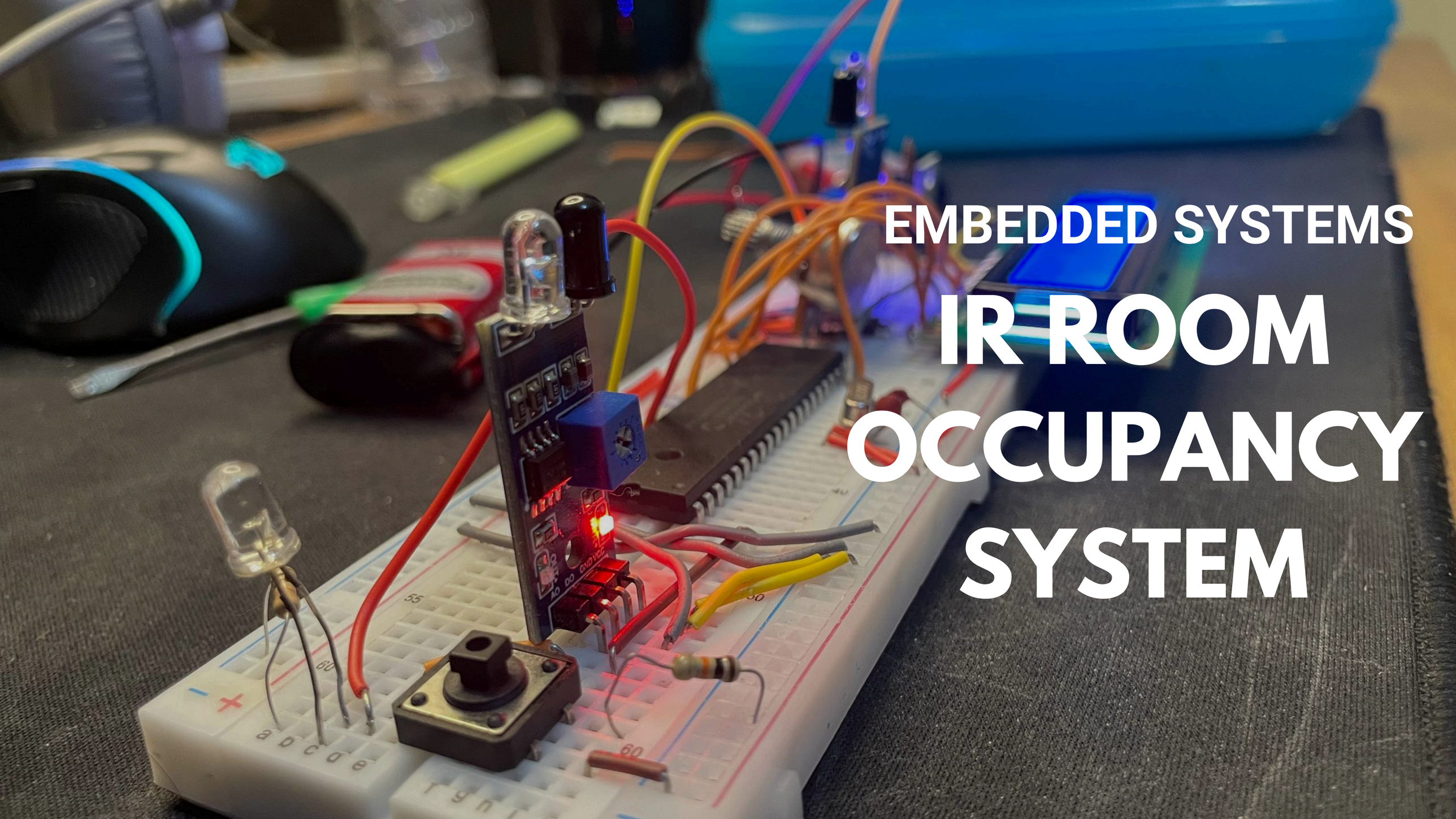
EMBEDDED SYSTEMS
IR ROOM OCCUPANCY SYSTEM

# TEAM 5 MEMBERS

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# PROJECT EXPLANATION

## Smart Room People Counter

This project is an IR Room Occupancy Counter Controller built with Mikro C

It uses infrared (IR) sensors to detect room entry and exit events

Counts the number of people present

Displays real-time occupancy status on an LCD

it controls a light (LED) based on occupancy

# PROJECT EXPLANATION

## FEATURES

- Entry/Exit Detection: Uses two IR sensors to monitor both entry and exit points.
- Real-Time Occupancy Counter: Counts number of people present in the room.
- LCD Display: Shows current count, room status (empty/full/occupied)
- Maximum Capacity Control: Notifies when the room reaches full capacity.
- Timeout Management: Resets detection state if sensors remain active for too long.
- Automatic Lighting: Turns on a LED when room is occupied.

