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# EMBEDDED C

**Course Code: BECE320E**

# PROJECT REPORT

## BIDIRECTIONAL COUNTER

## AND

## AUTOMATIC ROOM LIGHTING SYSTEM

**SUBMITTED TO**

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# ABSTRACT

This project aligns with Goal 9 of the Sustainable Development Goals (SDGs), which aims to build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation. Our project contributes to this goal by leveraging technological innovation to enhance energy efficiency in indoor environments.

This project introduces a Bidirectional Counter and Automatic Room Lighting System designed to automate room lighting control based on human presence. By integrating the capabilities of the AT89S52 microcontroller, Passive Infrared (PIR) sensors, LCD, and a relay module, the system intelligently detects and responds to human movement within a room.

The core functionality of the system lies in its ability to seamlessly manage room illumination by toggling lights on or off in response to occupants entering or leaving the space. This not only ensures automatic activation upon entry but also maintains illumination until the last occupant exits, thereby optimizing energy consumption.

Key features include bidirectional visitor counting, providing real-time occupancy data for informed lighting decisions. Additionally, the inclusion of a 16x2 LCD display enhances system transparency and user engagement. Meticulously designed circuitry ensures safety and reliability, making it a cost-effective and scalable solution for various room environments.

By harnessing technology to improve energy efficiency and user convenience, this project exemplifies the spirit of Goal 9 by fostering innovation in infrastructure development and promoting sustainable practices in building management.

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# INTRODUCTION

The aim of this project is to automatically turn on or off the lights in a room and count the number of persons inside the room by detecting the human movement. The “Automatic Room Lighting System using Microcontroller” project addresses the critical need for efficient energy utilization and automation in contemporary living spaces.

Traditional methods of manually switching lights on or off often lead to energy wastage due to human oversight or forgetfulness. Moreover, the repetitive task of managing room lighting adds unnecessary burden to occupants, detracting from overall comfort and convenience. Recognizing these challenges, the project leverages the power of microcontrollers to automate the lighting process, thereby alleviating the need for manual intervention and promoting energy conservation.

At its core, the project employs a microcontroller, specifically the AT89S52, as the central processing unit responsible for coordinating the various components of the system. Through programming and sensor integration, the microcontroller enables seamless interaction between the environment and the lighting infrastructure, facilitating real-time response to human presence within the room.

The inclusion of Passive Infrared (PIR) sensors serves as the primary means of detecting human movement, strategically positioned at the entrance point of the room. By monitoring changes in PIR radiation patterns, the sensors effectively signal the microcontroller to initiate lighting adjustments based on occupancy status. This dynamic approach not only enhances energy efficiency by ensuring lights are only activated when needed but also enhances user experience by eliminating the need for manual intervention.

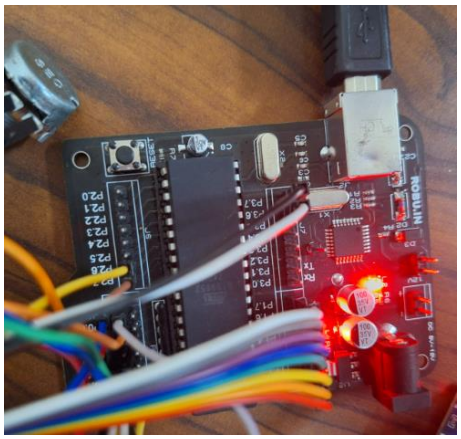
A key highlight of the project is its bidirectional visitor counting functionality, enabled through sophisticated algorithmic logic embedded within the microcontroller. This feature allows the system to accurately track the number of individuals entering and exiting the room in real-time, providing valuable insights into occupancy patterns and enabling more informed lighting decisions.

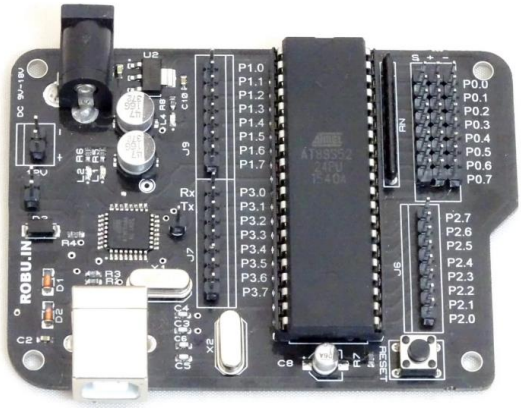
# COMPONENTS USED

- AT89S52 Microcontroller (any 8051architecture based microcontroller)
- Aryabhatta 8051 Development Kit
- 2 x Passive Infrared (PIR) Sensors
- 16 x 2 LCD Display
- 100k Potentiometer
- 5V- 1 Channel Relay Module
- LED
- Jumper Wires
- External Power Supply – Wemos D1 Mini

