Smart Light for Home with Automatic Direction and Intensity Adjustment using Arduino

Soumyajit Mitra, Priya Mishra, J. Ajay Daniel, S. Balaji

Abstract--- In this paper the idea of adaptive smart lighting control system with human motion tracking has been demonstrated. The system uses a series of sensors to track human movement in a confined space and focus more light in that direction. Also the system has the ability to adapt the intensity and number of lights based on number of people in the room. The lighting system also has the ability to adapt the intensity of light based on the availability of natural light. The idea behind this system is to provide sufficient lighting to room where a human is detected, while automatically adjusting the intensity based on natural light and number of people for optimum power consumption and will reduce power quality issues.

Keywords--- Human Movement, Arduino, Optimum Power Consumption, Automatic Direction, Intensity, Smart Light.

I. INTRODUCTION

In any room the intensity of light across the room is not uniform. This causes some area of the room to have less intensity than other. This is especially true for big rooms. This leads to installation of multiple lighting units in a room which leads to more electricity consumption. A lighting system that would track human movement and adjust the focus of the light accordingly would eliminate this problem. Using an artificial light that would work in conjuncture with natural light and adjust its intensity accordingly will provide and efficient lighting system and would lead reduce power consumption while maintaining adequate brightness level.

The advent of LED technology has led to huge improvement in artificial lighting.[1] It is more bright, has a longer lifespan and consumes less electricity. It also allows for easier control of intensity compared to conventional CFLs and fluorescent lamps[6].

The paper provides a design methodology in which the following objectives have been implemented. The system also provides for automatic switch off and switch on of the lights based on human presence and a mobile application based control. In designing this system an array of sensors that together provides all the above-mentioned functionalities which leads to reduction in power consumption and a subsequent increase in efficiency[3].

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II. BASIC BLOCK DIAGRAM OF THE SYSTEM

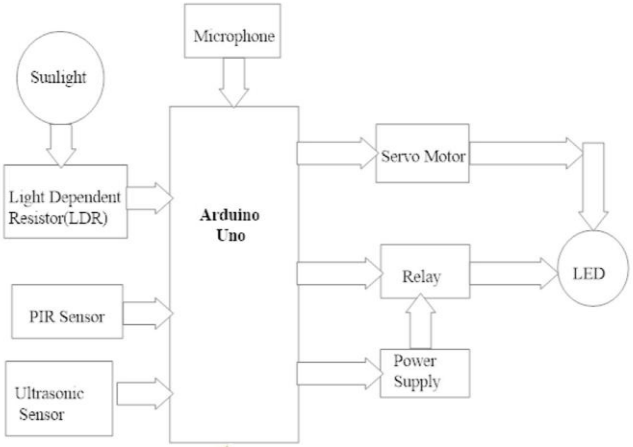

Fig. 1: Block Diagram of Proposed System

Fig.1 represents the block diagram of the system and the components used in the system. The following are the components used:

Arduino Microcontroller

The Arduino Microcontroller is an open-source hardware and is a widely accepted development platform. The board consists of an Atmel 8-bit AVR microcontroller along with several other features that provides an easy to use development environment. For this project an Arduino Uno board is used which is the latest Arduino microcontroller. The following fig. 2 shows an Arduino Uno board.

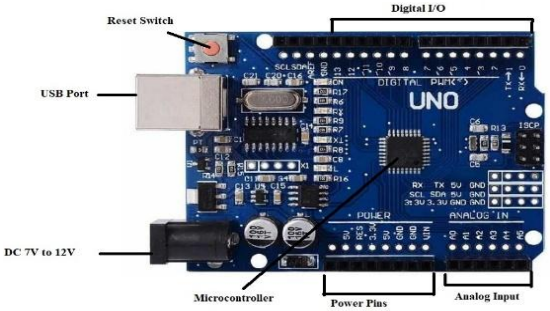

Fig 2: Arduino Uno Development Board

The Arduino Uno board has an ATmega328P microcontroller and has an operating voltage of 7 to 20 Volts. It has 14 digital I/O pins and 6 analog input pins. It has 32 kb flash memory along with 2 KB SRAM and 1 KB EEPROM. The Arduino Uno provides a clock speed at 16 MHz.

