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CAPSTONE PROJECT

PEOPLE COUNTING SYSTEM

MIDTERM CAPSTONE PROJECT REPORT

MENTOR

PhD. TRI NHUT DO

HO CHI MINH CITY, 2023

VIETNAM NATIONAL UNIVERSITY
HO CHI MINH CITY
UNIVERSITY OF INFORMATION TECHNOLOGY

SOCIALIST REPUBLIC OF VIETNAM
Independence – Freedom - Happiness

DETAILED TOPICS

VIETNAMESE PROJECT NAME: BỘ ĐẾM SỐ LƯỢNG NGƯỜI RA VÀO
ENGLISH PROJECT NAME: PEOPLE COUNTING SYSTEM
Instructor PhD. Tri Nhut Do, Faculty of Computer Engineering
Implementation time: From: 02/10/2023 To: 19/11/2023
Student Perform: **TRUONG TUAN LAN - 21521068** **TRAN NGUYEN NHUT TAM - 21520441**
Overview of the topic: This project has the capability to count and display the quantity of individuals entering various spaces, such as conference rooms, seminar halls, restaurants, offices, or classrooms.

The goal of the subject: The objective of this project is to effectively monitor and oversee the flow of individuals entering and exiting specific locations where the headcount is of significant concern.

Methods of implementation: Simulation and hardware system.

Main contents of the topic: We want to make a small contribution to help reduce the physical strain on workers, increase labor productivity significantly, and ensure high accuracy where the number of people entering and leaving are required to be counted precisely

Certification of Instructor (Sign and clearly state full name)	**HCM city, 2023 November 19** **Student** (Sign and clearly state full name)

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Chapter 1. INTRODUCTION

Nowadays, with the strong development of science and technology, human life has seen increasingly positive changes, bringing optimal convenience with modern devices serving the industrialization and modernization of the country. Contributing to this development, the field of electronic engineering has played a significant role in the nation's construction and growth. Among these contributions, the integration of electrical and electronic circuits has become increasingly essential as technology advances towards the era of microprocessor circuits, replacing bulky circuits that once occupied a significant area with smaller and more compact microchips that are now favored. Its achievements have turned seemingly impossible ideas into realities, contributing to the improvement of both material and spiritual lives of individuals.

In this context, the field of "Computer Engineering" plays a crucial role in the application of digital control in modern technology. Digital technology has sparked a revolution in every aspect of modern life, from electric rice cookers, washing machines, and mobile phones to television, photography, and information technology. Its applications in the production processes of both large and small companies are countless.

Based on observations at factories and visits to production enterprises, we have noticed that many processes have been automated in the manufacturing industry. One simple automation process in an automated production line is the automatic counting of produced items. However, for small and medium-sized enterprises, complete automation has not yet been applied in the process of counting products and packaging, and manual labor is still used.

Given these observations and our capabilities, we want to make a small contribution to help reduce the physical strain on workers, increase labor productivity significantly, and ensure high accuracy. For places with a high influx of people, such as supermarkets and stores, there is a need to manage the number of people entering and exiting to assess the business situation accurately. Therefore, we have decided to design a device for counting people entering and exiting because it is highly relevant to reality and holds great significance for us, as it represents our small contribution to society.

Recognizing the wide-ranging applications of a people counting device in places like supermarkets and stores, we conducted research and designed it under the enthusiastic guidance of our mentor, Mr. Do Tri Nhut, a lecturer in the Faculty Computer Engineering at the University of Information Technology - Vietnam National University, Ho Chi Minh City (VNU-HCM). Due to our limited knowledge and experience, our project may have some imperfections. We sincerely hope for the evaluation and feedback from our esteemed professors, teachers, and friends to improve our project further.