# DESCRIPTION

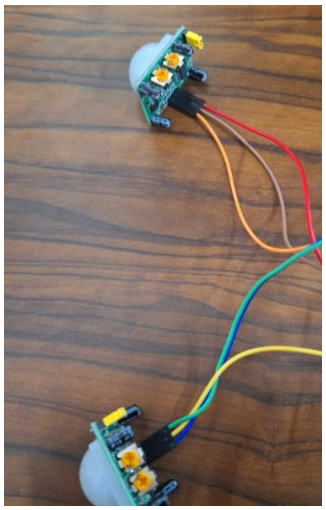
## 1. ARYABHATTA 8051 DEVELOPMENT KIT WITH AT89S52 MICROCONTROLLER:

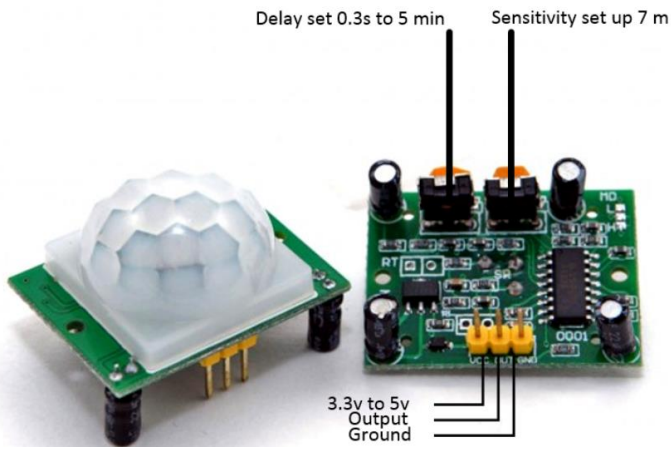





The Aryabhatta 8051 Development Kit serves as the foundational hardware platform for the project, housing the AT89S52 microcontroller at its core. This microcontroller is pivotal for processing data and executing programmed instructions to automate the control of room lighting and displaying the number of counters based on human presence. It provides essential computing capabilities and interfaces with various peripheral components, including Passive Infrared (PIR) sensors, LCD displays, and relay modules.

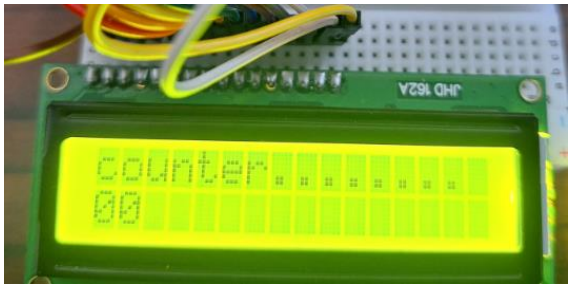
## 2. PASSIVE INFRARED (PIR) SENSORS:






The project incorporates Passive Infrared (PIR) sensors as critical components for detecting human presence within the monitored space. PIR sensors operate on the principle of the pyroelectric effect, reacting to changes in infrared radiation emitted by objects in their field of view. They serve as the project's sensory apparatus, facilitating the detection of movement and enabling the automatic control of room lighting based on occupancy. Strategically positioned within the room, the two PIR sensors ensure comprehensive coverage, effectively detecting movement across different areas and allowing for precise lighting adjustments.