IR Sensor

Mostly used for motion detection an IR sensor or an Infrared Sensor measures the infrared light radiating from objects in its field of view. Working of an IR sensor is complicated when compared to most other contemporary sensors as the input and output of the sensor depends on multiple variables.

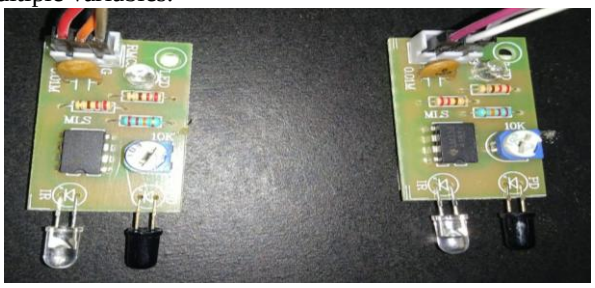

Fig. 3: IR sensor

The IR sensor has a special material that is sensitive to infrared light which is placed in two slots. When the sensor is idle it detects the infrared light emitted by the walls and any other object in its surrounding and as a result both slots detect same amount of infrared light[8]. But if a warm object passes by, it obstructs one half of the sensor which causes a positive differential change between the two halves. The opposite happens when the warm body leaves the field of view of the sensor causing it to produce a negative differential change. These differential changes produce an output voltage that triggers the detection[12]. The IR sensor can detect for a range of 15 cm to 150 cm.

Ultrasonic Sensor

An ultrasonic sensor is used to measure the distance of an object using ultrasonic sound waves. Ultrasonic sensors use transducers that send and receive ultrasonic sound. The transducer sends a pulse and receives an echo. When a voltage is applied to the ultrasonic sensor it vibrates across a specific spectrum of frequencies and generate a burst of ultrasonic waves[10]. The object in front of the sensor will reflect the waves in form of echo and generate an electric pulse. The distance is calculated by measuring the time taken between sending the ultrasonic wave and receiving the echo.

The proposed system uses HC-SR04 ultrasonic sensors. It provides high accuracy object detection in a range of 2 cm to 400 cm.

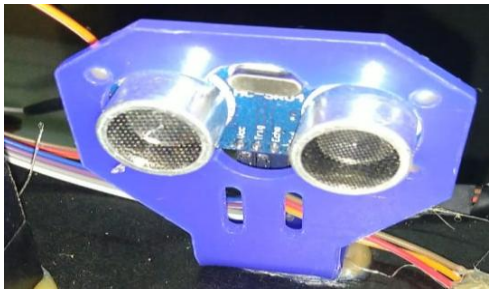

Fig. 4: HC-SR04 Ultrasonic Sensor

LDR

Also known as a light dependent resistor a LDR is a type of variable resistor whose resistance changes according to the intensity of light incident on its surface. The resistance of a LDR is inversely proportional to the intensity of light falling on its surface[9].

Relay

A relay is a device that is used to isolate or change the state of an electrical circuit from one state to other.

In the proposed system we have used relays to switch on and switch off the lights on the basis of human presence. When the IR sensor detects the presence of a human the relay turns on the LED and turns the off as soon as the person leaves the room.

Bluetooth Module

The HC-05 Bluetooth module can be used to establish a full-duplex wireless connection between the system and a mobile phone with Bluetooth functionality. This in turn will allow the user to control the system from his mobile phone[4].

