SMART STREET LIGHTING SYSTEM

A project submitted in partial fulfillment of the requirement for the degree of

Bachelor of Science

In

Electrical Electronic and Communication Engineering

Submitted by

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APPROVAL

This project paper titled **"Smart Street Lighting System"** submitted by the group as mentioned below has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Electrical, Electronics and Communication Engineering at Military Institute and Science and Technology (MIST) under Bangladesh University of Professionals (BUP) on December 2017.

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DECLARATION

We hereby declare that the work presented in the project titled **"Smart Street Lighting System"** is an outcome of the study carried out by the authors under the supervision of Lt. Col. A K M Nazrul Islam, PhD, EME. It is also declared that neither of this thesis paper nor any part has been submitted anywhere else for degree, diploma or other qualifications. Materials of work found by other researcher mentioned by reference.

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DEDICATION

To our beloved parents

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All praises goes to almighty Allah, the most gracious and most merciful, who bestowed upon us the courage and enthusiasm to complete the project work within the scheduled time. Our heartiest gratitude, profound indebtedness and deep respect go to our supervisor Lt. Col. A K M Nazrul Islam, PhD, EME, Instructor Class 'A' (Associate Professor), Department of Electrical Electronics and Communication Engineering (EECE), Military Institute and Science and Technology (MIST), Dhaka, Bangladesh, for his constant supervision, affection, guidance, great encouragement and motivation. His keen interest in this topic and valuable advices throughout the study was of great help in completing our project. We are especially grateful to Gp Capt Dr. Md Hossam-E-Haider, Head of the department, Department of Electrical Electronics and Communication Engineering (EECE), Military Institute and Science and Technology (MIST) for providing all support during project time. We are also grateful to all members of our faculty, lab assistants, sub-assistant engineers and all staffs of the department of EECE. Finally, we would like to thank our families and our course mates for their appreciable assistance, patience and suggestions during the course of our project.

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ABSTRACT

Street lights pay a very important role for lightening the walkway during nights when surroundings go dark. It is also very important for the vehicles running during the night for the proper direction of the roads. Nowadays controlling the street lights require human presence to switch them ON/OFF which means this system is not digitalized yet. This human controlled system has the disadvantage of having regular individual presence to turn the lights ON/OFF which is a loss of electrical energy and manpower because this people can be deployed somewhere else. Thus to overcome these problems the controlling system might be converted to a system where it is controlled via wireless technology. In this paper, an automatic system is demonstrated to control the system by wireless technology using Arduino Uno. The system is programmed in such a way that the whole street light is divided in some sections which can be turned ON/OFF with a single short message service (SMS). The system can also be turned ON/OFF by using the intensity of light basing on day or nighttime and if intensity of light goes up or down a certain threshold value, the lights will be switched ON/OFF. The feature of getting the feedback about the functionality of the lights has also been added on this project. That means a feedback message will be sent via short message service (SMS) if the lights are not functioning properly. This automation process if utilized will save manpower, huge amount of electrical energy and make the system easier to control than the conventional controlling system.

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LIST OF ABBREVIATION

AC	Alternating Current
ADC	Analog to Digital Conversion
AREF	Analog Reference
AVR	Automatic Voltage Regulator
BSC	Base Station Controller
BJT	Base Junction Transistor
BTS	Base Transceiving Station
CPU	Central Processing Unit
DC	Direct Current
EIR	Equipment Identity Register
EPROM	Erasable Programmable Read Only Memory
GSM	Global System for Mobile Communication
GPRS	General Packet Radio Service
HPS	High Pressure Sodium
HLR	Home Location Resistor
IDE	Integrated Development Environment
IC	Integrated Circuit
ICSP	In Circuit Serial Programmer
IMEI	International Mobile Equipment Identity
ISDN	Integrated Services Digital Network
IEEE	Institute of Electrical and Electronics Engineers

LAN	Local Area Network
LASER	Light Amplification by Stimulated Emission of Radiation
LDR	Light Dependent Resistor
LED	Light Emitting Diode
MHz	Megahertz
MIPS	Microsoft without Interlocked Pipeline Stages
MLF	Micro Lead Frame
MSC	Mobile Switching Center
MOSFET	Metal Oxide Semiconductor Field Effect Transistor
NPN	Negative Positive Negative
PDIP	Plastic Dual In Line Package
PSTN	Public Switched Telephone Network
PWM	Pulse Width Modulation
RTC	Real Time Clock
RF	Radio Frequency
SCL	Serial Clock Line
SDL	Serial Data Line
SI	International System of Units
SIM	Subscriber Identity Module
SIMCOM	Simultaneous Communication
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory

SSL	Secure Sockets Layer
TTL	Transistor Transistor Logic
TQFP	Thin Quad Flat Package
TWI	Two Wire Interface
USB	Universal Serial Bus
VLR	Visitor Location Resistor

Chapter- 1

INTRODUCTION

1.1 Introduction

Street lights are an integral part of a city's infrastructure. Street lights are placed at almost every corner of the street to illuminate darkness at dark hours. They provide services for security and traffic safety. It alerts people to potential hazards. The objectives of using street lights are far many to count. Street lights are useful in making the vehicles and people on the street visible. In addition, people can easily spot if there are any harmful objects on the street, saving them from unconstructed and blocked roads. Apart from the practical purposes, it also adds to the city's appearance and feature.

Previously the number of street lights were smaller and it was easier to monitor them. However, with time, the number of streets has increased in addition to heavy traffics. Which makes the monitoring and controlling of the lights very difficult. Controlling them manually using the control switch set in each street is quite impossible. It is an inefficient process that leads to wastage of manpower and electricity. In addition, it is very difficult to maintain the activation and deactivation of street lights leading to large amount of power wastage. This leads to light's automation. The aim is to find techniques to increase product efficiency and reduce power consumption.

The project is made to control the street lights from anywhere in the country with mobile phone. It only requires a Short Message Service (SMS) in a particular number to switch ON/OFF the street lights of a particular area. The SMS can be as simple as "switch on" or "switch off". It is built with a logical embedded system, which includes Global System for Mobile (GSM) and Arduino. It is also capable of switching the street lights according to the intensity of the light of that particular environment and light intensity sensors are used here.

The monitoring and control system for street lights based on GSM is an automated system. It is designed to increase the accuracy as well as efficiency by controlling street lights using mobile phone. GSM based automation of street lights is used to control street lights automatically by using GSM module.

This GSM based automation can be done via SMS. If designed properly, it can be a simpler and cost effective, reliable and far-reaching method to switch ON/OFF of the street lights. In this method, a coded SMS is sent to the GSM. The GSM receives the message and by decoding it performs automation operation accordingly.

Also light sensors like, Light Dependent Resistor (LDR) can be used to automatically control the street lights by sensing the intensity of light. The intensity of light at daytime is much larger than that at the evening. By using this change in intensity of light, the light sensor can be used to turn the street lights ON or OFF. Therefore, our proposed plan can be used to automatically control the street lights from anywhere within the network.

1.2 Present State of Street Lighting System

There are currently a total of 304 million streetlights in the world. This number will grow to a total of 352 million streetlights by the year of 2025. The lighting market is currently undergoing a period of change where conventional streetlights are being replaced with new and more efficient Light Emitting Diode (LED) or solid-state lighting technology. This LED and solid-state lighting technology are used together to communicate at a time through a network to make them “Smart Street Lighting System”. LED and smart streetlights will transform cities across the globe over the next decade. LED offers longer lifetime, lower energy consumption and reduced maintenance cost when compared with conventional street lighting system.

In Bangladesh, street lighting system is still manual. That means, street lighting system is not smart and the modern technologies are yet to be implemented. The lights currently used in the streets of our country are of three kinds – sodium, fluorescent and energy-saving lights (ESL). The Dhaka city authorities are going to install LED lights in all street lamps to ensure security for the citizens as well as to provide enough lighting on the streets for the law enforcers to perform their duties properly. According to a survey by the government’s Power Cell conducted in 2014, there are a total of 71,276 street lights in the capital of different types stated above [8].

In most of the developed countries, LEDs are already replacing the existing streetlights as an economically beneficial alternative. The modern countries are also focusing to replace the existing streetlights with "smart" streetlights as a part of the “smart city” concept. Smart streetlights help cities further to reduce costs through reduced

maintenance expenditures and waste of electrical energy. In 2014, the World Bank announced a $1 billion fund exclusively for LED street lighting.

Overall, the LED and smart street lighting market are rising gradually. Given these clear advantages, from 2015 to 2025, countries are expected to invest $53.7 billion in LED street lighting. LED and smart streetlights are projected to reach 84% and 37% of the total streetlight market, respectively, by 2025. This will total a $63.5 billion market [9].

1.3 Literature Review

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 used 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]. Later, an Ethernet based research has proposed to monitor and manage the street light control system. Ethernet is the most widely installed local area network (LAN) technology. It enables a better and cheap lighting control system for small cities. The presented system consists of a LED lamp module, a digitally controlled multiphase driving system for LED lamp and an Ethernet-based communication interface [2]. To add communication capabilities to the system already in use, a technology was developed through the integration of a ZigBee (Appendix A) compatible transceiver to the photoelectric relay used to turn the High Pressure Sodium (HPS) lamps ON/OFF. That change will turn each device into a node of a large wireless network across the city. The main idea is the integration of a ZigBee compatible transceiver to the relay used to turn the HPS lamps ON/OFF, turning each device into a mode of a large wireless network across the city. The proposal system makes easier to read sensor measurements (current, voltage, power, illuminations etc.), it can reduce total system power consumption and maintenance costs. In addition, it enables the system to be used in a variety of other public services [3]. There was a technical development to overcome the overload difficulties during the peak hour. It enables the

disconnection of street lighting system from the mains during the peak hour for decreasing the overload difficulties in the system and makes it easy for the distribution of electrical energy. For this purpose, it uses a wireless sensor network based on IEEE 802.15.4TM standard (Appendix A) [4]. The usage of smartphone started after this for representing a Smart Street Light System for dynamically switching the street lights based on the pedestrians' locations and safety zones. The pedestrians are localized via their smart phone, periodically sending location and configuration information to the Secure Sockets Layer (SSL) server. For controlling the street lamps, the lampposts are equipped with a ZigBee-based radio device, receiving control information from the SSL server via multi-hop routing [5]. A research later focused on two aspects: the selection of the adequate communication protocol, on the one hand, and the selection of the network topology that supports the architecture, on the other hand. Given these circumstances, the paper focuses on an assessment of the performance of the mesh and tree network topologies, which, along with the ZigBee communication protocol, can be implemented in a street lighting, control architecture. Because of the simulations that have been conducted, the data reveals that the tree topology is much more efficient than the mesh topology. When employing the tree network topology, the network load is divided among the coordinator and the local routers, thus reducing collisions and the number of lost packages. Therefore, the performance of the tree network topology far outbalances the benefits of a mesh topology. The number of hops performed in a mesh network is much higher than that if a tree topology. This particular characteristic may equate a lower power consumption than that required by tree network topologies if the nodes are battery-powered. The tree topology performs highly better than topologies when implementing a street lighting control system [6].

A wireless street lighting system with better management and efficiency using ZigBee-based wireless devices came into implementation, which delivered better efficiency in management, advanced interface and control architecture. Many sensors were used for transferring the information through the ZigBee transmitters and receivers. The state of the system is checked and appropriate measures are taken in case of failure [7]. A high performance and expensive LED module was designed for general lighting. The 9-LED Module (9-LEDM) has been designed and evaluated. An adaptive driver with two frequencies to enhance the lifetime and simplify the induction treatment has been proposed. Photometric, thermal and electrical factors have been considered together in

order to obtain a complete street lighting system. Finally, experimental results based on the suggested methodology have been obtained from laboratory measurements and a demonstration project [10]. For explaining a fast, reliable and power efficient street lamp switching system regarding pedestrian's location and safety, a SSL system was proposed. The location, detection of safety zone and configuration information is delivered using Smartphone. For street lamp control, each lamppost is extended with a ZigBee-based radio device, receiving control information from the SSL server via multi-hop routing [11]. To accomplish long distance communication using ZigBee wireless technology involving ZigBee coordinator, ZigBee end node was interfaced with a GSM modem. The street light can be monitored and controlled from a centralized position and remotely via cell phone. The brightness of the lights can be adjusted via dimming control circuit like the IRS2530D, which is a new dimming ballast control IC in a compact 8-pin form and with respect to the surrounding ambience-using sensor [12]

A system came into implementation where the microcontroller is programmed to switch ON/OFF the lights according to the time and intensity of light. They used LDR and Real Time Clock (RTC) interfaced to the microcontroller. The LDR was used to sense the light and the variation was processed as a voltage signal to the microcontroller through the Analog to Digital Converter (ADC) and had the functionality to set the time during which the lights have to be switched ON/OFF [13]. The street lights are then programmed to switch ON if the ambient light intensity falls below a threshold. The RTC used in the system monitors the time and puts the light in dimming condition between certain hours when the traffic intensity is too low. Light Amplification by Stimulated Emission of Radiation (LASER) gates used here detects the movement and makes particular street lights to go to its full intensity for public movement. It reduces the power consumption a lot [14]. The project 'Timer & Dimmer' is capable of energy consumption up to 35% and can increase this efficiency up to 40% with a good distribution of networks and lamps. This system is capable of increasing the lifetime of the lamps used up to two times [15]. A strong and long lasting street light control system, which needs minimum maintenance, was introduced later. It works on the intensity of light where time sensing is used for decoding the intensity of light. The system uses microcontroller, real time clock, Metal Oxide Semiconductor Field Effect Transistor (MOSFET) based driver circuit for controlling the intensity of LEDs. It saves 15.96 KWhr per street lights per year in comparison to traditional controlling system. It is more reliable and less maintenance is

required than the wireless sensor networks [16]. Now, all the research stated above indicates the necessity of a smart street lighting system, which would be convenient and flexible to operate and has a better sustainability.

1.4 Project Objective

From the above discussions, we have come to know the evolutions of street lighting system. Now, we have developed a smart project, which is different from the developed system of others in various aspects. The objectives of the projects are:

a. To obtain manual switching street lighting system, which can be operated manually in case of the smart system fails to operate.
b. To implement the project using LDR light sensor, which will automatically switch ON/OFF the lights.
c. To implement, the project for switching ON/OFF via SMS, using a GSM module to turn the switches ON/OFF from any part of the operator network.
d. To implement a programmed system, which will send SMS if any light is not switched ON/OFF properly.
e. To implement the project in several sections which can be turned ON/OFF individually to operate the system efficiently.
f. To design the system for specific time dependent operation and propose some diversity of applications with little modification of the proposed system.

1.5 Outcome of the Project

The project can accomplish following outcome considering the above objectives:

a. Since the project can be switched in three ways- manually, via mobile SMS and according to the light intensity, the most important advantage of this project is that, we can easily avoid manual switching when necessary. As a result, the presence of a person while switching ON/OFF the street lights is not necessary.
b. When the light intensity goes down in case of bad weather, the lights will be switched ON/OFF according to the light intensity automatically. Thereby, we do not need to worry about switching the lights.
c. Since we are using GSM module here, the lights can be switched from a long distance within the mobile network and the controller can control them form anywhere around the region within the respective mobile network.

d. This project also has the feedback SMS technology, which will send us a feedback SMS if any light was not turned ON/OFF according to given command. The SMS will mention the specific identity of the light, which will help us to quickly find it out and repair it as soon as possible.
e. However, a disadvantage of this project is, when there is fog or rain, the sensor used here may not function properly while measuring the light intensity. However, it can be easily overcome by using a better quality sensor can be used for flawless outcome.
f. The project can be used in diverse ways with a little modification of the system.