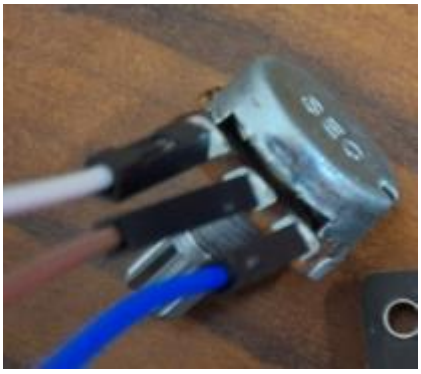
## 3. 16 x 2 LCD Display:





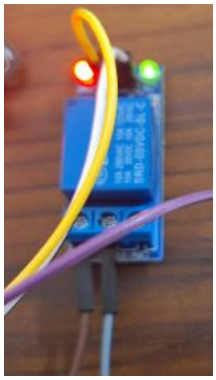
The project incorporates a 16x2 LCD display as a crucial user interface component, providing real-time feedback and enhancing system transparency. This display module consists of 16 columns and 2 rows of alphanumeric characters, offering a compact yet informative visual output. It serves as a means for users to conveniently monitor the current visitor count. Integrated seamlessly with the project's microcontroller and sensors, the LCD display ensures clear and concise communication of relevant information, facilitating user engagement and interaction.

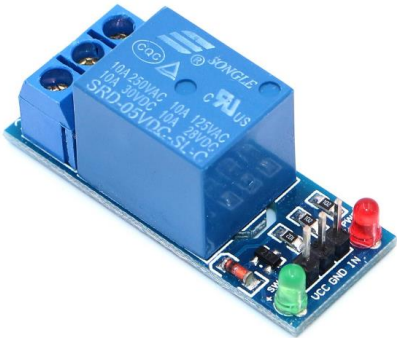
## 4. POTENTIOMETER:



The project integrates a 100k potentiometer to regulate the brightness of the LCD display, offering users control over visual output intensity. Connected directly to the LCD module, this potentiometer serves as a variable resistor, allowing adjustment of the voltage supplied to the display's backlight. By turning the potentiometer, users can finely tune the brightness level to their preference, ensuring optimal visibility in various lighting conditions.

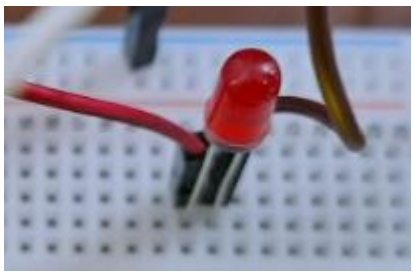
## 5. RELAY MODULE (1 – CHANNEL; 5V):






The project incorporates a 1-channel 5V relay module to facilitate the control of LED lighting. This relay module serves as an interface between the microcontroller and the LED, enabling the microcontroller to switch the LED on or off based on predetermined conditions. By sending appropriate signals to the relay module, the microcontroller effectively controls the flow of electrical current to the LED, dictating its operational state. Integrated seamlessly into the project's hardware configuration, the relay module enhances the system's functionality by providing reliable and efficient control over the LED lighting.