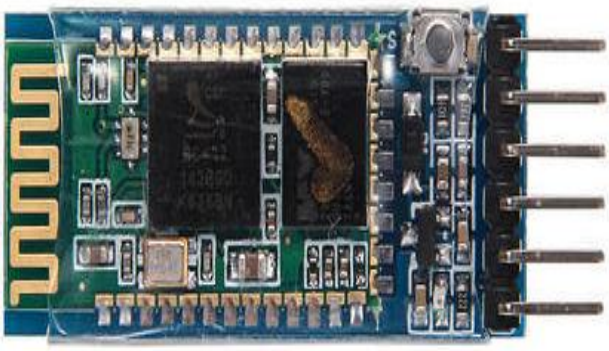

Fig 5: HC-05 Bluetooth module

III. Working Of System & Implementation

The system is meant to provide sufficient light in every part of a room. When a person walks in the room the IR sensors detect the motion and turns on the light while at the same time the ultrasonic sensor detects the distance of the person from the light and the direction he is moving it and moves the light accordingly by using a servo motor that can rotate the socket of the light[14]. There are two IR sensors to detect whether the person is entering or leaving the room. The light changes its intensity on the basis of natural light available in the room and the number of lights in the room depends on the number of people in the room. In case of multiple lights in a room the light that is closest to the person is turns on. However if the number of people entering the room exceeds the number of lights available then the ultrasonic sensors will turn off and the lights won't move. The Arduino keeps an account of the number of people entering and leaving the room and checks whether it is more than the number of lights available. Fig 5 shows the block diagram of the proposed system.

The automated working of the system in turning on and off, varying the number of lights based on number of people in a room and adjusting intensity allows it to consume less power and at the same time being equally effective like normal lights.

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This ergonomic approach can be advantageous in rooms where the lighting is not adequate in the working area where a person is and the light can turn to the direction of the person providing him more visibility to work. It can be beneficial in case of elderly people or people who low vision and there is not sufficient light for him to see clearly, in this case the light will turn towards the direction he is moving and illuminate his path.

This system can also be installed in the hallways of a house, in this case fewer number of lights would be required as the light would move in the direction of the person thus illuminating a larger area than an immovable light.

IV. SIMULATION & PROGRAM

Fig. 6 shows the circuit diagram of the proposed system. The circuit consists of the above mentioned components and have been implemented in the prototype with the C++ program mentioned below. Fig 7 shows the simulation of the working of the ultrasonic sensor using Ultra3000.