Chapter 2. OVERVIEW

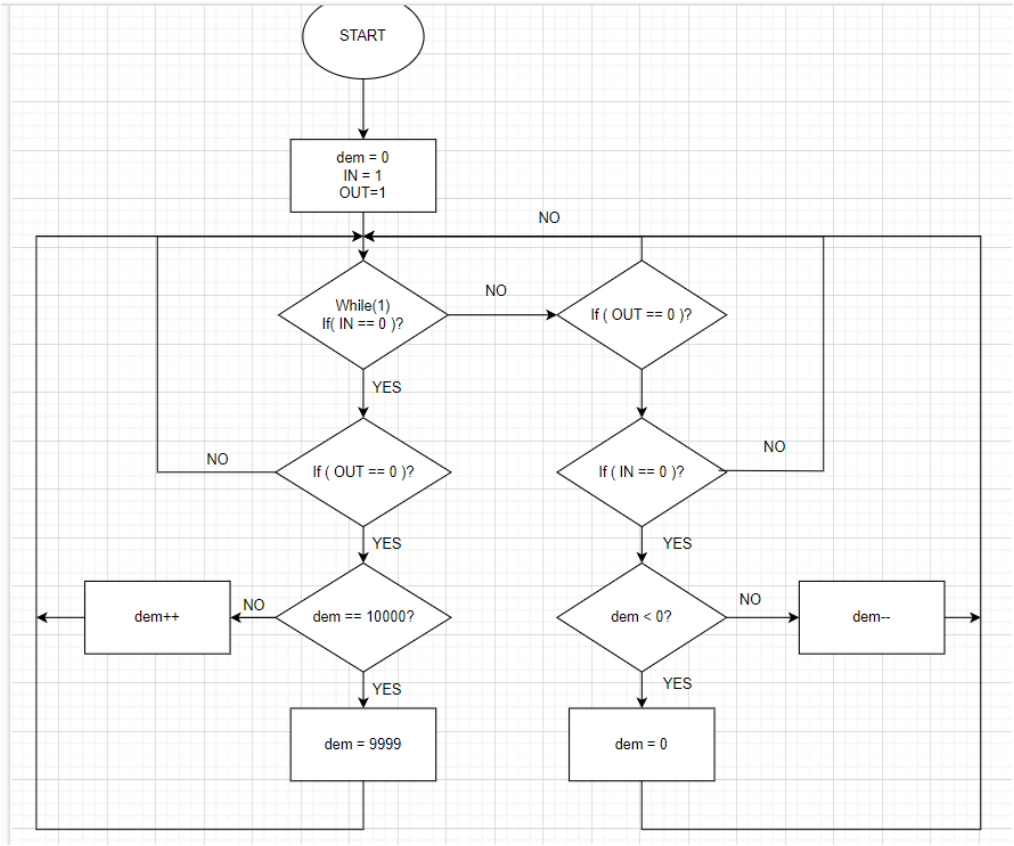
2.1 Research directions

Before the advancement of information systems, counting of people used to be done manually. This method is straightforward but can be labor-intensive. With the innovation of technology, there are many ways to develop a counting system. Modern people counters use advanced technologies such assensors, cameras, and machine learning algorithms to accurately count and classify individuals based on factors such as height, speed, and direction of movement. This allows for more precise and detailed data collection, which can be used to optimize business operations and improve the customer experience.

2.2 Problem

A people counter is a device or system that is designed to count the number of people who enter and exit a particular area, such as a building, room, or store. This counter is capable of counting in two directions - both when people enter and when people exit. The primary function of a people counter is to keep track of the number of people in a given space at any given time. The heart of the counter is a micro-controller that counts the visitors up using output from a button. Two laser sensors to detect the visitors entering and leaving the room. The two laser will be divide into "IN" and "OUT" laser. If the "IN" get blocked first, "OUT" get blocked next (people entering from outside), the system will count up. If the "OUT" get blocked first, "IN" get blocked next (people coming out from inside), the system will count down.

2.3 Flowchart



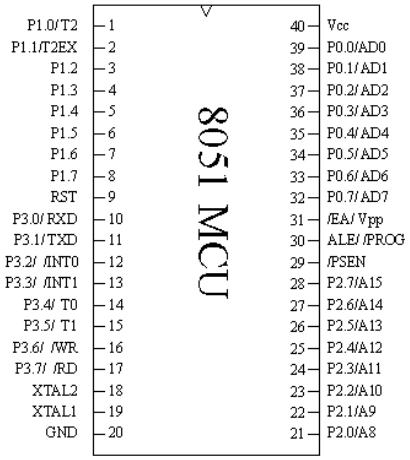
Chapter 3. THEORY BASIS

3.1 8051 MicroController

8051 is an IC (Integrated Circuit) microcontroller and a general-purpose microcontroller of the MCS-51 family. The initial component of this family was introduced to the market by the manufacturer Intel.

The IC 8051 has the following summarized features:

- 4KB internal EPROM (Erasable Programmable Read-Only Memory).
- 128 Bytes internal RAM (Random Access Memory).
- 4 8-bit I/O ports.
- Serial communication interface.
- 64KB external program memory space.
- 64KB external data memory space.
- Boolean processing.
- 210 bit-addressable memory locations.
- 4μs for multiplication and division operations.



The pin diagram of the 8051 microcontroller

- VCC Pin:

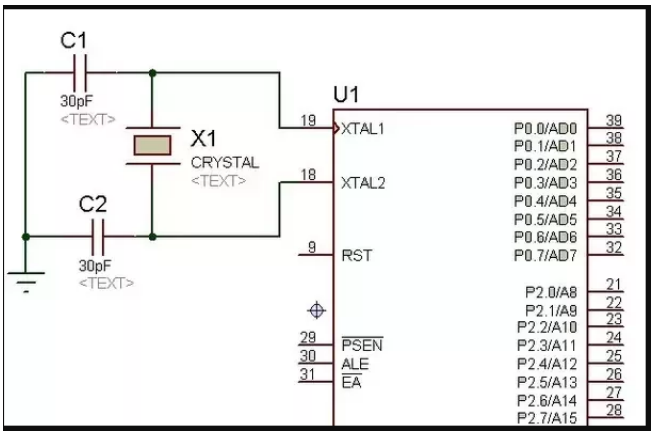
Pin 40 is the VCC pin, and its function is to supply power to the chip. The power supply voltage is typically +5V.

- GND Pin:

Pin 20 is the GND pin, and it is connected to ground, which is at 0V.

- XTAL1 and XTAL2 Pins:

The 8051 microcontroller has an on-chip oscillator, but it requires an external clock signal to run. A quartz crystal oscillator is connected to the XTAL1 (pin 19) and XTAL2 (pin 18) pins. The quartz crystal oscillator connected to XTAL1 and XTAL2 also requires two ceramic capacitors with a value of approximately 30pF. One terminal of each capacitor is grounded



XTAL connection

- RST Pin:

RST, which is pin number 9, stands for Reset. It is an active-high input (typically held low). When a high pulse is applied to this pin, the microcontroller will be reset, and all operations will come to a halt. This is often referred to as a power-on reset. Activating a power-on reset will clear all the values stored in the registers.