# PROJECT EXPLANATION

## HOW IT WORKS

- The system uses a simple state machine to interpret sensor changes:
  - Idle: Waits for sensor input.
  - Entry Detected: Marks the beginning of an entry sequence.
  - Exit Detected: Marks the beginning of an exit sequence.
  - Increments or decrements the counter based on completed sequences.
- The count is displayed on the LCD, which updates whenever occupancy changes.
- The LED is controlled by the occupancy count (Counter > 0 => light ON).
- Maximum room capacity can be set (default is 10).

# PROJECT EXPLANATION

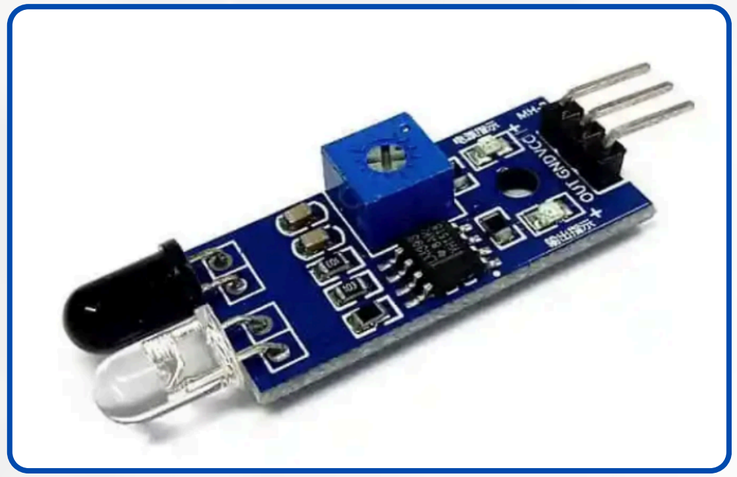
## Core System Structure

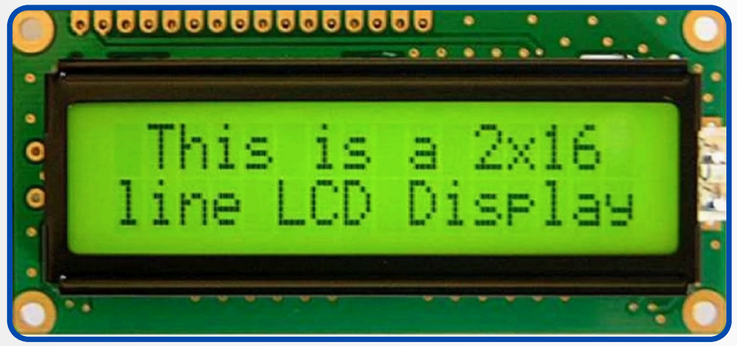
- Sensors: Connected to PORTB (input pins).
- LCD: Connected to PORTD.
- LED: Output pin on PORTB.
- Timer0: Used for timeout handling to improve sensor accuracy.

## Code Highlights

- Entry and exit events are debounced and managed in interrupts.
- LCD updates and lighting decisions are made based on global counter value.
- User can adjust maximum capacity in code.