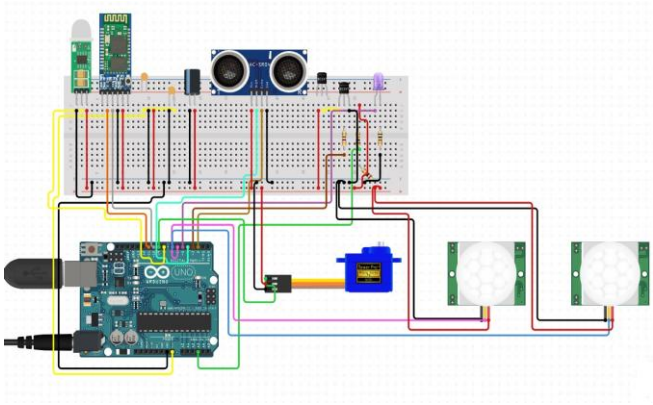

Fig. 6: Circuit Diagram of Experimental Set-up

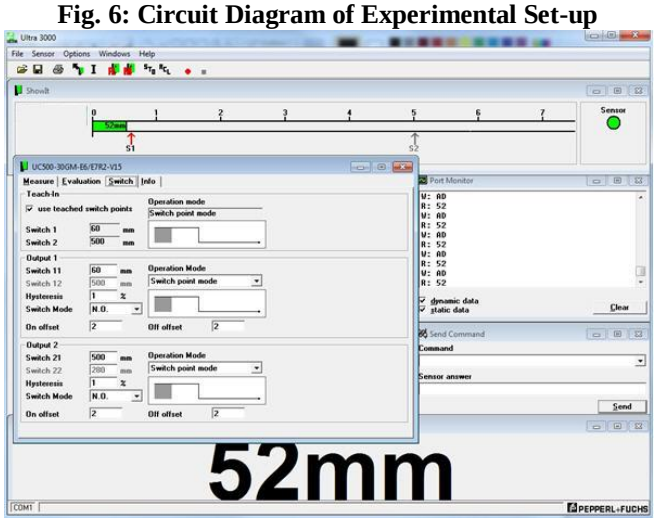

Fig. 7: Simulation of Ultrasonic Sensor

The following program written in C++ has been implemented in the experimental set-up:

```
#include<SoftwareSerial.h>
#include<Servo.h>
#define pin2 2
#define pin3 3
#define trigPin 6
#define echoPin 7
#define servo 8
#define gndOutPin 9
#define IR 10
#define highOutPin 11
SoftwareSerial myserial(4,5); /* (Rx,Tx) */
Servo myservo;
volatile boolean IR1;
volatile boolean IR2;
int IR_val = 1;
int pos = 0;
long duration, distance;
int count=0;
int poweron=1;
int pdistance=0;
void myserial_collect();
void ultrasonic_collect();
void IR_check();
void setup()
{
  pinMode(trigPin, OUTPUT);  //Ultrasonic
  pinMode(echoPin, INPUT);
  myservo.attach(servo);  //Servo
  pinMode(pin2, INPUT);
  pinMode(pin3, INPUT);
  pinMode(13, OUTPUT);
  pinMode(gndOutPin, OUTPUT);
  pinMode(IR, INPUT);
  myserial.begin(9600);
  Serial.begin(9600);
  pinMode(A0, OUTPUT);
  pinMode(A1, OUTPUT);
  pinMode(A2, OUTPUT);
  pinMode(A3, OUTPUT);
  pinMode(highOutPin,OUTPUT);
  attachInterrupt(digitalPinToInterrupt(pin2),          ISR1,
RISING);
  attachInterrupt(digitalPinToInterrupt(pin3),          ISR2,
FALLING);
  digitalWrite(A0,0);
  digitalWrite(A1,0);
  digitalWrite(A2,0);
  digitalWrite(A3,0);
  digitalWrite(highOutPin,0);
  digitalWrite(gndOutPin,1);
}
void loop()
{
  myserial_collect();
  Serial.print("poweron :");
  Serial.println(poweron);
  if(poweron==1)
  {
     Serial.print("cunt :");
     Serial.println(count);
     IR_val=digitalRead(IR);
     IR_check();
     Serial.print("IR :");
     Serial.println(IR_val);
    // digitalWrite(gndOutPin,1);
    //count=1;
     if(count==1)
     {
      digitalWrite(A0,1);
      digitalWrite(A1,0);
```


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```
      digitalWrite(A2,0);
      digitalWrite(A3,0);
      digitalWrite(gndOutPin,1);
      digitalWrite(highOutPin,1);
      ultrasonic_collect();
      if(distance<60)
      {
       distance = map(distance, 0, 60, 30, 90);
       if(((distance < pdistance+3)&&(distance > pdistance-
2)))
       {
         myservo.attach(servo);
        myservo.write(distance);
        Serial.println(distance);
        delay(500);
        //myservo.detach();
       }
       pdistance=distance;
      }
     }
     else if((count>1)||(IR_val==1))
     {
      myservo.detach();
      digitalWrite(gndOutPin,0);
      digitalWrite(highOutPin,0);
      if(count==2)
      {
       digitalWrite(A0,1);
       digitalWrite(A1,1);
       digitalWrite(A2,0);
       digitalWrite(A3,0);
      }
      else if(count==3)
      {
       digitalWrite(A0,1);
       digitalWrite(A1,1);
       digitalWrite(A2,1);
       digitalWrite(A3,0);
      }
      else if(count==4)
      {
       digitalWrite(A0,1);
       digitalWrite(A1,1);
       digitalWrite(A2,1);
       digitalWrite(A3,1);
      }
      }
     else
     {
        myservo.detach();
        digitalWrite(A0,0);
        digitalWrite(A1,0);
        digitalWrite(A2,0);
        digitalWrite(A3,0);
        digitalWrite(gndOutPin,1);
        digitalWrite(highOutPin,0);
     }
   }
   else
   {
        myservo.detach();
        digitalWrite(A0,0);
        digitalWrite(A1,0);
        digitalWrite(A2,0);
        digitalWrite(A3,0);
        digitalWrite(gndOutPin,1);
        digitalWrite(highOutPin,0);
   }
   //delay(1000);
}
void ultrasonic_collect()
{
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH);
  distance = (duration/2) / 29.1;
  Serial.println(distance);
  //Serial.println("--------------");
}
void myserial_collect()
{
  if (myserial.available())
  {
     //Serial.println(myserial.read());
     //while(1);
     int x=0;
     char c=myserial.read();
     do
     {
      x=myserial.read();
     }while(x>0);