## 6. LED(5V):

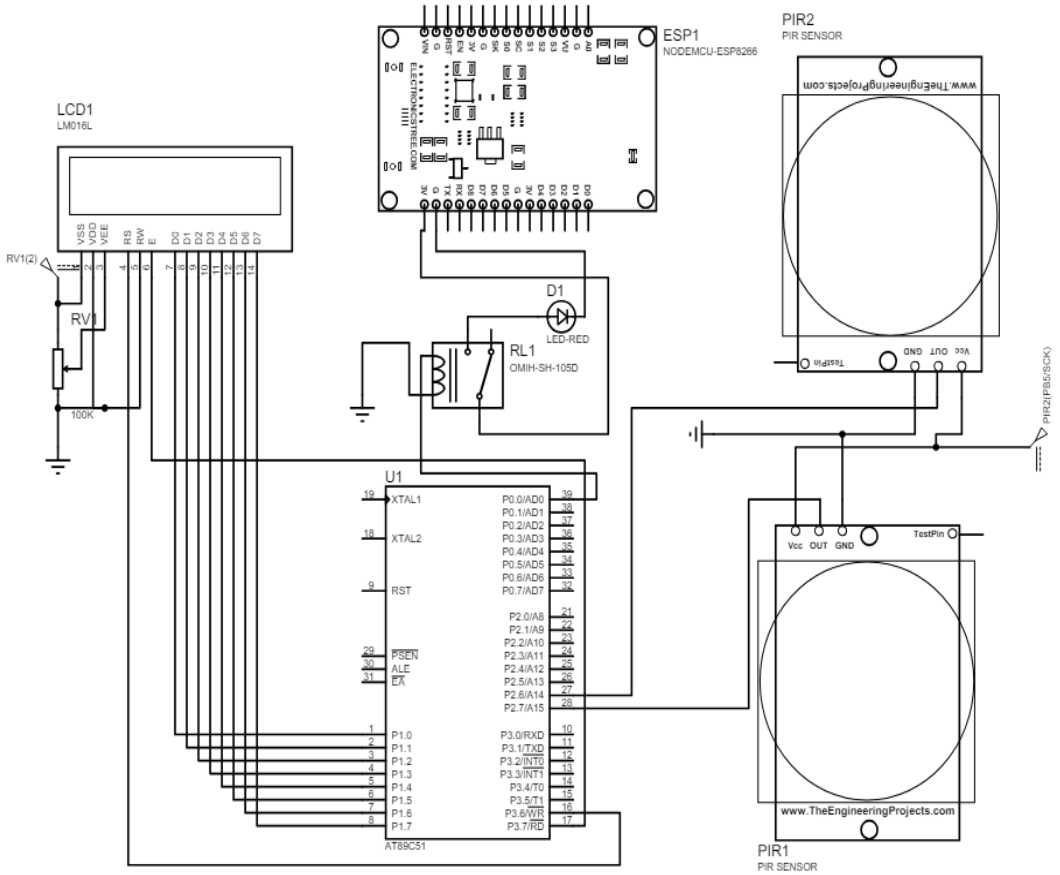


The project integrates 5V LED as essential component for illuminating the room based on occupancy detection. This LED serve as the primary light source, providing illumination when activated by the microcontroller in response to human presence.

## 7. External Power Supply – Wemos D1 Mini:

The project utilizes the 5V output from the Wemos D1 Mini as an external power supply for the relay module. This arrangement simplifies the project's wiring and power management, as it leverages the onboard voltage regulator of the Wemos D1 Mini to provide a stable 5V supply for the relay module. By tapping into the 5V output of the Wemos D1 Mini, the relay module receives the necessary power to control the LED lighting based on occupancy detection.

# DESCRIPTION OF THE SCHEMATIC




Above is the schematic diagram that illustrates the connections for this project:

- The 16 x 2 LCD display is connected to the 8051 microcontroller. The 8 data pins of the LCD (D0 to D7) are connected to PORT1 pins P1.0 through P1.7.
- The control pins of the LCD, namely RS, RW, and E, are connected to the microcontroller as follows:
- RS is connected to P3.6.
- RW is connected to ground (GND).
- E is connected to P3.7.
- A 100 KΩ potentiometer is used to adjust the contrast of the LCD. This potentiometer is connected to the LCD's contrast pin (pin 3).
- The circuit includes two PIR (Passive Infrared) sensors, which are connected to PORT2 pins. Specifically, one sensor is connected to P2.6, and the other is connected to P2.7.
- The 5V Relay module is connected to the microcontroller to control high-power components. The input of the relay module is wired to PORT0 pin P0.0.

# WORKING OF THE PROJECT

This project operates on a sophisticated yet intuitive mechanism that seamlessly manages room lighting based on human presence and displays the count of number of persons.

## 1. SENSOR PLACEMENT:

We have installed two sensors, s1 and s2, near the entrance of the room, spaced at a distance from each other. These sensors detect movement as people enter or leave the room.

## 2. ENTRY DETECTION (SENSOR 1 - S1):

- When someone enters the room, sensor 1 (s1) detects their movement.
- The microcontroller increments the count by one, indicating the presence of an additional person in the room.
- The updated count is displayed on the LCD screen, providing real-time feedback to users.
- If the count is now greater than or equal to 1, the relay activates, powering the LED light, illuminating the room.

## 3. EXIT DETECTION (SENSOR 2 - S2):

- When someone leaves the room, sensor 2 (s2) detects their movement.
- The microcontroller decrements the count by one, reflecting the departure of a person from the room.
- The updated count is displayed on the LCD screen, keeping users informed about the current occupancy status.
- If the count becomes 0 after the decrement, indicating that there are no people left in the room, the relay deactivates, turning off the LED light to conserve energy.

## 4. DELAY HANDLING:

- To prevent immediate response to subsequent sensor triggers and ensure system stability, delays are implemented after each sensor detection event. This prevents rapid changes in the lighting state due to transient movements near the sensors.

## 5. USER INTERACTION:

- Users can observe the count displayed on the LCD screen, which provides a visual representation of the room's occupancy status.
- The automatic control of the LED light based on occupancy enhances user convenience and promotes energy efficiency, as the light is only activated when people are present in the room.