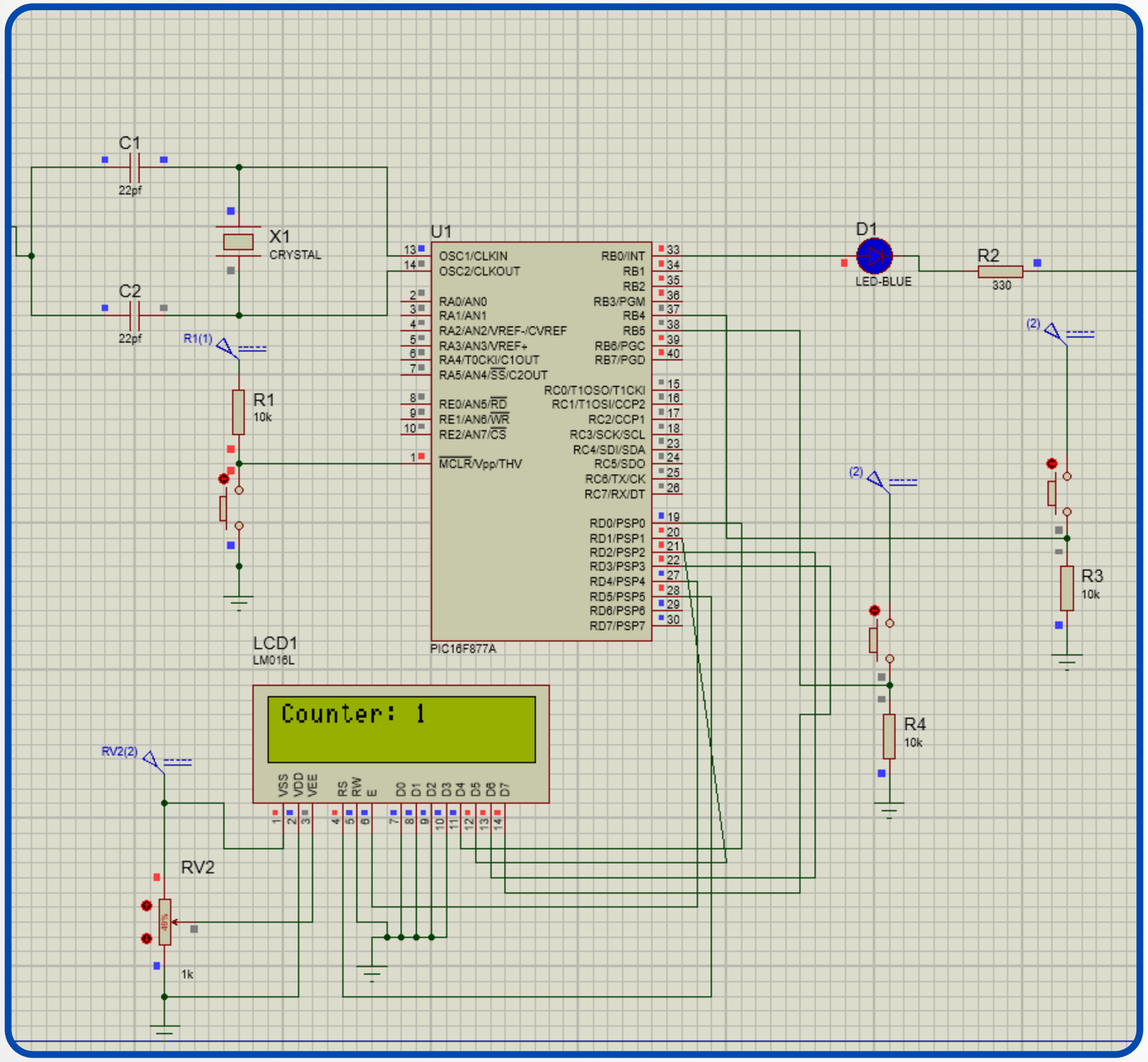
# COMPONENTS






1 - 1x PIC16F877A
2 - 2x Infrared Sensors
3 - 1x 2x16 bit LCD
4 - 2x 9V Battery & 2x 9V Battery Snap
5 - 1x LM7805 Voltage Regulator
6 - 1x 8MHz Crystal
7 - 2x 22pF Capacitors
8- 2x  100nF Capacitors
9 - 1x Reset Button
10 - 2x 330Ω & 1x 10KΩ Resistors
11 - 2x Blue LEDS
12 - 1x Bread Boards & Wire Kit

# CIRCUIT DESIGN




- **Sensors: Connected to PORTB (RB4 & RB5).**
- **LCD: Connected to PORTD.**
- **LED: Output pin on RB0.**

