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Energy saving automatic street lighting system

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I confirm that I understand my coursework needs to be submitted online via Google Classroom under the relevant module page before the deadline in order for my assignment to be accepted and marked. I am fully aware that late submissions will be treated as non-submission and a mark of zero will be awarded.

Acknowledgement

This report took a lot of time and work. We were familiar with the research portion of this report, such as being able to locate and polish credible material before including it in the report, but we were unaware of the practical parts of the project that were necessary for the report. Although IoT has long been a hot issue in security management, it would be absurd to expect a student to be conversant with real-world applications of the topic. As a result, this report took a lot of time and work to complete. Despite the fact that we were entirely responsible for the report's production, it goes without saying that the research was a team endeavor in the sense that we were fortunate enough to have support from both vibrant members of our group and teachers.

Mr. Maharjan, our lecturer and tutor was very expressive and clear in his teaching approaches, and he never hesitated to answer our concerns and queries. In addressing our inane questions, he has been kind and understanding, and he has sought to explain the issues in the simplest and most straightforward manner imaginable. We owe a debt of gratitude to him since he has been instrumental in the completion of this report. In presenting the module's tutorial and lab workshops, he has been equally helpful to students. He has always been very quick to answer to our email queries, saving us a lot of time that we might have spent doing more research. Mr. Maharjan has also helped us navigating through research papers and by pointing us in the right direction when we needed it. we would not have been able to finish our work if he hadn't presented us with a variety of research materials.

We are also fortunate to have a group of friends that are equally curious and eager to help. Each one of us in the group has equally helped in lectures, workshops, and assignments, among other things. It's fascinating to have a group of close pals that are willing to assist each other and work together.

Abstract

The main goal of this project is to explain the notion of the Internet of Things to the audience. Electricity is essential for a country's effective operation, yet Nepal has insufficient sources of electricity to feed the entire country. As a result, we devised an effective and practical solution. The gadget is built using IoT, and this project is based on a Power Saving Street Light. The light will work according to a motion detector, and it will only turn on when it is required. The light is turned on when the gadget detects the movement of a vehicle or a human; when the individual has passed, it likewise shuts off automatically. This can help save up to 80% of the energy that street lighting consumes.

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1. Introduction

Today is the age of science and technology, and practically everything in our environment is tied to technology in some way. There isn't a single platform where technology hasn't stamped its authority, from smart homes to various Internet of Things (IOT) gadgets. As a result, it is not an exaggeration to argue that humans have managed to live in a world that is always evolving (Possey, 2022).

We were given a group project where we had to build an IOT device which is efficient and practical. We decided to make a Power Saving Street Light. This project describes a smart street lighting system based on LEDs that can be controlled both automatically and on demand. The street lights are controlled based on Motion Sensing to use the least amount of energy possible. This will glow up when a vehicle or a person is passing by and turn off automatically after they leave, the energy consumption will lower down to a great level using this.

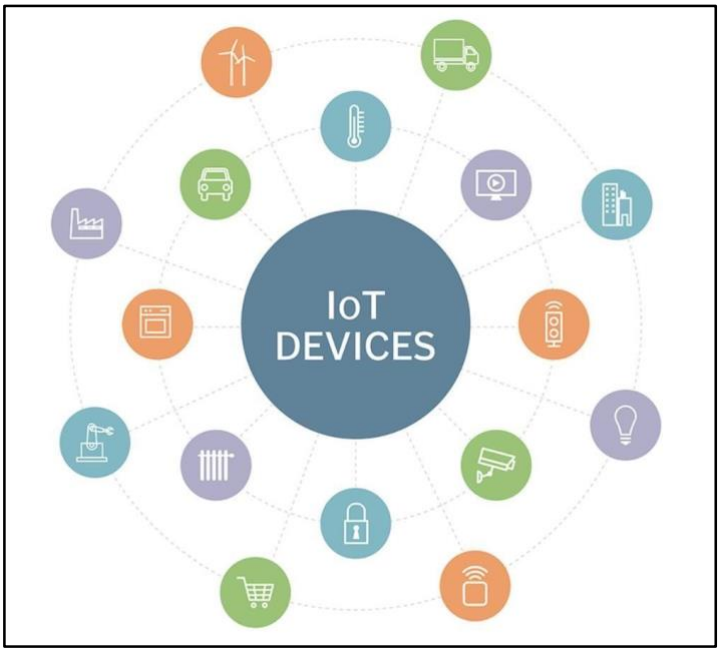

Figure 1: Devices working on IoT (Trend Micro, 2020)

1.1 Current Scenario

A few years ago, Nepal was hit by a huge power outage. People were without power for up to 16 hours each day, many businesses were forced to close, and economic foundations were thrown off. The NEA then decided to develop a long-term solution that would cut energy use .

The government build Power Saving Street Light at various locations, and currently most of Kathmandu and Pokhara have them. The most recent project is in Lalitpur, where 669 smart electric street lighting will be erected along three roads (Ojha, 2020).

