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Microcontroller Based Automatic Room Light Controller and Visitor Counter: Design and Construction

Ryan Greene
School of Undergraduate Studies
Excelsior College, Albany, NY 12203, USA
greenerbg@gmail.com

Sohail Anwar
Division of Business, Engineering, and Information System Technology
Penn State University, Altoona College Altoona, PA 16601, USA
sxa15@psu.edu

Patrick Favier
Department of Electrical Engineering
IUT Bethune, Universite d' Artois, Bethune, France
Patrick.favier@univ-artois.fr

***Abstract* – The key objective of green building is energy saving. Energy saving plan for green buildings depends on the efficient use of three main systems; lighting, heating, and cooling. The project described in this manuscript is related to the lighting system. To achieve energy saving lighting, a microcontroller based automated room light control system with a visitor counter is proposed here. The control system uses infrared sensors to determine when a person enters or exits a room and counts the number of people in the room. When a person enters the room, the light turns on automatically and the system adds one to the current person count. As more people enter the room, a display shows the number of people in the room. When the counter goes down to zero, the light turns off. The manuscript presents the design and construction details for the microcontroller based automatic room light controller and visitor counter.**

Keywords—green building; energy saving; lighting system; microcontroller

1. INTRODUCTION

In comparison with conventional buildings, green buildings focus on the efficient use of resources, such as, water and material, and provide better lighting and ventilation [1]. For energy saving in green buildings, one of the key systems to perform efficiently is the lighting mechanism in the building. Energy loss occurs when the lighting system in a building illuminates an area where no one is present, and it is not being used [2]. When the light switch is operated manually, there is a chance of keeping the lights in an area in ON state even though it may not be needed during that time. Therefore, a microcontroller based automated room light controller with a visitor counter is proposed here. This system is designed to control the room lights in addition to counting the number of persons/visitors in the room with accuracy. A microcontroller serves as the central processing unit (CPU) for this system. The microcontroller receives signals from multiple sensors. These signals are operated upon by the code stored in the microcontroller-based system memory.

2. DESIGN

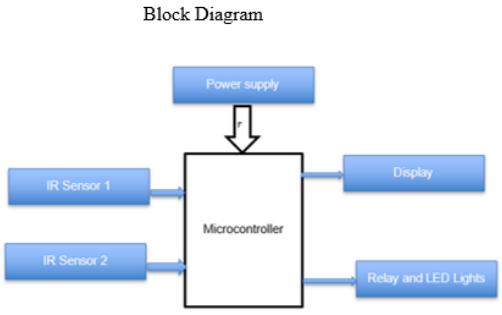

Fig. 1: The functional block diagram

The functional block diagram for the automated room light controller is presented in Figure 1. The key components of the system are shown in this block diagram. The microcontroller interfaces with two (2) infrared sensors, a display, relays, and LEDs. Each of the functional blocks is described here.

2.1 Power Supply

The power supply circuit for this control system accepts 120 volts at 60 Hz through a transformer to step down the voltage to 24 volts AC. This voltage is supplied to a full rectifier and smoothing capacitor and then to a 7812 voltage regulator. The regulated 12-volt output of the voltage regulator powers an LED and then it goes through a 7805 voltage regulator to produce a 5-volt output which is used to power the microcontroller, the sensors, the LCD, and the relay circuit.

2.2 Microcontroller

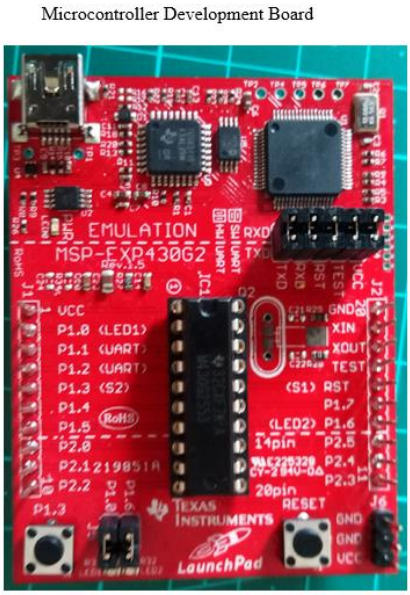

Fig. 2: Microcontroller development board

The microcontroller used as a CPU for this system is an MSP430G2553 ultra low power mixed signal controller with built-in 16-bit timers and up to 24 I/O capacitive-touch enabled pins. It has a 16-bit R1SC architecture with 62.5 ns instruction cycle time and it supports up to 16 MHz internal frequency. More information regarding this microcontroller is provided in [3]. The microcontroller development board is shown in Figure 2.

