SMART STREET LIGHTING SYSTEM

Dissertation/ Project report submitted in partial fulfillment of the requirement for the degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

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May 2019

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DECLARATION BY THE SCHOLAR

We hereby declare that the work reported in the B-Tech project entitled "**Smart Street Lighting System**" submitted at **Jaypee University of Information Technology, Waknaghat, India**, is an authentic record of our work carried out under the supervision of **Dr. Shweta Pandit**. We have not submitted this work elsewhere for any other degree or diploma.

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SUPERVISOR'S CERTIFICATE

This is to certify that the work reported in the B-Tech. project entitled "**Smart Street Lighting System**", submitted by **Rushil Bhatnagar (151056)** and **Mohit Kumar Gupta (151031)** at Jaypee University of Information Technology, Waknaghat, India, is a bonafide record of his original work carried out under my supervision. This work has not been submitted elsewhere for any other degree or diploma.

(Dr. SHWETA PANDIT)
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Date:

LIST OF ABBREVIATIONS

CFL	Compact Fluorescent Light
HW	Hi-Watt
IEEE	Institute of Electrical and Electronics Enginners
IR	Infrared
LDR	Light Dependent Resistor
LED	Light Emitting Diode
USB	Universal Serial Bus
PC	Personal Computer
PCB	Personal computer
PWM	Pulse Width Modulation
RTC	Real Time Clock

LIST OF FIGURES

ACKNOWLEDGEMENT

I would like to express my gratitude to my supervisor **Dr.Shweta Pandit, Assistant professor (Senior Grade)**, Electronics and Communications Department of Jaypee University, Waknaghat for the useful guidance, remarks and engagement in the learning process of this bachelor project**. Dr. Shweta Pandit** consistently allows this project to be our own work, but always steers us in the right direction whenever she thinks we need it.

I'm highly grateful to **all of the teachers of JUIT** for their guidance right from the very beginning. They actually laid the ground for conceptual understanding of technologies we used in the project. This accomplishment would not have been possible without them. Thank you.

BY

MOHIT KUMAR GUPTA (151031)

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ABSTRACT

The project is about a real time adaptive street lighting scheme, detecting the presence of vehicles and dynamically adjusts the brightness of lights to the optimal level. The main aim of **smart street lighting system** is reducing the power usage when no vehicle movements are being detected on the road and to turn ON the smart street light only when car approaches. When a vehicle comes, then the next pair of three lights glows while the vehicle keep moving ahead, the coming pair of the lights glows and the pair before, comes back to the initial level after a certain time interval. With this, the energy efficiency is being improved of street lights and its usefulness. The streetlights are assumed to start their operation at sunset and finish at sunrise the next day. We have also proposed a new adaptive smart street lighting algorithm which will illustrate how the system is going to operate according to seasonal changes, and what would be the corresponding operational hours of the smart streetlights to keep them on without causing any delays and problems for the vehicles.

Our proposed model uses Infrared (IR) sensor and LED lights. As LEDs are more efficient and have longer lifespan, lights on the streets of our country are being substituted by LED street lights, which helps to solve the problem of power wastage. The other reason for using LED in our project is that its intensity can be varied as per the time and traffic on road. The successful implementation of a prototype further will be helping in large-scale development of the project. The project presents alternative to a profitable and nature friendly solution to the excessive energy wastage problem with the current street light systems and is one of the effective scheme for electricity saving in smart city project.

CHAPTER 1
INTRODUCTION

1.1 Motivation

Presently, in our country more than 28 million street lights are lit up during night consisting mainly CFL, metal halides or sodium vapour lights. From several sources we found that the demand of electricity usage to lit up street lights falls between 20% to 40% of the total energy produced in our country. So as the need of the hour, even our government is considering to implement LED technology to reduce this energy requirement to a much lower level. [1]. The glitches faced by the street lights include:

Lights not working

No reference data to find what is the number of lights that are not working. The next point is that there is no record to understand which of the lights is working or not and how long is the lifespan.

Stealing of electricity

Electricity stealing is a big issue in India. No statistics on the amount of electricity used by a light every night is available and on a wider level there is no statistics summarizing the amount of electricity that a phase is consuming.

Redundant wastage

Inspite of the fact that it is a country with a shortage of electricity, the conventional street lights lead to wastage of power due to unnecessary on time. This entail to develop a system which understand and avoid electricity wastage in street lights.

1.2 Literature survey

Following literature has been studied and the findings are discussed in below table.

Author/s	Content
[2] D. K. Srivatsa, B. Preethi, R. Parinitha, G. Sumana and A. Kumar	This paper is based on smart regulator of street lights to heighten the issue of power usage and brilliance of the streets.
[3] Y. M. Yusoff, R. Rosli, M. U. Karnaluddin and M. Samad	Paper helped us in learning how to program to control the light intensity of the LEDs and about the sensor usage and connection to the board.
[4] R. Müllner, A. Riener	Learning of the paper involves wide-ranging accessibility to the emerging technology like light emitting diodes and their ecofriendly nature to the environment and long lasting ability motivates the user to believe that power conserving street lighting systems are a reality and can be implemented in the country.
[5] M. Castro, A. J. Jara and A. F. G. Skarmeta	In this paper authors described the need of smart lighting system. They have described that the sustainable development of cities affects the overall electricity use of lighting and the curiosity in offering greater control of its use. They have proposed the solution for lightning system through Machine to Machine protocols.

Based on the literature survey which we have carried out, it has been observed that designing of smart street lighting systems is the need of hour which will play a major role in smart city project also. This system will save a lot of electricity wastage compared to the conventional street lights. A large number of street lights can be seen glowing at full intensity on highways, as also observed on airport roads where the street lights were always on during night time with full intensity even if there is no vehicular or pedestrian movement which leads to a burden on power stations supplying electricity. This excessive wastage of electricity can be utilized by some other electrical systems requiring surplus amount of power.

CHAPTER 2

PROPOSED SYSTEM DESCRIPTION

2.1 Design Specifications:

For the proposed system, following are the list of necessities that system targets to deal with to handle the glitches of the current light systems:

1**. Signal Discovery**: The sensors will be switching on lights when it is required or motion is in range (when vehicle passes by).

2. **Arduino:** The microcontroller is the control unit with the following functions:

   a. Course Statistics: Sensors detect the presence of vehicles.

   b. Handle Output: It handles the potency of the lighting system according to the readings of sensors.

3. **Intensity Management:** This function ensures the adjusting of LED lights so that lower lighting levels are used when there is motion according to the clock time.

4. **Algorithm:** Algorithms are used to control the lights smartly to act according to the cars on the road.

Microcontroller-Arduino

It is a microcontroller board which contains on-board power, USB to connect with Computer. This is a regular board which can be programmed and easily connected to without need of any PCB design and execution process. Anyone can get the details of its design to modify it according to the requirements. Fig. 2.1 shows the Arduino UNO Board with its components.

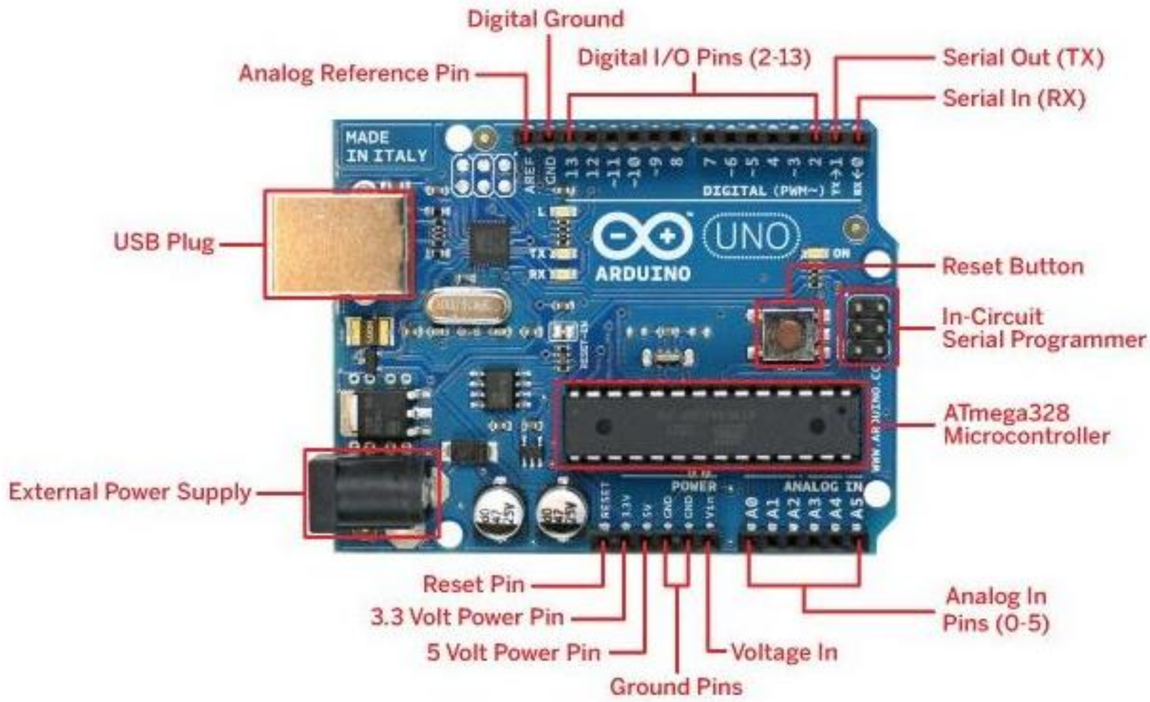


Figure2.1: Arduino UNO Board [6]

Arduino UNO Board has 14 digital input/output pins of which 6 can be used as PWM output pins, there are 6 analog input and output. It has everything which is needed to support the microcontroller. Arduino IDE (Integrated Development Environment) is used to burn the code to the microcontroller.