1.6 Outline of the Project Report

The project report is organized as following based on the objectives-

In chapter-2, we have discussed all the equipment required in our project, their working principle, features and specifications and the software requirement of the project.

Chapter-3 demonstrates the system model, power supply and connections of the projects for both prototype and implementation.

Chapter-4 represents the different key features of the project, their working mechanism, implementation in AC line, fields of application and diversity of application of the project.

In chapter-5, we have discussed the improvements and scope of future works that can be achieved through this project.

Chapter- 2

EQUIPMENT TO IMPLEMENT THE PROJECT WORK

2.1 Introduction

We have used many equipment and spare parts in this project. This chapter will demonstrate the functionality, availability, pricing and working principle of the major equipment used in this project. The basic principles, pin diagrams, the features and specification of our basic equipment such as Arduino Uno, relay, GSM module, LDR sensor, voltage regulator etc. will be discussed in details and it will give a clear idea about the project. GSM module mainly receives SMS from the controller and can also send SMS to the controller via Arduino Uno in this project. LDR sensor is used to sense the intensity of light and it turns ON/OFF the street lights accordingly. For example, in daytime the intensity of light is higher so it turns the street lights OFF. Along with these, the other components used for this project are discussed in this chapter.

2.1.1 Arduino Uno

Arduino is a single-board microcontroller, which is used to make the application more accessible which are interactive objects and its surroundings. The Arduino Uno Microcontroller is prepared based on the ATmega328 (Appendix A). There are 14 digital input and output pins in it. It also has six analog inputs, a Universal Serial Bus (USB) connection jack, a power jack, and in Circuit Serial Programming Header (ICSP) (Appendix A), and a reset button. The microcontroller has all the elements to support it properly. The microcontroller can be powered by a battery or by an USB or an AC-DC adapter. Arduino Uno is programmed by Arduino software. Arduino Uno is the controller of our project.

This microcontroller can operate between 6 volts DC to 20 volts DC, however if it is supplied by less than 7 volts then the 5volts pin may not supply 5volts and the board may malfunction. Therefore, it is better to use more than 7 volts and less than 20 volts.

The necessary power can be supplied by an external power supply like a battery or an AC to DC adapter or it can be supplied via a USB cable or any kind of voltage regulator that

can provide the required voltage. The pin diagram and features and specification of Arduino is discussing below.

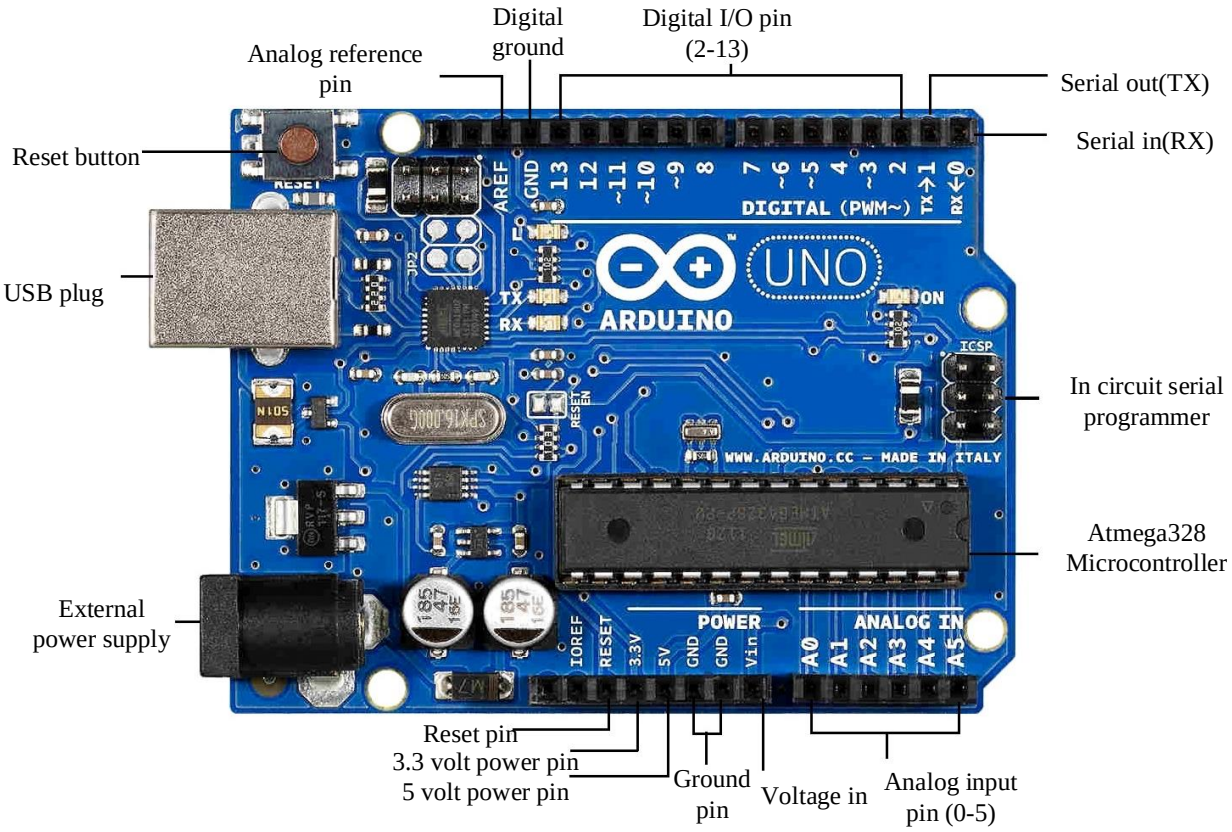

Figure 2.1: Arduino Uno. [17]

2.1.1.1 Pin Description

Arduino Uno has 14 pins that can be used as an input/output pin. Each of the pins have an internal pull-up resistor that is of 20 to 50 kΩ. Each of them operate at 5V and can supply or consume a maximum of 40 mA. The details of the pins are given below.

a. The Uno has six analog input pins, which are labeled as A0 to A5 and provide with 10 bits of resolution.
b. Among the 14 pins of input/output, pin 0 is used for receiving and pin 1 is used for transmitting purpose of the data. They are connected to the corresponding pins of the ATmega8 USB to TTL chip.
c. Pin 2 and 3 are used to start up an interrupt in case there is a low value, change in value or rising and falling edge.
d. Also pin 3, 4, 5, 6, 9, 10, 11 are used for 8 bit pulse width modulation (PWM).

e. Pin 10, 11, 12 and 13 provide the serial peripheral interface (SPI) communication with the help of SPI library. A LED is connected to the pin 13. When the pin 13 is HIGH, the LED is on and when the pin is LOW, the LED is off. Using the wire library A4 (SDA) or A5 (SCL) pin support the two wire interface (TWI) communication.

f. There are few more pins and one of them is an AREF pin which works as a reference voltage for the analog inputs

g. By default, the voltage varies from 0V to 5V but the upper end value can be changed using this pin along with analog Reference () function.

h. There is also a RESET pin which if brought down resets the microcontroller.

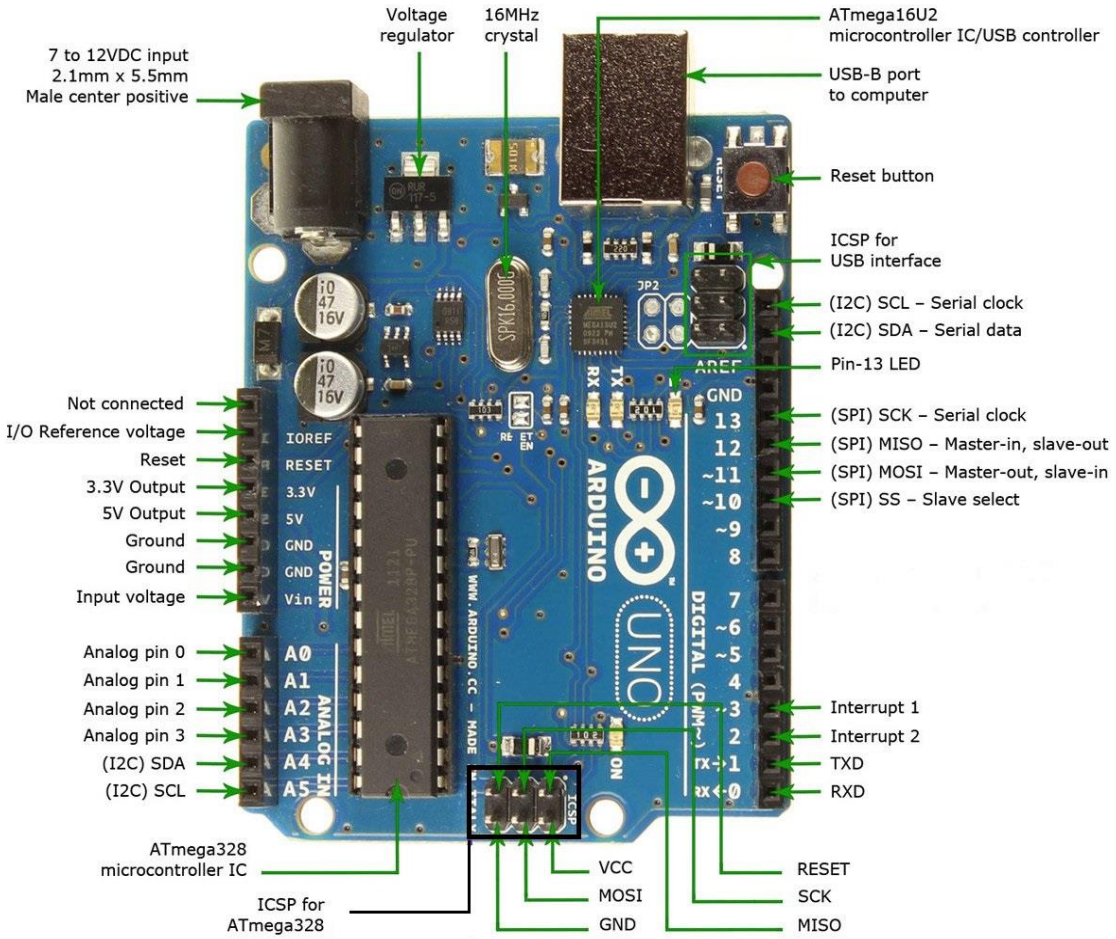

Figure 2.2: Arduino pin out diagram [18].

2.1.1.2 Features and Specification

The CPU type of Arduino Uno is 8-bit AVR. It generally performs at 20 MIPS at 20 MHz frequency. Its EPROM (Appendix A) is 1-kilo byte (kB), SRAM (Appendix A) is 2 kB

and the flash memory is of 32 kB. There are 16 channels and 28-pin PDIP, MLF, 32-pin TQFP, MLF. There is a maximum of 26 input/output pins. The maximum frequency for this is 20 MHz. There are two external interrupts.

2.1.1.3 Connections with Arduino

Arduino is the controller in this project. It controls the whole project. Each equipment of this project has connection with Arduino. Figure 2.3 represents the connection of the main equipment of this project like GSM, LDR sensor LED with Arduino.

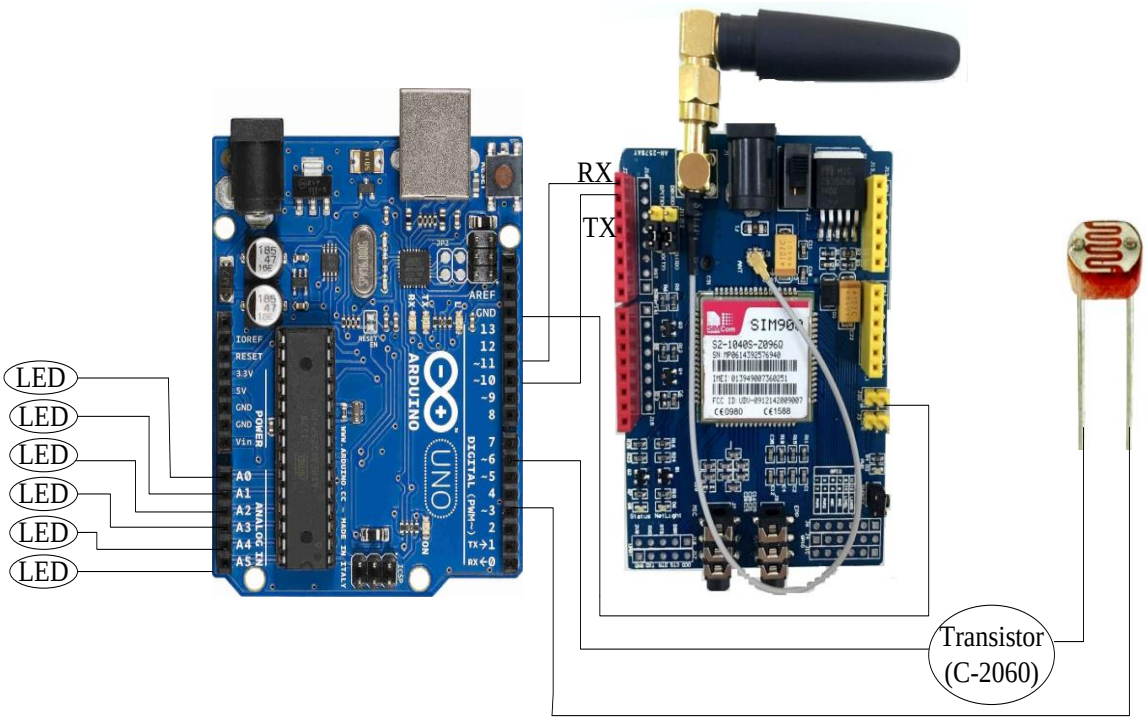

Figure 2.3: Connection between Arduino and different equipment.

Arduino is mainly a PCB board, which contains different equipment like microcontroller, IC, resistor, capacitor, amplifier etc. Figure 2.4 represents the circuit diagram of Arduino and its connection with different equipment of the project. There are three sections in the circuit diagram of Arduino. They are given below,

a. Microcontroller section.
b. USB bridge section.
c. Power section.