## 6. HARDWARE EXPLANATION:

When the PIR sensor 1 detects movement, it sends a signal indicating its detection to the AT89S52 microcontroller. The microcontroller processes this data and responds accordingly by incrementing the count by one. This updated count is then displayed on the 16x2 LCD display for user visibility. Simultaneously, the microcontroller activates the relay, triggering the LED to illuminate the room. To ensure proper functioning and prevent interference from sensor 2, a delay is introduced after sensor 1's detection.

Conversely, if PIR sensor 2 detects movement first, it sends a signal to the microcontroller indicating its detection. In response, the microcontroller executes instructions to decrement the count by one. If the count reaches zero, indicating no occupants in the room, the microcontroller deactivates the relay, turning off the LED to conserve energy. Again, a delay is incorporated to manage subsequent sensor triggers and maintain system stability.

Throughout these processes, the 16x2 LCD display plays a crucial role in providing real-time feedback to users by displaying the current count status. This seamless integration of hardware components ensures efficient and intelligent room lighting control based on human presence detection.

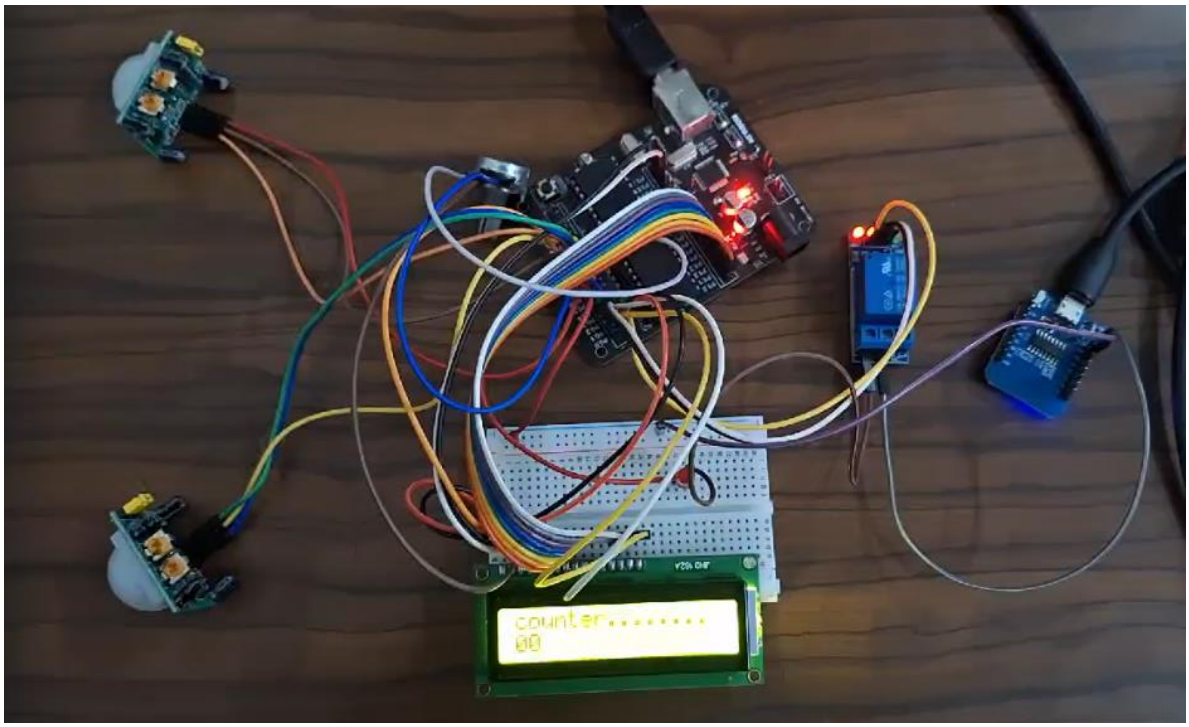
## SUMMARY:

This project effectively automates room lighting control based on human presence detection, enhancing both energy efficiency and user convenience. By intelligently managing the lighting system, it ensures that the room remains illuminated only when occupied, thus optimizing energy consumption while providing adequate lighting for occupants.

