A
Report
on
"Automatic Sensor Based Staircase Lighting Control System"

Prepared by

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Under the guidance of

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CHARUSAT
CHAROTAR UNIVERSITY OF SCIENCE AND TECHNOLOGY

CERTIFICATE

This is to certify that the report entitled "**Automatic Sensor Based Staircase Lighting Control System**" is a bonafide work carried out by **Akshat Dharmesh Patel (19EC037)** under the guidance and supervision of **Asst. Prof. Miral Desai** & **Mr. Alpesh Pandya** for the subject **Summer Internship - I (EC351)** of 5th Semester of Bachelor of Technology in Electronics & Communication at Faculty of Technology & Engineering (C.S.P.I.T.) – CHARUSAT, Gujarat.

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CERTIFICATE OF INTERNSHIP

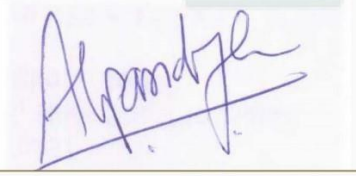
This is presented to

AKSHAT PATEL

Roll Number 19EC037 , for successfully completing his internship under the name of

" Automatic Sensor Based Staircase lighting Control System "

DATED : 3/7/21



ALPESH PANDYA
Proprietor
AATMAN CORPORATION

COMPANY DESCRIPTION

Founded and established in 2003, Aatman Corporation has been a frontrunner for proffering advanced and technically sound tools to enhance your lifestyle. Well-known for providing services like home automation, installing home/office security systems, electrical consulting and customizable amenities are being served by the company. Along with this, the firm have been working and researching simultaneously on much broader projects in the industrial, residential and commercial aspects. Talking about our lighting control systems, we have had major breakthroughs in the above-mentioned sectors.

Through inculcating a strong workforce and advanced technology, we strive to provide the best and cost-effective solutions in the array of home and offices automation. Making an extensive usage of recent tools, we have put forth an impeccable opportunity for the engineering students to gain and apply knowledge about the upcoming technology in the respective field.

ABSTRACT

In our sensor-based lighting system, the lights are automated according to the presence of people using the staircase. This model is further modified with the Bluetooth module, to craft it into more advanced & remote. It can be further extended with a user interface on mobile devices. With this project, we will successfully create a system where lighting control will be purely based on human presence, terminating the need to manually switch the circuit. Through this smart design, the power consumption can be reduced and also, can be utilized in the emergency situation as a backup. In order to implement this technology, we first need to survey the various methods available for sensing data and controlling the lighting based on occupancy of the area.

ACKNOWLEDGEMENT

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1. INTRODUCTION

With the rapid advancements in technology taking place in the 21st century, more and more devices in our day-to-day activities are getting integrated and intuitive. As the name suggests, Home Automation means connecting multiple home devices over a common link channel and giving users the overall control of all the connected devices to function according to their needs remotely. The user-interface enables the peripheral devices to connect internally, and are controlled by a common hub. Further, home automation also uses tablet, mobile, desktop etc. for the offsite access. Home automation is becoming more and more popular these days.

Home automation is the automatic control of electronic devices in your home. These devices are connected to the internet, which allows them to be controlled remotely. With home automation, devices can trigger one another so you don't have to control them manually via an app or voice assistant. Home automation works on three levels: Monitoring, Control, and Automation.

1.1 Automated Staircase Lighting System

Automated Lighting control system is a formidable application of home automation. An automatic light system prototype to replace ordinary staircase light switches has been developed. The system keeps track of the patterns in which lights are used and when are used. The system is controlled by Arduino UNO and multiple circuits, and communicates with a smartphone application via Bluetooth. The final prototype designed in this project, uses a relay switch to turn on and off home lights, and has a user interface panel with manual switches, indicator LEDs, and two ultrasonic motion sensors. One major objective behind the design of this model is to reduce the energy and power consumption in homes, through the utilisation of low-power, standard sensor network.