Power to Arduino:

The power to Arduino Uno is given through USB connection or external power through battery. The power source selection is made by the user.

V_{in}: It is input voltage to Arduino when it is on an external power source.

5V Pin: Pin outputs a controlled 5V from the regulator on to the board.

3V3 Pin: 3.35volt supply which provides maximum current of 50mA.

Gnd Pin: Ground pins.

2.2 Sensors:

Sensors in our proposed system are performing functions such as detecting the vehicle presence and controlling the ambient lighting, which are vital for switching on lighting at night.

2.2.1 IR Sensor

IR stands for Infrared Sensor and is used for motion detection purpose and the placement of the sensors is critical. IR sensor detects objects which align ahead of the sensor. [7] Sensor keeps spreading infrared lights and whenever object comes near, the sensor detects by observing the reflected lights. Feature of IR sensor is to be activate HIGH on object detection.

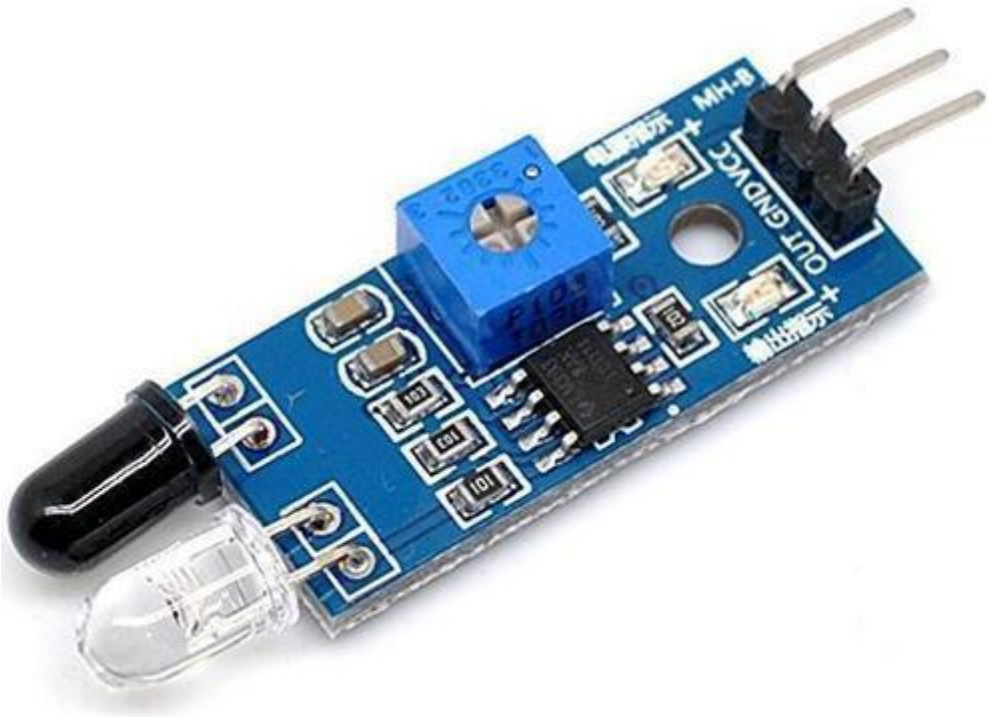


Figure 2.2:IR motion sensor [8]

2.2.1.1 Tracking through IR Sensor

The sensors have two elements namely infrared source and the infrared detector. Infrared sources include an LED. Infrared detectors include photodiodes or phototransistors. The energy which is emitted by the infrared source is reflected by an object and falls on the infrared detector. [9]

IR Transmitter:

Infrared Transmitter is a LED which releases infrared radiations and hence named as Infrared LED's. An IR LED is similar to a normal LED, but the radiations of it is not visible to the naked eye. The construction of a simple, this transmitter involve using an infrared LED, a current limiting resistor and power supply.

Figure2.3: Infrared LED Transmitter [10]

IR Receiver:

Infrared receivers also called as infrared sensors detect the radiation from an IR transmitter. The picture shown below is a IR receiver:

Figure2.4: IR Receiver [11]

The existence of different types of IR receivers is based on the wavelength, voltage, package. When it is used in an infrared transmitter it is important that receiver grouping and the value of wavelength of that receiver should be matched with that of the transmitter.

2.2.1.2 Principle of Working

The principle of an IR sensor working as an Object Detection Sensor can be very well understood by observing the figure given below. An IR sensor consists of an IR LED and an IR Photodiode so collectively both of them are called as Photo – Coupler. [12]

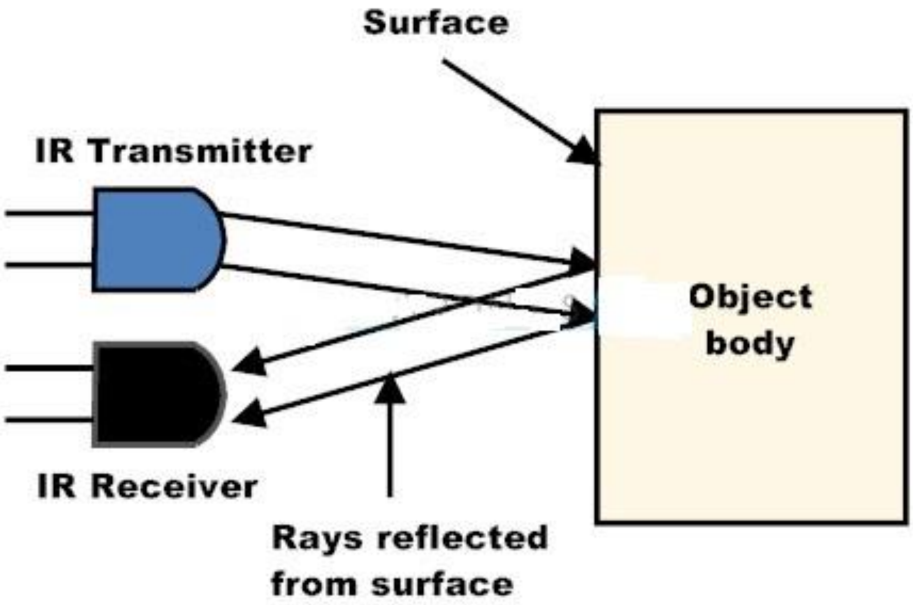


Figure2.5: Showing detection procedure of the IR sensor [13]

2.2.2 Ambient Light Sensors

Light Dependent Resistor is basically optically variable resistor. The resistance and the light intensity varies inversely in this sensor. [14] When the intensity of light increases, resistance decreases as is illustrated in Fig. 2.6. LDR keeps our smart street lights in OFF state during the day and as the day passes and the light in the atmosphere decreases, the resistance increases and then our system gets turned ON with LED's working at the intensity level as per the algorithm we designed as illustrated in the next chapter.

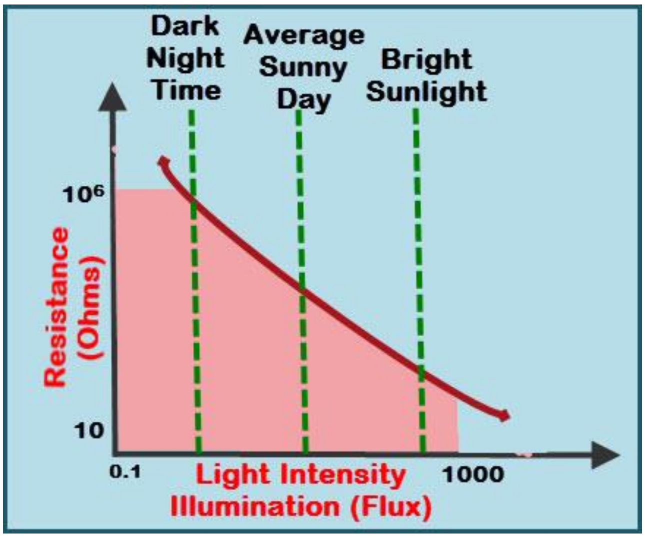


Figure2.6: Graph characteristic of LDR [15]

Figure2.7: Light Dependent Resistor (LDR) [16]

CHAPTER 3

PROPOSED ALGORITHM

3.1 DETAILED EXPLANATION

Our developed algorithm will work throughout the year. We have proposed timings according to seasons for which we have considered two seasons – Summer Season and Winter Season. Our project aims to control the intensity of the street lights between different time intervals according to the seasons.

We have decided the intensity levels of street lights on the basis of natural light at that time and the amount of traffic.

For example: When the Sun is about to set there is some amount of light present, so we have decided to keep intensity of street light to 50% at the time just before sunrise and at the time just before sunset.

We are using LED's instead of Sodium Lamps which causes environmental pollution and their lifetime is also low when compared to LED's.

We have decided four intensity levels as:

- **50% intensity:**

  50% intensity will be there at time of sunrise and sunset when there is some amount of natural light in the atmosphere.

- **100% intensity:**

  100% intensity will be there after sunset and before sunrise. Because after sunset, there is no natural light present in atmosphere and the traffic amount is high due to rush hours.

- **65% intensity:**

  65% intensity will be there after the peak time in night had over. At that time, we don't need 100% intensity because the amount of crowd near the midnight is very few.

- **10% intensity:**

  Our proposed model glow light to a brighter intensity only when a vehicle is there, otherwise the default intensity of street light when there is no motion near the street lights is set to 10%, so that there is little consumption of electrical energy.

We have thought to close the lights when there is no motion near the street light but its sounds darkness, so we have decided to keep initial level intensity to 10%.