     if(c=='p' || c=='P')
        poweron=1;
     else if(c=='s' || c=='S')
        poweron=0;
  }
}void ISR1(){
  IR1=1;
  Serial.println("-------ISR1-------");
  delay(2000);
}
void ISR2(){
  IR2=1;
  Serial.println("------ISR2--------");
 // IR_check();
  delay(2000);
}
void IR_check()
{
    if(IR1 && (count<4))
    {
      int cnt=50;
      while(!IR2 && cnt-- ){delay(1000);}
      if(IR2)
      {
        count=count+1;
        IR1=0;
        IR2=0;
```


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```
    }
    else
    {
      IR1=0;
    }
  }
  else if(IR2 && (count>0))
  {
   int cnt=50;
   while(!IR1 && cnt--){delay(1000);}
   if(IR1)
   {
      count=count-1;
      IR1=0;
      IR2=0;
   }
   else
   {
      IR2=0;
   }
  }
}
```

V. PROTOTYPE HARDWARE & RESULTS

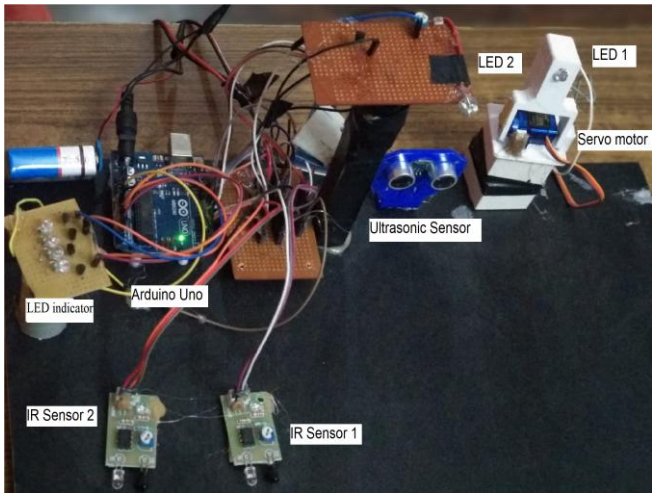

Fig. 8: Prototype

Fig.8 shows experimental set-up for the proposed system and fig 9 shows the set up with LED1 turned on. The set-up shows a miniature room of length 45 cm and breadth 41 cm, in which the system has been implemented. When a person enters the IR sensor measures the temperature of the object to determine whether the object is living being or non-living. This causes the Arduino to send a signal to the relay and turns the lights on. The change in position of the person inside the room is measured by the ultrasonic sensor and any change in position causes the Arduino to trigger the servo motor and the lights socket move according to the position of the person. In case of presence of more than one person the surge in temperature is measured by the IR sensor that the number of lights varies accordingly.

The IR sensors in the set-up measures the variation in the intensity of natural light and changes the intensity of the light according to it. So together with the RTC module the IR sensor will change the intensity of the LEDs and provide adequate brightness to the room. Once a person leaves the room the Arduino will send a signal to the relay to turn off the light. The entire system can also be turned on or off using voice command or a mobile based application.

Fig. 9: System with LED turned on.

VI. CONCLUSION

The proposed system is cost effective and reduces power consumption as it is automatic and there is no need of the lights to be switched on or off. The LED can shift its direction depending on the corner of the room where a person is and where lighting is required. The proposed system is also capable of changing the intensity of light based on presence of natural light, thus saving energy, which otherwise would be wasted as the intensity of the LEDs would have remained the same, although some natural light is available and full intensity is not required.