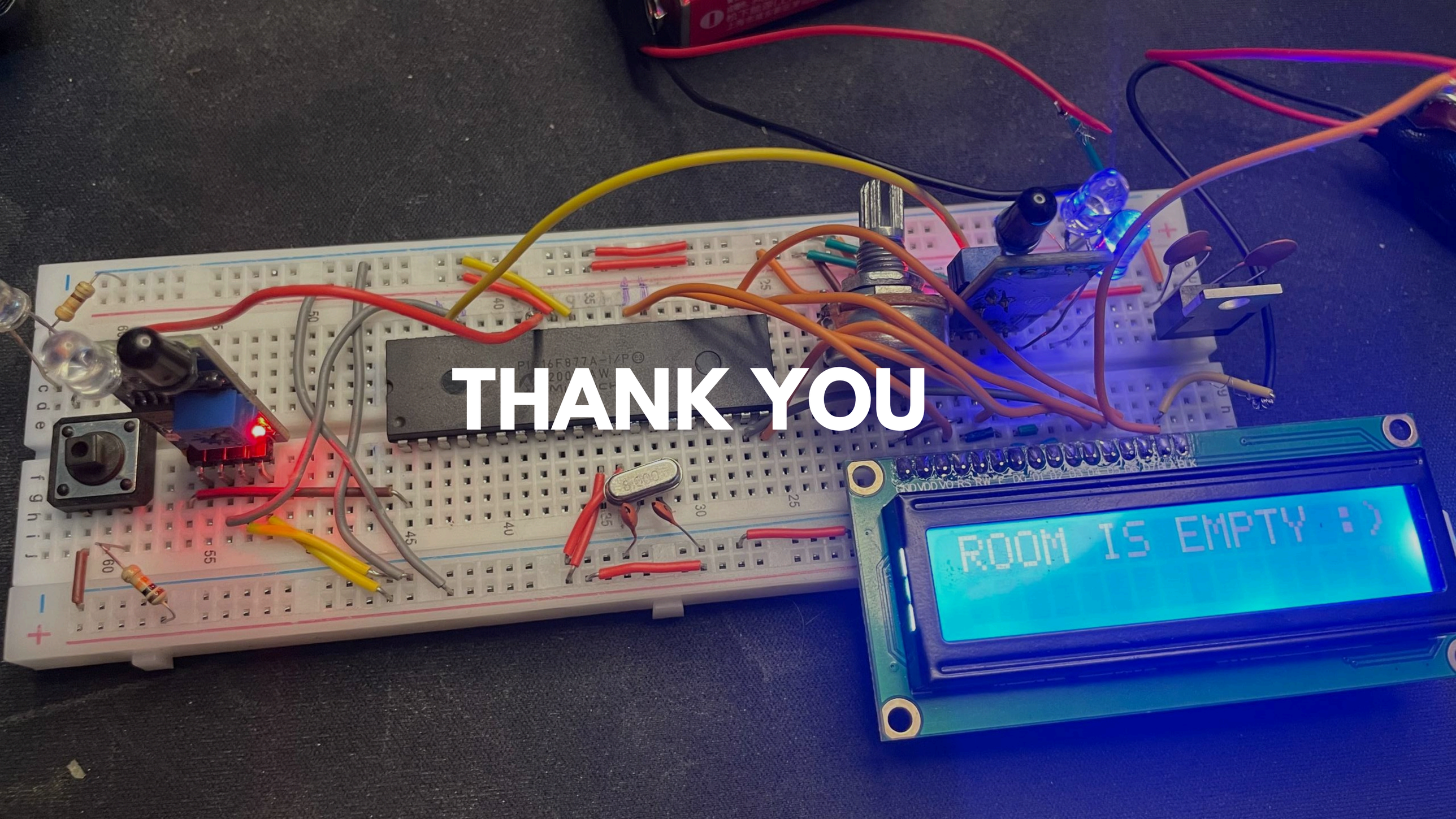
```
// Sensor pins definition
sbit SensorIN at PORTB.B4;
sbit SensorOUT at PORTB.B5;

// LCD data pins definition
sbit LCD_D4 at RD0_BIT;
sbit LCD_D5 at RD1_BIT;
sbit LCD_D6 at RD2_BIT;
sbit LCD_D7 at RD3_BIT;
sbit LCD_EN at RD4_BIT;
sbit LCD_RS at RD5_BIT;

// LCD data direction pins definition
sbit LCD_D4_Direction at TRISD0_BIT;
sbit LCD_D5_Direction at TRISD1_BIT;
sbit LCD_D6_Direction at TRISD2_BIT;
sbit LCD_D7_Direction at TRISD3_BIT;
sbit LCD_EN_Direction at TRISD4_BIT;
sbit LCD_RS_Direction at TRISD5_BIT;

// Global variables
volatile int Counter = 0;                    // Current count of people in room
int LastCounterState = -1;                   // Previous counter value for LCD update detection
int MaxCapacity = 10;                        // Maximum room capacity
volatile int State = 0;                     // State machine variable (0: idle, 1: entry detected, 2: exit detected)
int OverFlows = 0;                          // Maximum number of timer overflows for timeout
volatile int OverFlows_counter = 0;          // Current overflow counter
char Str[7];                                 // String buffer for integer to string conversion
```

```
// Function prototypes
void TimeOutHandler();
void DisplayState();
void ClearLcdBasedOnCounter();
void PICConfig();
void LcdConfig();
void LightControl();
double Time0OverFlows(int time);


void main() {

    PICConfig();

    LcdConfig();

    // Calculate timer overflows for 1 second timeout
    OverFlows = Time0OverFlows(1);

    // Main loop
    while(1) {

        // Convert counter to string
        inttostr(Counter,Str);
        ltrim(Str);

        // Update LCD when counter changes
        ClearLcdBasedOnCounter();

        // Display current state on LCD
        DisplayState();

        // (ON if room occupied)
        LightControl();

        // Reset State if stuck
        TimeOutHandler();
   }
}
```

```
void interrupt() {
    // Sensor triggered
    if (INTCON.RBIF == 1) {
        delay_ms(80);  // Debounce delay

        switch(State) {
            case 0:  // Idle state
                if (SensorIN == 1) {
                    State = 1;  // Entry sequence started
                    OverFlows_counter = 0;
                }
                if (SensorOUT == 1) {
                    State = 2;  // Exit sequence started
                    OverFlows_counter = 0;
                }
                break;