Remote control for home appliances can be operated by a handheld device, such as a smart phone, a tablet, etc. The performance superiority of an automatic LED lighting control system over its conventional counterparts is demonstrated in the proposal in many aspects. Further cost savings are realized by the proposed colour-changing and fully dimmable smart LED lighting controller relative to a conventional one. This work is validated as a very effective approach to the performance improvement of an LED lighting system under various circumstances such as art exhibitions, alarm indicators in plants for safety concern, and many more. In short, a tremendous amount of advancing progress has been made in this automatic stair lighting design, as the consequence of network and automatic control technique improvement.
The performance of the proposed system is verified by experiments in practical environments under the supervision of our mentor.

Components used:

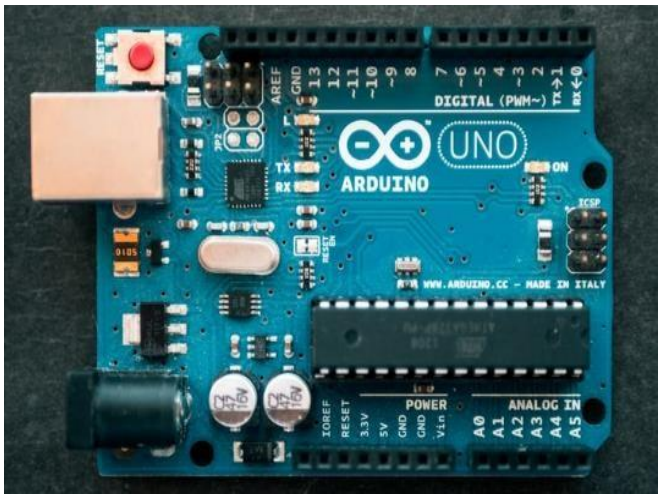


Figure 1 Arduino UNO Board

Arduino UNO is basically a microcontroller based on the ATmega328P. It consists of: 14 digital input/output pins, 6 analogue inputs, 16 MHz ceramic resonator, USB connection, power jack, ICSP header and reset button. Arduino UNO is basically the mind of the entire circuit that acts like the brain of the circuit and does all the functions, through an interconnection among the peripheral devices.

It is functioned to communicate from PC to other microcontrollers to other components connected. It is an open-source electronic platform.

Figure 2 Ultrasonic Sensor

A cheap, efficient sensor for detecting the human or animal presence/movement. This sensor is a special instrument that measures the distance of any obstructing object with the ultrasonic sound waves. The sensor uses transducer for sending and receiving the ultrasonic pulses.
Thus, relaying back the information and sensing the presence of an obstruction.

Figure 3 Relay Module

Relay module acts as a switch for opening and closing the circuit connected with it. It closes or opens one circuit while being connected to another circuit. In case of LEDs, relay module is the perfect fit as it is utilized with lower currents in control circuit. Further, protecting the LEDs from being damaged and switching the LEDs simultaneously as the circuit breaks from Arduino.

Figure 4 Bluetooth Module

A wireless communication peripheral device, utilized for sending and receiving any information or instruction. With an operational frequency of 2.41 GHz, it is the perfect fit for small range of applications. The Bluetooth module here is applied to control the LED time lag and for manual switching remotely.
The setting of the LEDs can be controlled through a mobile application via Bluetooth.

Figure 5 LED Stripes

Light Emitting Diodes (LED) are the lights which glow on the voltage power. This is turned on automatically whenever the ultrasonic sensor detects any movement. Thus, breaking the circuit and is turned off when the movement is detected once again in another sensor.