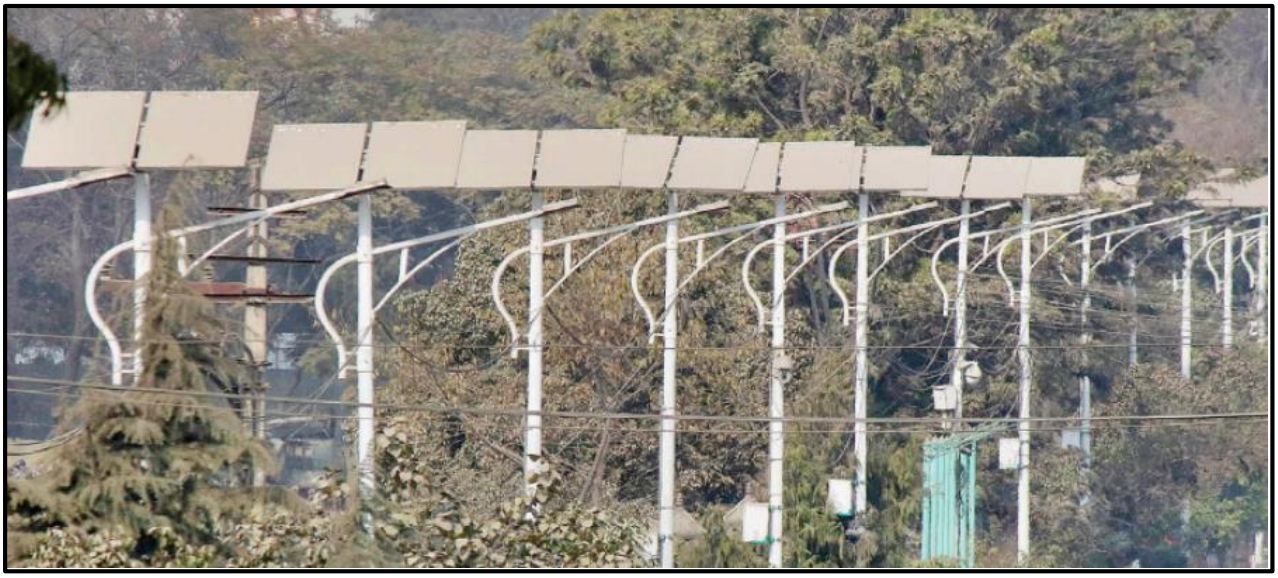

Figure 2: Power saving street lights in lalitpur (Ojha, 2020)

1.2 Problem Statement and Project as a Solution

Nepal is a country with limited power resources and high demand; in the past, Nepal has been subjected to long-term power outages. Nepal's power supply is entirely reliant on hydroelectricity, which is insufficient.

This project helps to minimize power consumption to a large level by giving an alternative to traditional street lights that remain on for 6-8 hours. This project will help to utilize street lights only when they are needed, reducing power consumption by up to 60%-80% (Bhargava, et al., 2021).

1.3 Aim

To build a power saving street light, in order to reduce power consumption and unnecessary electricity leakage and provide an efficient power saving light system to mitigate power crisis.

1.4 Objectives

To full fill the aims above the following objectives are carried out.

- To learn about the usage of a proper electronics hardware and software platform, preferably Arduino.
- To learn about different movement detection and measurement devices like, IR and LDR sensors.
- To understand various intricacies of electronics connection and wire system.
- To finalize an effective and well-working IoT system.
- To productively work as a group through efficient communication, proper definition of roles and clarity.

2. Background

2.1 System Overview

The system as described earlier creates a smart lighting system which glows up when motion is detected. It saves a lot of power and is very useful in countries like Nepal where power outages are very common. The system contains very sophisticated wiring of different IOT devices.

2.2 Hardware Architecture

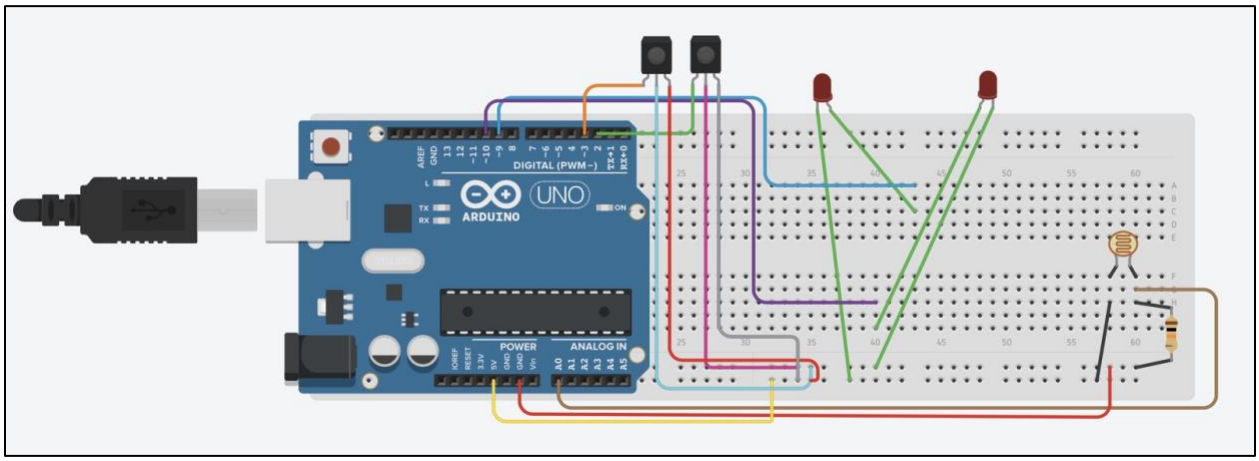

Figure 3: Hardware architecture of the system.

As shown by the tinker cad diagram above, the hardware architecture is mostly occupied by bread board and Arduino. Furthermore, it consists of wires of different types such as: male to female, male to male, and female to female. An LDR sensor, that is photo resistor that changes its resistance with the intensity of light is used. Two IR sensors that detect motion in a straight line of sight are used. Two LED bulbs are used to synchronize with two IR sensors respectively. One general resistor of 220 ohm is used.