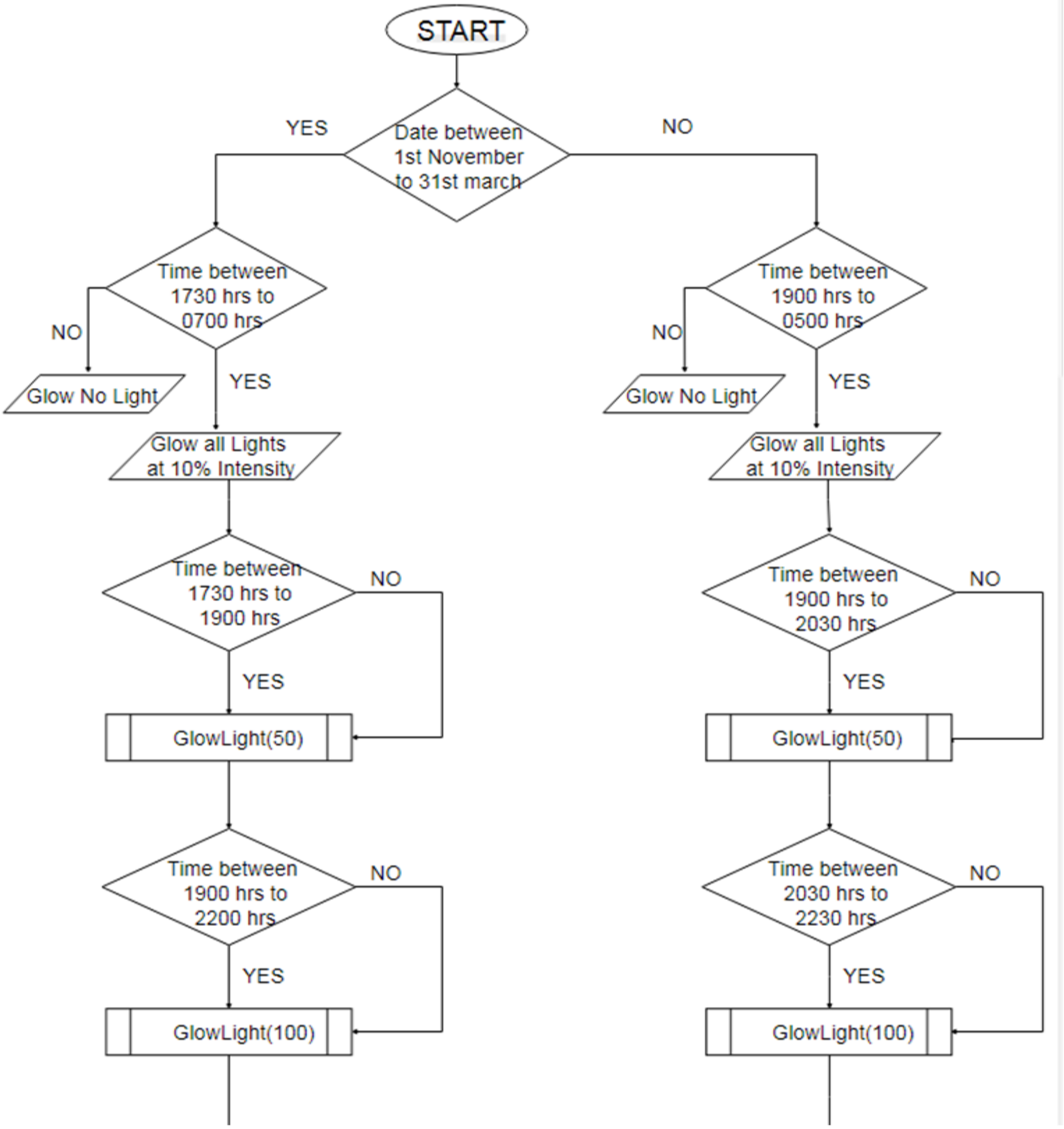
We will use LED’s, so that their intensities can be controlled. Our algorithm will start working according to clock in the real world.

We have pre-defined the times intervals keeping in sync with sunset and sunrise and according to season.

Following are the main steps of our proposed algorithm:

- When the sun is about to set till sun is about to rise, our purposed system will glow lights at default intensity, that is 10%.
- During the day time, the street lights will be switched off.
- If there is motion on the road near the street light, as detected by IR senor, our purposed system will check time interval and glow the light according to the interval set intensity as shown in Fig. 3.1
- The next 3 lights will glow from the light where motion is detected.