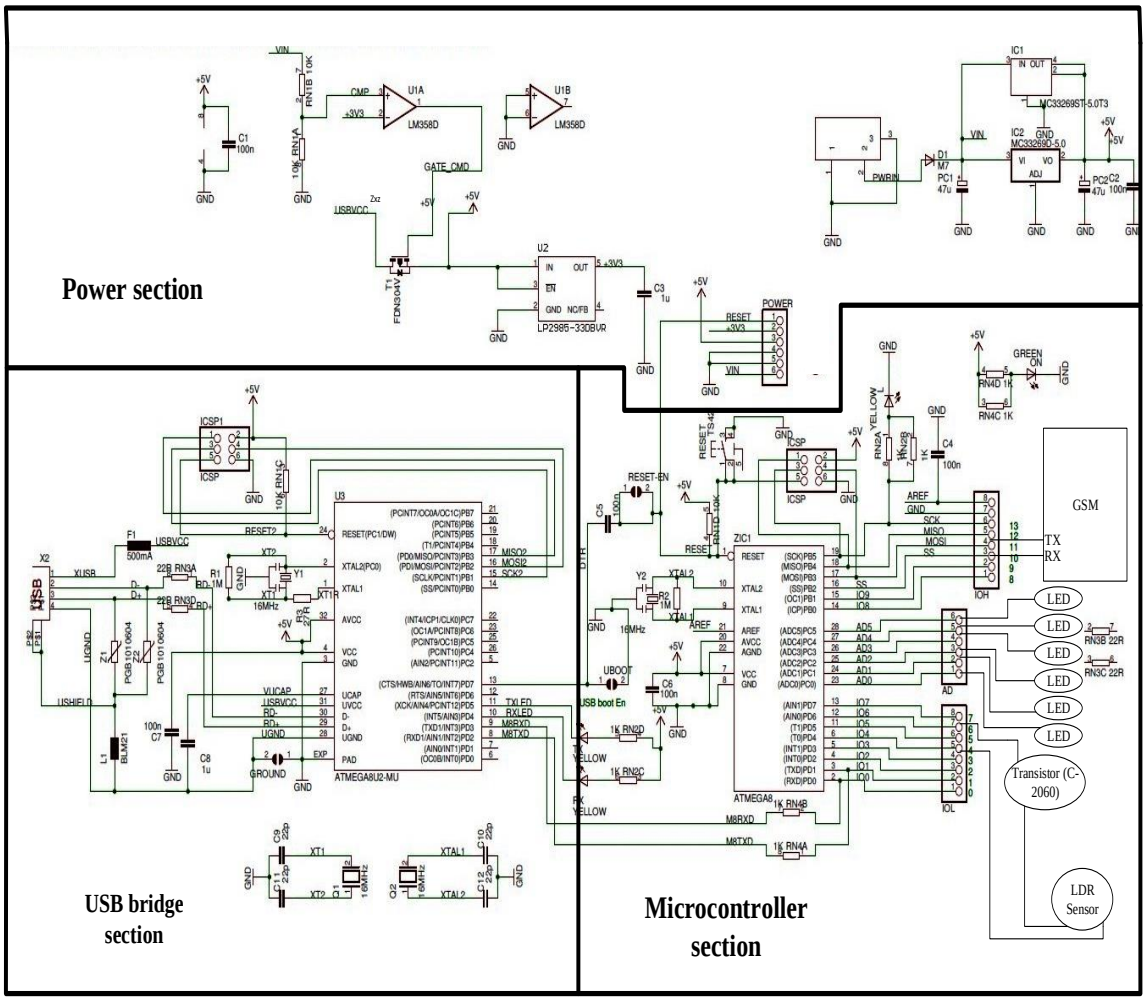

Figure 2.4: Circuit diagram of Arduino and connection with different equipment [19].

2.1.1.4 Working Principle of Arduino Uno

Arduino Uno is a microcontroller board and it is based on ATmega328 chip that is easily available. Microcontroller acts as the brain of the Arduino and send/receive information or command from the device that is connected to the Arduino. The Arduino Uno board can be programmed with the Arduino software. Arduino Uno have many features that include PWM pins, external and internal interrupts, timers etc. As shown in figure 1.1, the Arduino Uno board has an USB interface and it can be plugged-in in any USB port at any place thus making it easier to connect the Arduino with modern day devices at any place. The clock speed for this device is 16 MHz, which makes its application very fast, and to save the code it has 32 KB of memory allocation. In addition, it is good for troubleshooting and debugging and as for power control; it has a voltage regulator already built inside it. It can be externally supplied up to 12V, the voltage regulator will regulate

it to 5V, and 3.3V or it can be directly connected to any USB port without connecting it to any external power supply. There is a pin that take on external power supply and two other pins for 5V and 3.3V power and also there are ground pins. There is an ICSP connector that is used to bypass the USB port. Other than that, it also interfaces the Arduino as a serial device and act as a re-bootloader for chips that get damaged. A bootloader is a programmer that programs the microcontroller and installs new firmware without needing an external programmer. It has a few RESET buttons that reset the Arduino microcontroller and make it easier to carry out different operations. We can see that it has 14 digital pins and six analog pins form figure 1.1 and sensors or other electronic devices can be connected to the corresponding pins directly. Arduino Uno microcontroller has the potential to sense the environmental status after it receives data from various sensors. It has the ability to influence its surroundings by controlling lights, motor etc.

2.1.1.5 Why Arduino is Chosen over Microcontroller

There are some advantages of Arduino, that's why we choose Arduino over Microcontroller.

a. The Arduino allows easy and fast prototyping.
b. Arduino is a must when it is necessary to control more parameters and also in case of implementing the prototype or practical implementation because it is very difficult to implement practically if Microcontroller is used.
c. Arduino provides a number of libraries which can be used for programming it easily than Microcontroller.
d. The greatest advantage is having the hardware platform which is set up already.
e. Though Arduino is more expensive than Microcontroller, but the Arduino has more features and it is less time consuming.

2.1.2 GSM Module

Global System for Mobile communication or shortly GSM is a digital cellular technology developed for communication purpose. It is one type of communication modem that provides voice and data services to the user. This digital system was designed using Time Division Multiple Access (TDMA) technique. The service operates from 850 MHz up to 1900 MHz approximately.

2.1.2.1 Working Principle of GSM Module

A GSM digitizes the information data and thus reduces it. Then it sends the reduced data down a channel. The channel has two separate streams of client data and different time slots are assigned to each. The data rate of this system ranges from 64 kbps to 120 Mbps.

The components with which a GSM is formed are shortly described here. By mobile station, we refer to the mobile phones that we use and it includes the processor. It also consists of the display and the transceiver. The mobile station is controlled by a SIM card, which operates through the network. The base station subsystem works like an interface between the mobile station and network subsystem. It includes the Base Transceiver Station (BTS) (Appendix A). The BTS consists of the radio transceivers and controls the protocols for communication with mobile stations. There is also Base Station Controller (BSC) (Appendix A), which is used to control the BTS. In addition, it interfaces between the mobile switching centers and the mobile stations. The network subsystem gives the basic network connections needed for a mobile station to function. The main content of this network system is the Mobile Service Switching Center (MSC) (Appendix A). It also consists of the Home Location Register (HLR), Visitor Location Register (VLR) and Equipment Identity Register (EIR). The MSC give access to various networks such as Integrated Services Digital Network (ISDN), Public Switched Data Network (PSDN), Public Switched Telephone Network (PSTN) etc. The HLR and VLR provides call routing and roaming facilities to GSM. The EIR maintains an account for all the mobile equipment. In this account, all the mobiles are identified each by their unique International Mobile Equipment Identity (IMEI) number.

2.1.2.2 Features and Specifications

GSM module has quad band of 850/ 900/ 1800/ 1900 MHz and also its GPRS multi-slot class 10/8 and GPRS mobile station class B. Compliant to GSM phase 2/2+Class 4. Control via AT commands (GSM 07.07, 07.05 and SIMCOM enhanced AT Commands). It has low power consumption capability. It operates from 40°C to +85°C.

Figure 2.5: GSM Module. [20]

2.1.2.3 Applications of GSM

GSM is used in many ways and it has different applications. Some of the applications of GSM are given below-

a. Mobile telephone
b. Telemetry system
c. Automatic meter reading
d. Toll collection
e. Remote control
f. Value added service
g. Anti-theft detection alarm
h. Fault detection

2.1.3 LDR Sensor

A LDR is a sensor whose resistivity is a function of incident ray on the sensor. Therefore, they are light sensitive devices and made up of semiconductor materials having high resistance. LDR is also called as photo conductors, photoconductive cells or photocells.

Figure 2.6: LDR sensor. [21]

2.1.3.1 Basic Structure of the LDR Sensor

LDR consists of two metal film contact and Cadmium Sulfide (CdS) track. The spiral track in the figure 2.7 is the Cadmium Sulfide film. The metal film contact is on the top and bottom which are connected to the terminal. A clear plastic covers the whole structure of LDR, so that the external light can easily enter through it. The cadmium sulfide is used where there is no light.

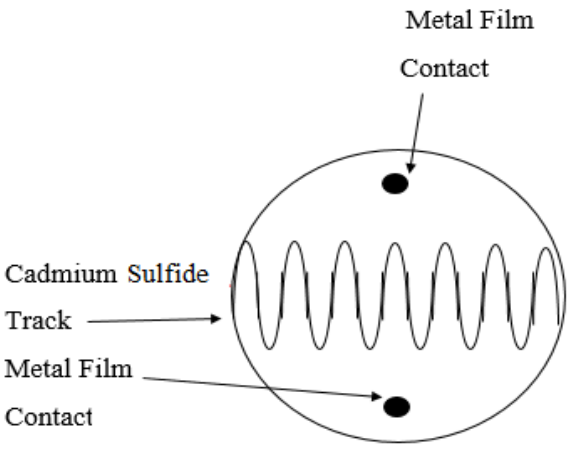

Figure 2.7: Basic structure of LDR.

2.1.3.2 Working Principle of LDR

When light falls or to be specific, photons fall on the device, the electrons in the valence band of the semiconductor material are excited and moved to the conduction band. If the photons in the incident light have greater energy than the band gap of the semiconductor material, then electrons will jump from the valence band to the conduction band. Hence, when light having enough energy fall upon the device, more and more electrons are

excited and moved to the conduction band. It results in large number of charge carriers. By this process more current starts flowing through the device when the circuit is closed and thus the resistance of the device is decreased. This is the most common working principle of LDR.

2.1.4 Adaptor (Voltage regulator)

Adaptor is one kind of voltage regulator. A voltage regulator is an electronic device that maintains the voltage level of a power source according to a given voltage range. A voltage regulator is designed such that it automatically stabilize a particular voltage level. It reduces voltage variation and thus protects the equipment from damage. Thus it plays a very important part in protecting electronic devices. Figure 2.8 represents circuit diagram of a 12V, 2 amp DC. This is mainly a 12V voltage regulator. The design of a voltage regulator either can be a forward design or can have a negative

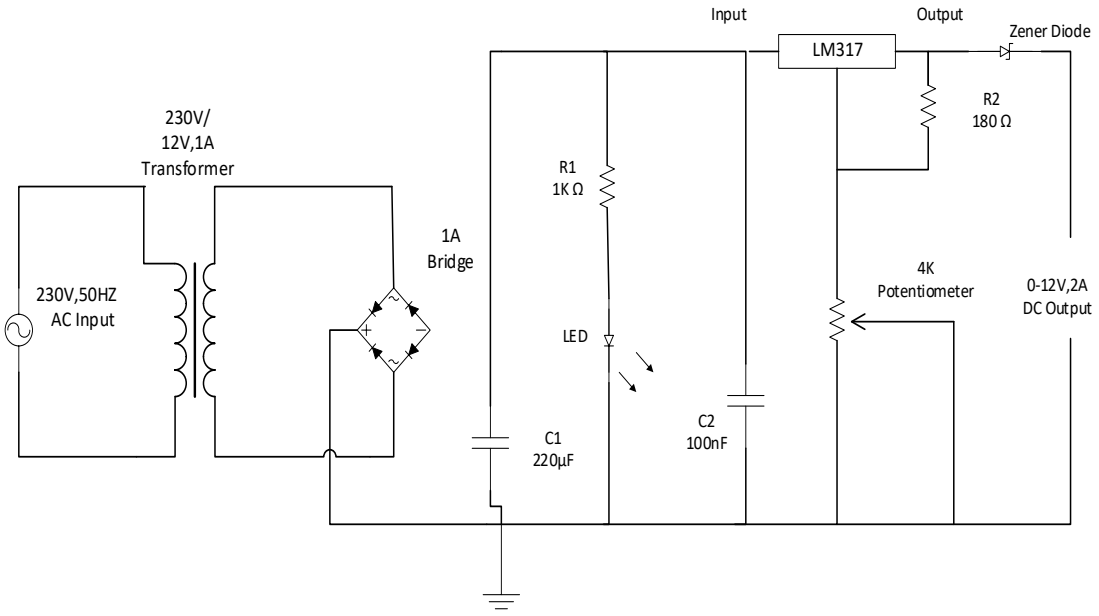

Figure 2.8: 12V, 2 amp circuit diagram.

feedback loop. Depending on its design, it is decided if it can regulate a single or more voltages (AC or DC). The reason to use voltage regulator is to stabilize a constant dc output voltage and to block ripple voltages that the filter could not block.

The voltage regulator can be used for two purposes. One is to keep the output constant at desired voltage despite of variations in the circuit while the other one is to regulate the output voltage according to the need. The voltage regulator may also include other circuits

like short circuit, current limiting circuit etc. for protection purpose. We have to use an adaptor for our project of 12V, 2 amp. This is used for the external supply of GSM. This adaptor is very flexible and is widely employed in all types of circuit like a voltage regulator.

2.1.5 BC-547

BC-547 is a Bipolar Junction Transistor (BJT). Like any other transistor, the BC-547 transistor can be used for several purposes. It can be used as a switch that can toggle small electronic compliances whenever there is any external changes. It can be both NPN and PNP, which has three terminals. Among which the left most terminal is usually the collector, the middle one is base and the right most one is the emitter. In the NPN transistor the collector is generally connected with a power supply, the base provides the circuit with switching signal and the emitter terminal is connected to the ground. It can work for with switches and amplifiers actively. It generally works as transistor array, which is used in digital switching that, helps making the layouts easier. The switching is done if the configuration of the 3 terminals of the transistor is appropriate.

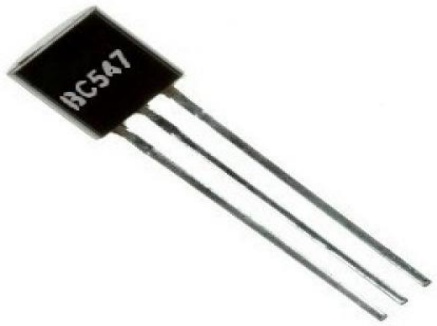

Figure 2.9: BC-547 [22]

2.2 Software Requirement

Software is used for programming purpose. Without programming the Arduino, it is impossible to run the project. In the proposed system, we have programmed Arduino UNO by using Arduino software. It is a full software development environment with an editor, simulator, programmer etc. The Arduino IDE supports the languages C and C++ using special rules of code structuring.

To program Arduino, Arduino software was installed. Then we have to connect Arduino to the USB port of the computer. USB cable is required to connect it to the computer. Every Arduino has a different virtual serial-port address, so we have to reconfigure it. Then the board type and the serial port will be set in the software. After writing the code, it was loaded to the Arduino board and Arduino cable was disconnected from the combiner.

2.3 Expenditure of the Project

The equipment used for this project is listed below. Their expenditure has also been added our main focus was to keep the costing minimum but get the most efficient result. The market prices at the moment are listed below.