2.3 Circuit Diagram

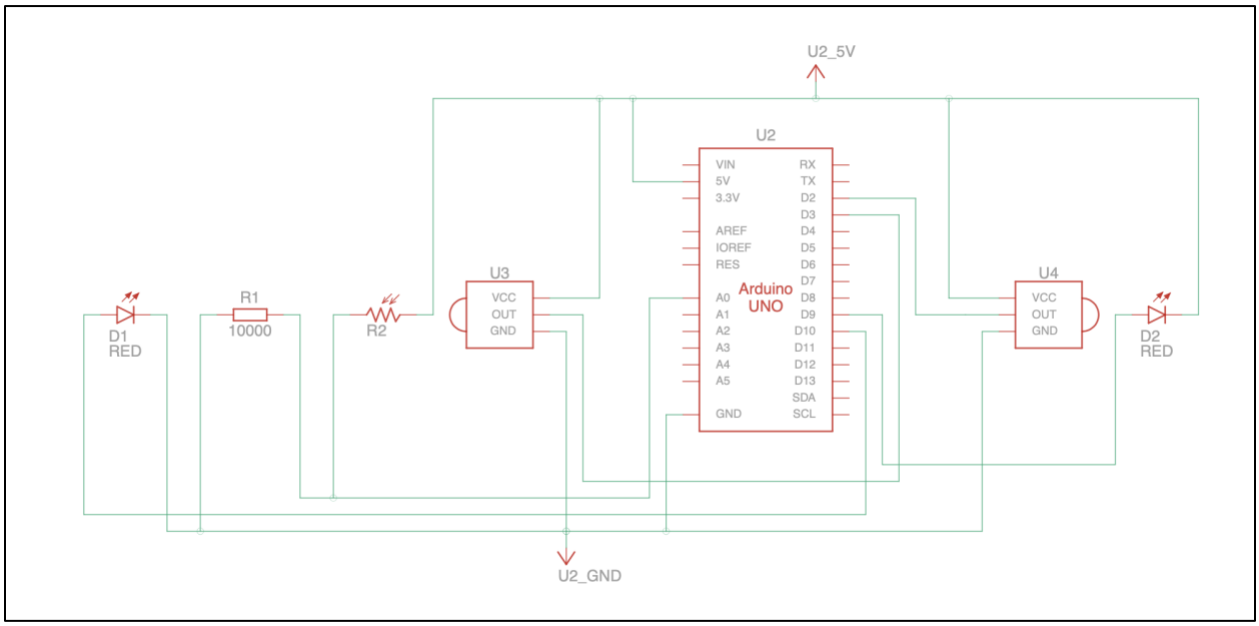

Figure 4: Circuit Diagram of the system.

As shown by the circuit diagram the Digital output 9 of Arduino is connected to positive terminal of LED1. The positive line of breadboard is connected to negative terminal of LED1. The digital output 10 of Arduino is connected to positive terminal of LED2. The negative line of breadboard is connected to the negative terminal of LED2. The digital output 2 of Arduino is connected to the output of IR sensor 1. The negative line of breadboard is connected to the ground of IR sensor 1. The positive line of breadboard is connected to VCC of IR sensor. The digital output 3 of Arduino is connected to output of IR sensor 2. The negative line of Breadboard is connected to ground of IR sensor. The positive line of Breadboard is connected to VCC of IR sensor 2. A0 of Arduino is used for analog input. 5V and GND is used for power supply. For LDR 10000 ohm resistor is used where one end is connected to A0 for analog input and other is connected to GND using 10000 ohm resistor.

2.4 Flowchart

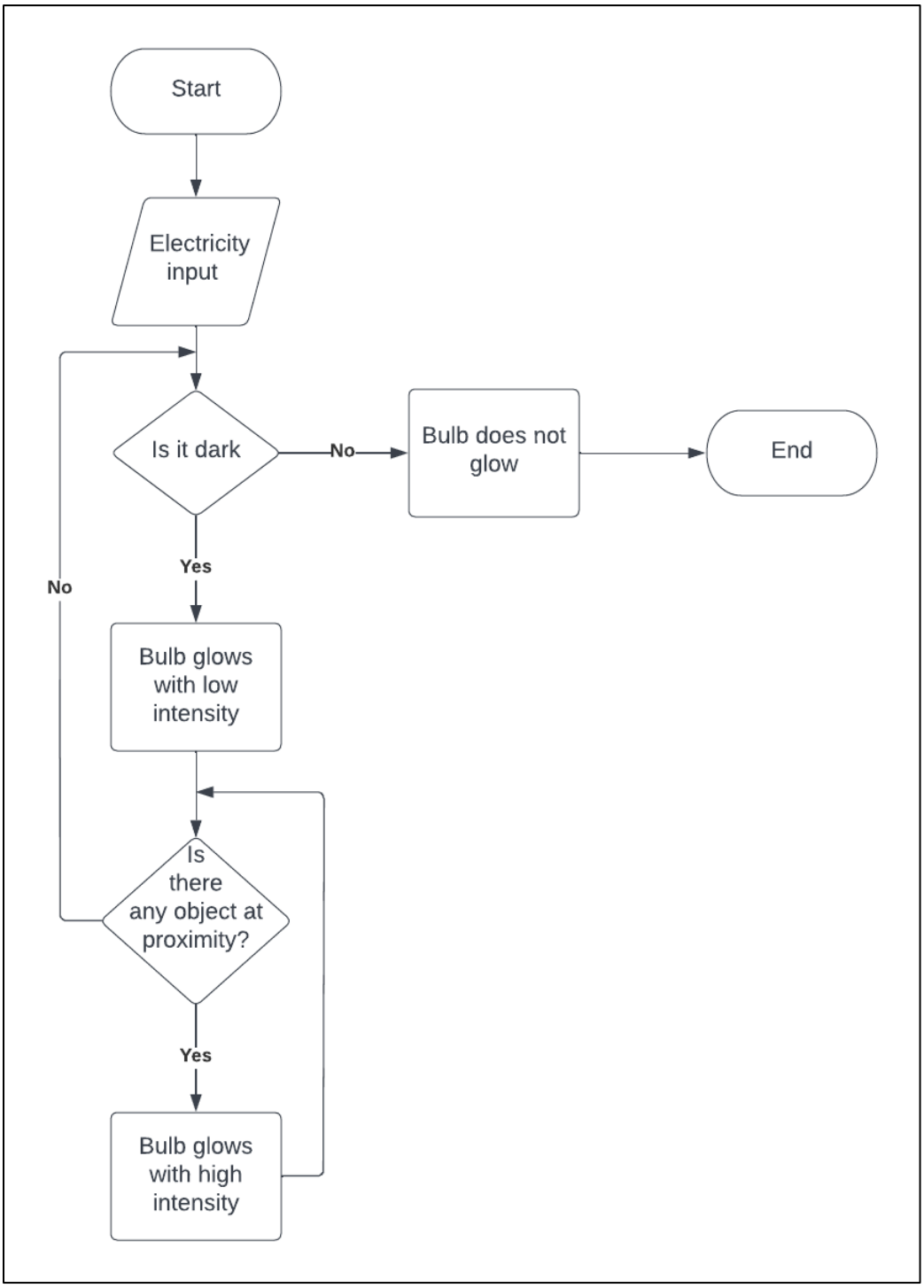

Figure 5: Flowchart of the system.