3.2 FLOW DIAGRAM OF THE PROPOSED ALGOTITHM



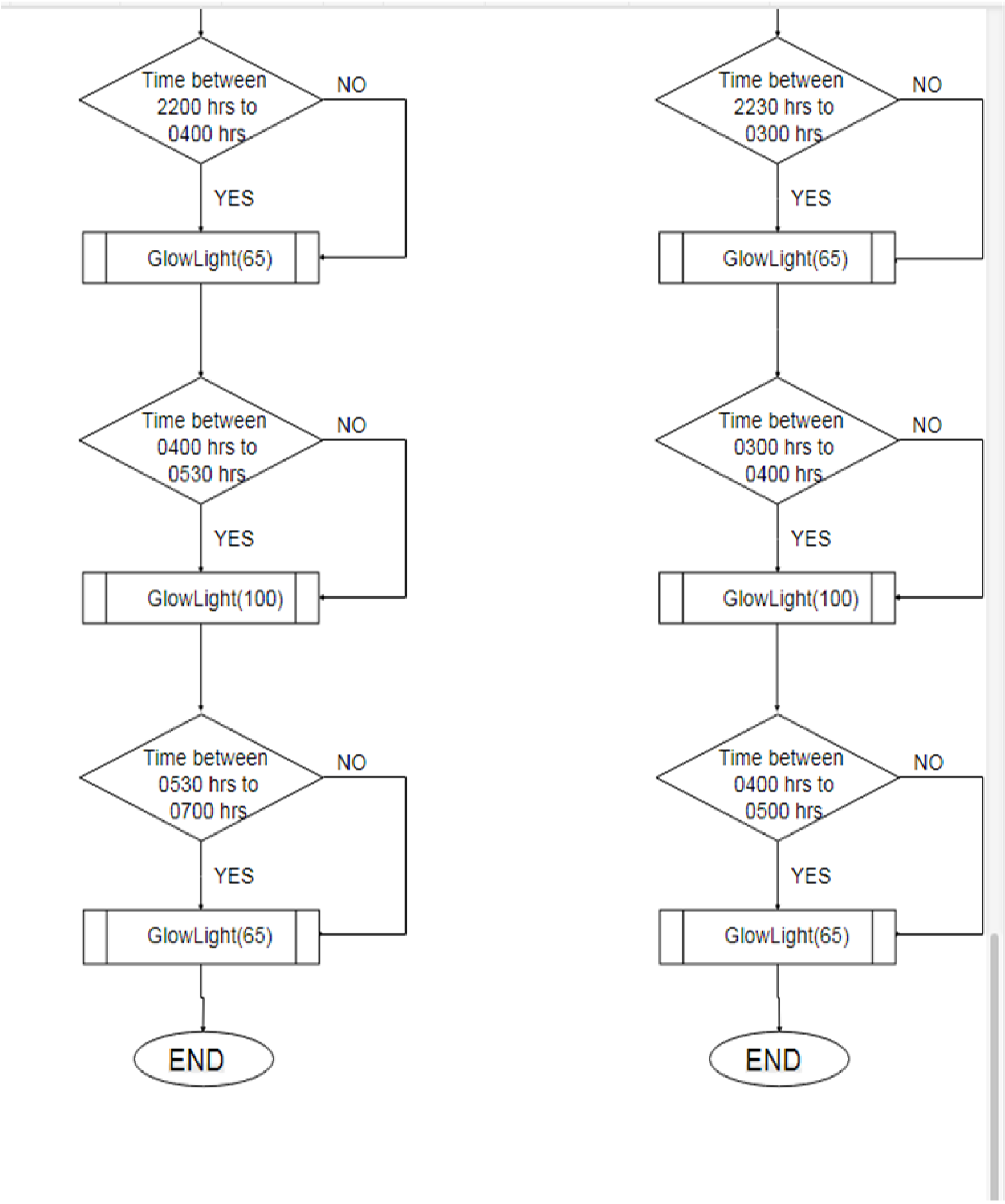


Figure 3.1: Flow diagram to illustrate Smart Street Lighting System working

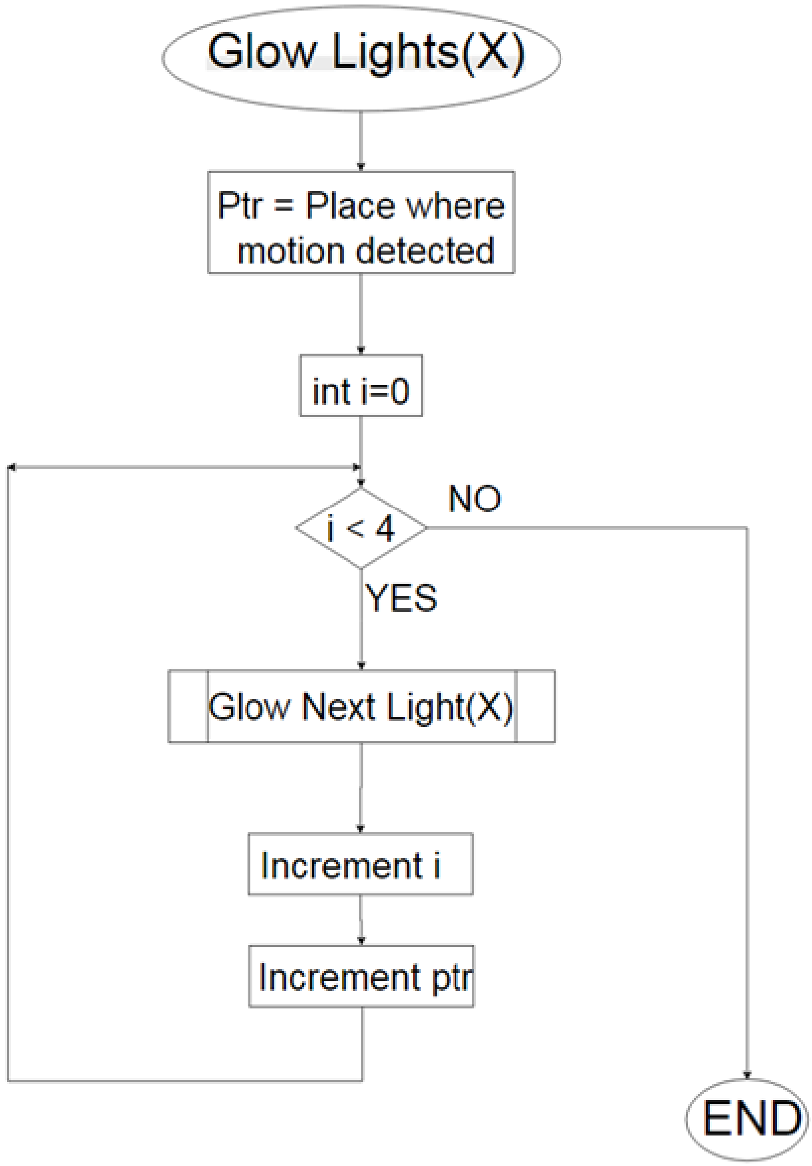


Figure 3.2: Flow diagram to illustrate working of Glow lights function

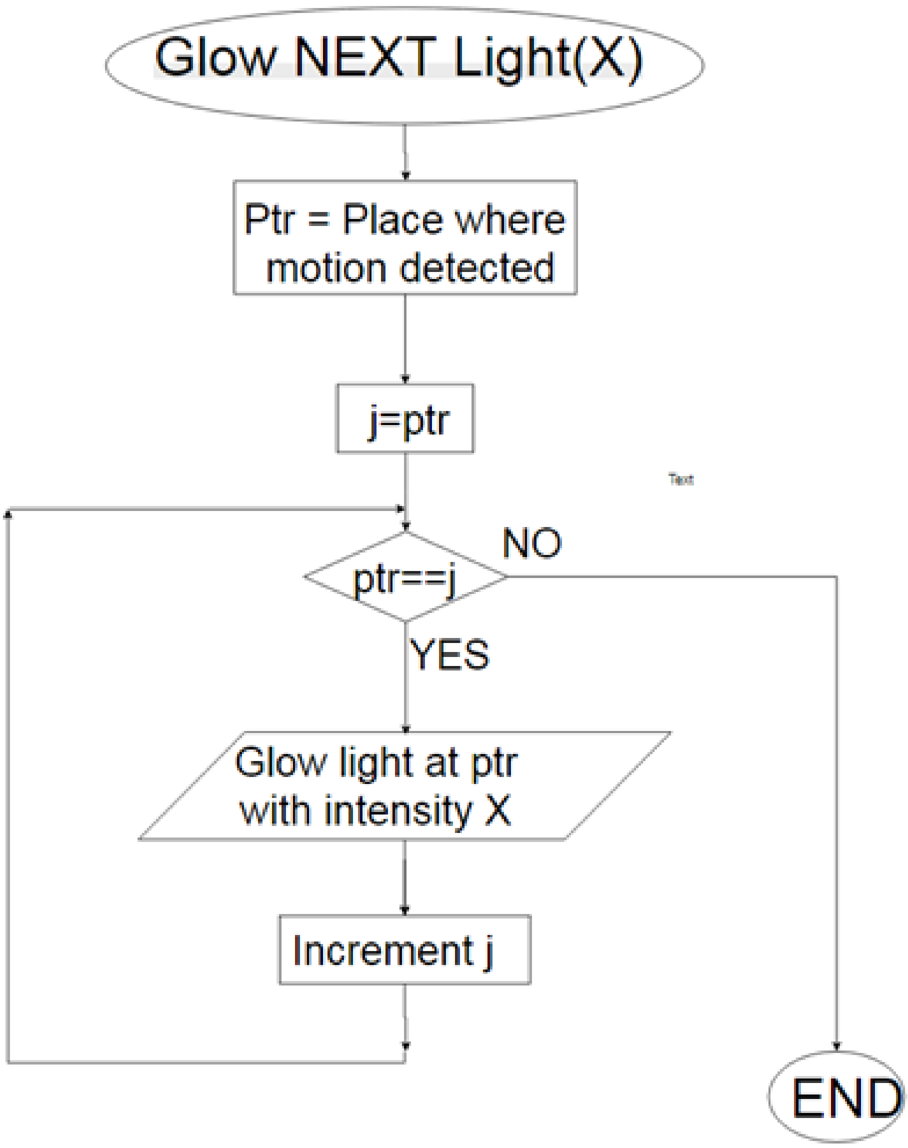


Figure 3.3: Flow diagram to illustrate working of Glow next lights function

3.3 HARWARE IMPLEMENTATION

In the Figure 3.5 shown below, the connections of the LEDs, LDR and the IR sensors to the Arduino UNO microcontroller is shown. There are 9 LEDs whose output is connected to the digital pins of the Arduino UNO and 3 IR sensors having output pins connected to the Analog Pins A1, A2 and A3 and the LDR is connected to A0.

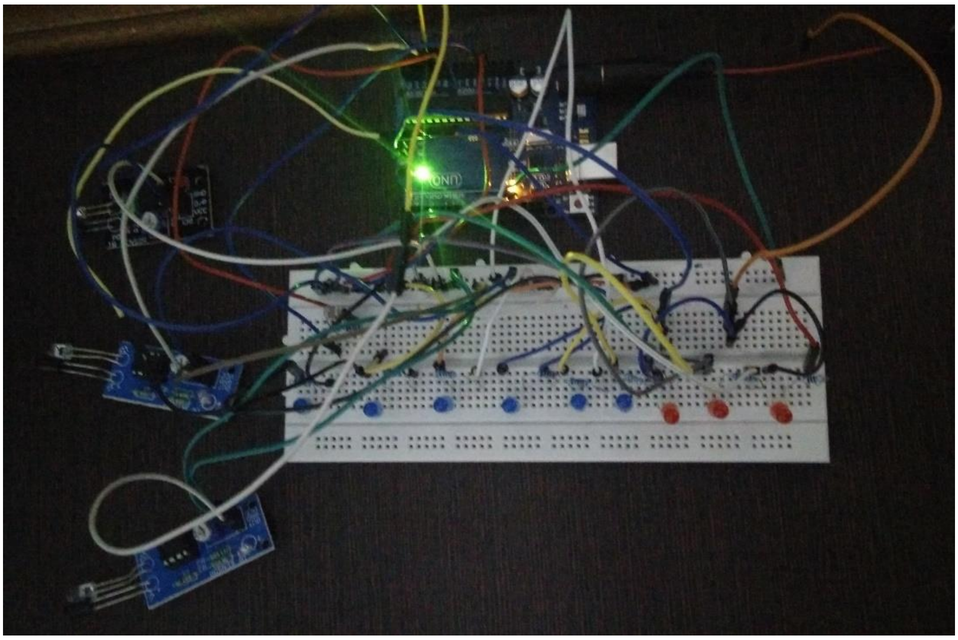


Figure3.4: Showing the Prototype for the smart street light system

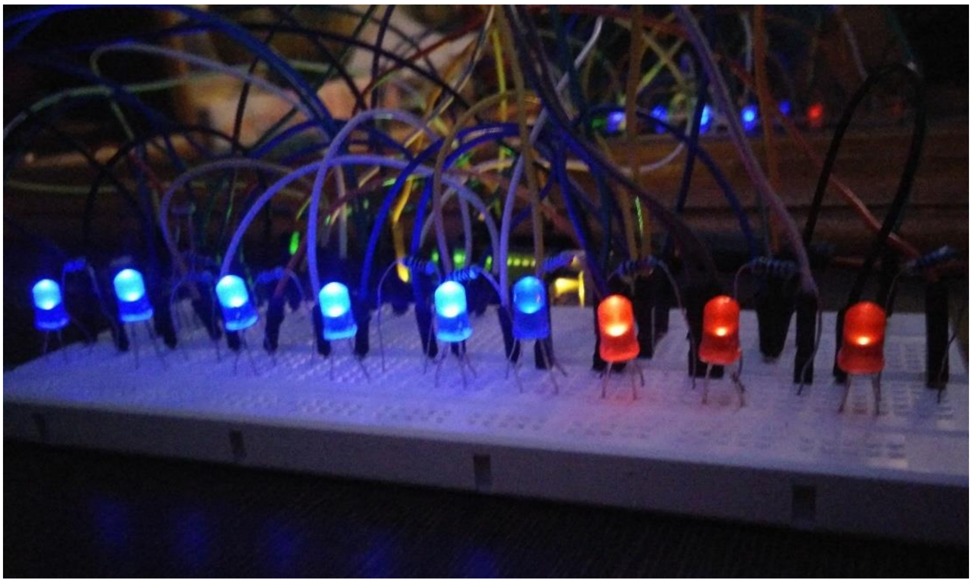


Figure3.5: All LEDs turned on at minimum intensity (10%) when the LDR resistance increase because of low lighting conditions.

