

Intelligent Home Lighting System

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Abstract:- this project has been carried out to create a sample “Intelligent Home Lighting System” which uses sensors and microcontroller interfacing in order to keep track of the number of people in a room and to automatically shut off the main power supply if the room occupancy reaches zero.

Index Terms:- Arduino Uno, 7805 voltage regulator, Relay, Light Dependent Resistor, Transformer, Liquid Crystal, Serial Input.

I. INTRODUCTION

It is common knowledge that a majority of people forget to turn off the lighting and other electrical and electronic devices after vacating a room. This malpractice leads to the wastage of a lot of electricity and as a result, money. This project has been prototyped as a functional energy saving electronic device which will automatically cut off power to the room if the occupancy in the room is zero. Typically only the power to non-vital components, such as lights and fans, will be cut off. It is inadvisable to switch of power to vital electrical or electronic devices such as servers, active workstations, experimental equipment etc. These devices must have their power routed outside the scope of the system in question.

The design of the circuit is fairly simple. The main power line to the room is diverted through the circuit before powering the electrical devices in the room. A pair of Light Dependent Resistors keep track of the number of people in the room and their output signal is fed to the Arduino board through Serial Analog input channels. The Arduino board also controls the relay switch which cuts off power to the room accordingly. A Liquid Crystal Display interfaced with the Arduino Board dynamically displays the number of people in the room.

II. COMPONENTS REQUIRED

The following components have been used for this project:

- Arduino Uno x1
- Transformer 230 to 12 Volt x1
- Diode 1N4007 x4
- Light Dependent Resistor x2
- Electrolytic Capacitor 1000uF/35V x1
- Ceramic Capacitor 0.1uF x1
- Carbon Resistor 1K ohm x2
- Potentiometer 10K ohm x1
- 16x2 Liquid Crystal Display x1
- 9V Relay Switch x1

Description:

1. Arduino Uno

Arduino boards are open source prototyping microcontroller platforms. The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller. The Arduino Uno has been used in this project owing to its ease of programming.

2. Transformer 230 V to 12 V

A transformer is a static electrical device that transfers energy by inductive coupling between its winding circuits. A varying current in the primary winding creates a varying magnetic flux through the secondary winding. This varying magnetic flux induces a varying electromotive force (EMF) or voltage in the secondary winding. This transformer steps down the commercially supplied voltage of 230 V to 12 V.

3. Diode 1N4007

The 1N400x series is a family of popular 1 A (ampere) general purpose silicon rectifier diodes commonly used in AC adapters for common household appliances. The blocking voltage varies from 50 to 1000 volts. This diode is made in an axial-lead Do-41 plastic package. These diodes are used in the bridge rectifier circuit to convert 12 V AC voltage to DC.

4. Light Dependent Resistor

The LDR, as the name suggests, is a resistor whose resistance depends on the light incident on it. Unlike conventional resistors, the LDR is a semiconductor device of high resistance. Its resistance is inversely proportional to the intensity of light falling on it. The LDR is the main component of the sensors used in this project.

5. Electrolytic Capacitor

An electrolytic capacitor is a capacitor that uses an electrolyte (ionic conducting liquid) as one of its plates to achieve a larger capacitance per unit volume than other types. All capacitors conduct alternating current and block direct current.

6. Ceramic Capacitor

A ceramic capacitor is a fixed value capacitor in which ceramic material acts as the dielectric. It is constructed of two or more alternating layers of ceramic and a metal layer acting as the electrodes. The composition of the ceramic material defines the electrical behavior and therefore applications.

7. Liquid Crystal Display

The 16x2 liquid crystal display can display 16 character per line and has 2 such lines. Each character is displayed in a 5x7 matrix. LCDs are easy to use and can display a wide range of characters. It operates on 5 V.

8. Relay Switch

A relay switch is used to switch electrical devices running on high power AC voltages using low power electronic circuits running on low voltage DC. It is an electrical-electronic interfacing device. The switching takes place mechanically using magnetic induction but the electrical and electronic sides are isolated from each other. The relay used here operates on 5 V which is enough to operate it as its maximum voltage threshold is 9V.