- EA Pin:

EA stands for External Access and is pin number 31 on the DIP package. It is an input pin and must be connected to either Vcc or GND. In other words, it should not be left unconnected.

Members of the 8051 family such as 8751, 89C51, or DS5000 have on-chip ROM for program storage. In such cases, the EA pin is connected to Vcc. For members of the family like 8031 and 8032 that do not have on-chip ROM, the program code is stored in external ROM memory and loaded into the 8031/32.

- P0 Port:

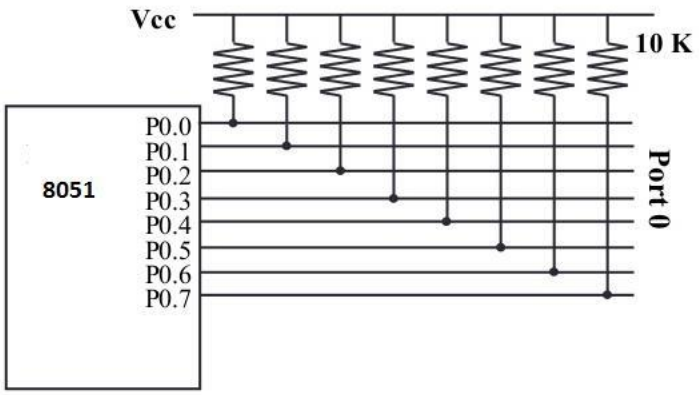
The P0 port consists of all 8 pins, ranging from pin 32 to 39. It can be used as an output port. To use the P0 pins as both outputs and inputs, each pin should be connected to an external 10kΩ pull-up resistor. This is because, in reality, the P0 port is an open-drain, unlike the P1, P2, and P3 ports. The concept of open-drain is used in MOS chips and is somewhat similar to an open collector in TTL chips.

In any system using 8751, 89C51, or DS5000, the P0 port is typically connected to pull-up resistors. This configuration allows the use of P0 for both output and input purposes. With the external pull-up resistors connected, during a reset, the P0 port is configured as an output port.

P0 Port as an Input: When resistors are connected to the P0 port to turn it into an input port, it must be programmed by writing 1 to all the bits of P0.

Dual Role of P0 Port: the P0 port is assigned as the address bits AD0 - AD7, allowing it to be used for both address and data. When connecting the 8051/31 to external memory, the P0 port provides both address and data. The 8051 multiplexes data and address

through the P0 port to save on the number of pins. ALE (Address Latch Enable) is used to separate address and data with the assistance of the 74LS373 data latch.



P0 Port with pull-up resistors

- P1 Port:

The P1 port also consists of all 8 pins, ranging from pin 1 to pin 8, and it can be used as either an input or an output. Unlike the P0 port, this port does not require external pull-up resistors as it already has internal pull-up resistors. During a reset, the P1 port is configured as an output.

P1 Port as an Input: Similar to P0, to turn the P1 port into an input, it must be programmed by writing 1 to all of its bits.

- P2 Port:

The P2 port also consists of 8 pins, ranging from pin 21 to pin 28. It can be used as either an input or an output, similar to the P1 port. Like P1, the P2 port does not require external pull-up resistors as it already has internal pull-up resistors. During a reset, the P2 port is configured as an output.

P2 Port as an Input: To use the P2 port as an input, it must be programmed by writing 1 to all of its pins.

Dual Role of P2: In systems using 8751, 89C51, and DS5000, P2 is typically used as an output. However, in the 80312 system, the P2 port can be used in conjunction with P0 to create a 16-bit address for external memory. The P2 port is also designated as the high-order address bits A8 - A15, indicating its dual function. Because an 8031 can access up to 64k bytes of external memory, it requires a 16-bit address. While P0 provides the low 8 bits through A0 - A7, the role of P2 is to provide the high-order address bits A8 - A15. In other words, when the 8031 is connected to external memory, P2 is used for the high 8 bits of the 16-bit address and cannot be used for input/output.

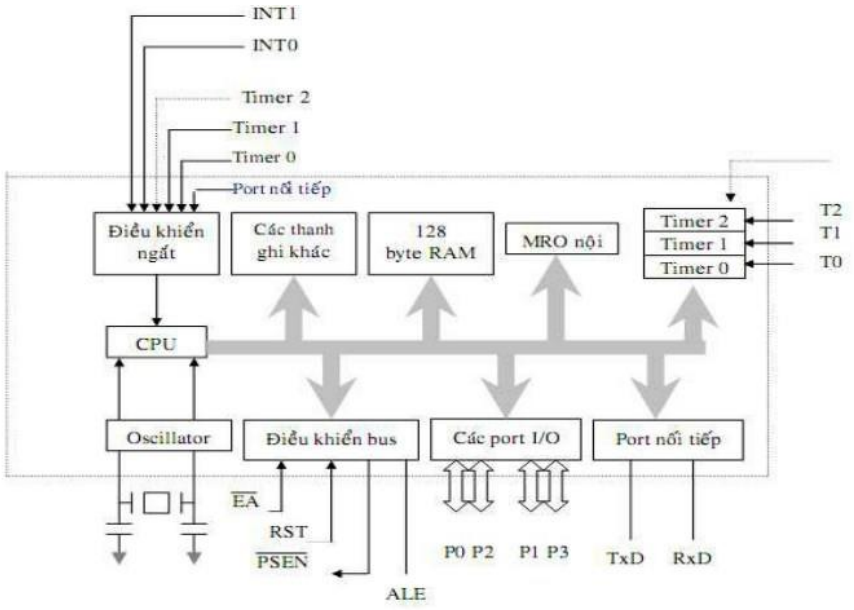
- P3 Port:

The P3 port comprises a total of 8 pins, from pin 10 to pin 17. It can be used as either an input or an output. Similar to P1 and P2, the P3 port does not require pull-up resistors.