Table 2.1: Total expenditure of the project

Serial No.	**Name of the Equipment**	**Quantity Required**	**Unit Price (TK)**	**Total Price (TK)**
1	GSM module	01	2300.00	2300.00
2	Arduino Uno	01	500.00	500.00
3	Adaptor	01	150.00	150.00
4	Breadboard	02	120.00	240.00
5	SIM	01	100.00	100.00
6	Wire	05 gauge	5.00	25.00
7	Resistor	20	0.50	10.00
8	Capacitor	02	30.00	40.00
9	LDR sensor	01	20.00	10.00
10	BC-547	01	20.00	20.00
11	C-2060	01	30.00	30.00
12	LED	10	10.00	100.00
	Total Cost in TK			3525.00

2.4 Conclusion

Above are the equipment used in this project. The working principle of the equipment and their features as discussed above will help us to understand the structure and mechanism of our aspired project. From the given pin diagrams, an abstract idea about

the equipment is provided. The list of equipment and their prices have been stated in the above discussion. The equipment are very much available in the local electronics stores with a very reasonable price. They also have a good sustainability and the equipment function well enough to execute our project. We have shown the details of expenditure that the project may cost in case we want to implement it as well as the software we have used to program the project. In the next chapter the analysis of the whole system is stated in details with necessary circuit diagram and block diagram in case of implementing the project prototype or practical implementation with the power requirements to the equipment.

Chapter-3

ANALYSIS OF THE SYSTEM

3.1 Introduction

In the previous chapter, we have discussed the components that are used in this project and their cost. In this chapter, we are going to discuss the whole system for both prototype and practical implementation. We are also going to discuss the system model and system analysis, block diagrams, power supply of the system etc. For completing this project, we need to follow some circuit diagrams and block diagrams. In this chapter, we have also discussed the whole project procedure in the project overview, from where we can easily understand the function of each equipment and how the project works. In the system diagram, we have discussed how the street lights are controlled. We will discuss these things in details in this chapter.

3.2 System Block Diagram for the Project

Different Types of hardware components are used in this project. They are already discussed in chapter 2. Block diagram of the project shown in figure 3.1 represents the main concept of our project. The block diagram consists of various components such that Arduino UNO as controller, LDR sensor for sensing the intensity of light, GSM module for wireless transmitting and receiving of SMS, and street lights. Here, Arduino needs 5V and GSM needs both 5V and external 12V supply.

We have made a prototype, which has two sections of street lights. There are three features to control the street lights. First, one is manual switching system. Manual switching is done by hand. By manual switching we can control both sections together and also individually. Second, one is using the sensor and third one is implemented by mobile SMS. For the sensor based switching system, we are using LDR sensor. It gives the output by measuring the intensity of light. At night, the intensity of light is very low and the sensor then send the instruction to the Arduino and light is turned ON. During daylight, the intensity of the light is high, the sensor will send the instruction to the Arduino, and lights will remain turned OFF. For SMS system, there is a SIM, which is programmed in the GSM module. The SIM contains a fixed number, which is operated

by a controller. When there is a need to turn ON/OFF the lights, controller will send a code word SMS that has been programmed beforehand. Then GSM will receive the command and it sends the instruction to the Arduino and then Arduino sends command to the light accordingly. We can control both sections together and individually via SMS. If any light is damaged or does not turn ON or any fault occurs, then a SMS will be sent to the fixed number from GSM and then proper step will be taken by changing the damaged light or by repairing it.

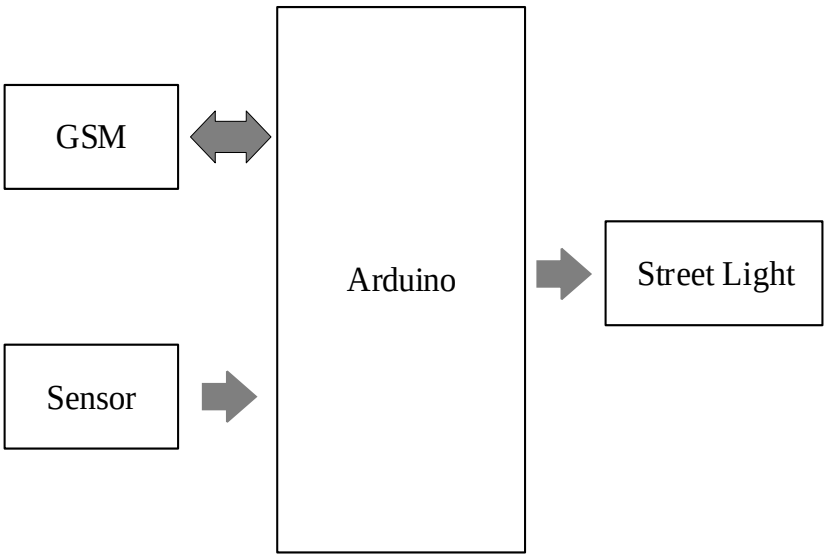

Figure 3.1: Block diagram of our project.

3.2.1 System Model for Practical Implementation

System model that is described in article 3.1 is applicable for the prototype that we have made. However, if we want to implement it practically, we will have to change the power supply, use more equipment and modify the process a little. We need some extra equipment like relay, circuit breaker etc. for practical implementation of this project. The output of the logical embedded system is directly connected to LED in our project but for practical implementation, the output of the logical embedded system is connected to street lights via relay and circuit breaker which is shown in figure 3.4. Relay is placed before circuit breaker and it switches the power supply to 220V. Circuit breaker is placed before street lights. Because if there is overflow of current then the lights will get damaged. Hence, circuit breaker save lights from being damaged from overflow of current by disconnecting the circuit. Figure 3.2 shows the implementation of this project for a section of street lights.

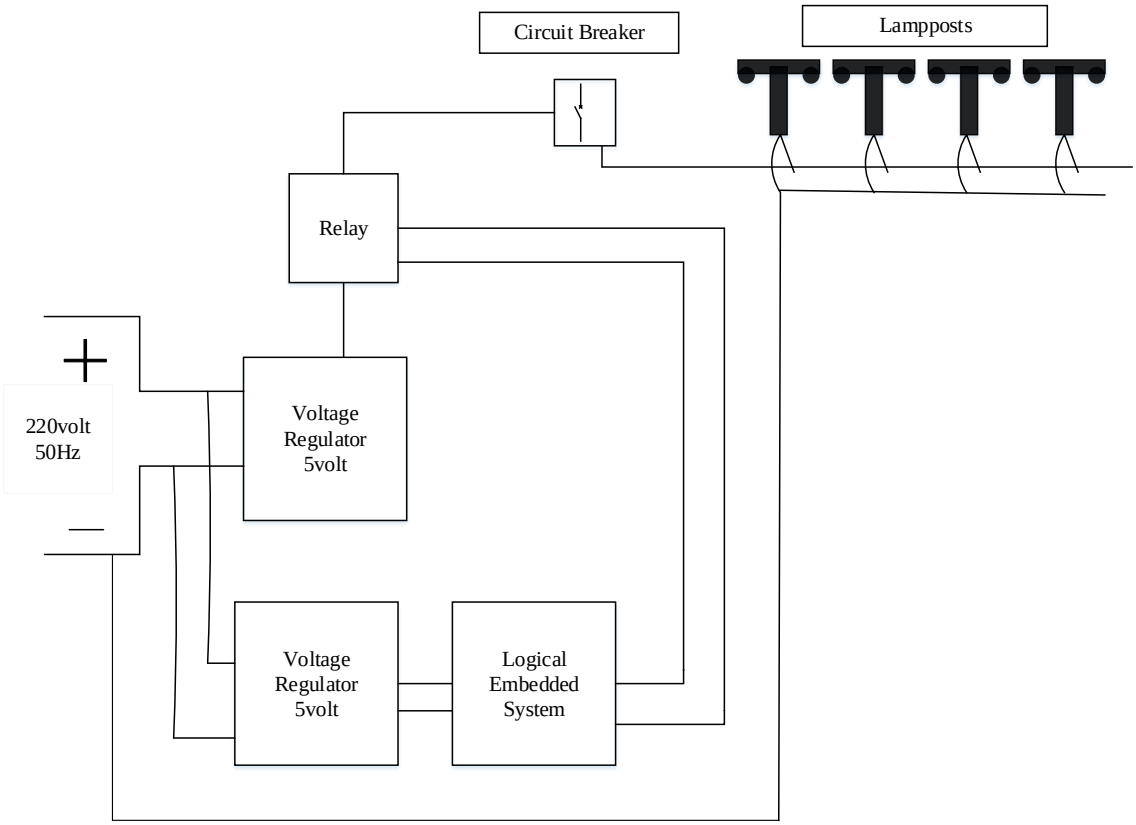

Figure 3.2: Block diagram for the implementation of the project.

3.2.2 Power Supply of the System

Primarily we need to supply required amount of power to run the project. Here, we need 5V DC power supply and 12V, 2amp DC power supply because the operating voltage for Arduino used in this project is 5V DC and the operating voltage of GSM is 12V, 2 amp DC. Normally the AC supply voltage is 220V. Hence, if we want to get 5V and 12V power supply, we have to regulate the AC supply. Figure 3.3 represents this process.

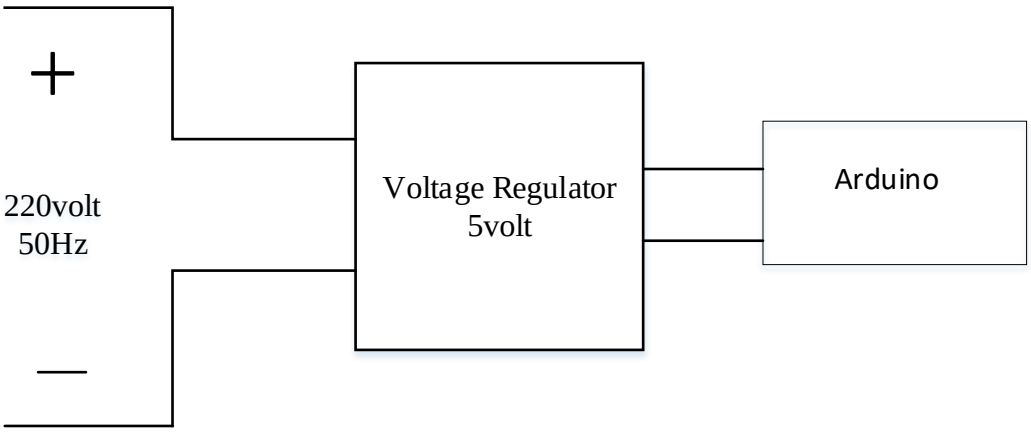

Figure 3.3: Power supply to Arduino.

Similarly, as GSM needs 12V, 2amp DC power supply, this voltage is regulated from 220V. We use a 12V, 2amp adaptor as a voltage regulator. This adaptor regulates 220V to 12V, 2amp DC that is fed to GSM. This process is shown in the following figure 3.4.

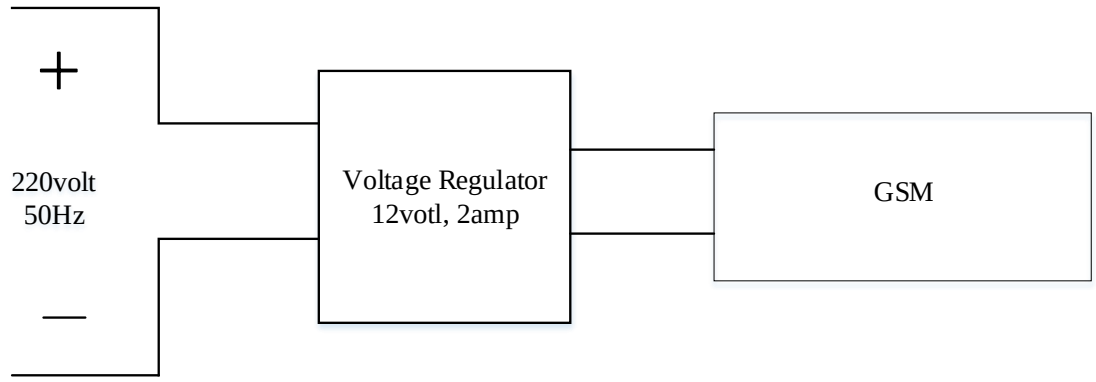

Figure 3.4: Power supply for GSM.

3.2.3 Picture of the Project

We have shown the whole picture of this project in this article. The side view of our project is shown in figure 3.5 and the upper view of project is shown in figure 3.6. In both figure we can see the connections of this project. We have used LED light as street lights. We can see in the picture that there are total six lights divided by two sections. Each section consists of three lights. There are Arduino Uno and GSM module, breadboard, two switchboxes that are switchbox 1 and switchbox 2, LDR sensor, 2 types of transistors, which are C-2060 and BC-547 etc. The descriptions of the equipment have already been given in article 2.1. The system model of the project is given in article 3.2. There are some key features of this project like manual switching, sensor based switching, switching via mobile SMS, feedback SMS, switching according to specific time. How this features work are described in article 4.2. The project mechanism and circuit diagram of this project is given in article 4.3.

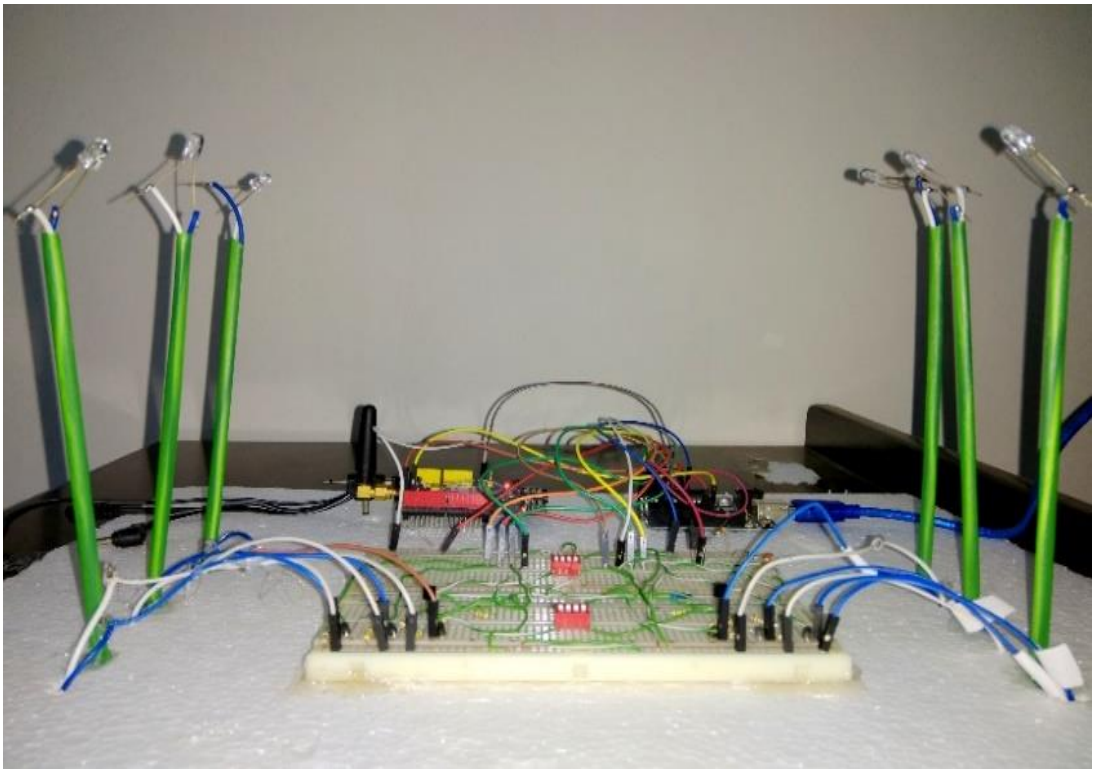

Figure 3.5: Side view of the project.