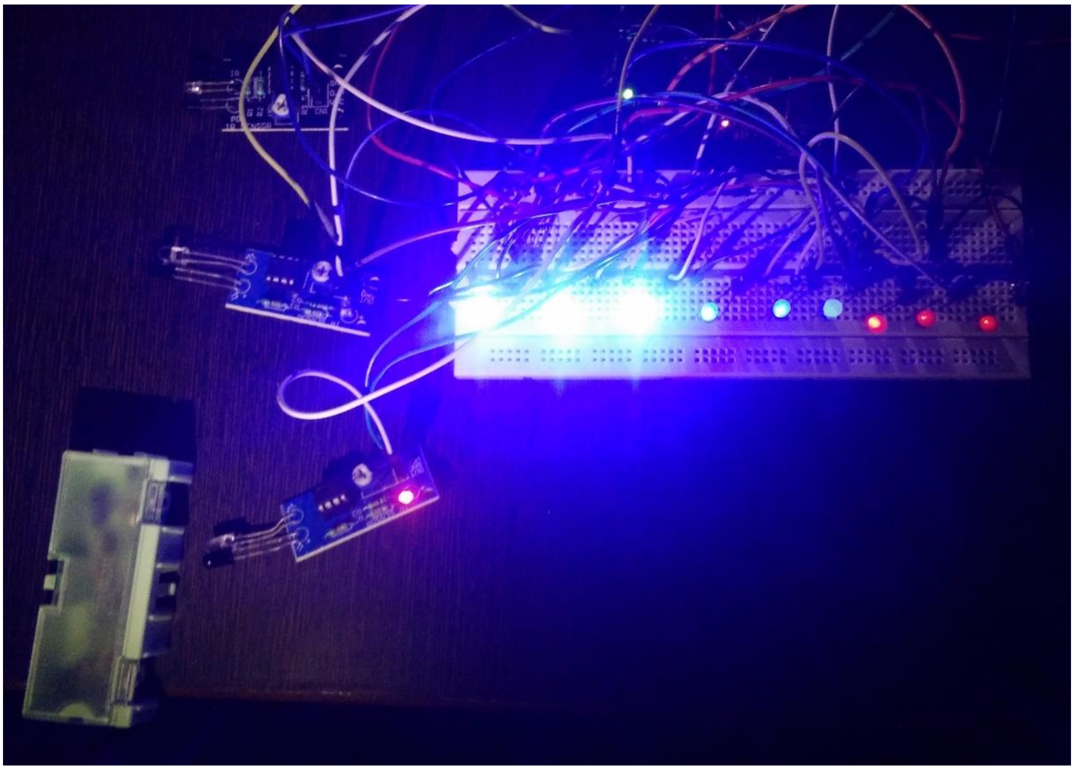


Figure3.6: The first 3 lights glow at night with full intensity because of the object being detected by the first IR sensor.

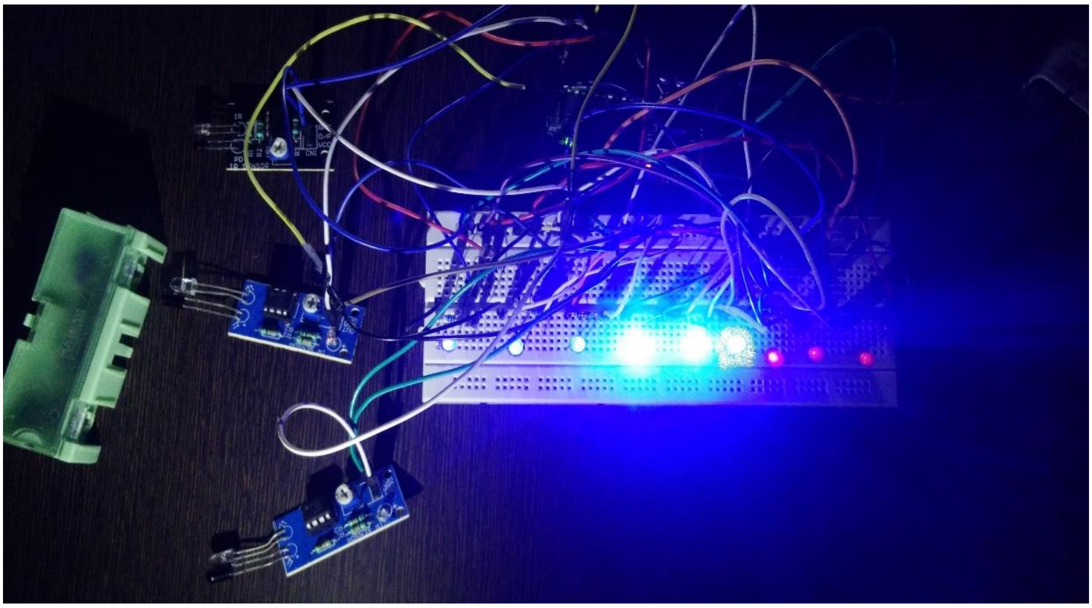


Figure3.7: The next 3 lights glow because of the object being detected by the second IR sensor.

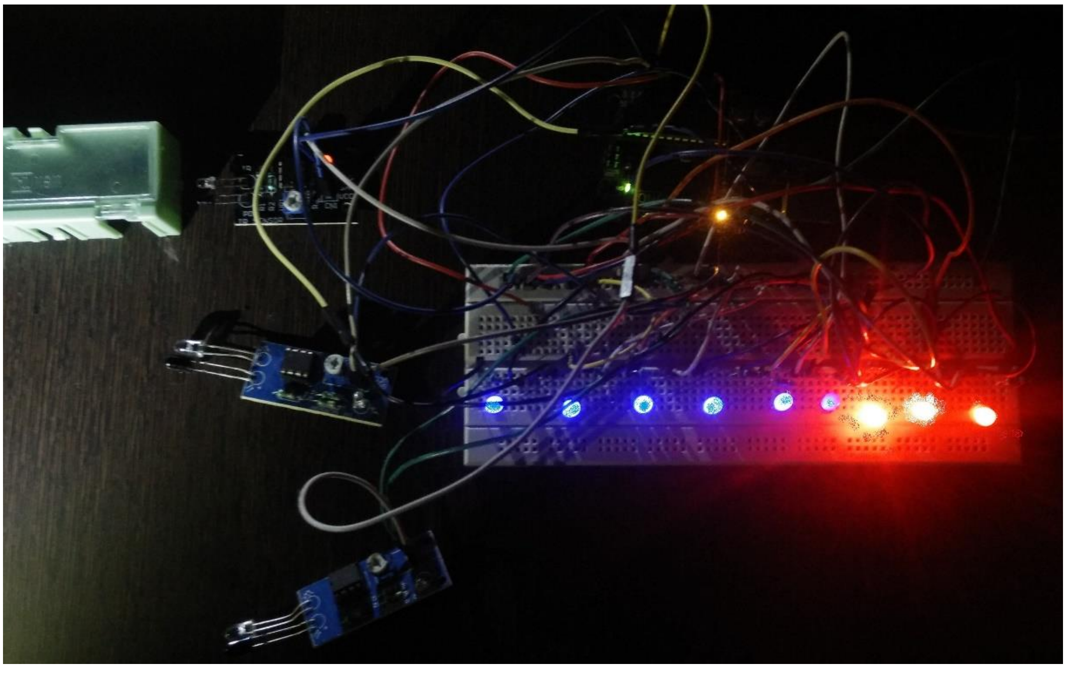


Figure3.8: The next 3 lights glow because of the object being detected by the third IR sensor.

The above circuit is powered by a Hi-Watt (HW) 6F22 9V battery for transistor radios and the source code for the circuit is also mentioned in the Appendix A.

CHAPTER 4

REAL TIME CLOCK INTERFACING WITH STREET LIGHTING SYSTEM

Need of introducing Real Time Clock (RTC) module in our smart street lighting system is to overcome the drawbacks of the LDR based smart street lighting system which will turn on lights due to dark weather conditions during the day. Therefore, RTC module will help in better management and support our aim of power consumption.

4.1 REAL TIME CLOCK (RTC)

The DS1307 RTC has 58 bytes of battery standby. The clock provides detail of every second, every minute, every hour, every day, every date, every month and the present year. It has feature of adjusting the last date of every month of the year. Some amount keeps the clock animated. RTCs have many applications like embedded systems and computer mother boards. The real time clock (RTC) is shown below. [17]

Figure4.1: DS1307 Real Time Clock Module [18]

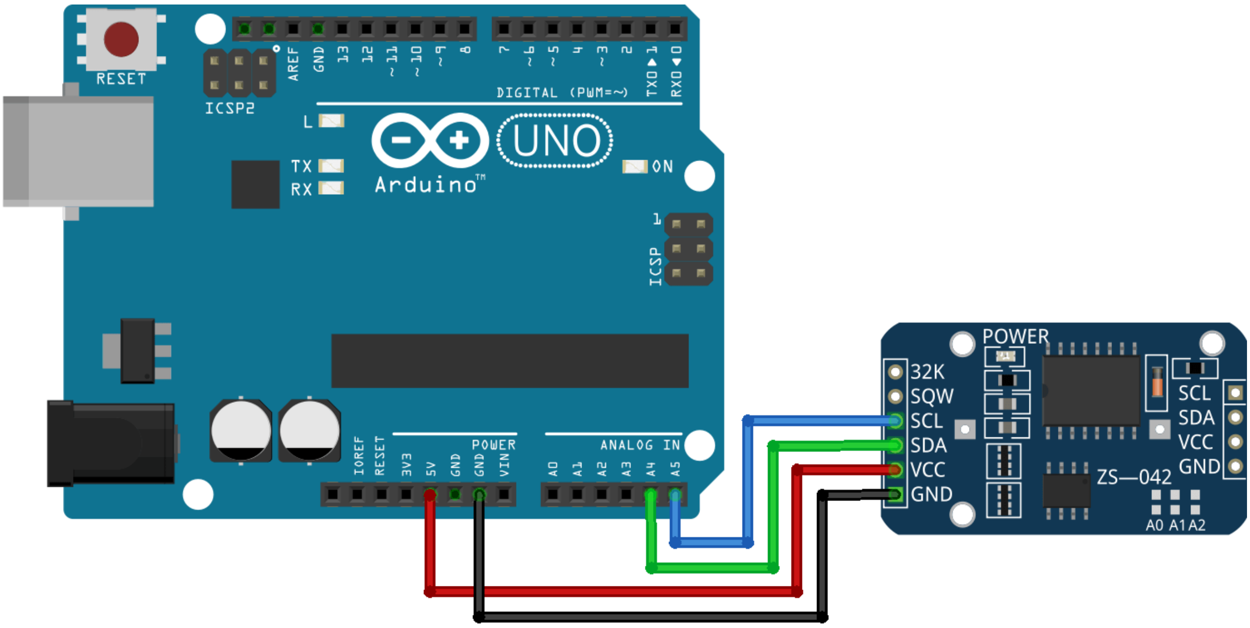


Figure4.2: Connection of RTC to the Arduino UNO [19]

The above figure shows the connection of the pins on the RTC to the Arduino UNO. The connection and functions of the pins are as follows:

- The SCL pin is connected to the A5. The function of this is to synching of the data.
- The SDA pin is connected to the A4. The function of this is to provide pull up voltage to 5.4V with help of a resistor.
- The VCC pin is connected to the 5V. The function of this is to supply power the clock to read and update time on the clock.
- GND pin is connected to the GND.