Although the P3 port is configured as an output during reset, this is not the most common use of it.

- Bits P3.0 and P3.1 provide receive and transmit signals for serial data communication.
- Bits P3.2 and P3.3 are reserved for external interrupts.
- Bits P3.4 and P3.5 are used for timer 0 and timer 1.
- Bits P3.6 and P3.7 are used for reading from and writing to external memory when connected to 8031 systems.

3.2 Internal structure



The internal memory of the 8051 microcontroller consists of RAM and ROM. RAM comprises several components: general-purpose storage, addressable storage for each register bank, and special function registers.

The 8051 follows a Harvard architecture, which means it has separate memory areas for program and data. While program and data can coexist within the 8051, it can still access 64KB of program memory and 64KB of extended data memory.

The RAM in the 8051 is divided as follows:

- Register banks with addresses from 00H to 1FH.
- Bit-addressable RAM with addresses from 20H to 2FH.
- General-purpose RAM from 30H to 7FH.
- Special function registers from 80H to FFH.

3.3 Other components used for the project

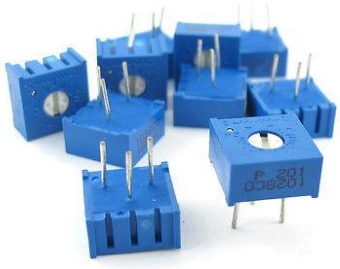
1. Resistor

Resistor is a passive component that provides resistance to both current and voltage. Resistors are widely used in electronic circuits

Resistor is a physical quantity characteristic of the ability to impede the flow of electric current through a conducting object. It is defined as the ratio of the voltage difference across two points of that object to the current intensity flowing through it.

2. Variable resistor.

It is a resistor that can be adjusted and has the function of changing voltage according to the user's requirements

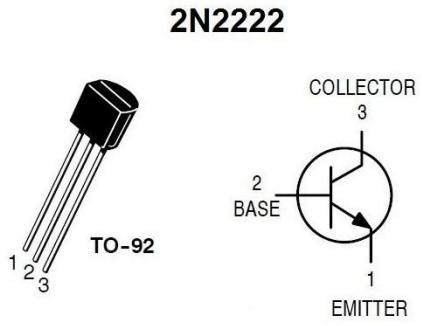


3. 12MHz crystal:

It is a source that generates a stable 12MHz clock signal for the oscillation of the 8051 microcontroller. The crystal will be connected to the XTAL1 and XTAL2 pins.

4. Transistor

The 2N2222 is a BJT (Bipolar Junction Transistor) that consists of three regions separated by two p-n junctions. In the middle, there's a p-type semiconductor region, the region with the highest impurity density is labeled as n+ and it's the emitter region. The region with a lower impurity density, labeled as n, is called the collector region. The middle region, with very low impurity density, is labeled as p and is referred to as the base region. Three metal pins are connected to the three corresponding regions, which are the emitter (E), base (B), and collector (C) terminals of the transistor.



5. Capacitor.

It filters noise for the quartz crystal oscillator. Two 33pF ceramic capacitors are connected with one end to the crystal pin, and the other end is connected to ground (Mass).

A capacitor is a passive component, and its structure consists of two metal plates separated by a distance d, and between the two plates, there is a dielectric material or insulating substance with capacitance C. The characteristic of a capacitor is that it allows alternating current to pass through while blocking direct current.

6. LED

LED stands for Light Emitting Diode. It is a type of semiconductor diode that emits light when forward-biased (positive voltage applied) and does not emit light when reverse-biased (negative voltage applied).

7. 7-Segment 4-Digit LED Display:

A 7-segment 4-digit LED display is constructed from four individual 7-segment LEDs.

The 7-segment LED consists of seven individual LEDs arranged in the shape of a figure eight (8), with an additional small round LED in the lower right corner to indicate a decimal point.

The 8 individual LEDs on the 7-segment display share a common Anode (+) or Cathode (-) connected together at a single point, and these are extended as pins to connect to the circuit. The remaining 7 pins on each of the individual LEDs on the 7-segment display and one pin on the LED for the decimal point in the lower right corner are brought out as separate pins to control the on/off state of the LEDs as desired.

If the 7-segment display has a common Anode (+), this common pin is connected to +Vcc, and the remaining pins are used to control the on/off state of the individual LEDs. The LED lights up when signals placed on these pins are at a logic 0 level (ground).

If the 7-segment display has a common Cathode (-), this common pin is connected to Ground (Mass), and the remaining pins are used to control the on/off state of the individual LEDs. The LED lights up when signals placed on these pins are at a logic 1 level.