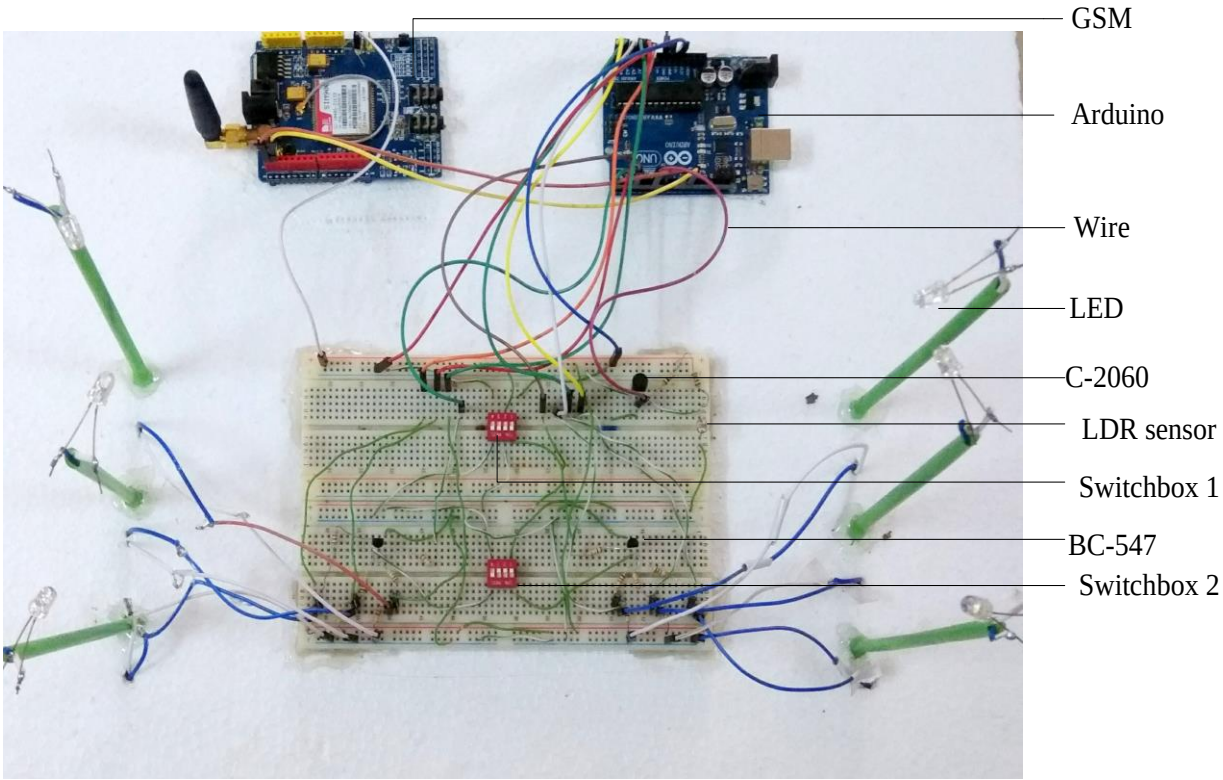

Figure 3.6: Top view of the project.

3.3 Conclusion

In this chapter, we have discussed the whole project procedure. Here Arduino controls GSM and SMS transmission and reception is done by GSM module. For the light sensor technique, by sensing the intensity of light, LDR sensor turns the light ON/OFF. The system may also be operated according to specific time instead of using LDR sensor. We have shown the power requirements of the Arduino and GSM and the connection of the major equipment with Arduino. The connection diagram for practical implementation in AC line is also shown in this chapter. We have also discussed how the lights can be controlled in different ways. In the next chapter, we will discuss the different key features of the project, their working mechanism, implementation in AC line, fields of application and diversity of application of the project with necessary figures and block diagrams.

Chapter- 4

RESULTS AND DISCUSSIONS

4.1 Introduction

The prospect of the project was the easy and user-friendly implementation of the street lighting system as well as the reduction of necessary manpower to run the whole system. Our project helps to achieve this target especially by four ways. Manual switching, with the help of sensor, mobile SMS, can do this street lighting process and we can get a feedback SMS if there is any fault in any lights. The key features will be discussed elaborately in this chapter and we will discuss the feature of timing based switching here. The project mechanism and the process of implementing it on AC line will also be discussed in this chapter. We can apply this project in different fields; some of them will be mentioned in this chapter. With some modification, it can be used for much different use and the scope for that will also be discussed here. In general, we will discuss the result of the whole project in this chapter.

4.2 Key Features

This project has many especial features that makes the street lighting system easier, user friendly, cost effective and reduces power consumption. The key features of the project are,

a. Manual switching
b. Sensor based switching
c. Switching via mobile SMS
d. Feedback SMS system
e. Switching according to specific time

We have discussed the working principle and operation of each feature of the project in details with necessary figures below.

4.2.1 Manual Switching

We have two manual switching system. Firstly, switching the lights according to individual section. Secondly, we can control both section together that means we can

ON/OFF both section simultaneously. This is the simplest process and this feature is common for all street lighting system over the world. If for any reason, the sensor does not work or switching via SMS fails due to network problem then we can use the manual switching system.

If we want to turn ON/OFF the lights of section 1 and section 2 simultaneously, then we can do it by moving the selected switch of switchbox 1 upward/downward. If we want to turn ON/OFF the lights of section 1 or section 2 individually then we can move the selected switch for each section in switchbox 2.

The process of manual switching can be easily understood by the following figures. At first, the manual switching process for individual section of light will be discussed. By using switchbox 2, the lights of individual sections can be turned "ON" or turned "OFF". The switch 1 of switchbox 2 is assigned to light section 1 and the switch 4 of switchbox 2 is assigned to the light section 2.

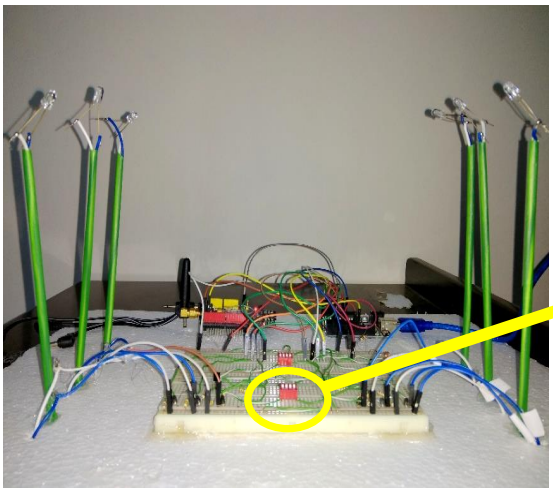

Figure 4.1 (a): Lights of two sections are switched OFF.

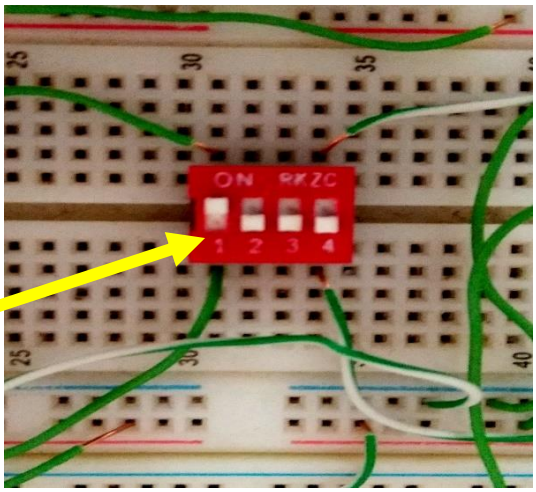

Figure 4.1 (b): Switch 1 of switchbox is moved upward.

As shown in figure 4.1(a), all the lights are turned off. To turn ON the lights of section 1 switch 1 of switchbox 2 is moved upward. The expanded view of the switchbox 2 has been shown in figure 4.1(b) and after moving the switch upward, the lights of section 1 are turned ON as shown in figure 4.1(c).

Similarly, if we want to turn “OFF” the lights of section 1, switch 1 of switchbox 2 will have to be moved downward. This is the process of turning ON/OFF the lights of section 1 individually in manual switching system.

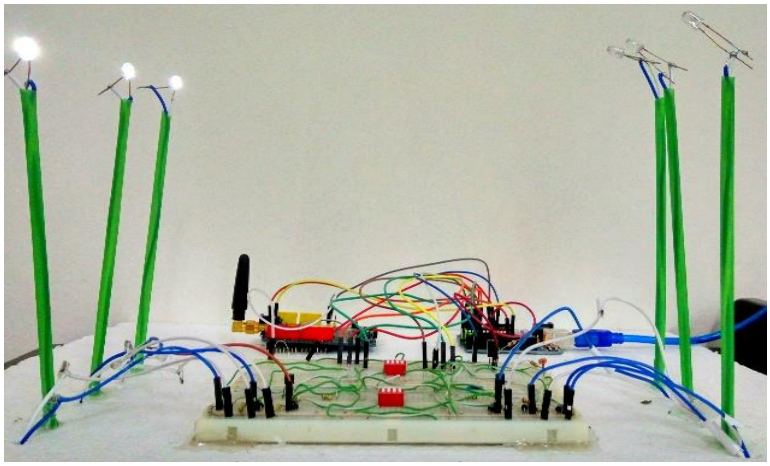

Figure 4.1 (c): Lights of section 1 is switched ON after moving the switch 1 upward.

Similarly, to turn ON/OFF the lights of section 2, we have followed the following procedure.

We can see, at first all the lights of both sections are turned OFF as shown in figure 4.2(a). We can turn the lights of section 2 ON by moving switch 4 of the switchbox 2 upward. The expanded view of the switchbox 2 when switch 4 is moved upward is shown in figure 4.2(b).

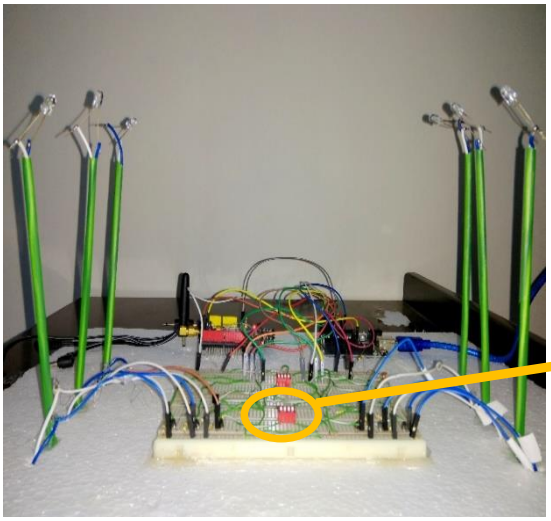

Figure 4.2 (a): Lights of two sections are OFF.

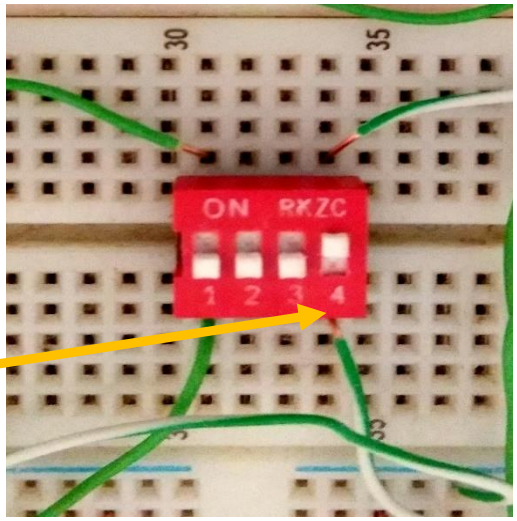

Figure 4.2 (b): Switch 4 is moved up.

After moving the switch upward, the lights of section 2 are turned ON as shown in figure 4.2(c). Similarly, if we want to turn “OFF” the lights of section 2, switch 4 of switchbox 2 will have to be moved downward. This is the process of turning ON/OFF the lights of section 2 individually in manual switching system.

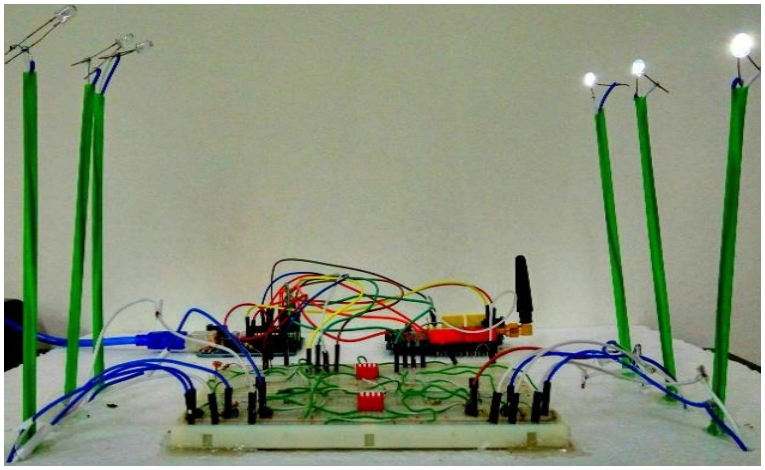

Figure 4.2 (c): Lights of section 2 is switched on after making the switch 4 ON.

To control both sections simultaneously switchbox 1 is used. We can switch ON/OFF the lights of the both section manually. If anyhow, the lights are turned ON at a wrong time or other features do not work properly, then we can move the switch 4 of switchbox 1 downward. In figure 4.3(a) all, the lights are turned ON and to turn OFF the lights of both sections simultaneously the switch 4 of switchbox 1 will have to be turned downward. The expanded view of switchbox 1 when switch 4 is moved downward is shown in figure 4.3(b) and after moving the switch 4 of switchbox 1, all the lights of both section will be turned OFF.

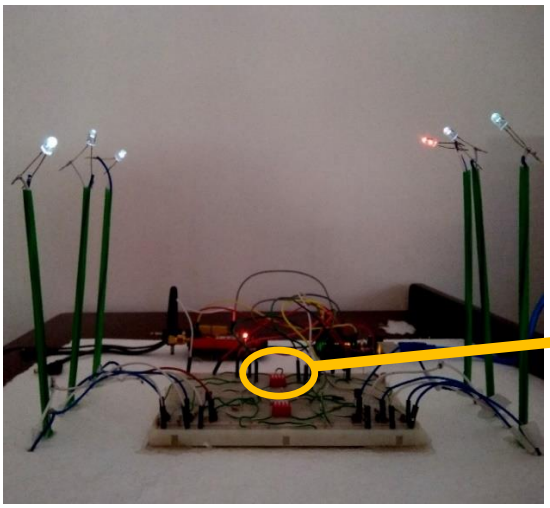

Figure 4.3 (a): Lights of both sections are turned ON.