DIMER Circuit

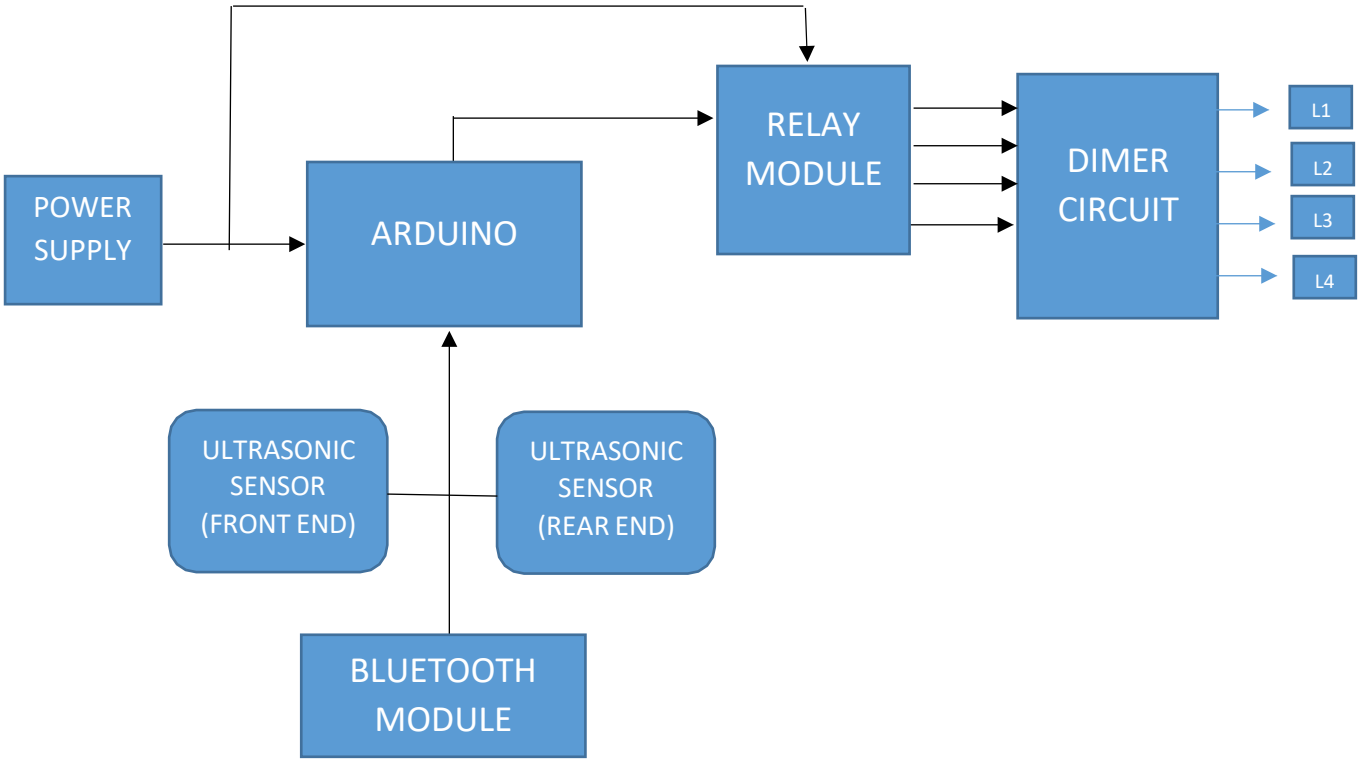
This circuit is devised using the capacitors, resistors and power supply on the breadboard. Due to this circuit, the LED is turned OFF in sync with a minor time delay in terms of nanoseconds. Thus, allowing only a considerable amount of current to pass through the capacitors so that the LED won't get shorted on passing of sudden, huge voltage.

Figure 6 SMPS (Switch-Mode Power Supply)

Mainly used for a smooth and stable switching of power supply, without causing any damage to the components. It is the high frequency power conversion device to convert the voltage or current to the level at which the peripheral components function.

1.2 Circuit Design

A Block Diagram of Circuit Components:



In this diagram, the Arduino is initiated with the power supply. The data is fetched to the Arduino board from any of the ultrasonic sensors (rear or front). The very moment any ultrasonic sensors are cut, the data is sent to the Relay Module via Arduino. Further, the relay module powers the Dimer circuit for a transitional switching of the LEDs. In the end, Dimer circuit enables the LED to switch ON/OFF at a regular interval of time delay.
Above all, this process takes place right when the movement is detected by any sensor to the simultaneous switching of LED by the Dimer circuit. In the same circuit, the LED light switching is also controlled by the Bluetooth module manually from the mobile application. Through this, the time delay of the LEDs can be set manually too.

