .Such system utilize less component which enable it to be produced at low cost and easy construction. Despite of the system simplicity and easy implementation it contributes largely to introduce more features, hence the most remarkable features that can be obtained from the traditional street lighting system can be discussed below:

- I. No man power required, in which the system utilize full automotive working principle, so that doesn't require the involvement of humansto operate of control
- II. Simple Construction, where simple and less components used to design the system
- III. Efficient method, since it utilizes effective components that doesn't waste energy
- IV. Less Consumption of electrical energy, the main function of the system is to turn off street light in the day time which save electrical energy
- V. Less maintenance, the system is well-built and accurately designed so that a regular maintenance is not required
- VI. Cheap and economical, due to simple and cheaper components used the system is presented at low cost so that it is more economical.

### 2.3 Smart street lighting system

Smart street lighting system, as the name implies it provides a smart control mechanism for the street lighting. The system achieves the function of traditional system and added more advantageous features, where a smart system besides the turning on and off a street light during day and night time. It also automatically controls the light intensity in accordance to the presence of vehicle and pedestrian. Moreover, the system can control the light on and off states in late time of the night where most of the streets are free of vehicles and pedestrian. The system implementation utilizes a microcontroller as control mechanism of the entire system, Infrared Sensor (IR) to detect the presence of vehicles or pedestrian in the road so that the light intensity will be adjusted accordingly. Figure 2.8 shows street lighting implementing smart system []



Figure 2.8 Smart street lighting

### 2.3.1 Smart Lighting system components

The Street light monitoring and Control using low cost microcontroller system utilize a set of components namely, microcontroller, infrared sensor(IR) ,light dependent resistor ( LDR) ,Light Crystal Display (LCD).In this section the main components form up the smart lighting system will be discussed individually.

#### 2.3.1.1 Real Time Clock

Real time clock RTC can be defined as a computer clock usually in form of integrated circuit which continues tracing the current time. RTC is very important where it exists in almost every electronic device that requires maintaining exact time. In microcontroller the RTC is used largely to interface with microcontroller to provide the accurate time [11]. The main purpose of including real time clock in the street smart lighting system is that to store the data of time during day and night. In smart lighting system, sometimes the street light will be off in the darkness period .This because the data information stored in real time clock to turn off the light or reduced in accordance to specified time like after midnight where the street is free of vehicles and people. Figure 2.9 shows the circuit real time clock interfacing with microcontroller.

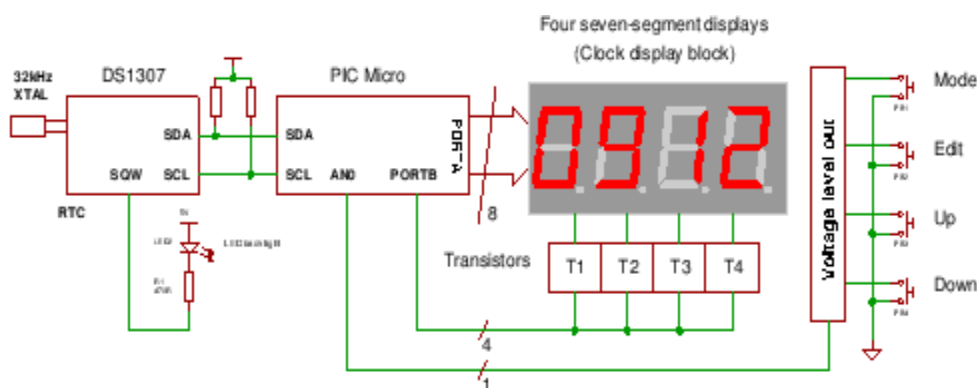


Figure 2.9 Real time clock design

### 2.3.1.2 Light Dependent Resistor (LDR)

Light Dependent Resistor (LDR) or a photo resistor is a light variable resistor. Its resistance is inversely proportional to the light intensity, as the light intensity increases, the LDR resistance decrease and vice versa. LDR is created utilizing a high strength semiconductor. In darkness period, it can possess very high resistance reaching a mega ohm ( $M\Omega$ ), but in the light, it can have a very low resistance not more than hundred ohms. The working concept of LDR is, whenever it exposed to lights that exceeds a specified frequency, photons resolved by the semiconductor produce bound electrons enough power to go into the conduction cycle [4]

In the street lighting system, the using LDR is beneficial where; it can provide a simple control mechanism for the street light system. In the time of darkness or when there is no light, the resistance of LDR is very high so that the street light will turn on, but in the presence of light or in brightness, the LDR resistance is very, hence the street light is off. Figure 2.10 show the type of Light Dependent Resistor (LDR)

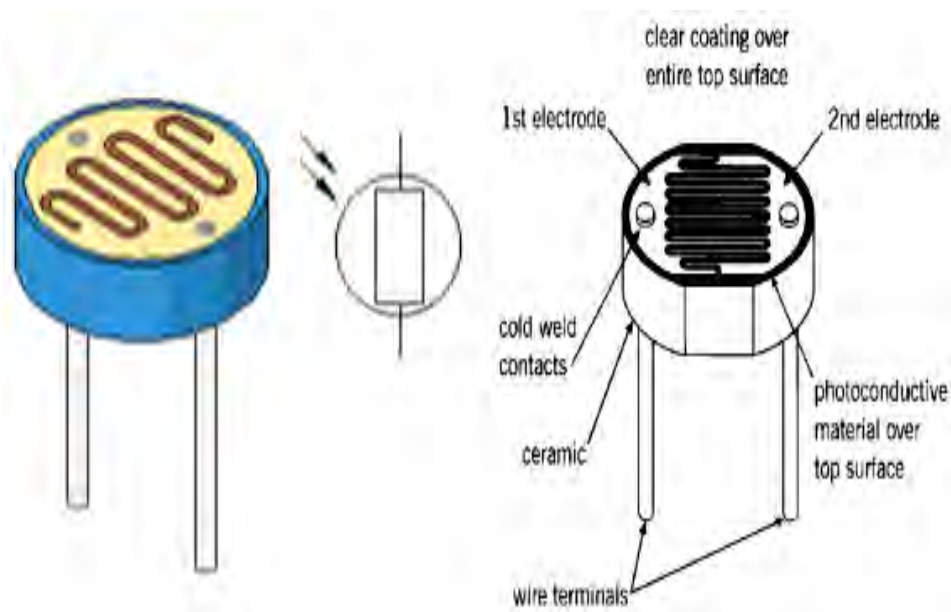


Figure 2.10 Light Dependent Resistor (LDR)