2.5 Requirement Analysis

The required materials have been generally explained in above paragraphs. They can be listed out as below:

- One 10,000 ohm resistor
- Two blue LED’s
- One Light Dependent Resistor(LDR)
- One Arduino Uno R3
- Two IR sensors
- One bread board
- Multiple jumper cables

3. Development

The development process is quite straightforward. As stated above the major items required were Arduino, cables, bread board, lights and sensors. In terms of those equipment, the development process can be described in following steps:

Step 1: Planning and Design

After it was agreed that smart street lighting should be built, the plans were laid out soon. First the IOT system was designed in tinker cad which is a very good platform for virtually designing the IOT systems. This was a wise decision because it prevents various mishaps such as voltage irregularity, damaging of devices, etc due to human error. The circuit diagram was also built and studied so that it can implement later on the real device with very good precision and understanding.

Step 2: Resource Collection

For all the required resources, the resource department of the college was consulted. The resource department provided, all the required materials like Arduino uno, breadboard, sensors, jumper cables. However it was felt that the cables were not enough so more of them were bought from an electric store. Few resistors were also bought. Apart from all the technical resources, cardboards, paper, glue stick, straws, foams, etc were bought for aesthetic designs so that real life street scenario can be emulated.

Step 3: System Development

For LDR sensor:

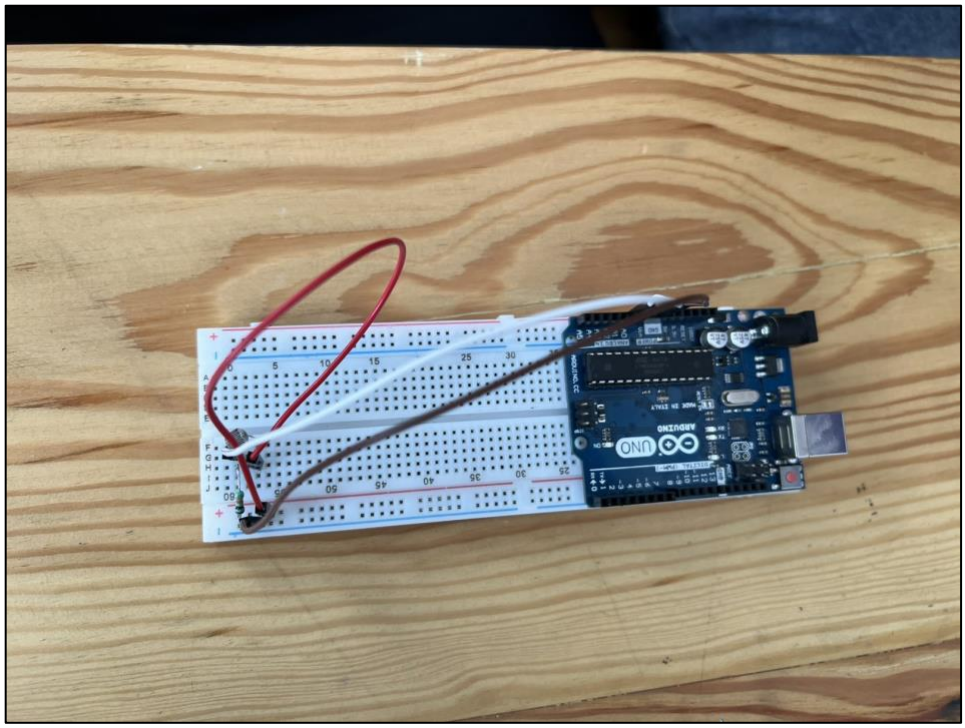

Figure 6: Connecting LDR sensor.

Since the project involves using a photo resistor, the first step involves connecting the LDR sensor to the bread board and Arduino with necessary wires. The light is supposed to glow with dimmed intensity upon darkness first so the LDR sensor is connected.

For the circuit:

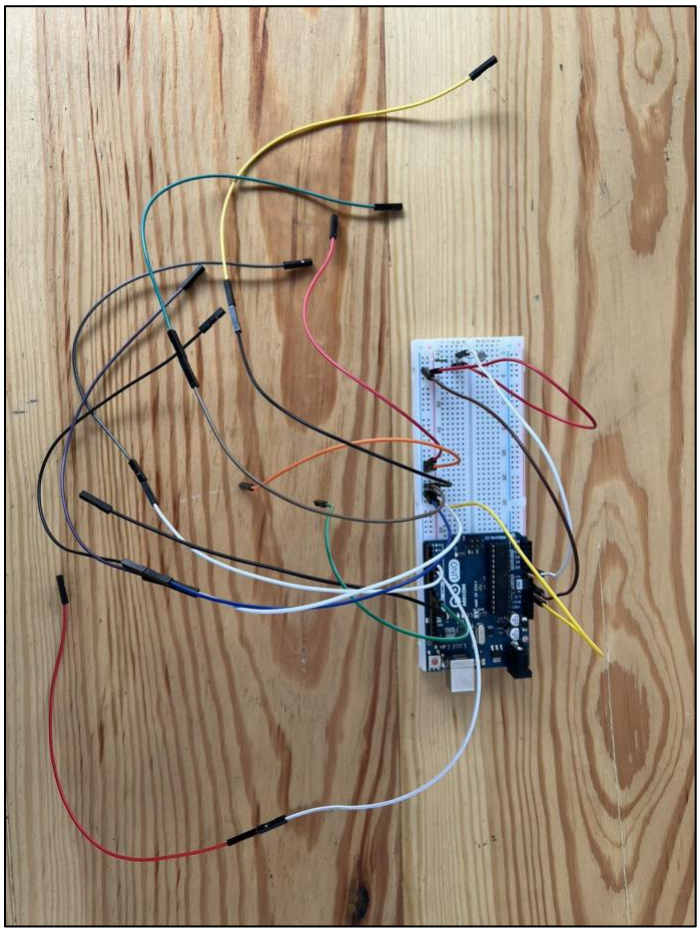

Figure 7: Buildiing the necessary circuit.