[Here, L1=LED 1, L2=LED 2, L3=LED 3, L4=LED 4]

1.3 Mobile Application Screenshots

Screenshot of mobile application controlling the staircase lighting system through Bluetooth module:

Figure 7 *Set time delay (Delay button, 5 seconds, 10 seconds, 20 seconds)* Default Screen showcasing the Master ON and OFF for manual switching. Set Delay option is given to choose the time delay after which the LEDs will turn ON. (5 sec, 10 sec, 20 sec or Default)

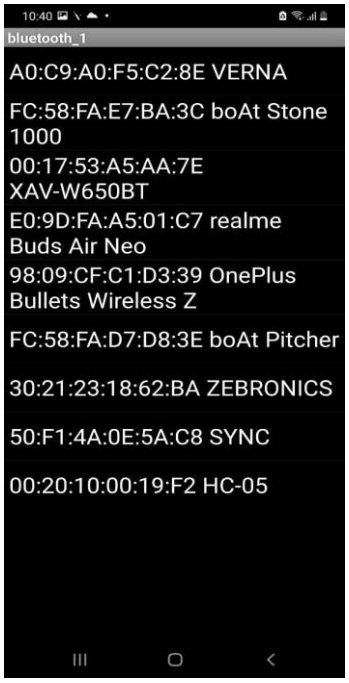
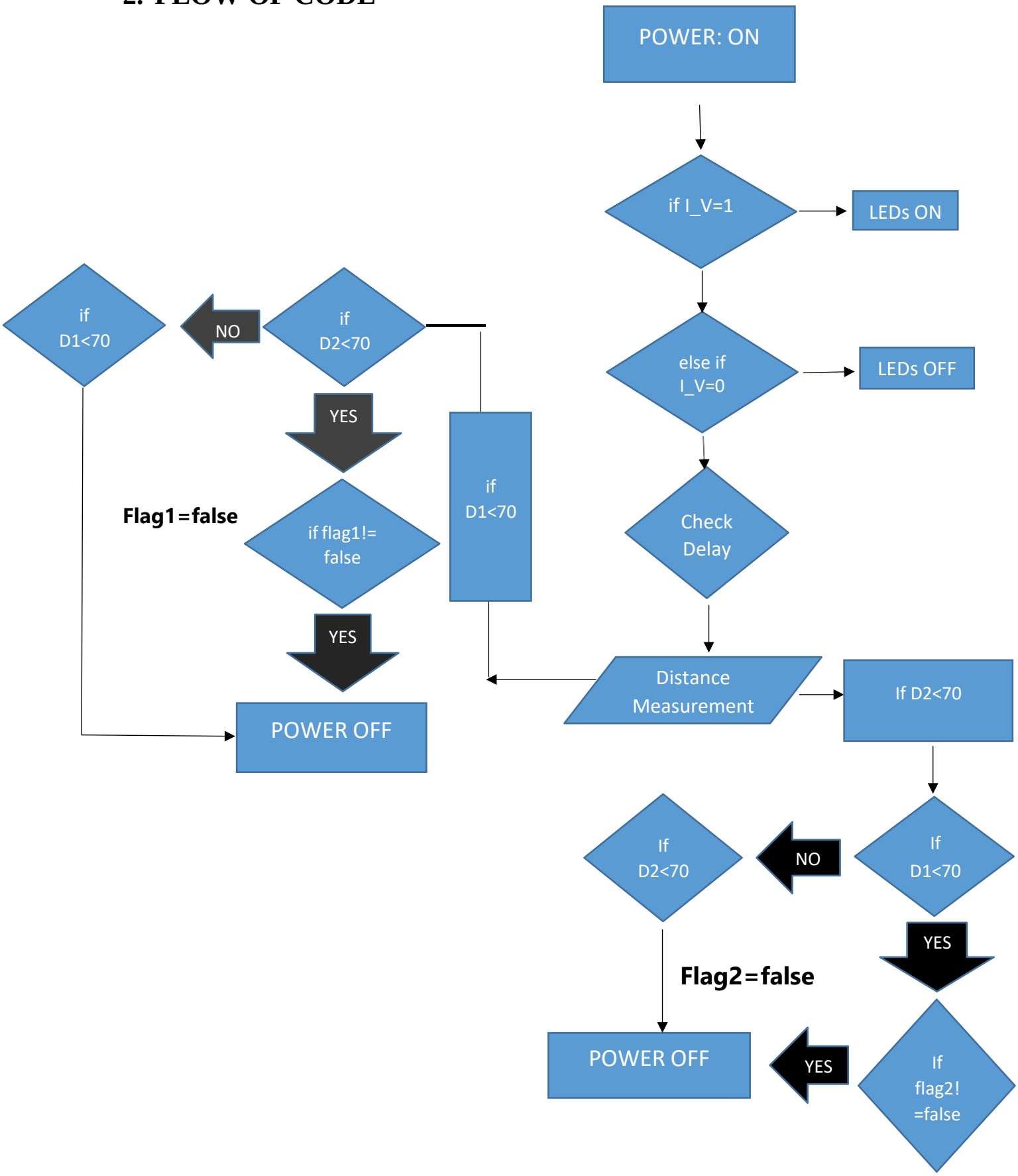