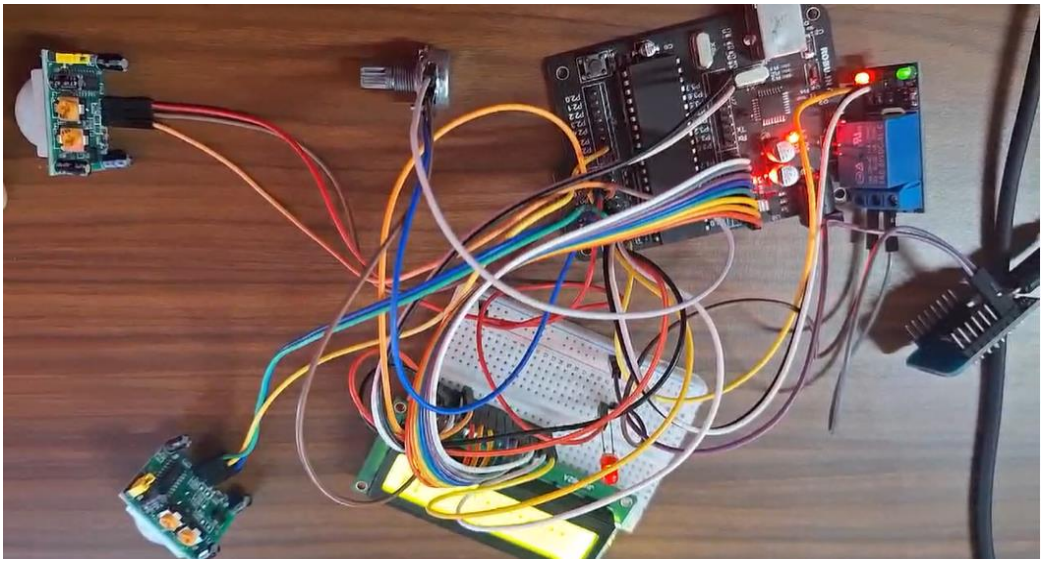
# OUTPUT

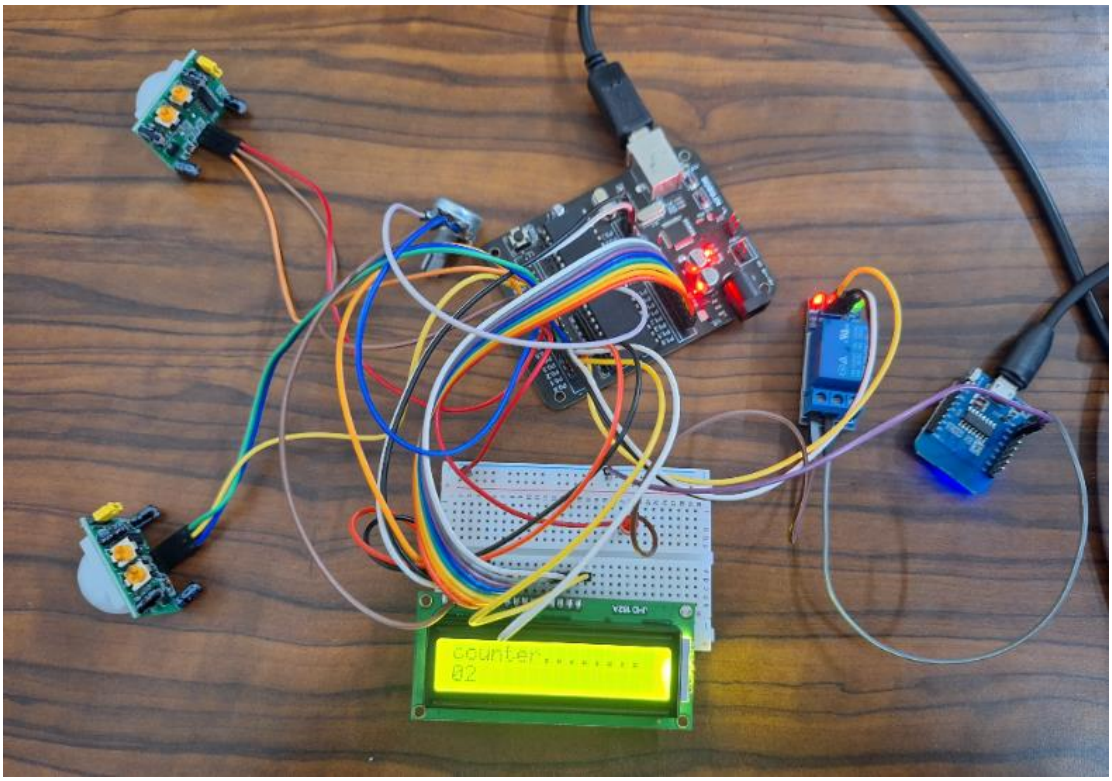
**NOTE: THE TOP LEFT PIR SENSOR IS THE SENSOR 1 WHICH IS NEAR TO THE ENTRANCE AND THE LEFT BOTTOM PIR SENSOR IS THE SENSOR 2 WHICH IS ADJACENT TO SENSOR ONE WITH SOME DISTANCE**