4.2 CLOCK OUTPUTS

As illustrated in Fig. 4.3, the clock embedded in our proposed system is configured with the current time showing month and year also.

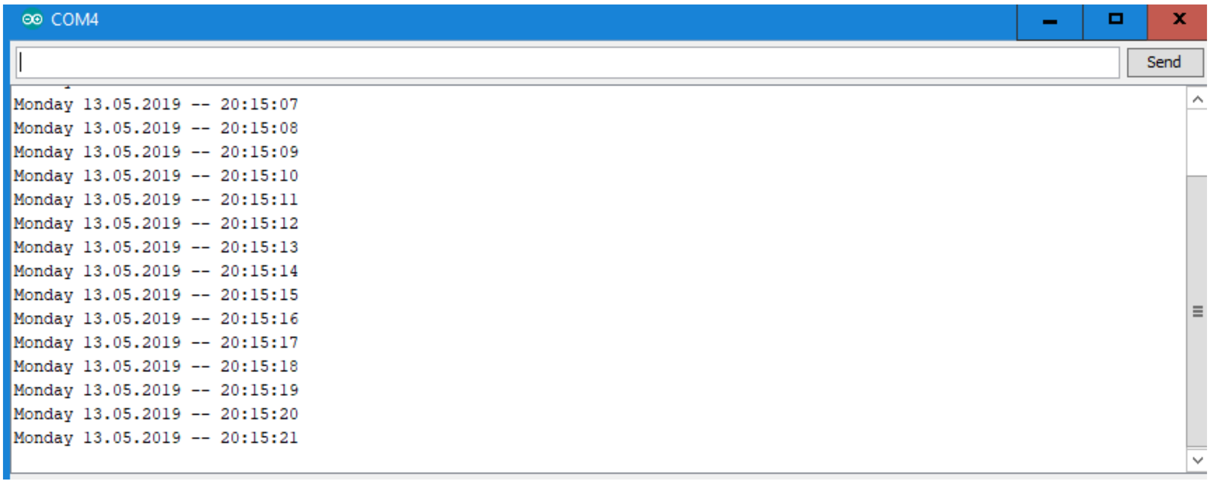


Figure4.3: Showing the clock time date month and year synced with the real time.

Taken a sample case we have programmed the clock time 20:17 to 20:18 to turn on lights. So seeing the time on serial monitor we have generated the below observations.