Figure 8 *Bluetooth Devices Available. Serial Monitor Screen after the "Set Delay" is pressed. This shows the serial numbers while the staircase is lighting up.*

Figure 9 *Bluetooth (Master On and Off)*

2. FLOW OF CODE



2.1 Source Code

```
#include <AltSoftSerial.h>      //including libraries AltSoftSerial
sending;
#define echoPin1 2        //defining pins
#define trigPin1 3
#define echoPin2 10
#define trigPin2 11
#define relay1 7
#define relay2 6
#define relay3 5
#define relay4 4
long duration;           //global variables
int distance;
int adp=1;
bool flag1=true;
bool flag2=false;
int incoming_value=0;
int n=3000;               //here 'n' is default delay (in case user
haven't sent any delay via android application)
void setup() {
   sending.begin(9600);
  pinMode(trigPin1, OUTPUT);    //Declaration of ports
  pinMode(echoPin1, INPUT);
  pinMode(echoPin2, INPUT);
  pinMode(trigPin2, OUTPUT);
  pinMode(relay1, OUTPUT);
  pinMode(relay2, OUTPUT);
  pinMode(relay3, OUTPUT);
  pinMode(relay4, OUTPUT);
  pinMode(13,OUTPUT);
  Serial.begin(9600);
  digitalWrite(relay1,HIGH);    //Set all the relays by-default as
HIGH (i.e in OFF condition)
  digitalWrite(relay2,HIGH);
  digitalWrite(relay3,HIGH);
  digitalWrite(relay4,HIGH);

}

void loop() {

  while(adp)
  {
 if(Serial.available()>0)   //fetch/checking the delay value if given
by user through mobile application.
  {
    incoming_value=Serial.read();     //if value detected then it
will get stored in the variable "incoming_value"
    Serial.print("incoming_value: ");
```

```
    Serial.print(incoming_value);
    Serial.print("\n");
    if(incoming_value=='1')        //All the relays will set to high
if user gives input as 1 through android application (i.e Master ON
and OFF via mobile application).
    {
      digitalWrite(13,HIGH);
      digitalWrite(relay1,LOW);
      delay(100);
      digitalWrite(relay2,LOW);
      delay(110);
      digitalWrite(relay3,LOW);
      delay(120);
      digitalWrite(relay4,LOW);

      }
     else if(incoming_value=='0')   //All the relays will set to low
if user gives input as 0 through android application.
     {
      digitalWrite(13,LOW);
      digitalWrite(relay1,HIGH);
      delay(100);
      digitalWrite(relay2,HIGH);
      delay(110);
      digitalWrite(relay3,HIGH);
      delay(120);
      digitalWrite(relay4,HIGH);
      }
      else if(incoming_value==50){    //This condition will check for
the value inputed by the user via application and set the delay
accordingly.
          n=5000;
          Serial.print("Delay added of 5 seconds ");
          }
      else if(incoming_value==51){
          n=10000;
          Serial.print("Delay added of 10 seconds ");
          }
      else if(incoming_value==52){
          n=20000;
          Serial.print("Delay added of 20 seconds ");
          }
    }
  long duration1=0;   //Declaring the variables
  int distance1=0;
  long duration2=0;
  int distance2=0;
  digitalWrite(trigPin1, LOW);    //Code for Ultrasonic Sensor 1
  delayMicroseconds(2);
  digitalWrite(trigPin1, HIGH);
  delayMicroseconds(10);
```

```
  digitalWrite(trigPin1, LOW);

  duration1 = pulseIn(echoPin1, HIGH);

  distance1 = duration1 * 0.034 / 2;    //Calculating distance 1

  sending.print("Distance 1: ");
  sending.print(distance1);
  sending.println(" cm");



  digitalWrite(trigPin2, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin2, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin2, LOW);

  duration2 = pulseIn(echoPin2, HIGH);    //Calculating distance 2

  distance2 = duration2 * 0.034 / 2;