- When there is no person inside the room and if the sensor doesn't detect any movement of the person the counter is 0 which is displayed on the LCD, the relay is in off condition (the green light of the relay is not glowing indicates that the relay is in off condition) and thus the LED is off.

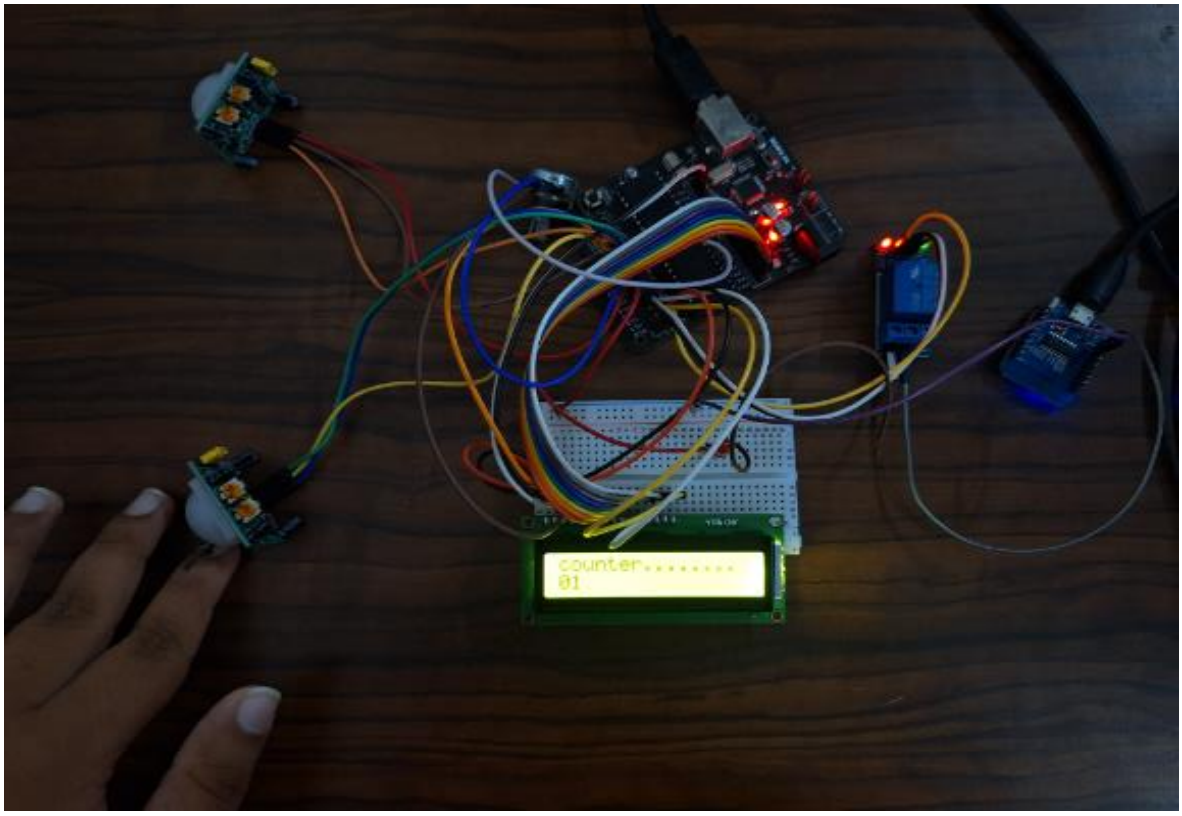


- When a person enters the room the sensor 1 detects the movement of the person and the count of number of persons is increased by one which is displayed on the LCD, the relay is in on condition (the green light of the relay is glowing indicates that the relay is in on condition)and thus the LED is on.