III. WORKING

The following show the step by step realization of the circuit

Power Supply:

1. The transformer takes input from the main power supply viz. 230 V at 60 Hz and steps it down to 12 V. The center tap is used as common ground for the entire circuit.
2. The stepped down voltage from the transformer is fed as input to the Bridge Rectifier which consists of four 1N4007 diodes. The Rectifier Circuit converts the incoming AC voltage to DC.
3. The DC voltage is passed through a filter circuit consisting of a 1000 μ F electrolytic capacitor which converts it to a constant DC voltage.
4. The treated voltage is fed to the 7805 voltage regulator and gets stepped down and stabilized at 5 V. This 5 V is used as a common rail to power all components in the circuit.

Sensor Module:

1. There are two LDR sensor modules. One module is placed outside the door frame of the room while the other is placed inside it.
2. Each module consists of an LDR and a series resistor with +5 V_{cc}, ground and signal channel. The LDR is illuminated by a light source from the opposite side of the door frame.
3. The signal channel transmits the voltage across the resistor in series with the LDR
4. When a person crosses the door frame, the light falling on the LDR gets interrupted and its resistance increases. Hence the voltage across the series resistor decreases and the signal gets lowered.

Microcontroller:

1. The Arduino Uno controls the relay and the LCD display.
2. The input signals from the LDR sensors are fed to analog pins of the Arduino board. Since the signal is analog, a threshold value is set to perform counting operations. Thus, the room occupancy is tracked.

The count is incremented or decremented depending on the direction of change in signal from the sensors

3. An output pin from the Arduino is connected to the relay. If the count (number of persons in the room) reaches zero then the output goes high and the relay gets activated thus effectively cutting off power to the room.
4. The LCD display connected to the Arduino dynamically displays the room occupancy.

Relay:

1. The relay performs the switching operation of the high voltage supply.
2. Pin A is connected to the Arduino while Pin B is grounded. The COM pin is connected to the main power supply. The NO (normally open) is left hanging while the NC (normally closed) goes to the subsequent power distribution circuit.
3. When the Arduino sends a High output, the relay gets activated and the COM goes from NC to NO thus cutting off power to the room.

IV. CIRCUIT DIAGRAM

The following is the circuit diagram for the system.