            case 1:  // Entry sequence in progress
                if (SensorOUT == 1) {
                    Counter++;  // Person entered
                    State = 0;
                }
                break;

            case 2:  // Exit sequence in progress
                if (SensorIN == 1) {
                    if(Counter != 0)
                        Counter--;  // Person exited
                    State = 0;
                }
                break;
        }

        INTCON.RBIF = 0;
    }

    // Timeout handling
    if(INTCON.TMR0IF == 1) {
        OverFlows_counter++;
        INTCON.TMR0IF = 0;
        TMR0 = 0;
    }
}
```

```
void PICConfig()
{
     // Configure PORTB: RB0 as output (LED), RB4-RB5 as inputs (sensors)
    TRISB = 0b11111110;

    // Configure PORTD as output for LCD
    TRISD = 0;

    // Enable interrupts
    INTCON.RBIE = 1;        // Enable PORTB change interrupt
    INTCON.GIE = 1;         // Enable global interrupts
    INTCON.TMR0IE = 1;      // Enable Timer0 overflow interrupt

    // Configure Timer0: Prescaler 1:256
    OPTION_REG = 0b00000111;

    PORTB = 0;
    PORTD = 0;

    TMR0 = 0;
}

void LcdConfig()
{
     // Initialize LCD module
     LCD_INIT();
     LCD_CMD(_LCD_CLEAR);
     LCD_CMD(_LCD_CURSOR_OFF);
}

// Calculate number of Timer0 overflows for given time in seconds
// Timer0 with 256 prescaler overflows every 0.032768 seconds (assuming 8MHz clock)
double Time0OverFlows(int time) {
       double overflowtime = 0.032768;  // Time per overflow in seconds
       double result = ceil(time / overflowtime);
       return result;
}
```

```
// Reset state machine if timeout occurs
void TimeOutHandler() {
    if(State != 0) {
        if(OverFlows <= OverFlows_counter) {
            OverFlows_counter = 0;
            State = 0;
        }
    }
}

// Display current room status on LCD
void DisplayState() {
    if(Counter == 0) {
        LCD_OUT(1,1,"ROOM IS EMPTY :)");
    }
    else if(Counter >= MaxCapacity) {
        LCD_OUT(1,1,"ROOM IS FULL :( ");
    }
    else {
        LCD_OUT(1,1,"Counter: ");
        LCD_OUT_CP(Str);
    }
}

//Control LED based on counter
void LightControl()
{
     if(Counter > 0)
         PORTB.B0 = 1;
     else
         PORTB.B0 = 0;
}

// Clear LCD screen when counter value changes
void ClearLcdBasedOnCounter() {
    if(Counter != LastCounterState) {
        LCD_CMD(_LCD_CLEAR);
        LastCounterState = Counter;
    }
}
```


THANK YOU
ROOM IS EMPTY :)