After that the necessary circuit involving all wires as shown in the circuit diagram was connected so that they can be later connected to other censors and light bulbs. In coming steps however, some wires will be removed for more clarity. All wires were connected early on to remove any confusion.

For IR sensor:

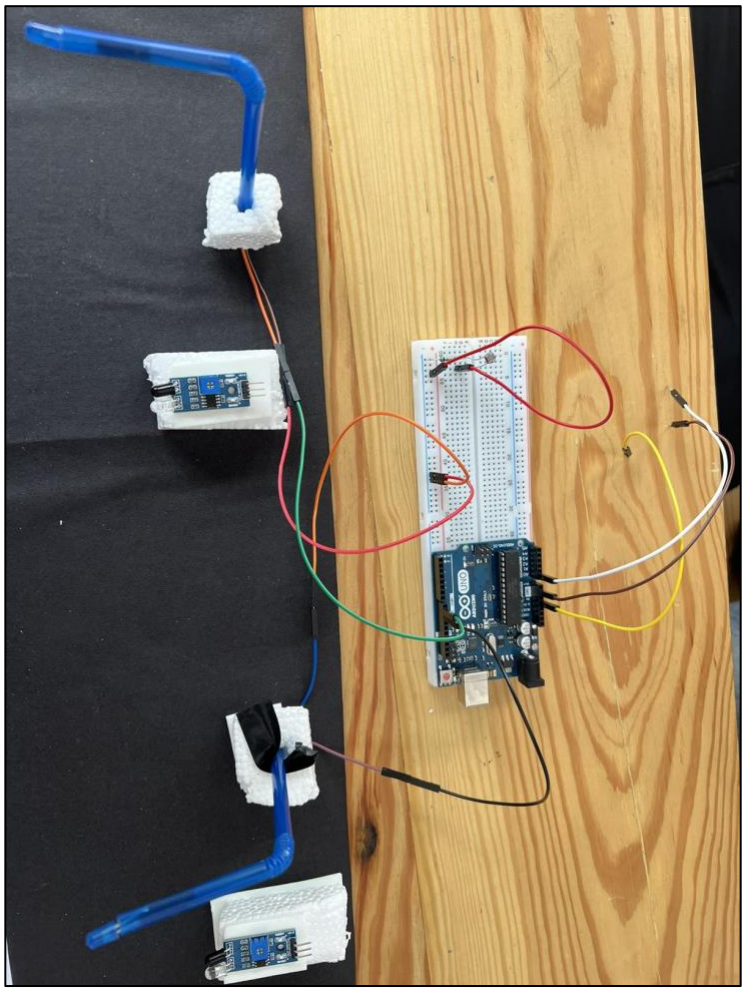

Figure 8: Connecting IR sensors

Then the IR sensors were connected to the circuit. The sensors detect an object's motion and increase the intensity of the light accordingly. The sensors were mounted on a styroform with double sided tape. It keeps those sensors stable and keeps the line of sight straight so that any object in front can be detected easily.

For LED bulbs:

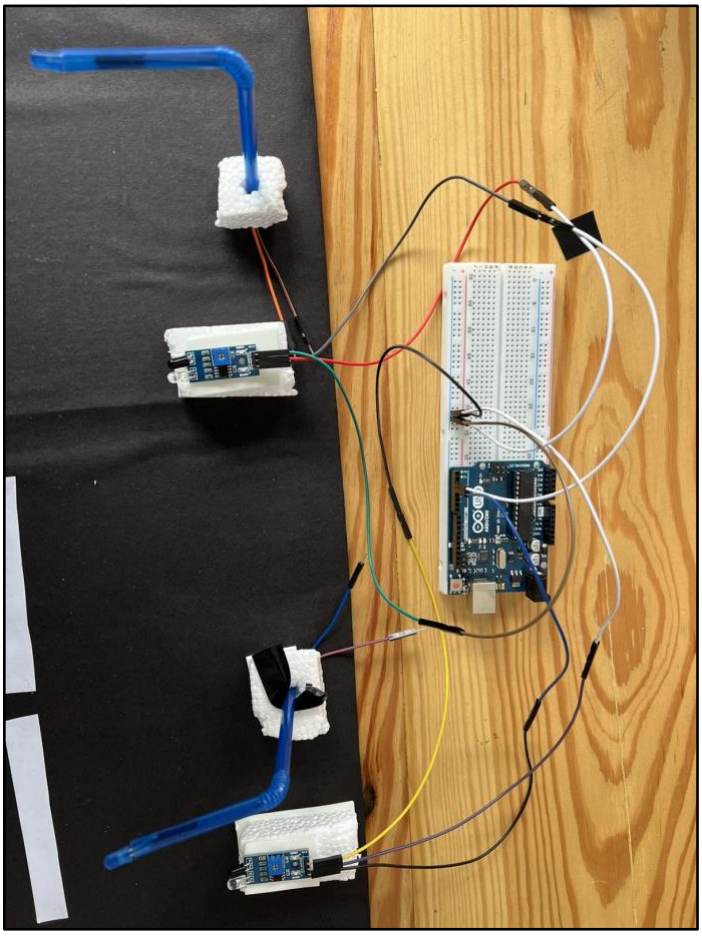

Figure 9: Connection of LED bulbs.

After connecting the sensors, the light bulbs were connected. The light bulbs too, were mounted on a styro foam. They were further raised with the help of a straw pipe to simulate a street light pole and make the scenario more realistic. This completes the necessary connection with all devices.