  sending.print("Distance 2: ");
  sending.print(distance2);
  sending.println(" cm");


  if (distance1 <70)                          //Condition for triggering
Ultrasonic sensor 1
  {
    while(distance1<70)
    {
      digitalWrite(relay1,LOW);
      delay(100);
      digitalWrite(relay2,LOW);
      delay(110);
      digitalWrite(relay3,LOW);
      delay(120);
      digitalWrite(relay4,LOW);
                                                  //Measuring distance1
                              again (for fetching values continuously)
       digitalWrite(trigPin1, LOW);
       delayMicroseconds(2);
       digitalWrite(trigPin1, HIGH);
       delayMicroseconds(10);
       digitalWrite(trigPin1, LOW);

       duration1 = pulseIn(echoPin1, HIGH);

       distance1 = duration1 * 0.034 / 2;
       sending.print("Distance 1 in while loop: ");
```

```
        sending.print(distance1);
        sending.println(" cm");
        delay(5000);

    }

//loop for checking entry and exit of any movement
   while(flag1!=false)
    {
       digitalWrite(relay1,LOW);

       digitalWrite(relay2,LOW);

       digitalWrite(relay3,LOW);

       digitalWrite(relay4,LOW);

       //distance1
       digitalWrite(trigPin1, LOW);
      delayMicroseconds(2);
      digitalWrite(trigPin1, HIGH);
      delayMicroseconds(10);
      digitalWrite(trigPin1, LOW);

      duration1 = pulseIn(echoPin1, HIGH);

      distance1 = duration1 * 0.034 / 2;

       digitalWrite(trigPin2, LOW);
       delayMicroseconds(2);
       digitalWrite(trigPin2, HIGH);
       delayMicroseconds(10);
       digitalWrite(trigPin2, LOW);

       duration2 = pulseIn(echoPin2, HIGH);

       distance2 = duration2 * 0.034 / 2;

//measuring distance2 (for fetching values continuously)
       sending.print("still, didn't passed the stairs!! Sensor 2
distance: ");
       sending.print(distance2);
       sending.println(" cm");
       if(distance2<70)
 //if user have completed the whole flight of stairs, flag1 will be
assigned false (i.e. user has gone through the stair case)
       {
        flag1=false;
        }
       else if(distance1<70)                                    //if
user came down without completing whole flight of stairs
```

```
        {
        // Serial.print("Switching off lights in 4 seconds...");
         delay(3000);
         digitalWrite(relay4,HIGH);
         delay(100);
         digitalWrite(relay3,HIGH);
         delay(110);
         digitalWrite(relay2,HIGH);
         delay(120);
         digitalWrite(relay1,HIGH);
         flag1=false;
         }


                                                          }flag1=true;
                          //declaring flag as true again for next entry
                                                            delay(n);
                        //adding delay (added by user or default delay)
    digitalWrite(relay1,HIGH);
    delay(100);
    digitalWrite(relay2,HIGH);
    delay(110);
    digitalWrite(relay3,HIGH);
    delay(120);
    digitalWrite(relay4,HIGH);

    }

 else if (distance2 <70)                        // Condition for
triggering Ultrasonic Sensor 2
  {
    while(distance2<70)
    {
      digitalWrite(relay4,LOW);                 //if the condition is
fulfilled, all the relay will be set to high.
      delay(100);
      digitalWrite(relay3,LOW);
      delay(110);
      digitalWrite(relay2,LOW);
      delay(120);
      digitalWrite(relay1,LOW);

                                                //Measuring distance2
again (Continuous checking for distance2)

       digitalWrite(trigPin2, LOW);
       delayMicroseconds(2);