If the 7-segment LED display has a common Anode, to make a specific segment light up, you need to drive the Cathode of that individual LED segment low (0). From there, you can use a decoding table for the common Anode 7-segment LED display as follows:

Digit	Hex Value	Segments Lit
0	0xC0	0b11000000
1	0xF9	0b11111001
2	0xA4	0b10100100
3	0xB0	0b10110000
4	0x99	0b10011001
5	0x92	0b10010010
6	0x82	0b10000010
7	0xF8	0b11111000
8	0x80	0b10000000
9	0x98	0b10011000

For a common cathode 7-segment LED display, to make a specific segment light up, you need to drive the Anode of that individual LED segment high (1). From there, you can use a decoding table for the common cathode 7-segment LED display as follows:

Digit	Hex Value	Segments Lit
0	0x3F	0b00111111

1	0x06	0b00000110
2	0x5B	0b01011011
3	0x4F	0b01001111
4	0x66	0b01100110
5	0x6D	0b01101101
6	0x7D	0b01111101
7	0x07	0b00000111
8	0x7F	0b01111111
9	0x6F	0b01101111

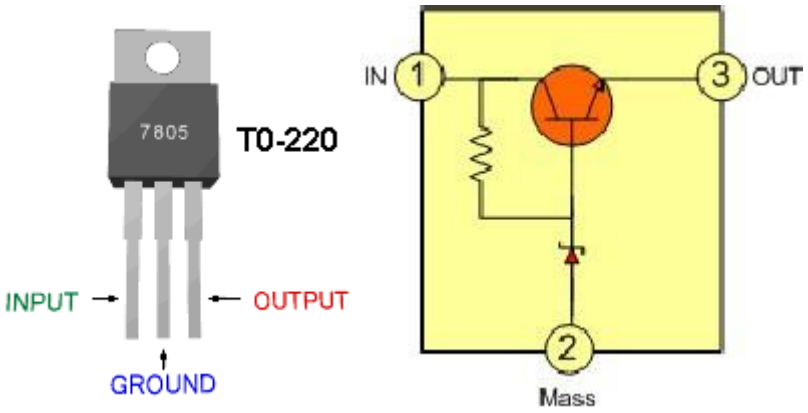
8. LM7805 Voltage Regulator.

LM78xx is a type of IC used to stabilize the positive output voltage, with the condition that the input voltage is always greater than the output by at least 3V.

The specific output voltage depends on the particular 78xx series IC being used.

The 78xx series ICs have 3 pins:

- Pin 1 (Vin): Input voltage pin.
- Pin 2 (GND): Ground connection pin.
- Pin 3 (Vout): Output voltage pin."

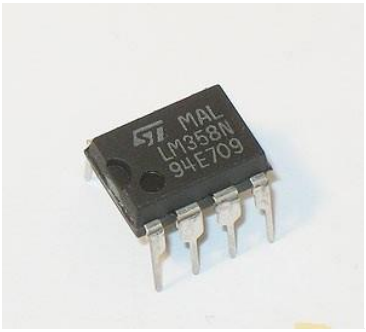


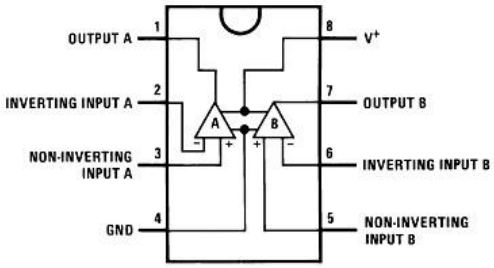
9. LM358

The LM358 is a low-power operational amplifier that has advantages over standard operational amplifiers in single-supply applications. It can operate within a voltage range of 3V to 32V.

Characteristics of the LM358:

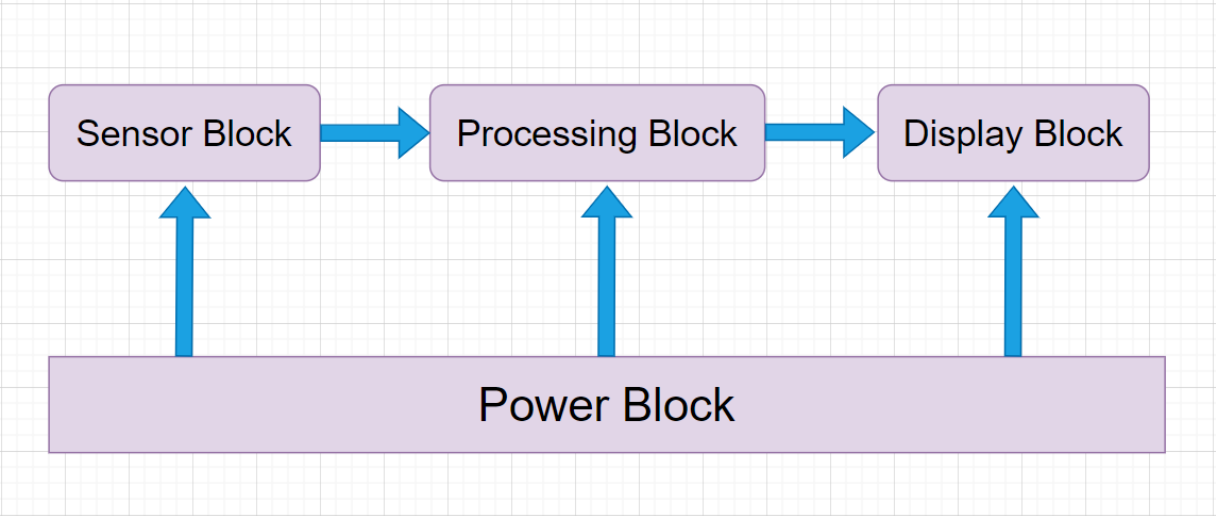
- Low quiescent power consumption.
- It contains two high-gain operational amplifier circuits.
- Compatible with various logic circuit configurations.