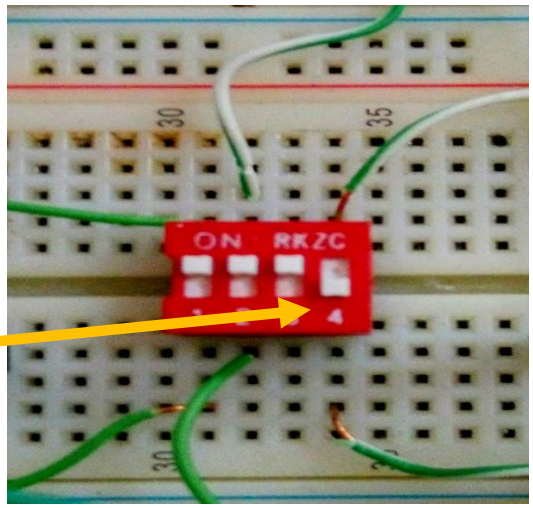

Figure 4.3 (b): Switch 4 of switchbox 1 is moved downward.

As shown in figure 4.3(c), the whole system is switched OFF. We can also switch ON the whole system by moving the switch 4 of switchbox 2 upward. Similarly, if we want to turn ON the lights of both section, switch 4 of switchbox 1 will have to be moved upward.

This is the process of turning ON/OFF the lights of both section simultaneously in manual switching system.

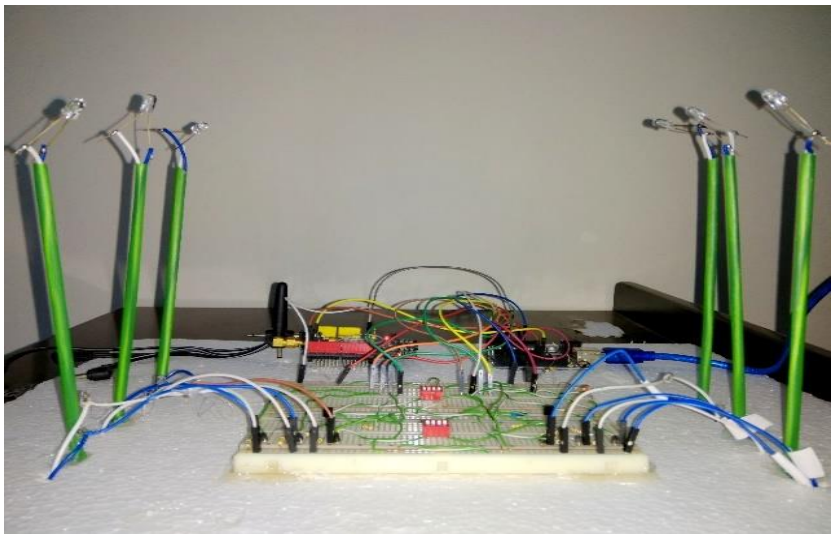

Figure 4.3 (c): All lights of both section are switched OFF after pressing the switch 4 OFF the second switchbox.

Above, we have discussed the manual switching of our project. We have shown the procedure for manually switching the lights of both sections individually and simultaneously to turn ON/OFF in details and the other features will also be discussed in this chapter.

4.2.2 Sensor Based Switching

We can switch the lights according to the intensity of light by using light sensors. We have used a LDR sensor, which switches the lights according to the intensity of light. If the intensity of light goes down a certain value, then the lights are automatically switched ON. Similarly, if the intensity of light goes up a certain value in the morning then the lights are automatically switched OFF. This process works fine during any season.

The intensity of light is higher at daytime and sensor sends the command to Arduino and Arduino command the lights accordingly and the thereby the lights are turned OFF, as shown in figure 4.4(a), by the LDR sensor. The expanded view of the LDR sensor used in our system is shown in figure 4.4(b).

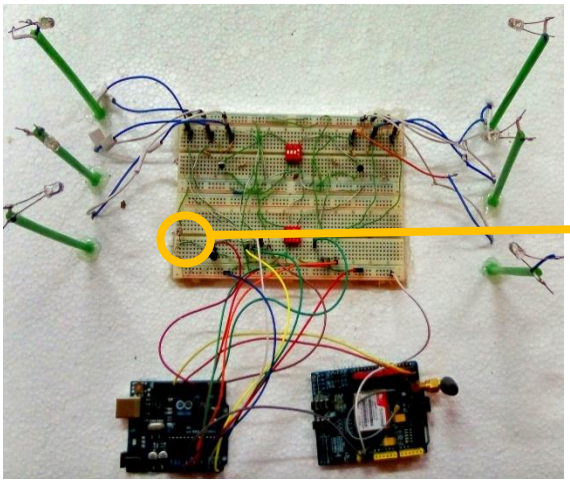

Figure 4.4 (a): Lights of two sections are OFF at daytime.

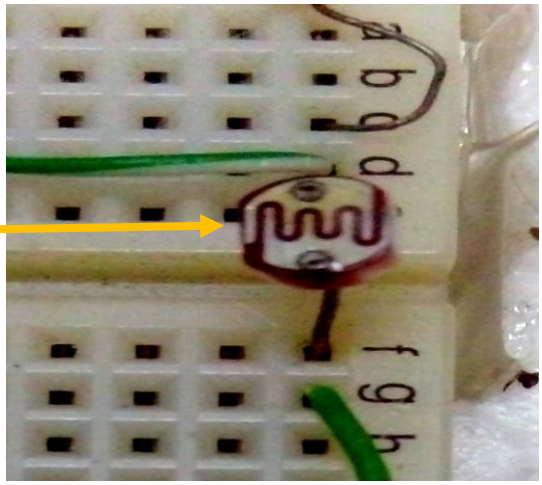

Figure 4.4 (b): LDR sensor.

Similarly, when the intensity is low at night, then sensor sends this command to Arduino and Arduino commands the lights accordingly and thereby the LDR sensor, which is demonstrated in figure 4.4(c), turns ON lights.

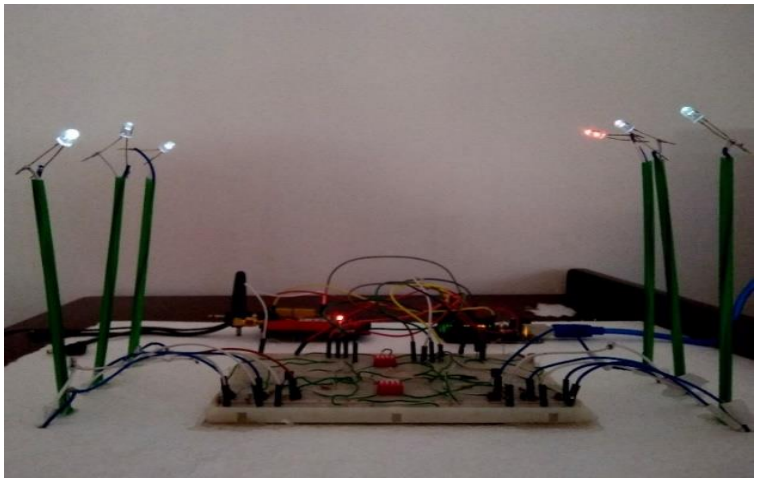

Figure 4.4 (c): Lights of two sections are ON at nighttime.

If any fault occurs which means if the lights are not turned ON/OFF at proper time, then the LDR sensor might be damaged which can be fixed very easily. The LDR sensor is very cheap and replacing the sensor will again make the whole system functional as before. We have shown the procedure for sensor based switching of the lights in details and the other features will also be discussed further.

4.2.3 Switching Via Mobile SMS

The main feature of the project is that we can switch ON and OFF the system via mobile phone SMS. The system has a GSM, which contains a SIM and we can choose any

network operator according to our choice. The controller is given a fixed number and the system is programmed in a way that, if we send a predefined coded SMS to our chosen SIM operator from the fixed number, the lights are switched ON or OFF according to the message. We have programmed different SMS for switching the lights ON and OFF.

When street lights are needed to be switched ON/OFF, controller sends SMS with specific code from the fixed number. This SMS is received by the SIM of the GSM, GSM sends the command to the Arduino, and then Arduino commands the lights accordingly. Thus, the street lights are turned ON/OFF via SMS.

We have programmed some SMS code, which are used to control the street lights for this project. To switch ON/OFF both the section simultaneously, the code word is "LaneN *ON"/ "LaneN OFF" respectively. To switch ON/OFF section 1, the code word is "Lane1 *ON"/ "Lane1 OFF". To switch ON/OFF section 2, the code word is "Lane2 *ON"/ "Lane2 OFF". The controller can use any of these code word according to the necessity. After getting command via coded SMS, street lights will work accordingly.

If there is a network problem, then the GSM will not receive the SMS in time and thereby lights will not be switched ON/OFF in time. In that case, we will have to switch the lights manually. Hence, it is better to choose a mobile operator that has the strongest network strength in the area where we want to implement this system.

For example, in our project, we have two sections and at the beginning, all the lights for both section are turned OFF as shown in figure 4.5(a). We have set the code "LaneN *ON" for switching ON the lights of two sections simultaneously as shown in figure 4.5(b).

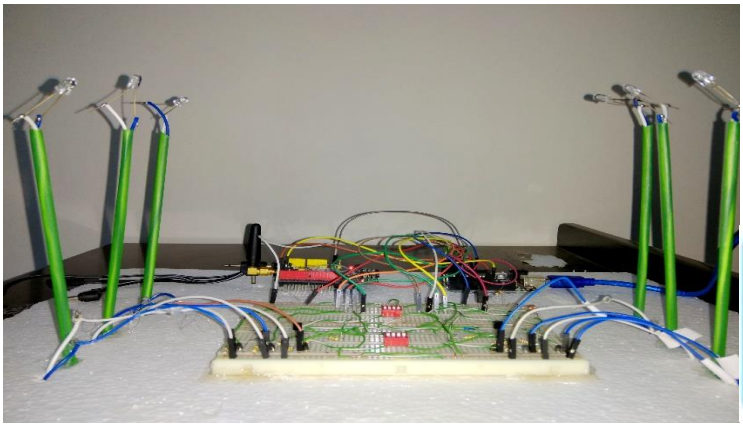

Figure 4.5 (a): While lights of two sections are OFF.

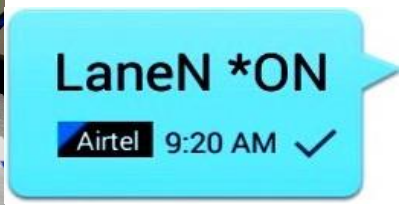

Figure 4.5 (b): SMS is sent.

After sending the SMS all the lights of both sections are turned ON as shown in figure 4.5(c). For switching them OFF, we have set the code word “LaneN OFF” as shown in figure 4.5(d).

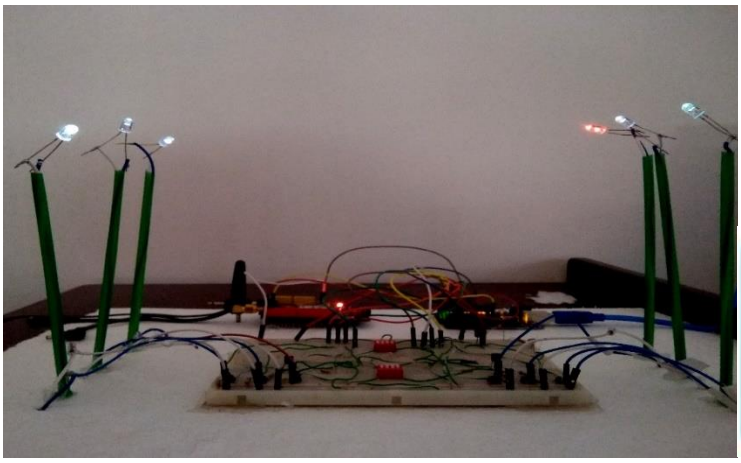

Figure 4.5 (c): After receiving SMS, all the lights are ON.

Figure 4.5 (d): SMS is sent.

After sending this code word to the GSM SIM number, it switches the lights OFF as shown in figure 4.5(e) and it takes few seconds to execute the command.

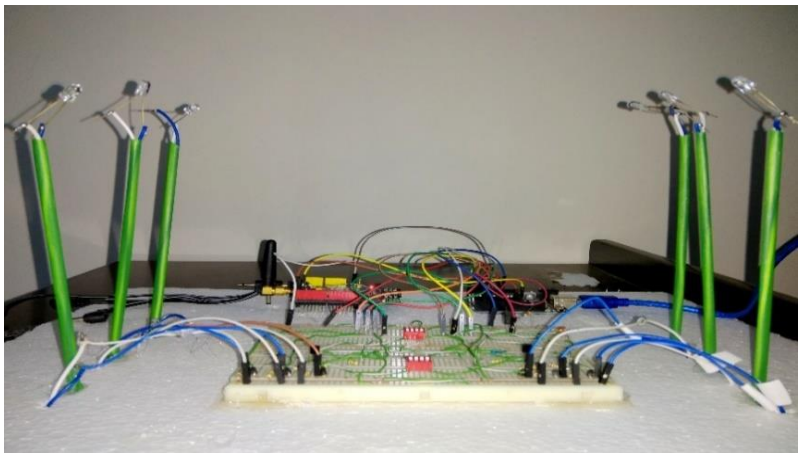

Figure 4.5 (e): After receiving SMS, all the lights are OFF.

In the above process, after sending SMS from controller, GSM receives the SMS and sends the command to Arduino and Arduino commands the lights according to the SMS.

Similarly, we can also control the sections individually via SMS. Suppose we want to control the lights of section 1 individually. All the lights are turned OFF as we can see from figure 4.6(a). If we send the SMS code word like “Lane1 *ON” as shown in figure 4.6(b).

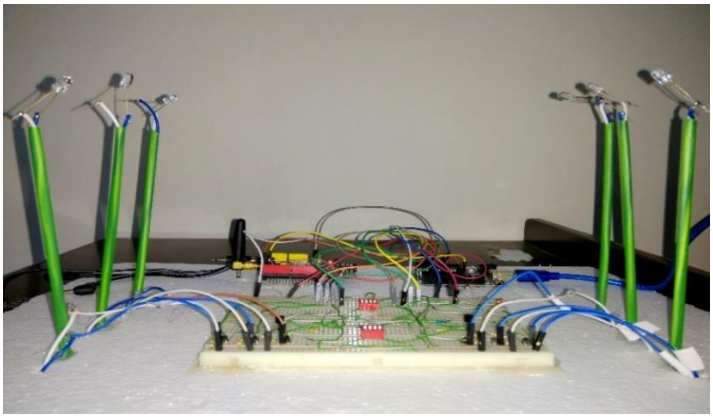

Figure 4.6 (a): While lights of two sections are OFF.

Figure 4.6 (b): SMS is sent.

After receiving SMS, GSM sends the command to Arduino and Arduino turns ON all lights of the section 1 as shown in figure 4.6(c). If we send the SMS code word like "Lane1 OFF" as shown in figure 4.6(d).

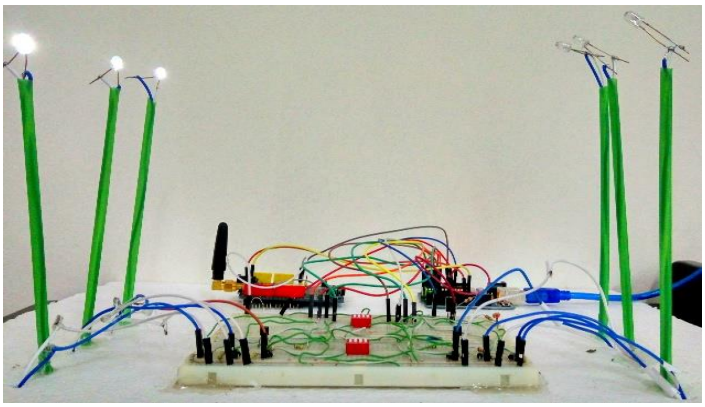

Figure 4.6 (c): After receiving SMS, all the lights of section 1 are ON.