       digitalWrite(trigPin2, HIGH);
       delayMicroseconds(10);
       digitalWrite(trigPin2, LOW);
```

```
       duration2 = pulseIn(echoPin2, HIGH);

       distance2 = duration2 * 0.034 / 2;
       sending.print("Distance 2 in while loop: ");
       sending.print(distance2);
       sending.println(" cm");
       delay(5000);

    }
                                                    //loop for checking
entry and exit of human(sensor 2)
   while(flag2!=false)
   {
      digitalWrite(relay4,LOW);

      digitalWrite(relay3,LOW);

      digitalWrite(relay2,LOW);

      digitalWrite(relay1,LOW);
      //measuring distance 1
      digitalWrite(trigPin1, LOW);
      delayMicroseconds(2);
      digitalWrite(trigPin1, HIGH);
      delayMicroseconds(10);
      digitalWrite(trigPin1, LOW);

      duration1 = pulseIn(echoPin1, HIGH);

      distance1 = duration1 * 0.034 / 2;

      sending.print("Still didn't passed the stairs!!Sensor 1
distance: ");
      sending.print(distance1);
      sending.println(" cm");

                                                      //measuring
distance 2
      digitalWrite(trigPin2, LOW);
       delayMicroseconds(2);
       digitalWrite(trigPin2, HIGH);
       delayMicroseconds(10);
       digitalWrite(trigPin2, LOW);

       duration2 = pulseIn(echoPin2, HIGH);

       distance2 = duration2 * 0.034 / 2;

      if(distance1<70)
      {
        flag2=false;
```

```
        }
      else if(distance2<70)
       {
                                                  // Serial.print("Switching
off lights in 4 seconds...");
        delay(4000);
        digitalWrite(relay1,HIGH);
        delay(100);
        digitalWrite(relay2,HIGH);
        delay(110);
        digitalWrite(relay3,HIGH);
        delay(120);
        digitalWrite(relay4,HIGH);
        flag2=false;;
        }
      else
      {
        continue;
        }


    }
    flag2=true;                                  //declaring flag again as
true for next entry
    delay(n);                                    //adding delay(via mobile
application/default delay)
    digitalWrite(relay4,HIGH);
    delay(100);
    digitalWrite(relay3,HIGH);
    delay(110);
    digitalWrite(relay2,HIGH);
    delay(120);
    digitalWrite(relay1,HIGH);

    }
}
}
```

2.2 Photos and Videos

The relevant multimedia can be accessed through the given drive link:
https://drive.google.com/drive/folders/1Dvn_cKaWOK2mhRepc6aZmmZpIgR9vm2j?usp=sharing

3 Limitations

- This system is not ready to be installed in the crowded/public places.
- Very expensive.
- Modifications are much complex after the home installation.

4 Future Enhancements

- Brightness and darkness detection using LDR sensors (i.e sensor will have the control to turn ON and OFF the system).
- Can be controlled through multiple devices by the means of Wi-Fi.
- Number of relay sets can be increased to enhance the smooth switching of LED.
- Number of ultrasonic sensors can be increased for controlling the entire design through one microcontroller.

Conclusion

This work presents the automatic lighting and security system using ultrasonic sensors. We have shown how effectively the power is saving because of using motion sensors. We have shown that using PIR sensors we can save both money and our generated power on a large scale which ultimately helps the power distribution. So, it is an effective and very time demanding project for our country as well as others. This application permits both automatic and manual functional control, which is flexible for the user.

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