Chapter 4: SYSTEM IMPLEMENTATION PROCESS:

1. Block diagram



2. Functions of the Blocks:

Power Block: This is the voltage supply system for the circuit, ensuring that the circuit operates at a constant 5V. In this circuit, it uses a 9V power source from a battery.

Sensor Block: To detect each person passing through, the sensor must have both a transmitter and a receiver. The transmitter emits a laser beam, and the receiver detects that laser beam. CHAPTER 4: **SYSTEM IMPLEMENTATION PROCESS:**

Processing Block: This component has two main functions:

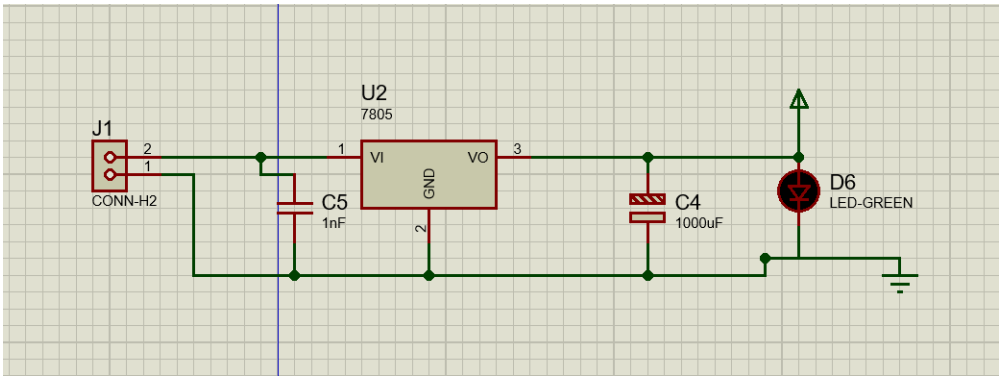
- It interfaces and connects different blocks in the circuit, ensuring that they operate in a specific cycle.
- It receives signals from the sensor block and processes them before sending the information to the display block.

Display Block: It consists of a system of 7-segment LED displays with 4 digits and indicator LEDs.

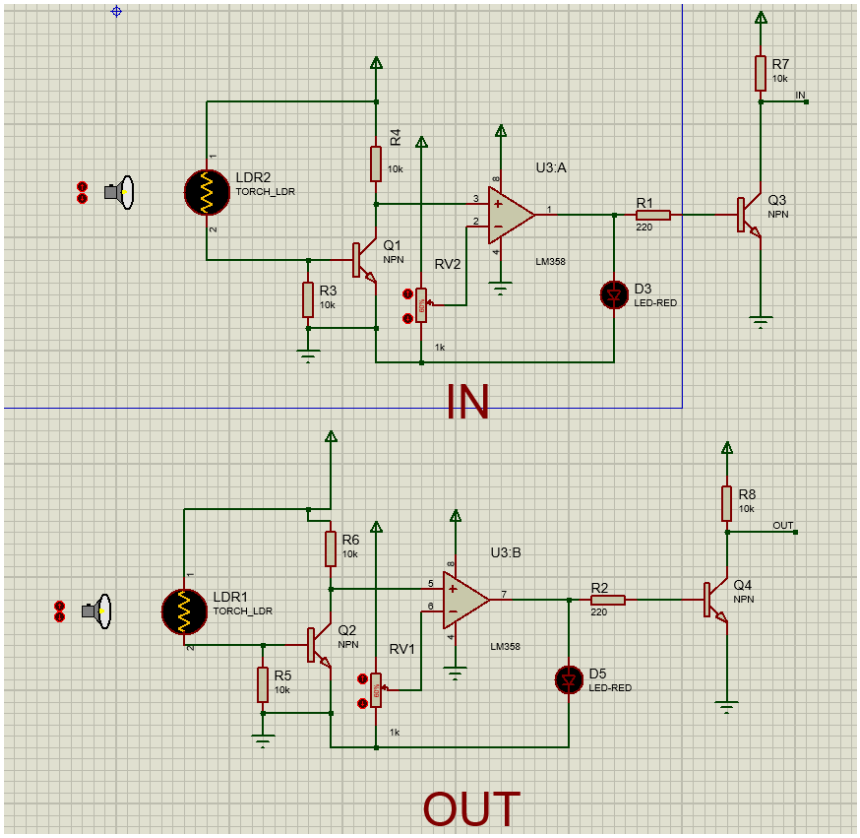
- The 7-segment LED displays show the number of people entering and exiting.
- The individual LEDs indicate the quantity of people in the room.