FOR the whole development:

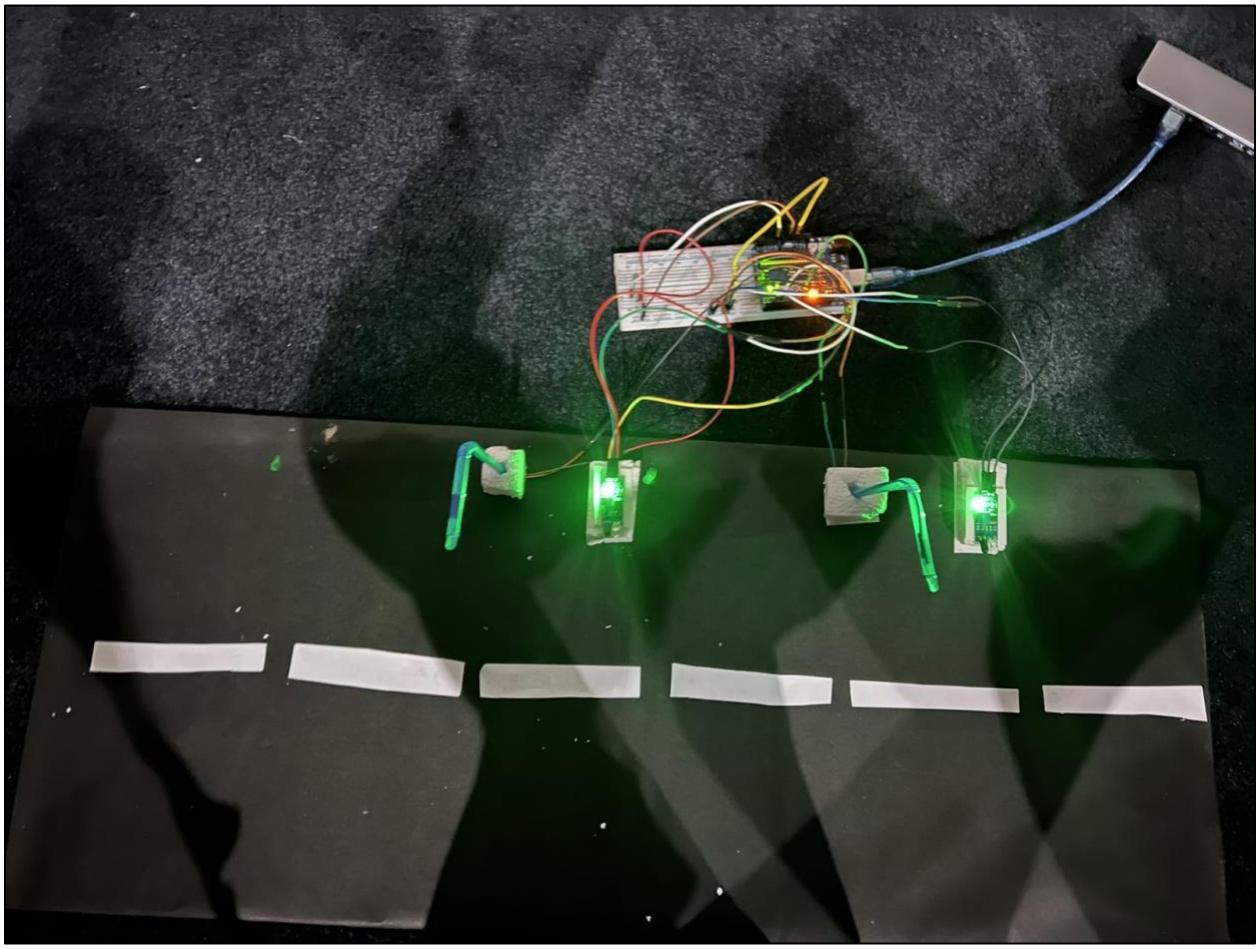

Figure 10: Development completed.

After all devices were connected and all necessary wires and circuit were kept in place, the final developed system looks as shown in the above picture. Here electricity is provided to the system and it is ready for tests.

4. Results and Findings

4.1 Results

The results were as expected and was fully compliant to the plan that was drafted at the initial phase of development. The final result was a working IOT system of smart light system. The final product has a prototype of street and lights made out of card board and drinking straw. A toy car was used to simulate a real car. It is amazing how a mere prototype can look so realistic. It can be concluded from the results found that, this prototype of a smart IOT device can be fully implemented for real is all places to reduce electricity waste and increase saving.

4.2 Findings

The findings can be described in following test cases:

Test 1: When it is bright outside

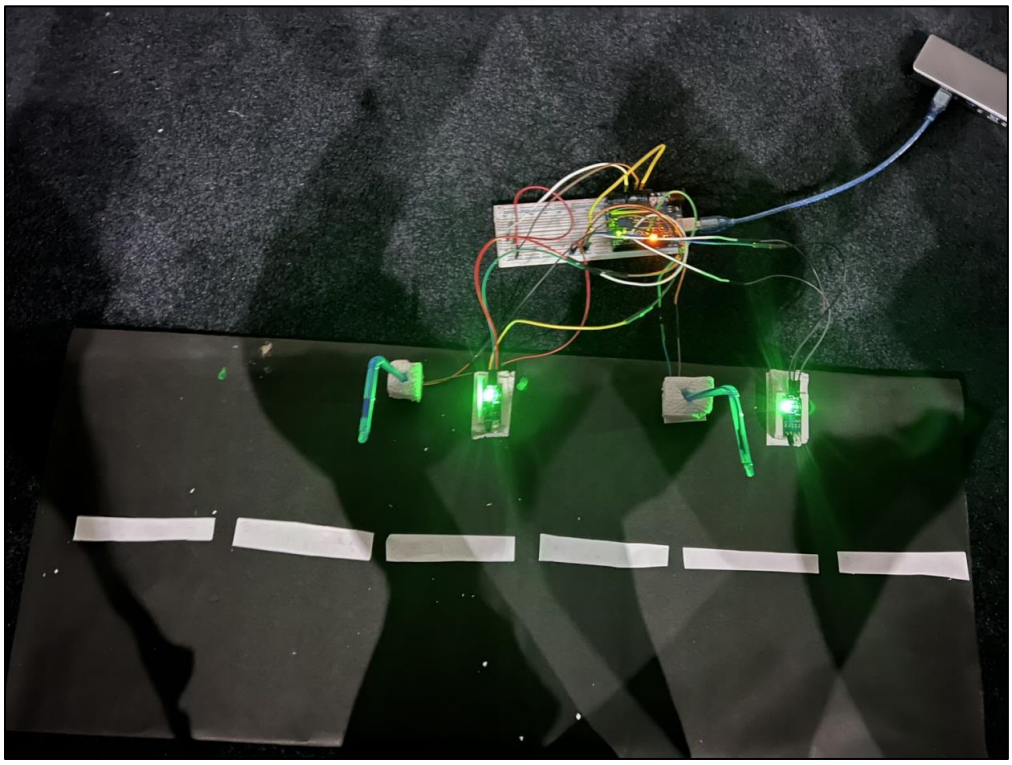

Figure 11: When it is bright outside.