Figure 4.6 (d): SMS is sent.

After receiving SMS, all the lights of section 1 will be turned OFF according to the same procedure as discussed above. This is shown in figure 4.6(e).

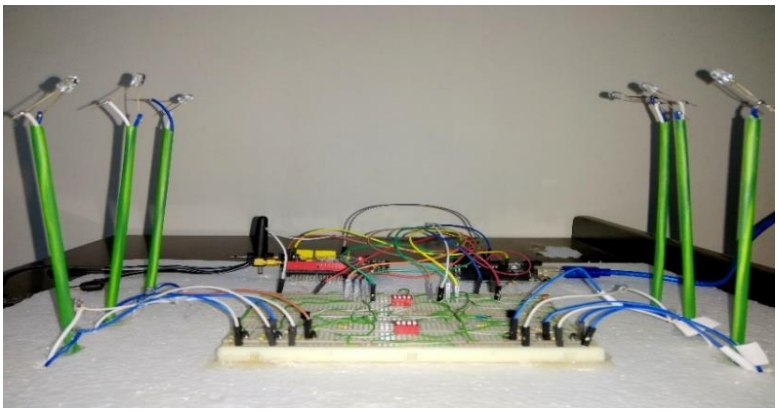

Figure 4.6 (e): After receiving SMS, all the lights of section 1 are OFF.

Similarly, we can control the lights of section 2 individually via SMS. We can see from figure 4.7(a) that all the lights of both sections are turned OFF. If we send the SMS code word “Lane2 *ON” as shown in figure 4.7(b) then all lights of section 2 will be switched ON.

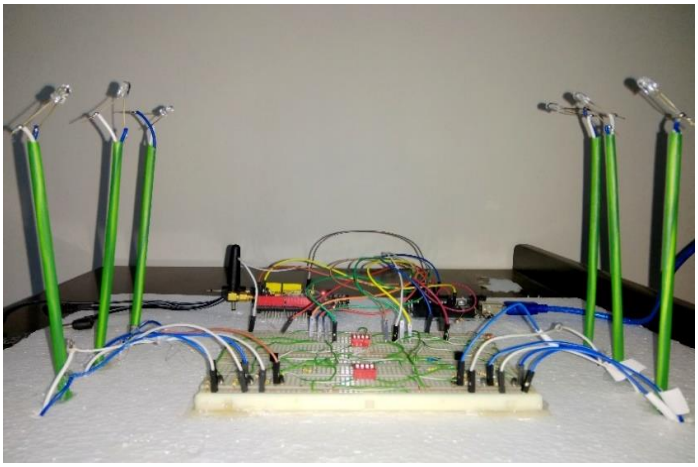

Figure 4.7 (a): Lights of both sections are OFF.

Figure 4.7 (b): SMS is sent.

The following figure 4.7(c) shows how the lights of section 2 were turned ON after the SMS was sent from the controller’s phone number and was received by the GSM. If we send the SMS code word “Lane2 OFF” as shown in figure 4.7(d).

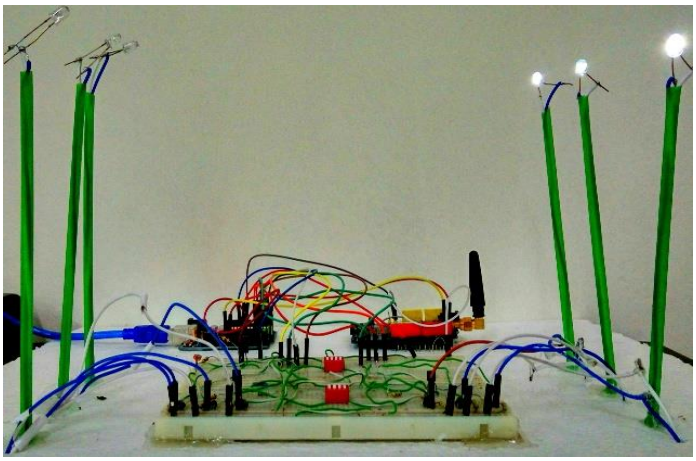

Figure 4.7 (c): After receiving SMS, all the lights of section 2 are ON.

Figure 4.7 (d): SMS is sent.

After receiving SMS, all the lights of the section 2 will be switched OFF as shown in figure 4.7(e). Above process is executed after receiving SMS by GSM, it sends the command to Arduino and Arduino commands the lights accordingly.

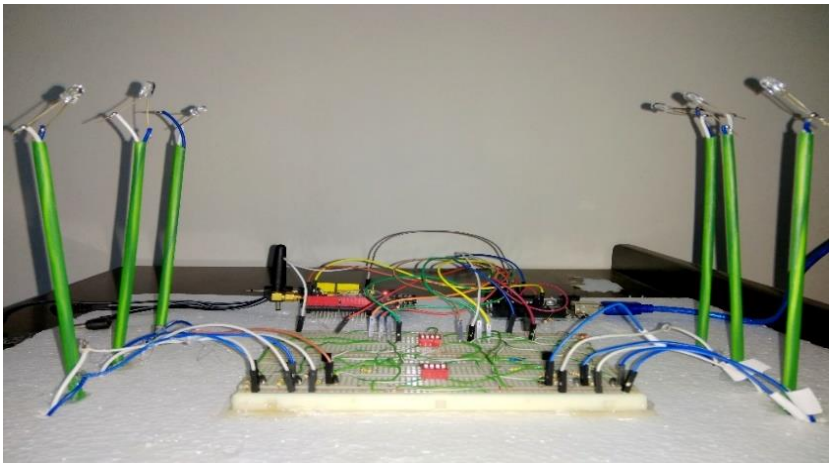

Figure 4.7 (e): After receiving SMS all the lights of section 2 are OFF.

It also should be mentioned that for switching the lights, the controller must know the GSM SIM number and the SMS code word. Therefore, the system is safe, as there is only one person with the fixed number who has the authority to control the street lights and there is no way to know the GSM SIM number or the SMS code word unless they are informed.

We have shown the procedure switching lights via SMS in details and the fourth feature will be discussed further.

4.2.4 Feedback SMS System

One of the key feature of the system is its feedback SMS process. If there is any occurrence of fault in any of the lights, then a SMS will be sent to the controller's number mentioning the number of the light. Fault may occur if connections get broken or the light may not be functioning as usual which will result in a feedback message to the mobile phone number that we is defined in the code for our system, that is basically the controller's SIM number.

GSM has signal transmitting and receiving capability and thus when fault occurs in street lights, Arduino sends a signal to GSM. Then GSM sends SMS to the controller's mobile number, which contains a specific code and thus the feedback SMS process works.

In this project, we have set feedback SMS code for each light and if a fault occurs in any of the street lights, a SMS will be sent to the GSM SIM number with a specific code for that light. Codes Set for six lights are "Fault in light-01", "Fault in light-02", "Fault in light-03", "Fault in light-04", "Fault in light-05", "Fault in light-06".

For example, we get the text “Fault in light 1” if there is a fault in the 1st light. We can understand this process better by the following figures. In figure 4.8(a) all the lights are turned ON.

After receiving the SMS, the light with fault can be easily detected and it will have to be replaced with a new one. Therefore, the feedback SMS is one of the most special features of our project as it makes maintenance of the street lights very efficient and comfortable for the person in charge.

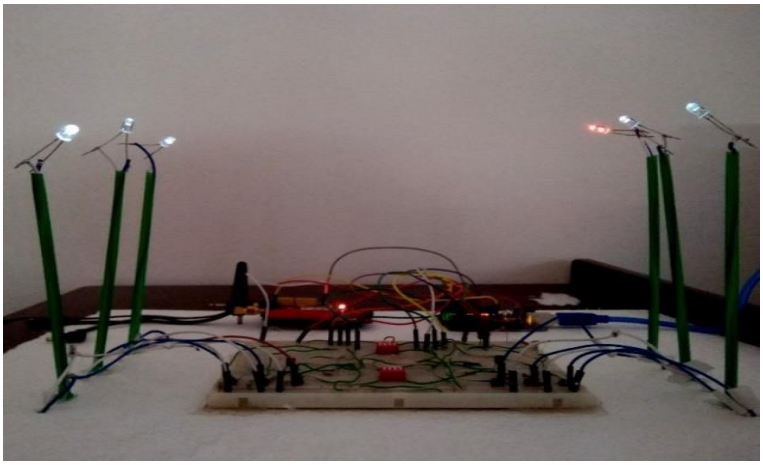

Figure 4.8 (a): All lights are ON.

If for some reason the first light of section 1 was damaged or could not be turned ON as shown in figure 4.8(b), it resulted in the feedback SMS with the code word set for the first light as shown in figure 4.8(c). This process is executed after any damage to any light, Arduino sends the command to GSM and then GSM sends SMS to the controller.

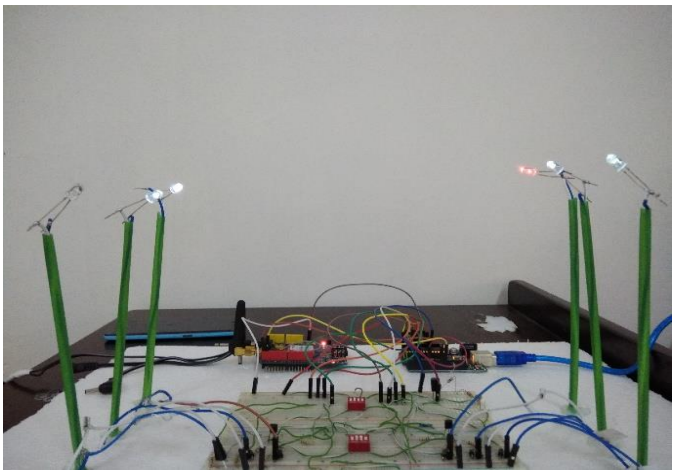

Figure 4.8 (b): 1st light is off due to fault.

Figure 4.8 (c): Feedback SMS when 1st light is off due to fault.

4.2.5 Switching According to Specific Time

The lights may also be switched according to a specific time. This switching system will switch the lights after reaching the time we have set in our system for different seasons throughout the year. Though we have not added this feature in our project as merging up all the processes would have made the system difficult to implement and execute. In addition, we already have several ways for switching the lights. So we chose to use the sensor and did not use the time specified switching option.

As we have multiple systems working together, we sometimes have to overwrite the value of the sensor during daytime or nighttime. The LDR sensor is programmed to work automatically all the time. Now, when we send SMS to switch the lights, this process actually overwrites the value and functionality of the LDR sensor. For example, sending code words to switch the lights off will anyway switch them off, no matter what is the intensity of light present on that particular moment. The next day again the lights will be switched on/off according to the mechanism and the value of the sensor.

If we want to control street lights by setting specific time for switching, then we have to modify the process a little. We have to use a timer and a specific time can easily be set for different seasons throughout the year. When the time we have set arrives, timer will pass the command to Arduino and Arduino will command the light accordingly. This is show in figure 4.9. Thus, street lights can be controlled by setting specific time.

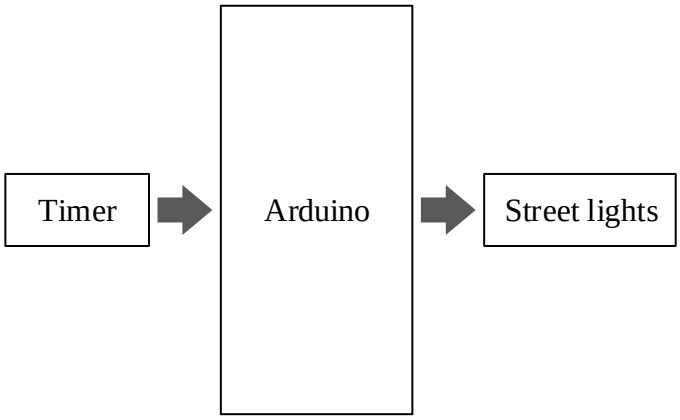

Figure 4.9: Switching according to specific time.

4.3 Project Mechanism

The main mechanism of the project is, LDR detects light intensity and sends an analog signal to the Arduino, which varies with the light intensity. Similarly, GSM gets

commands via SMS and transmit signal to Arduino and for feedback SMS The signal is amplified by a transistor C-2060 and is sent to Arduino. Arduino process the signal and controls the switching of the lights with its digital pins by giving a digital logic signal to another two transistors BC-547. The transistors are connected in common emitter biasing. Here the LED's are connected with the emitter and a diode is connected in series with each LED's to make the current flow unidirectional. From the diagram, we can see that every LED's positive terminal is connected with analog pins of the Arduino. Moreover, 470 kΩ resistors pull up the positive terminals. To detect if the LED are working or not by taking the analog voltage reading of the terminal. These whole things are shown in figure 4.10.

In this project, the input six pins of Arduino are connected to the six LED's and the two-output pins that are pin 2 and 3 are connected to two transistors. Diode and resistor are connected to each LED. After getting command from Arduino, the lights are turned ON/OFF accordingly. LDR sensor is connected to the output pin no. 6 of the Arduino.

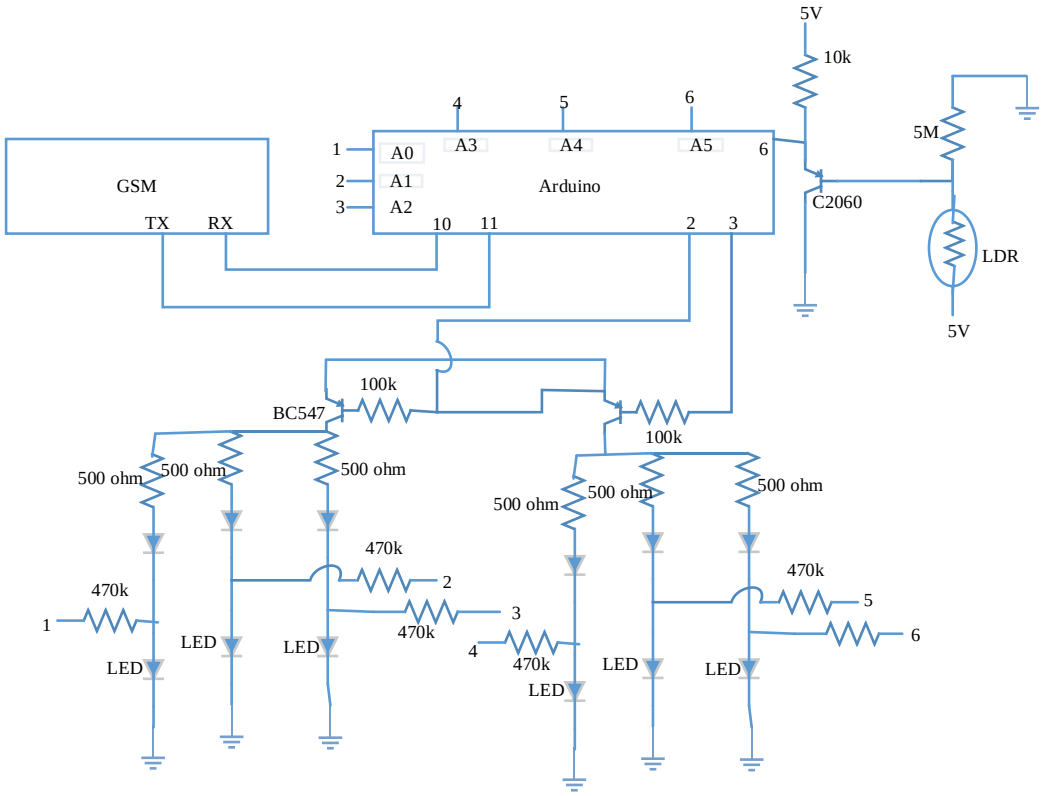

Figure 4.10: Circuit diagram of the prototype of the project.