- When the sensor 2 detects the movement of person going outside the room. The count of the number of persons is decreased by one which is displayed on LCD and if the count turns to be 0 then the relay is turned off automatically and the LED will be turned off.



# CODE

```
#include<reg51.h>
#define lcd P1
sbit rs=P3^6;
sbit e=P3^7;
sbit relay=P0^0;
sbit s1=P2^7;
sbit s2=P2^6;
void delay (int);
void cmd (char);
void display (char);
void init (void);
void string (char *);
void view (int);
int count=0;
int no[10]={48,49,50,51,52,53,54,55,56,57};
void delay (int d)
{
        unsigned char i=0;
        for(;d>0;d--)
        {
                for(i=250;i>0;i--);
                for(i=248;i>0;i--);
        }
}
```

```
void cmd (char c)
{
        lcd=c;
        rs=0;
        e=1;
        delay(5);
        e=0;
}
void display (char c)
{
        lcd=c;
        rs=1;
        e=1;
        delay(5);
        e=0;
}
void string (char *p)
{
        while(*p)
        {
                display(*p++);
        }
}
```

```
void view (int n)
{
        cmd(0xc0);
        display(no[(n/10)%10]);
        display(no[n%10]);
}
void init (void)
{
        cmd(0x38);
        cmd(0x0c);
        cmd(0x01);
        cmd(0x80);
}
void main()
{
  init();
        string("counter.....");
        cmd(0xc0);
        view(count);
        while(1)
        {
                if(s1==1)
                {
                        while(s1==1);
                        if(count!=99)
                        count=count+1;
                        view(count);
```

```
                if(count>=1)
                 relay=0;
          else
                 relay=1;
                delay(3000);
          }
          else if(s2==1)
          {
                while(s2==1);
                if(count!=0)
                count=count-1;
                view(count);
                if(count>=1)
                 relay=0;
          else
                 relay=1;
                delay(3000);
          }
    }
}
```

# APPLICATION

This project offers a versatile solution with diverse applications across various domains. Some of the key applications include:

- **Energy Efficiency and Resource Optimization:** The automatic room lighting system helps conserve energy by turning off lights when no motion is detected. This efficient use of resources aligns with SDG 9's goal to promote sustainable industrialization and infrastructure. The PIR sensors detect movement to activate or deactivate the lights, reducing unnecessary energy consumption.
- **Automated Building Management Systems:** The project can be integrated into broader building management systems, contributing to smarter, more automated infrastructure. The use of 8051-based microcontrollers in conjunction with PIR sensors allows for scalable solutions in office buildings, factories, or public spaces, supporting SDG 9's emphasis on infrastructure and technological innovation.
- **Visitor Tracking and Data Analysis:** The bidirectional visitor counter provides a way to track the flow of people entering and leaving a space, which is crucial for optimizing resource allocation and security. This data can help facilities managers better understand traffic patterns and make informed decisions about energy use, security, and maintenance, promoting innovative industry practices.
- **Safety and Security Enhancements:** By automating lighting and counting visitors, the project contributes to safer and more secure environments. The automatic room lighting reduces the risk of accidents due to dark areas, while the visitor counter provides a way to monitor the number of people in a given space, enhancing security protocols. This aligns with SDG 9's aim to build resilient and sustainable infrastructure.
- **Scalability and Adaptability:** The use of 8051-based microcontrollers ensures that the project is scalable and adaptable to different environments. The system can be customized for various room sizes and configurations, making it suitable for a wide range of applications, from small offices to large public venues. This flexibility encourages innovation and supports sustainable infrastructure development.

# RESULTS

After thorough testing and implementation, the project has yielded compelling results in automating room lighting control and bidirectional counter. By effectively integrating PIR sensors, 8051 microcontroller, relay module, LED, and LCD display, the system reliably detects human presence and adjusts lighting accordingly. Occupants entering the room trigger the sensors, prompting the microcontroller to increment the count and illuminate the space. Conversely, as individuals exit, the system decrements the count and dims the lights if the room becomes vacant. This responsive approach not only optimizes energy consumption by ensuring lights are only active when needed but also enhances user convenience through seamless automation.

The integration of user-friendly features such as the LCD display provides intuitive feedback, allowing occupants to easily monitor room occupancy status. Overall, the project's successful implementation highlights its potential to contribute significantly to energy conservation efforts while enhancing the comfort and convenience of indoor environments and this project meets up the Goal 9 of sdgs goals.