It was discovered that upon enough lighting condition the light bulbs are naturally turned off. This simulates an actual day time where light bulbs don't glow because obviously they are not needed.

Test 2: When it is Dark outside

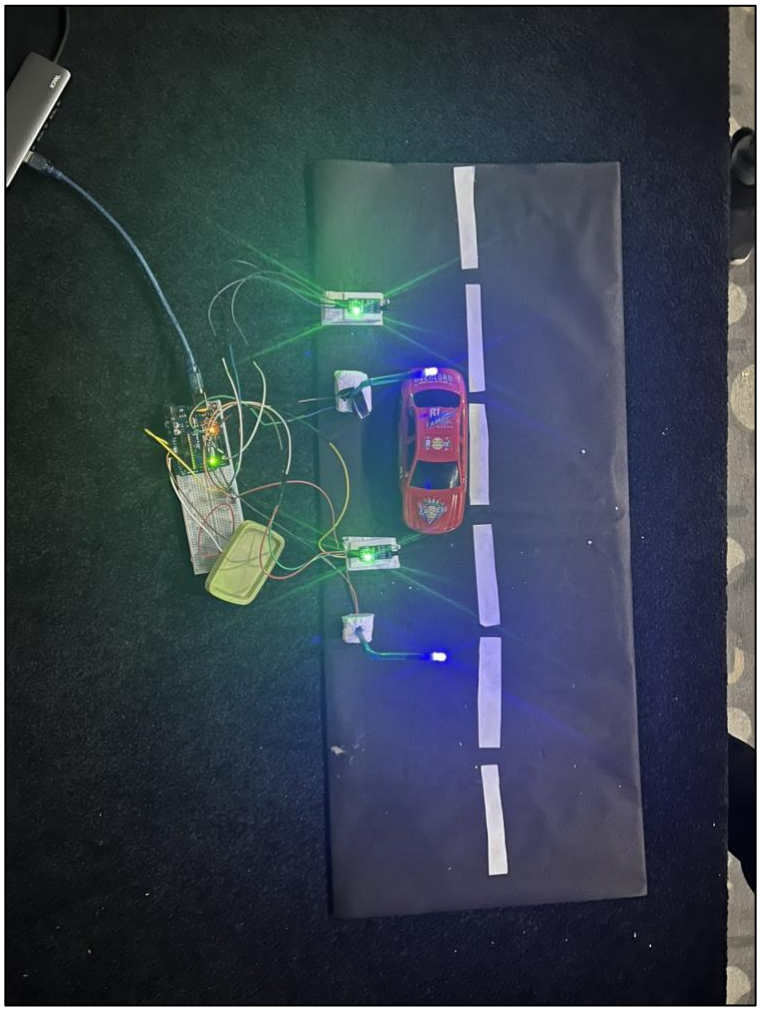

Figure 12: When it is Dark outside.

When the photo resistor was covered to simulate night environment, the bulbs glowed up as expected. The intensity of those bulbs were low however, because the car was not in the proximity of any sensors.

Test 3: First light turning on

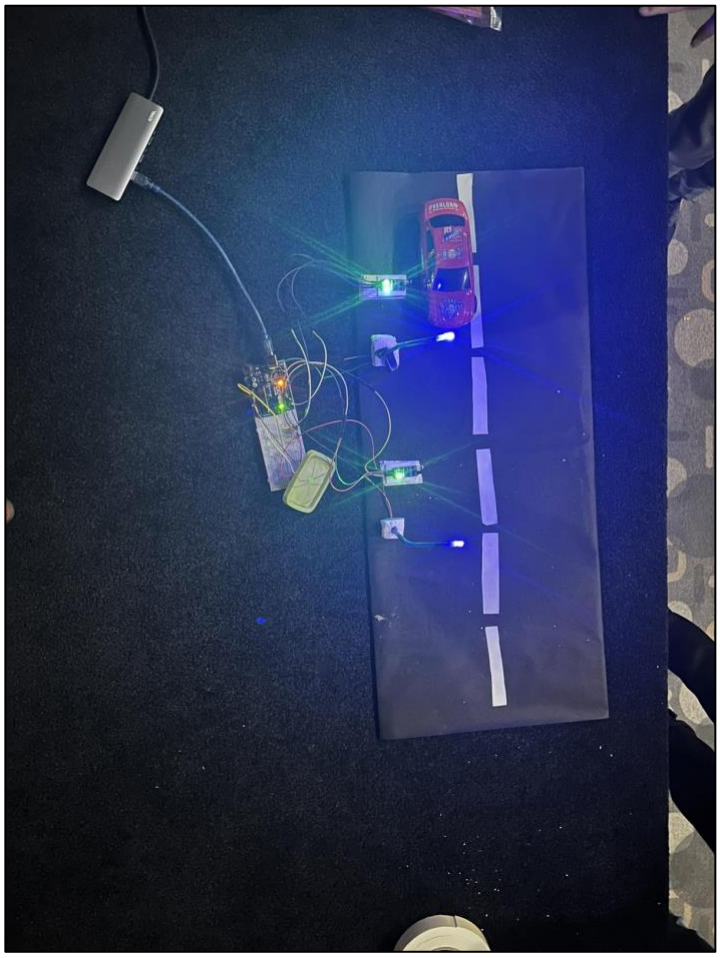

Figure 13: First Light turning on.

When the car passed through first sensor, the first bulb glowed at full intensity to allow the car more visibility. The second bulb however remained at the same low intensity. Thus the first IR sensor and bulb passed the test.