By metering the intensity of light LDR sensor gives the information to the Arduino and Arduino command the lights accordingly. The RX and TX pin of the GSM is connected

to the 10 and 11 no. pin of the Arduino. On the other hand, GSM transmit and receive SMS via Arduino and Arduino command the lights accordingly.

4.4 Implementation in AC Line

The project that we have made is a prototype with DC supply. There will be some changes if we want to implement the system in AC line. In case of DC power system used in the prototype, we can have the feature of individual feedback SMS for each light if there is any kind of fault while switching them ON/OFF. However, in case of AC power system, this feedback SMS system becomes just expensive. We have to use an individual GSM and current sensor for each light. The current sensor measures the current and sends a signal through the GSM if the value of the current is lower than the value that was set before, which causes the light some damage. As the price of GSM is high, so using individual GSM and current sensor is costly but we can easily overcome this hindrance by making sections, where a section will contain a few number of lights. In that case, the information about all the lights from all the sections can be received by a single GSM. If any fault occurs in any light of section 1 then controller will get a SMS like “Fault in Section-1”. We can sort out the damaged light easily from the segment and necessary steps will be taken depending on the type of problem.

For AC application, the BC-547 will be replaced by MOSFET’s, which will control relays or magnetic contractors as they control the street lights. A high quality current sensor will be connected in series with the street lights to detect overload and check the lights if they are working or not by using the reading of the current sensor. This sensor will give a feedback to the Arduino to maintain this functionality. Figure 4.11 represents the whole things of AC implementation.

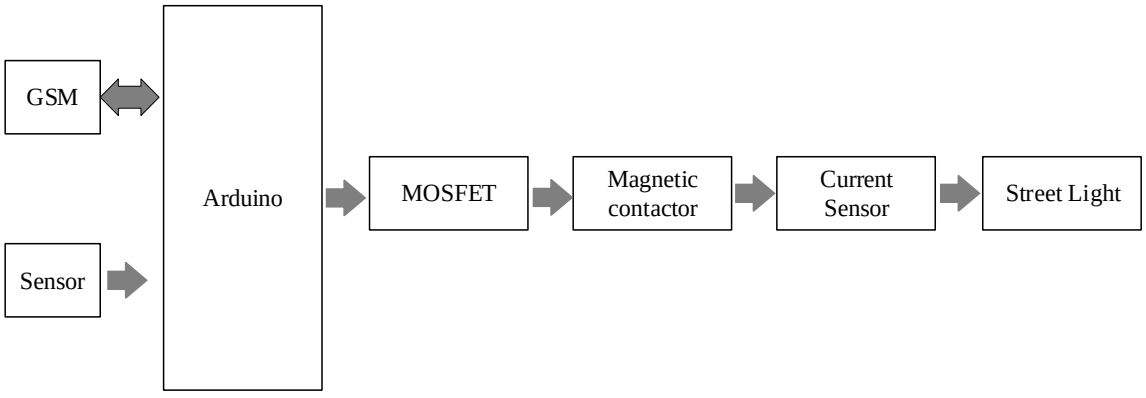

Figure 4.11: Block diagram for AC implementation.

4.5 Field of Application

The system can be expanded and used in many other fields other than street lights. With a little modification and in accordance to the area of use, the system can be used for many purposes. The field of application of the project is written below,

a. The project can be implemented in household compliances like bulbs, fans, ac etc. used in houses.
b. It can also be implemented in indoor garage where a large number of lights have been used.
c. The same way it can be implemented in garments sector, shopping mall etc.
d. It can also be implemented in a different way for switching the lights. We can use IR (Infrared) sensor to sense the presence of a person in any area. The lights will be switched ON sensing the presence of any person and will stay awake for a while. It will again be switched OFF if there is no person in that area.

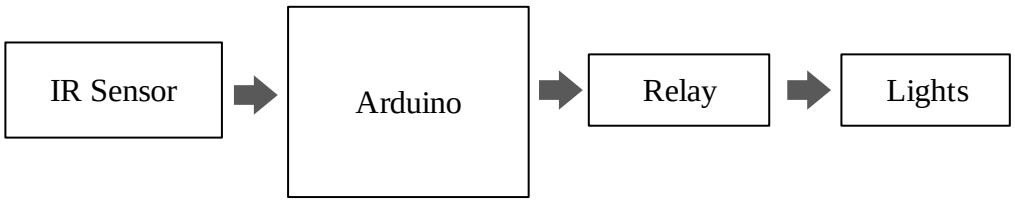

Figure 4.12: Block diagram in case of IR sensor.

The mechanism of this process is, IR sensor is placed in a selected area. When any person enters in that area, IR sensor will detect their presence and send the command to the Arduino. Then Arduino executed the command and light will be turned ON. Relay is used to switching the supply to 220 volt. This procedure is shown in figure 4.12. Similarly, when no person remain in that area all lights are turned OFF.

4.6 Diversity of Application

This project is made for controlling the street lights. In our project, there are GSM controlling system, sensor controlling system and sensor controlling system. Apart from lights, other electronic devices can be controlled with the help of this system. For this, the system will need some modifications. It may need some hardware modification and/or software modification. We can use this system to turn on/off fans and air conditioners. Heater and air cooler can also be controlled with this system if properly applied. Other

electronic device such as microwave oven, which need to be turned off in time to avoid accidents, can be controlled with this system. If we modify this project little bit, we can use it in different sectors like,

a. Fan
b. Air-conditioned
c. Air cooler
d. Refrigerator
e. Heater
f. Geyser
g. TV
h. Motor
i. Lift
j. Computer
k. Microwave oven

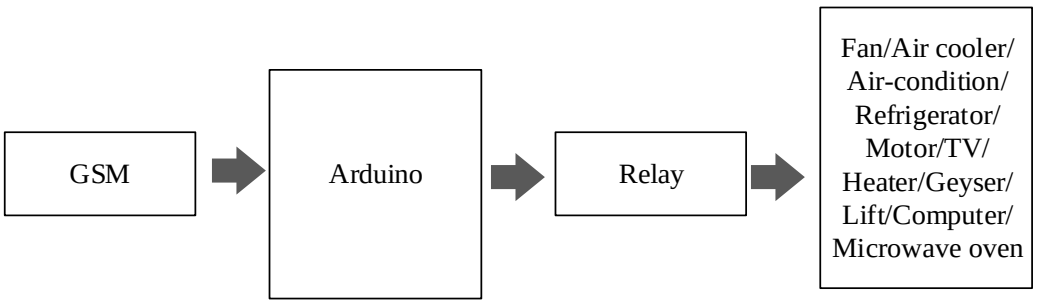

Figure 4.13: Block diagram of diversity applications.

For implementing this, we have to connect GSM with Arduino and then Arduino is connected to that device that we want to control. We have to set different SMS for different devices. To control different devices different code words will be provided for each device. For example, we set SMS code “Fan *ON” for switching ON the fan. Now if we want to switch ON the fan then we have to send that SMS from a fixed number. Then GSM will receive the SMS and send needed command to Arduino and then Arduino execute it. Similarly, we can do it for the other devices that are mentioned above as shown in figure 4.13. Cost is almost same for all devices for implementing this.

In case we are outside and want to cool down the room temperature so that we can relax upon reaching home, we can turn on the ac or air cooler with the help of the GSM one

hour before reaching home. Similarly, if it is cold outside and we want to warm up the room then we can turn on the heater before reaching home. In addition, if we want to have a hot water bathe, and then we can simply turn on the geyser before reaching home. When the water reaches desired temperature, it will give a back SMS that the hot water is ready then we can turn off the geyser by sending SMS to the GSM. In addition, if we forget to turn off any electronic device while leaving home, we can turn it off from any corner of the world with this GSM system. If not it will take a lot of time to go back home to turn them off and huge amount of electricity will go to waste it is not turned off in time. In this way, a lot of our electricity expenditure and time can be saved. It also reduces the chances of accidents that may occur in our absence.

We can use a single GSM to control all the electronic equipment of our household at any time from any place, which makes the switching very easier. It is also very cost effective as the expense for the SMS is very small and negligible compared to the cost that may occur if the equipment are not turned off in time.

4.7 Conclusion

In this chapter, we have discussed the working principle of the project with the circuit diagram, the key features of the project and the changes that have to be initiated for it's implementation in AC line. The mechanism of the project was shown with necessary figures for each of the feature included in this project. This project can be used in various aspects except the street lighting system. We have shown the diversity of application which demonstrates that this system can be applied in different household appliances or industrial machineries. We also have analyzed the wastage of power in conventional street lighting system, which can be saved by implementing our proposed system. The system is durable, user friendly and very easy to operate. The proper implementation of the system will save a lot of energy and manpower and thus it will digitalize the whole system. In the next chapter, we will discuss about the major contributions and recommendations for future work.

Chapter- 5

CONCLUSION AND FUTURE SCOPE OF THE PROJECT

5.1 Conclusion

This intelligent and smart project on street light will help us a lot for the maintenance of the street lights around the whole country. The project is very much user friendly and easy to implement. For various purpose and necessity, we can use all four features of the project. It will help us to reduce the inefficiency and waste of energy at the same time.

In this project paper, we have described the research carried out by the researchers and different technology of the street lighting system followed by the countries around the world. We have shown in our project about how the street lights are connected and how they receive power with the help of diagrams. We have also discussed how the lights can be controlled in different ways. We have shown the working principle of the project with the circuit diagram, its key features and the changes that have to be made for its implementation in AC line. We have analyzed the wastage of power in conventional street lighting system, which can be saved by implementing our proposed system.

This project will be greatly beneficial to reduce the manpower necessary for the maintenance of street lights in highways. The number of people used there can be deployed somewhere else which will reduce the cost of total system and will make it a cost effective project. This project with a better maintenance will easily last longer than the typical system as well as it will digitalize the whole system and is convenient for an individual to control when necessary without any physical presence.

The future aspect of smart street lighting is very emerging. Almost all the modern countries are nowadays replacing the existing street lights and modernizing the system. Replacing the existing system may cost some money but it can be easily overcome by the electrical power and maintenance cost, which will be saved by the new system and the system, is also more sustainable than the conventional switching and control system. With apparently low cost, if this system can be utilized properly, it will have a greater effect of functionality than the other systems.

5.2 Summary of Major Contribution

The summary of the major contributions are given below:

a. Developed a smart street lighting system, which can be directly turned ON/OFF from any part of the network by the usage of GSM technology.
b. Implemented the project with LDR sensor, which is capable of switching ON/OFF the lights according to the intensity of light when necessary.
c. Facilitated the feedback SMS system, which notifies the controller with specific location if any light is not switched ON/OFF properly.
d. Implemented the existing manual switching system in the project to control the lights in case the smart system fails to operate for any reason.
e. Organized the project in several sections so that we can easily find out the damaged lights if any fault occurs.

5.3 Recommendation for Future Work

The recommendation for future works are given below:

a. The lights can be switched ON/OFF at a particular time set by the operator. In this project, we have used the LDR sensor for sensing the light intensity of the system, which switches the lights according to the intensity of light. However, we can also set a constant time on the system for switching the lights ON/OFF instead of using any sensor.
b. We can have exact output from the sensors for measuring the light intensity if we use better sensors where the sensors do not show a wide change of resistance if the temperature changes. We can apply the same mechanism if we want to control the lights of any garage, shopping mall or household lighting system. Thus, this mechanism can be applied in various aspects where we need a wireless technology to switch any electrical device.
c. The project can be further developed by implementing off-peak dimming system. The lights will glow normally when there is a movement of vehicles and it will radiate dimming lights when there is no movement of vehicles or persons on the street. This will save some more energy consumption and thus reduce the system expenditure, which will increase the efficiency of the system.

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Appendix A: Glossary of Terms

ZigBee: ZigBee is a wireless networking standard that is aimed at remote control and sensor applications. ZigBee technology is built on IEEE standard 802.15.4 standard. ZigBee enables broad-based deployment of wireless networks with low-cost, low-power solutions. It provides the ability to run for years on inexpensive batteries for a host of monitoring and control applications. Smart energy/smart grid, lighting controls, building automation systems, tank monitoring are just some of the many spaces where ZigBee technology is making significant advancements.

IEEE 802.15.4 standard: The IEEE 802.15.4 standard is aimed at providing the essential lower network layers for a wireless personal area network (WPAN). The chief requirements are low-cost, low-speed communication between devices. The concept of IEEE 802.15.4 is to provide communications over distances up to about 10 meters and with maximum transfer data rates of 250 kbps.

ATmega328: ATmega328 is a single chip microcontroller. It is an 8-bit automatic voltage regulator and has 32 KB of flash memory. Mainly ATmega328 is used in autonomous systems where low powered, low cost microcontrollers are needed. It operates between 1.8 to 5.5 Volts.

ICSP: ICSP is the abbreviated form of In Circuit Serial Programming, is a type of In System Programming (ISP). It is the ability of microcontrollers and other programmable devices to be programmed while being installed in a system. That means it does not require to be programmed before installation.

EPROM: EPROM means Erasable Programmable Read-Only Memory which is a programmable read-only memory (programmable ROM) that can be erased and re-used. Erasure is caused by shining an intense ultraviolet light through a window that is designed into the memory chip. An EPROM differs from a PROM in that a PROM can be written to only once and cannot be erased. EPROMs are used widely in personal computers

SRAM: SRAM stands for Static Random Access Memory, which is a type of RAM that holds data in a static form, that is, as long as the memory has power. Unlike dynamic RAM, it does not need to be refreshed. SRAM stores a bit of data on four transistors using

two cross-coupled inverters. The cycle time of SRAM is shorter because it does not need to stop between accesses to refresh.

BTS: Base Transceiver Station (BTS) is one kind of network equipment that make the path easier for wireless communication between a network and a device. A BTS includes transceivers, amplifiers, duplexers and antennas. For mobile communication system, BTS work as a networking component as all the signals are received and transmitted from this. It is often known as base station (BS) or radio base station (RBS) or node B. BTS is controlled by base station controller (BSC).

BSC: Base Station Controller (BSC) is a networking component that controls one or more BTS. It manages the call setup, BTS handover and radio networks and also handles the network traffic measurement and authentication. It provides with the interface between the mobile switching centers (MSC) and BTS. It establishes the voice pathway for mobile phone and other similar devices and work with MSC to fulfill capacity requirement. Multiple BTS and MSC are connected with a single BSC.

MSC: Mobile Switching Center (MSC) is a networking component which is associated with call set-up, call release, routing etc. It also works as a host for routing SMS, service billing and conference call. It handles critical functions such as balancing the traffic and managing the database. It works as an interface with different networks, for example public switched telephone network (PSTN).