3. Schematic

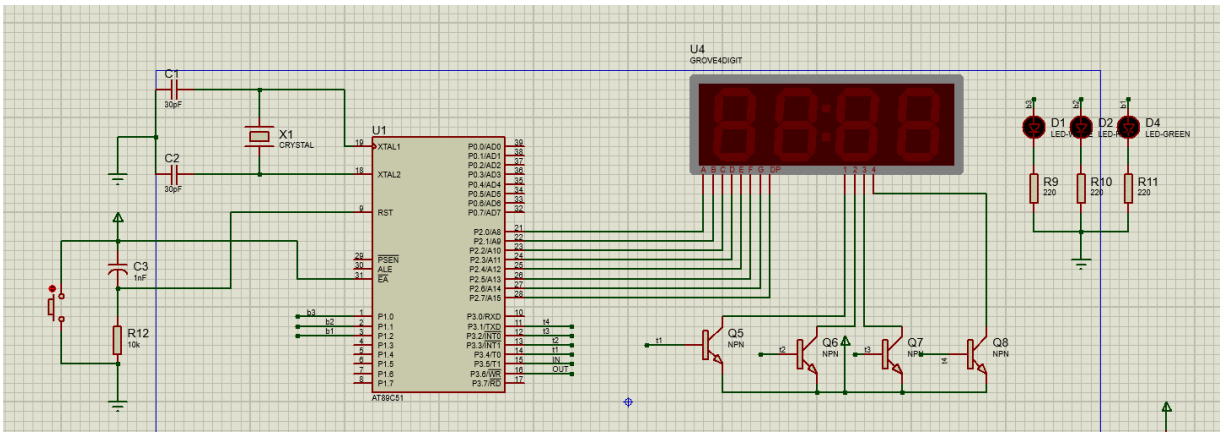
Power block:



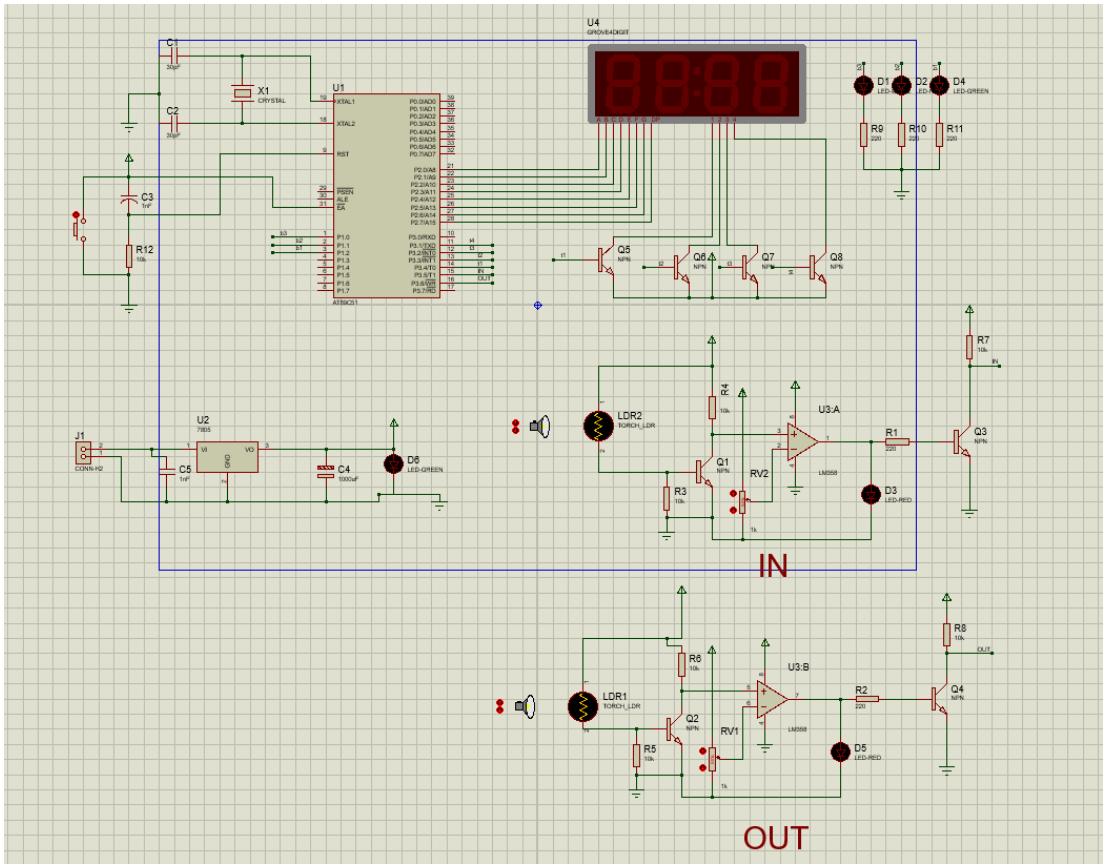
Sensor block:



Display block:



The whole schematic:



4. Operating Principle:

- When power is supplied to the circuit, it passes through the LM7805 voltage regulator with filter capacitors, providing power to the system and the single LEDs for indicating the power supply.
- On the sensor output side (OUT):

  - In normal mode:

  + Phototransistor -> Q2 conducts -> voltage at pin 5 of LM358 is around 2.5V. In this state, the LM358 IC compares this signal with the supply voltage at pin 6 of the LM358 through the variable resistor RV1. When that happens, the output at pin 7 of the LM358 is low, so Q5 is off. The sensor input side (IN) operates similarly. Pins T1 (pin 15 of AT89C51) and WR (pin 16 of AT89C52) are always high as they are directly powered with 5V via resistors R8 (out) and R7 (in).

  - When a person passes through the laser sensor, the laser light from the transmitter does not reach the receiver:

  + On the sensor output side: the phototransistor does not conduct -> Q2 is off -> voltage at pin 5 of LM358 is around 5V. In this state, the LM358 IC compares this signal with the supply voltage at pin 6 of the LM358 through the variable resistor RV1. When that happens, the output at pin 7 of the LM358 is high, so Q4 conducts. At that point, pin T1 (pin 15 of AT89C51) goes low, providing input for control processing and displaying the count of people in and out.