The system uses LEDs which are economical and have more higher brightness and a long lifetime of about 50000 hours which if higher than other lighting solutions. Also the Arduino microcontroller is affordable and the sensors used are also inexpensive. In proposed system is designed using components that are cheap, which brings the overall cost of the system down and makes it cost effective.

The proposed system allows the user to lead a comfortable life without the hassle of turning the light on or off or having less light in any part of the room that he requires. Thus the proposed system not only saves a lot of power but is also economical and easy to use.

REFERENCES

1. Burhanuddin Bharmal, Aniruddha Shahapurkar , Akshay Aswalkar, “Automatic Home Lighting solutions using Human Detection, Sunlight Intensity and Room Temperature”, International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 06, June -2017.
2. Omveer Singh, Tushar Singh Sisodia, “ Solar LED Street Light System with Automatic Scheme”, International Conference on Energy, Communication, Data Analytics and Soft Computing, IEEE, 2017.
3. Makkar, Deepak & Syal, Poonam. (2017). Simulation of Intelligent Room Lighting Illuminance Control. 1-4. 10.1109/ICCIC.2017.8524356.
4. Asadullah, Muhammad & Ullah, Khalil. (2017). Smart home automation system using Bluetooth technology.

10.1109/ICIEECT.2017.7916544.

5. Govindraj, Vignesh & Sathiyanarayanan, Mithileysh & Abubakar, Babangida.(2017). Customary homes to smart homes using Internet of Things (IoT) and mobile application.10591063.10.1109/SmartTechCon.2017.835852.
6. Gourab Das, "An intelligent method for optimizing the street-light-intensity", 2018 2nd International Conference on Electronics, Materials Engineering & Nano-Technology (IEMENTech).
7. Aldahoul, Nouar & Sabri, Aznul & Mansoor, Ali. (2018). Real-Time Human Detection for Aerial Captured Video Sequences via Deep Models. Computational Intelligence and Neuroscience. 2018. 1-14. 10.1155/2018/1639561.
8. Nyein Khine, San & Tun, Zaw. (2018). Sensor Analysis and Application of Arduino based Temperature and Light Intensity Control for Smart Home System. International Journal of Scientific and Research Publications (IJSRP). 8. 10.29322/IJSRP.8.6.2018.p7813.
9. Debata, Suchismita & Mantoliya, Rupa & Sahithi, Veena & Ratnam Kolluru, Venkata. (2018). Implementation of IoT based smart street light intensity control system using IR and LDR sensors. International Journal of Engineering & Technology. 7. 316. 10.14419/ijet.v7i2.7.10605.
10. Mediterranean Journal of Basic and Applied Sciences (MJBAS) (Peer Reviewed International Journal), Volume 2, Issue 4, Pages 35-38, Oct-Dec 2018 35 | P a g e ISSN (Online): 2581-5059 Website: www.mjbas.com Microcontroller Based Automatic Room Lighting System Dr.Sreeja Mole S.S., K.Ram Prasad, V.Krishna Veni, M.Swathi, L.Soumya.
11. Mangesh Nikose, Krutika Gaikwad, Priyanka Gamne, Aaishwarya Bodke(2018), A Survey on Bidirectional Visitor Counter with Automaticlight and Fan Control for Room, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, ISSN (Online): 2278 – 8875.
12. Vigil, Antony. (2018). A REVIEW ON RC-HOME AUTOMATION USING LDR AND IR SENSORS. International Journal of Pure and Applied Mathematics, Volume 118 No. 20 2018, 3555-3560.
13. Sasikumar, Aravind. (2015). Voice Controlled Smart Home. International Journal of Emerging Technology and Advanced Engineering (IJETAE). , ISSN: 2320-2084.
14. S, Suresh & Anusha, H.N.S. & Rajath, T & Soundarya, P & Vudatha, S.V.Prathyusha. (2016). Automatic lighting and Control System For Classroom. 1-6.