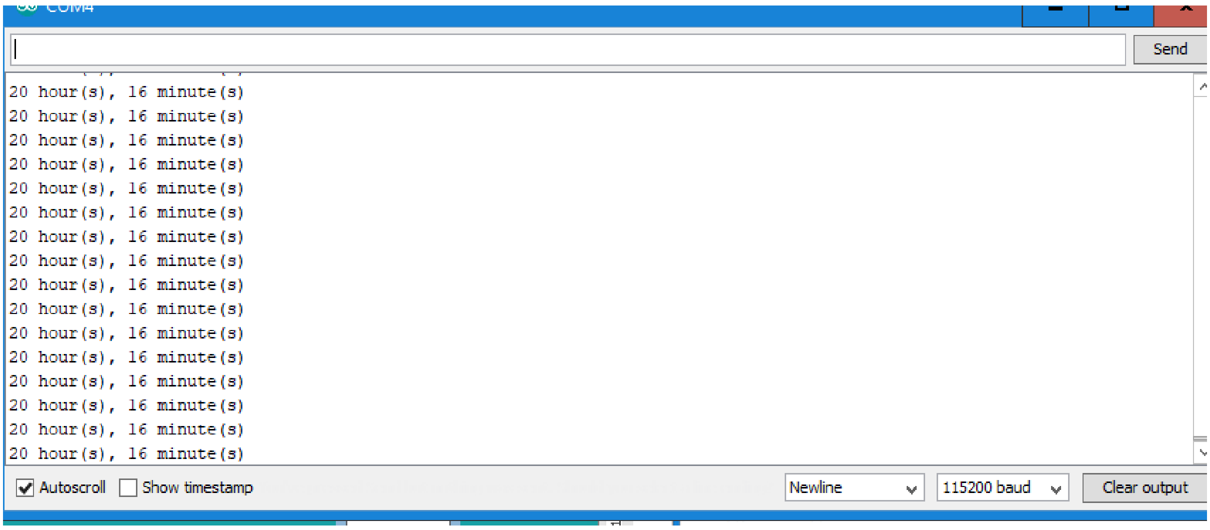


Figure4.4: Counting time with lights off

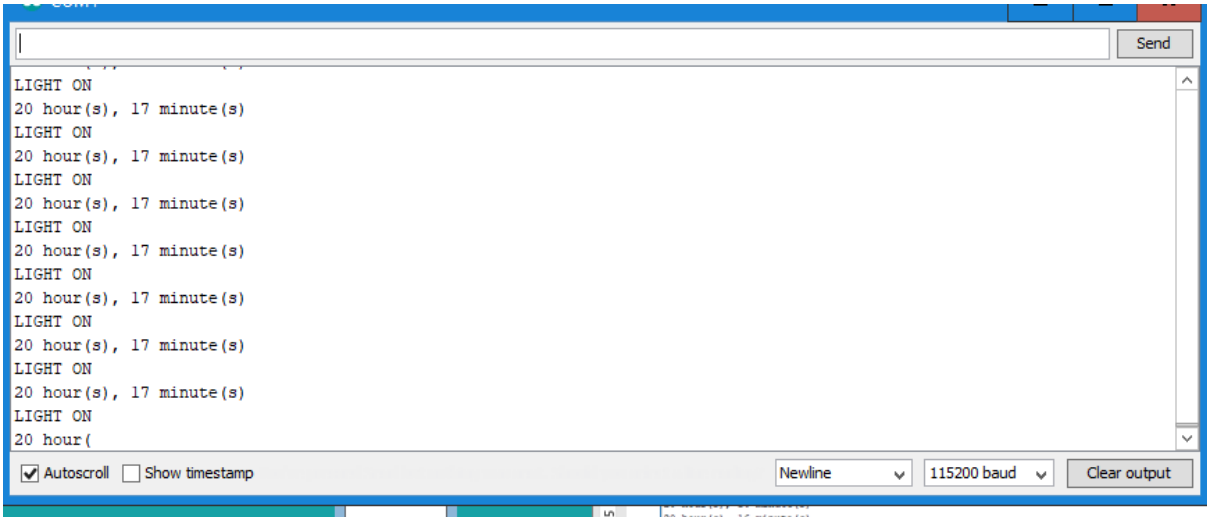


Figure4.5: Turning on the lights at the assigned time

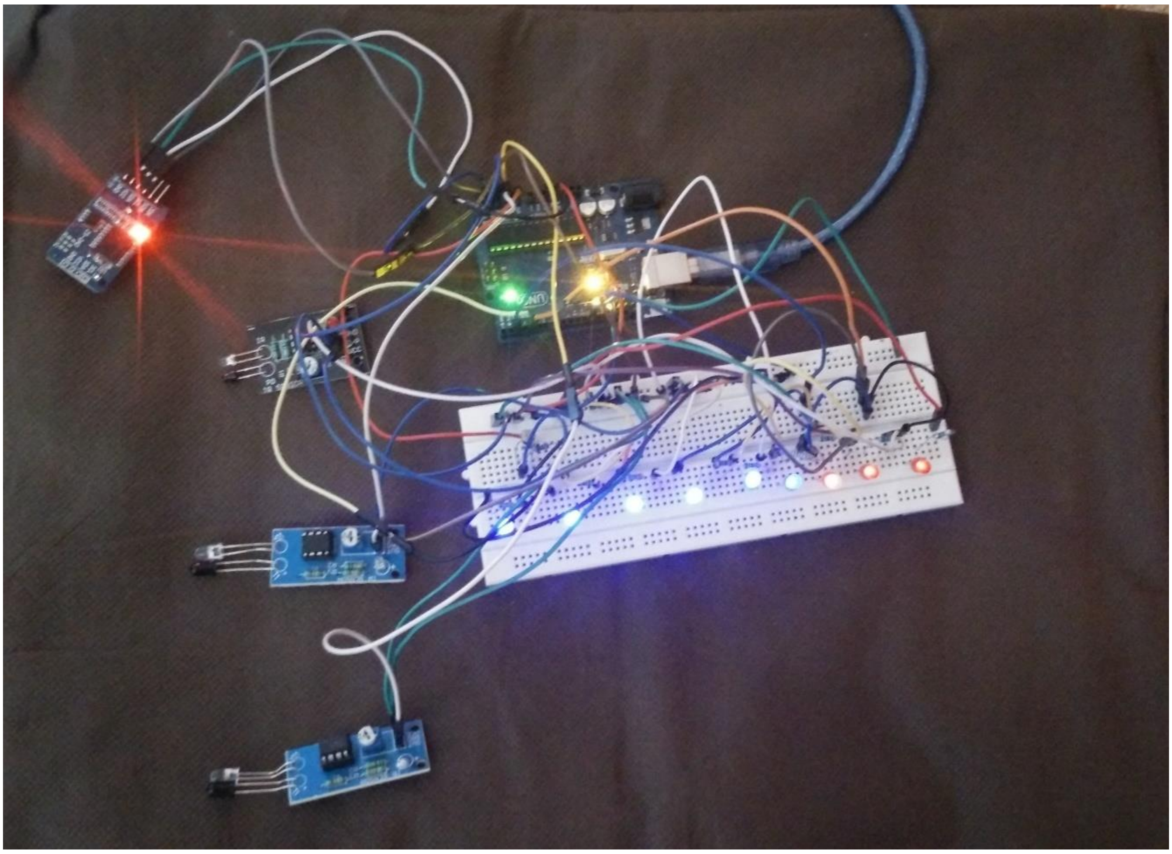


Figure4.6: Showing output of the serial monitor.

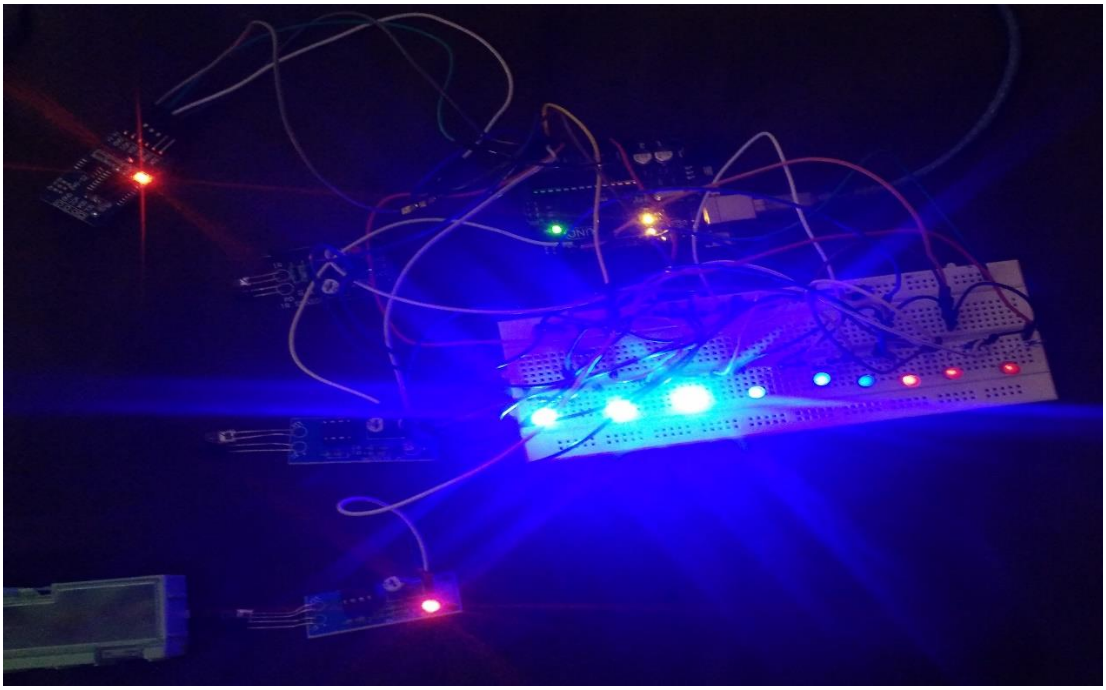


Figure4.7: The first 3 lights glow because of the object being detected by the first IR sensor.

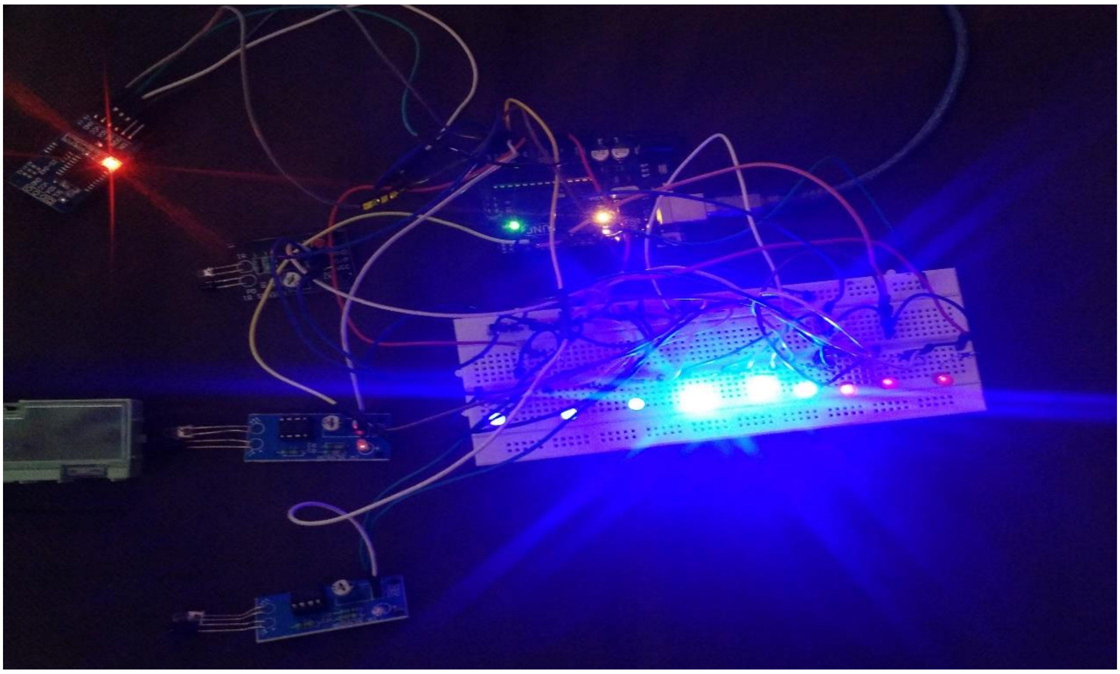


Figure4.8: The next 3 lights glow because of the object being detected by the second IR sensor.

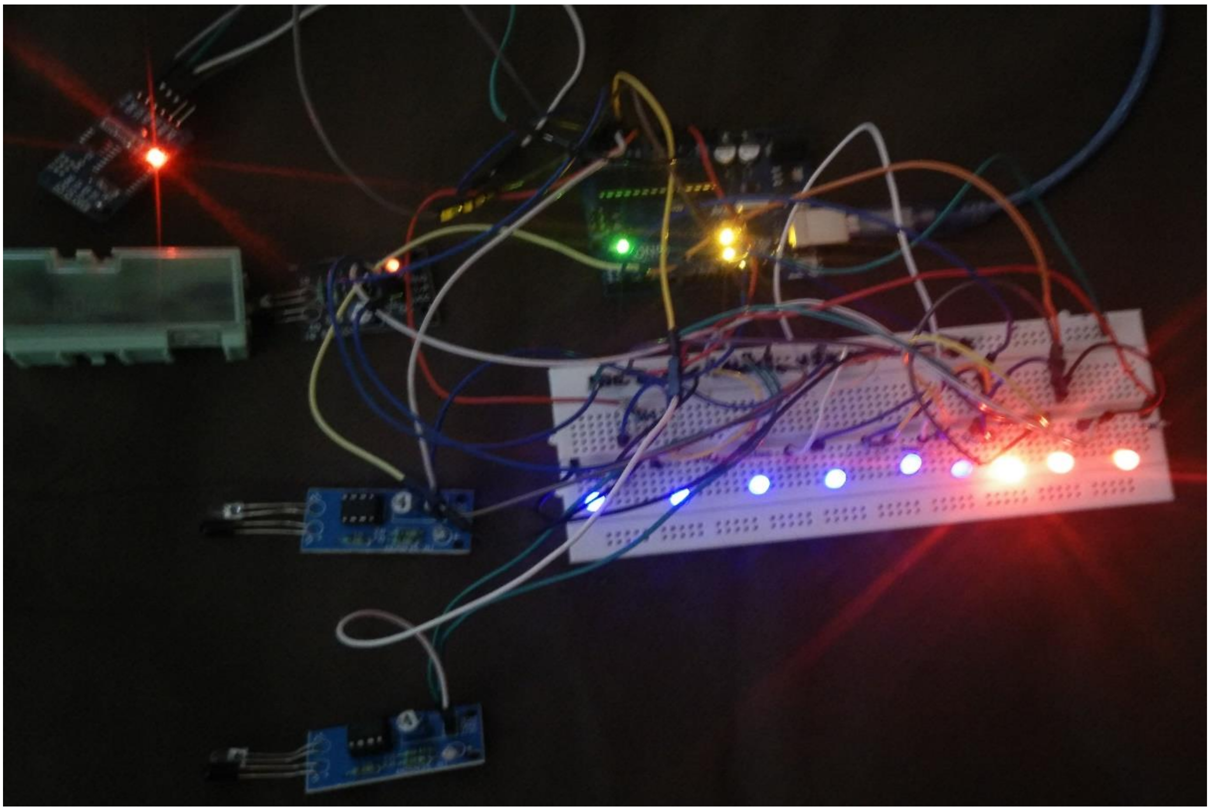


Figure4.9: The next 3 lights glow because of the object being detected by the third IR sensor.