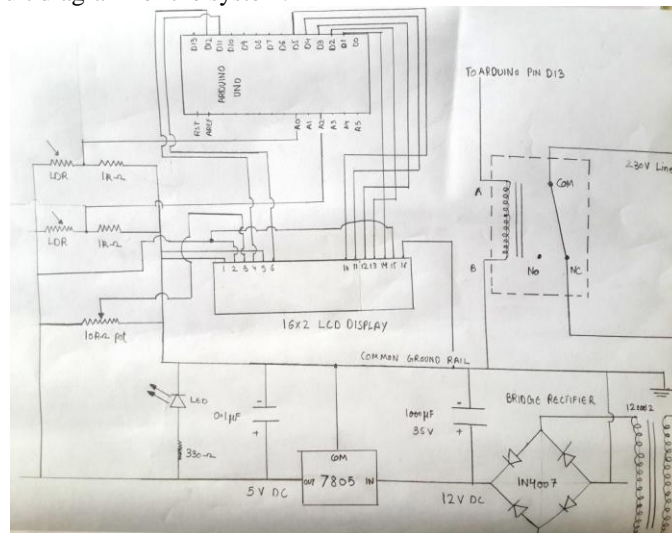


Fig1: Circuit Schematic

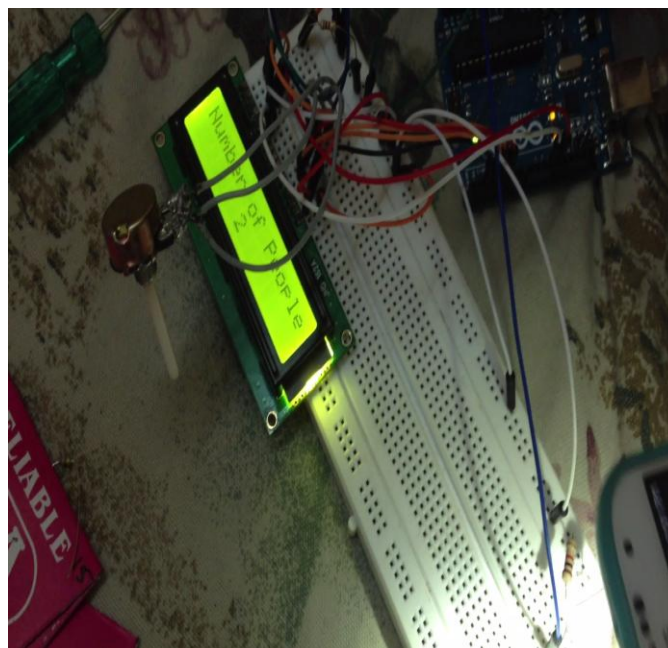


Fig2: Actual Circuit on breadboard

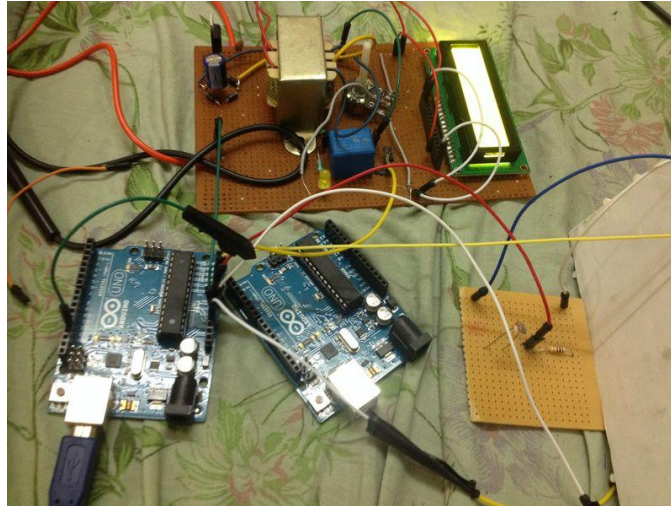


Fig3: Actual Circuit on PCB (printed circuit board)
Note: A general purpose PCB was used here

V. PROGRAM

Given below is the code for the Arduino Board. The code has been written in the Arduino IDE (Integrated Development Environment). The code can be easily changed to configure the threshold input of LDR for counting operations.

```
#include <LiquidCrystal.h>           //LCD Header
LiquidCrystal lcd(12, 11, 5, 4, 3, 2); //LCD interfacing pins
int sen1 = A0;                       //Pin assignment for sensors and Relay
int sen2 = A2;
int power= 13;
int count=0;                          //Counter

void setup()
{
  lcd.begin(16, 2);
  Serial.begin(9600);                 //Serial communication bitrate
  pinMode(sen1, INPUT);               //Analog 0 pin assigned as input
  pinMode(sen2, INPUT);               //Analog 2 pin assigned as input
  pinMode(power, OUTPUT);             //Pin 13 assigned as output
  lcd.print("Number of People");      //Static print on LCD
}

void loop()
{

  if(analogRead(sen1)>150)             //Threshold comparison
  {
    delay(250);
    if(analogRead(sen2)>150)
    {
      count++;
    }
  }
  else if (analogRead(sen2)>150) //Threshold comparison
  {
    delay(250);
    if(analogRead(sen1)>150)
```

```
{
count-- ;
}
}

Serial.println(count);
lcd.setCursor(7,2);      //Setting cursor on LCD
lcd.print(count);      //Updating counter in LCD
if(count==0)
digitalWrite(power, HIGH);    //Switching Relay
else if(count!=0)
digitalWrite(power, LOW);
delay(50);
```

VI. CONCLUSION

The circuit effectively reduces the power consumption by automatically switching off power. It has a variety of practical purposes such as in classrooms, homes, and offices etc. where there is a tendency of people forgetting to switch off lights.

ACKNOWLEDGMENT

The success and final outcome of this project required a lot of guidance and assistance from many people.

I respectfully thank Professor Sathya P for giving an opportunity to take up this project and explore the fascinating realm of electronic circuits.

REFERENCES

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