2.3 Infrared (IR) Sensors

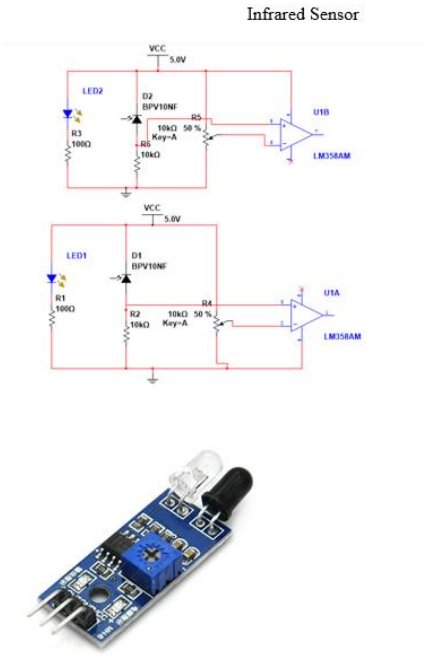

Fig. 3: Infra Red sensor module

To detect if someone enters or leaves the room, IR sensor module is used. The module consists of an IR LED, photodiode, and LM358 operational amplifier. The schematic for the IR sensor module is presented in Figure 3.

2.4 Relay Circuit

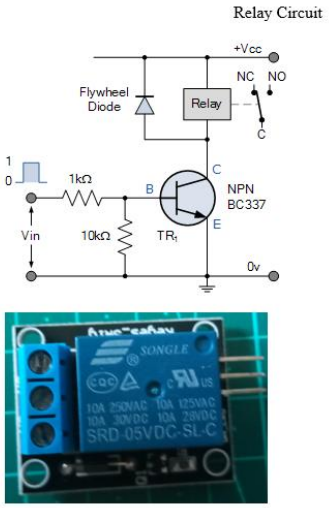

Fig. 4: Relay circuit

The relay switch circuit controls the LED light. An NPN relay switch circuit is used for this lighting control system. This circuit accepts digital input and employs a BC337 NPN transistor which activated the relay to turn ON the LED lights with a 12-volt DC power supply. Figure 4 depicts the schematic for the relay circuit.

2.5 LCD Display

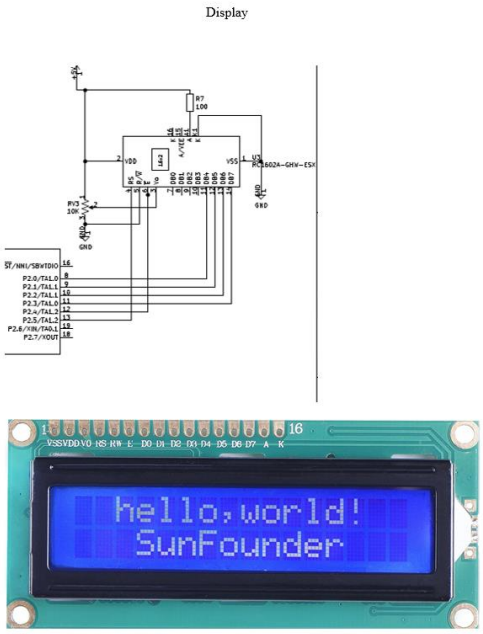

Fig 5: LCD display

The LCD display is a simple display that outputs the number of persons entering the room. This information is processed from the microcontroller, MSP430G2553. The LCD is a 16x2 display which is connected to Port 2 of the microcontroller. The schematic for the connection of the display to the microcontroller is shown in Figure 5.