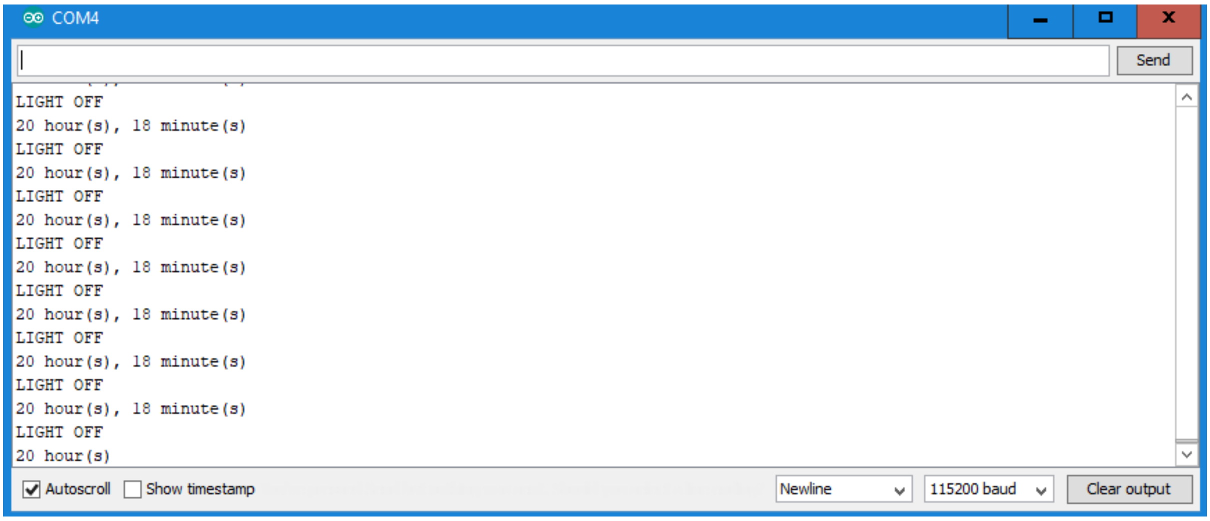


Figure4.10: Serial monitor output

The above shown results are generated by the source code attached in the appendix B.

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

The aim was to control the intensity of the road light framework between various time intervals with regular change, identify the movement out and about and increment the power of the lights when there is car moving and lessen the intensity once the movement has finished. By the utilization of Smart Street Light, additional portion of vivacity can be spared which is ended by superseding sodium vapour lights by LED. It counteracts the wastage of power brought about by manual exchanging of streetlights. It furnishes with a productive and programmed shrewd streetlight control basis with the support of IR sensors. It can control the vitality utilization and keep up the expense. This savvy framework is profoundly adaptable and unconditionally flexible to client needs.

This undertaking of Smart Street Light System is an effortful, functional, eco-accommodating and the most secure approach to spare vitality. It spares the vitality effectively by supplanting the traditional knobs by LEDs and via programmed darkening of LEDs as and when require. Primary downsides of this framework are the underlying establishment cost and support. Be that as it may, the costly scale usage of this proposed framework will definitely lessen the general expense up as it were. This undertaking has an extension in various different applications like: giving lighting in transport safe house and parking garages. The proposed framework is suitable for road lighting uncommonly in remote urban and rustic territories where the traffic is low on occasion. It can likewise be executed in the remote territories where established frameworks are restrictively costly.

Future Scope

In coming future fixing of security cameras will be central feature for the system we proposed. The job of the cameras would be to automatically capture the image of an object in motion across the streetlight and save it in its memory which can be used as a reference in future to ensure the safety at nights. This system can also be customized by upgrading ordinary LED lights to the solar LED lights which are new & renewable energy sources we could serve the same purpose of automatically controlling the street lights much more effectively in both aspects of cost and manpower. The system now is only to be used for one-way traffic on highways. The system has bright feature in two-way traffic environment which enables the system more efficient.

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APPENDIX A

Code of LDR Based Smart Street Lighting

```
int led = 12;
int led1 = 2;
int led2 = 4;
int ldr = A0;
int ir = A1;
int ir1 = A2;
int ir2 = A3;

void setup()
{
  Serial.begin (115200);
  pinMode (led,OUTPUT);
  pinMode (led1,OUTPUT);
  pinMode (led2,OUTPUT);
  pinMode (ldr,INPUT);
  pinMode (ir,INPUT);
  pinMode (ir1,INPUT);
  pinMode (ir2,INPUT);

}
void loop()
{
 Serial.println(analogRead(A0));
  int ldrStatus = analogRead (ldr);
    if (ldrStatus<=500)
     {
       digitalWrite(led, HIGH);
       analogWrite(led,255/5);



     digitalWrite(led1, HIGH);
     analogWrite(led1,255/5);

     digitalWrite(led2, HIGH);
     analogWrite(led2,255/5);
```

```
    if (analogRead(A1)>300)       // IR 1 CODE
        {
         digitalWrite(led,HIGH);
         digitalWrite(led1,HIGH);
         digitalWrite(led2,HIGH);
         analogWrite(led,255);
         analogWrite(led1,255);
         analogWrite(led2,255);
         delay(1000);

        }
     else
         {
           digitalWrite(led,LOW);
           analogWrite(led,255/5); // micro second
         }


      if (analogRead(A2)>300)       // IR 2 CODE
           {
            digitalWrite(led1,HIGH);
            digitalWrite(led2,HIGH);
            analogWrite(led1,255);
            analogWrite(led2,255);
            delay(1000);
           }
         else
            {
              digitalWrite(led1,LOW);
              analogWrite(led1,255/5);

             }
         if (analogRead(A3)>300)       // IR 3 CODE
           {
            digitalWrite(led2,HIGH);
            analogWrite(led2,255);
            delay(1000);
           }
         else
            {

              digitalWrite(led2,LOW);
              analogWrite(led2,255/5);

            }




}
else
  {
    digitalWrite(led, LOW);
    digitalWrite(led1, LOW);
    digitalWrite(led2, LOW);

  }
```

APPENDIX B

Code of RTC to set seconds, minutes, hour, date and year

```
#include <DS3231.h>

// Init the DS3231 using the hardware interface
DS3231  rtc(SDA, SCL);

void setup()
{
  // Setup Serial connection
  Serial.begin(115200);

  // Initialize the rtc object
  rtc.begin();

  // The following lines can be uncommented to set the date and time
  rtc.setDOW(MONDAY);     // Set Day-of-Week to SUNDAY
  rtc.setTime(20, 15, 0);     // Set the time to 12:00:00 (24hr format)
  rtc.setDate(13, 5, 2019);   // Set the date
}

void loop()
{
  // Send Day-of-Week
  Serial.print(rtc.getDOWStr());
  Serial.print(" ");

  // Send date
  Serial.print(rtc.getDateStr());
  Serial.print(" -- ");
```


```
  Serial.print(rtc.getDOWStr());
  Serial.print(" ");

  // Send date
  Serial.print(rtc.getDateStr());
  Serial.print(" -- ");
```


```

  // Send time
  Serial.println(rtc.getTimeStr());

  // Wait one second before repeating :)
  delay (1000);
}
```

Code to set the time to turn on lights and to turn off lights

```
#include <DS3231.h>
int led = 12;
int led1 = 2;
int led2 = 4;
int ldr = A0;
int ir = A1;
int ir1 = A2;
int ir2 = A3;
DS3231  rtc(SDA, SCL);
Time t;

const int OnHour = 20;
const int OnMin = 17;
const int OffHour = 20;
const int OffMin = 18;

void setup() {
  Serial.begin(115200);
  rtc.begin();
 pinMode (led,OUTPUT);
  pinMode (led1,OUTPUT);
  pinMode (led2,OUTPUT);
  pinMode (ldr,INPUT);
  pinMode (ir,INPUT);
  pinMode (ir1,INPUT);
  pinMode (ir2,INPUT);
}

void loop() {
```

```
void loop() {
  t = rtc.getTime();
  Serial.print(t.hour);
  Serial.print(" hour(s), ");
  Serial.print(t.min);
  Serial.print(" minute(s)");
  Serial.println(" ");
  //delay (10000);

  if(t.hour == OnHour && t.min == OnMin){
    digitalWrite(led, HIGH);
       analogWrite(led,255/5);
       digitalWrite(led1, HIGH);
       analogWrite(led1,255/5);
       digitalWrite(led2, HIGH);
       analogWrite(led2,255/5);
    Serial.println("LIGHT ON");
      if (analogRead(A1)>300)        // IR 1 CODE
               {
                digitalWrite(led,HIGH);
                analogWrite(led,255);
                //delay(1000);// micro second
               }
            else
                {
                  digitalWrite(led,LOW);
                  analogWrite(led,255/5);

                }
```

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```
                  analogWrite(led,255/5);

                }
                if (analogRead(A2)>300)       // IR 1 CODE
               {
                digitalWrite(led1,HIGH);
                analogWrite(led1,255);
                //delay(1000);// micro second
               }
            else
                {
                  digitalWrite(led1,LOW);
                  analogWrite(led1,255/5);

                }
                if (analogRead(A3)>300)       // IR 1 CODE
               {
                digitalWrite(led2,HIGH);
                analogWrite(led2,255);
                //delay(1000);// micro second
               }
            else
                {
                  digitalWrite(led2,LOW);
                  analogWrite(led2,255/5);

                }
    }


  }

  else if(t.hour == OffHour && t.min == OffMin)
  {
      digitalWrite(led, LOW);
      digitalWrite(led1, LOW);
      digitalWrite(led2, LOW);
    Serial.println("LIGHT OFF");
  }
}
```