Test 4: Second Light turning on

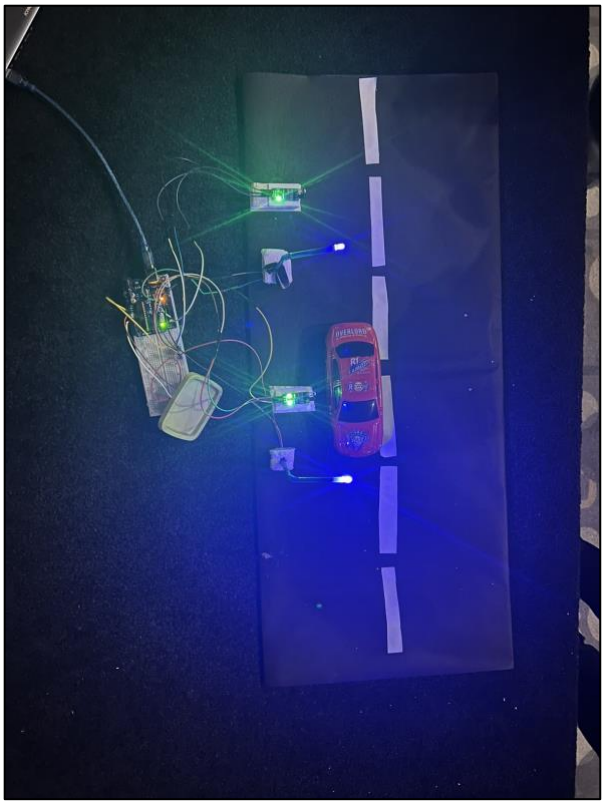

Figure 14: Second light turning on.

When the car was passed through the second sensor, the second bulb glowed with full intensity. The first bulb reduced its intensity as soon as the car passed through it. Thus the first IR sensor and bulb passed the test.

5. Future Works

The other purpose of this undertaking was also to research and see how viable is this project if implemented in the real world. As such, the future works that can be carried out from the idea of this project are:

- Normal roads, freeways, and expressways can all benefit from the street light control circuit.
- The project may also be utilized in retail parking lots, hotels, and industrial lights, among other places.
- Because LEDs have a longer life term and are more durable than Neon-based lights, which are commonly used as street lights, the cost of maintenance can be lowered if the lighting system uses exclusively LED lights.
- Huge amounts of energy may be saved by turning lights on and off automatically.
- In comparison to other systems, this system is less expensive, requires less installation and maintenance, and is more efficient.
- Light levels dimming as a result of an external cause.
- To improve efficiency, the time lamps are on at nightfall and sunrise is precisely reduced.
- Adapting power consumption to maintain a consistent light output, taking into account the combined impacts of slow LED brightness degradation and dirt accumulation between cleaning intervals.

6. Conclusion

The generation of power in Nepal has dropped dramatically, as the country is entirely reliant on hydroelectricity, which fluctuates. Nepal was hit hard by a power outage a couple of years ago. We sought to devise a long-term strategy for reducing energy usage while maintaining the same level of efficiency.

In general, a street light control system is a straightforward idea that employs a transistor to turn on at night and off during the day. A sensor called LDR can be used to complete the procedure (light dependent resistor). Nowadays, energy conservation is a must, since energy supplies are depleting at an alarming rate. As a result of this scarcity of resources, our future generations may confront several challenges. To switch on/off the street lights, this technology does not require a manual action. The street lighting system determines whether or not lighting is required.

Street lighting systems in enterprises and cities are rapidly expanding these days. Cost effectiveness, automation, and power consumption are major issues in the area of many technologies such as electrical and electronics. To maintain and regulate lighting systems, many street lighting systems have been designed. These lighting systems are used to manage and reduce energy usage. This article depicts a street light that turns on when it detects vehicle activity. Street light control is one of India's most advanced energy-saving systems.

The project attempts to save energy by sensing vehicle movement on highways and turning on the street light block ahead of it while turning off the tail lights. Sensors are needed for the project to detect vehicle movement and turn on the lights ahead of it. The tail lights turn off automatically as soon as the car goes forward. This may be utilized to conserve a lot of energy rather than utilizing the traditional technique of keeping the street lights on. Another way of operation is to keep the lights on at 10% intensity until the vehicle passes by, at which point the lights ahead of it are switched on at 100% intensity and the trailing lights return to 10% intensity.

7. References

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8. Appendix

8.1 Source Code

```
//defining the IR sensor and LED
#define irSensorOne 2
#define irSensorTwo 3
#define ledOne 9
#define ledTwo 10

void setup() {
  Serial.begin(9600);
  pinMode(A0, INPUT); //assigning the input pin number
  pinMode(irSensorOne, INPUT); //assigning the IR senor 1
  pinMode(irSensorOne, INPUT); //assigning the IR senor 2

  pinMode(ledOne, OUTPUT); //assigning the LED 1
  pinMode(ledTwo, OUTPUT); //assigning the LED 2
}

void loop() {
  if (analogRead(A0) >= 150) { //when the outside brightness is more than 150 the LED wont turn on
    digitalWrite(ledOne, LOW);
    digitalWrite(ledTwo, LOW);
    Serial.println("It's Bright Outside; Lights status: OFF"); //display message for serial monitor
  } else {
    if (digitalRead(irSensorOne) == HIGH) { //when the outside brightness is less than 150 the LED will turn on
```

```
      analogWrite(ledOne, 40); //assigning the lowest brightness of LED1 as 40
    } else {
      analogWrite(ledOne, 255); //assigning the highest brightness of LED1 as 255
      Serial.println("It's Dark Outside; LED1 Lights status: ON"); //display message for
LED1
    }
    if (digitalRead(irSensorTwo) == HIGH) {
      analogWrite(ledTwo, 40); assigning the lowest brightness of LED2 as 40


    } else {
      analogWrite(ledTwo, 255); //assigning the highest brightness of LED2 as 255
      Serial.println("It's Dark Outside; LED2 Lights status: ON");  //display message for
LED2
    }
  }
  delay(50); //assigning 50 as the delay for the LED
}
```