3. PROGRAMMING

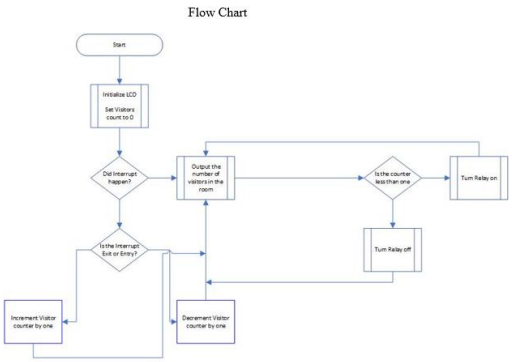

Fig. 6: Flowchart

The microcontroller is programmed to attain the following steps:

1. Initialize the Visitor count to zero
2. Enable port 2 for LCD display and Port 1.0 as output;
3. Set Port 1.1 and Port 1.2 to input
4. Enable interrupts of Port 1.1 and Port 1.2
5. Output the Visitor count to the LCD
6. If the visitor count is more than 1 then go to step 6 else go to step 9
7. Set Port 1.0 to high
8. Go to step 11
9. Set Port 1.0 to low
10. Set visitor count to zero
11. If Interrupt on Port 1.1
12. Increment Visitor counter by 1
13. In Interrupt on Port 1.2
14. Decrement visitor counter by 1
15. Go to step 5.
16. End Program

The flow chart for the above-mentioned programming steps is provided in Figure 6. The coding for this system is done using the Texas Instruments Code Composer Studio. More information regarding the Code Composer Studio is provided in [4]. To get the LCD function effectively, Port 2 of the microcontroller was used as the main driver for the LCD. The code to accomplish this step is listed in [5]. The code is provided in the APPENDIX.

4. CONCLUSION

This manuscript presents the design and construction details for a reliable microcontroller-based control system that performs the task of controlling the room lights as well as counting the number of persons/visitors in the room. An LCD display shows the number of people/visitors who enter the room. The microcontroller continuously monitors the infrared sensors. The code programmed in the system memory makes the microcontroller turn the room lights ON and OFF automatically.

REFERENCES

[1] Green Buildings and Energy Efficiency https://doi.org/10.13140/rg.2.1.3950.9362
[2] K. Mehrotra, S. A. Khan and S. K. Pawar, “Automatic room light controller using microcontroller and visitor counter,” International Journal of Research in Engineering and Technology, pp. 69-72, 2016.
[3] MSP430G2553 – 16 MHz MCU www.ti.com/product/MSP430G2553
[4] Code composer Studio (CCS) Integrated Development Environment (IDE) www.ti.com/tool/CCSTUDIO
[5] EE 3376 Lab 5. http://www.ece.utep.edu/courses/web3376/Lab_5_-_LCD.html

APPENDIX

```
#include <msp430.h>
#include "lcdLib.h"

int visitorCount = 0;
void displayVisitor(void);

void main (void)
{
    WDTCTL = WDTPW + WDTHOLD;                 // Stop w

    P1DIR |= BIT0;                            // Set P1
    P1OUT &= ~BIT0;

    P1REN |= BIT1 + BIT2;                             //
    P1OUT |= BIT1 + BIT2;                             //
    P1IES &= ~(BIT1 + BIT2);
    P1IFG &= ~(BIT1 + BIT2);
    P1IE |= BIT1 + BIT2;                              //

    __bis_SR_register( GIE );                 // Enable


    while(1)
    {
        if (visitorCount > 0)
            P1OUT |= 0x01;          //Turn on Relay
        if (visitorCount < 0)
            visitorCount = 0;
        if (visitorCount == 0)
            P1OUT &= ~(0x01);       //Turn off Relay
    /*    if (visitorCount > 9)
        {
            P1OUT ^= 0x01;
            delay_ms(100);
        }*/

        displayVisitor();
    }
}

void displayVisitor(void)
{
    lcdInit();
    lcdSetText("Persons:  ", 0, 0);
    lcdSetInt(visitorCount, 10, 0);
}

// Port 1 interrupt service routine
#pragma vector=PORT1_VECTOR
__interrupt void Port_1(void)
{
    // If Enter
       if(P1IFG&(BIT1))
       {
         visitorCount++;
         delay_ms(1000);
       }
       if(P1IFG&(BIT2))
       {
           visitorCount--;
           delay_ms(1000);
       }

       // Clear flag
       P1IFG=0;

}
```