- Similarly, the sensor in the input side operates based on the same principle.
- The microcontroller processes the signals received from pins 15 and 16 to display the count on the 7-segment LED display.
- When pin 15 is low (IN), and pin 16 is low (OUT), the counter increments by +1.

- When pin 16 is low (OUT), and pin 15 is low (IN), the counter decrements by -1.
- In normal operation, a green single LED lights up when there is 1 person. When the number of people exceeds 4, a red LED lights up, and when the number exceeds 9, a white LED lights up, indicating the quantity level.

5. How it work

- Initially, set the two laser sensors in the correct position for the phototransistor generate power. While the lasers still on, it means no person is coming in or out. The 7Segment Led presents '0000'.

*To simulate a person come in:

- Move the light source of IN far away from the sensor (to simulate a person go pass the door), then move the light source of OUT far away. Because the IN and OUT sensors are putting parallel, so if a person come inside, the light source at IN will be blocked first, then light source in OUT will be block next.

- Move light source of IN and OUT back to normal position (because the person has passed). If the sensor turn off in that order (IN then OUT), the counter will count up by one. The 7Segment Led will presents '0001'.

* To simulate a person come out:

- Move the light source of OUT far away, then the light source of IN far away. (To simulate a person get out from inside the room).

- Move light sources of IN and OUT back to normal position. (because the person has passed). If the sensor turn off in that order (OUT then IN), the counter will count down by one. The 7Segment Led will presents '0000'

* Other function:

- The system has 3 single led (GREEN, RED, WHITE) to help with the counting. If the system count from 1-4, the Green led will light up. If the system count from 5-9, the Red led will light up. If the counting is more than 10, the White led will light up.

- The system can count up to 9999 people come in. If the 10000th person come in, the system still count as '9999'.

- If there is nobody come in but a person come out, the system still count as '0000'

Chapter 5: EXPERIMENT

1. The code

The code is written in C using Keli Uvision5.

```
#include <REGX51.H>
int i=0;
unsigned char code
ma[10]={0xc0,0xf9,0xa4,0xb0,0x99,0x92,0x82,0xf8,0x80,0x90};
void delay(unsigned char t)
{
  unsigned char i,j;
  for(i=0;i<t;i++)
  {
    for(j=0;j<125;j++);
  }
}

int dem()
{
  if(P3_5==0)
    {
      while(P3_5==0);
      if(P3_6==0)
        {
          while(P3_6==0);
          i++;
          if(i==10000)
            i=9999;
        }
    }
    if(P3_6==0)
      {
        while(P3_6==0);
        if(P3_5==0)
          {
            while(P3_5==0);
```

```
            i--;
            if(i<0)
              i=0;
          }
      }
      return i;
}

void lay(unsigned int dem)
  { P1_0=P1_1=P1_2=0;
    if((dem>=1)&&(dem<5))
      {
        P1_2=1;
        P1_1=0;
        P1_0=0;
      }
    else if ((dem>=5)&&(dem<10))
      {
        P1_1=1;
        P1_2=0;
        P1_0=0;
      }
      else if (dem>=10)
        {
          P1_0=1;
          P1_2=0;
          P1_1=0;
        }
  }

  void main()
{
  unsigned int k;
  while(1)
    {
      k=dem();
      {
        lay(k);
        P3_1=1;
        P2=ma[k%10];
        delay(10);
        P2=0xff;
        P3_1=0;P3_2=1;
        P2=ma[(k%100)/10];
        delay(10);
        P2=0xff;
        P3_2=0;
        P3_3=1;
        P2=ma[(k%1000)/100];
        delay(10);
        P2=0xff;
        P3_3=0;P3_4=1;
        P2=ma[k/1000];
        delay(10);
        P2=0xff;
        P3_4=0;
      }
    }
}
```

The functions in the code:

- delay(): Used to create a small delay time of ~1ms for each loop.

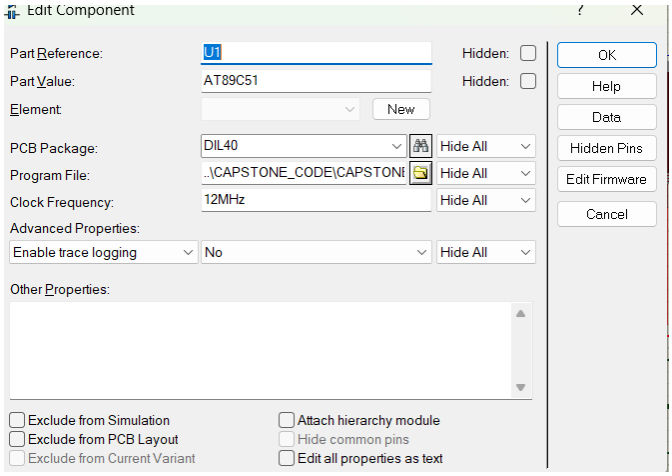
- dem(): Used for the Sensor block. It will check the power status of pin P3.5 (IN) and pin P3.6 (OUT) in the system. In normal condition, P3.5 and P3.6 = 1. The function is used to check if P3.5 and P3.6 = 0 in what order. If P3.5 = 0 then P3.6 =0, it means a person come in, then count up by one. (Maximum = 10000). If P3.6 = 0 then P3.5 = 5, it means a person come out, then count down by one (Minimum = 0000). It return the counted value.

- lay(): Used for the additional 3 single leds (green, red, white). It will check if the number of people is <5, then Green led will light up. If the number of people <10, red light will light. If the number of people is above 10, white led will light up.

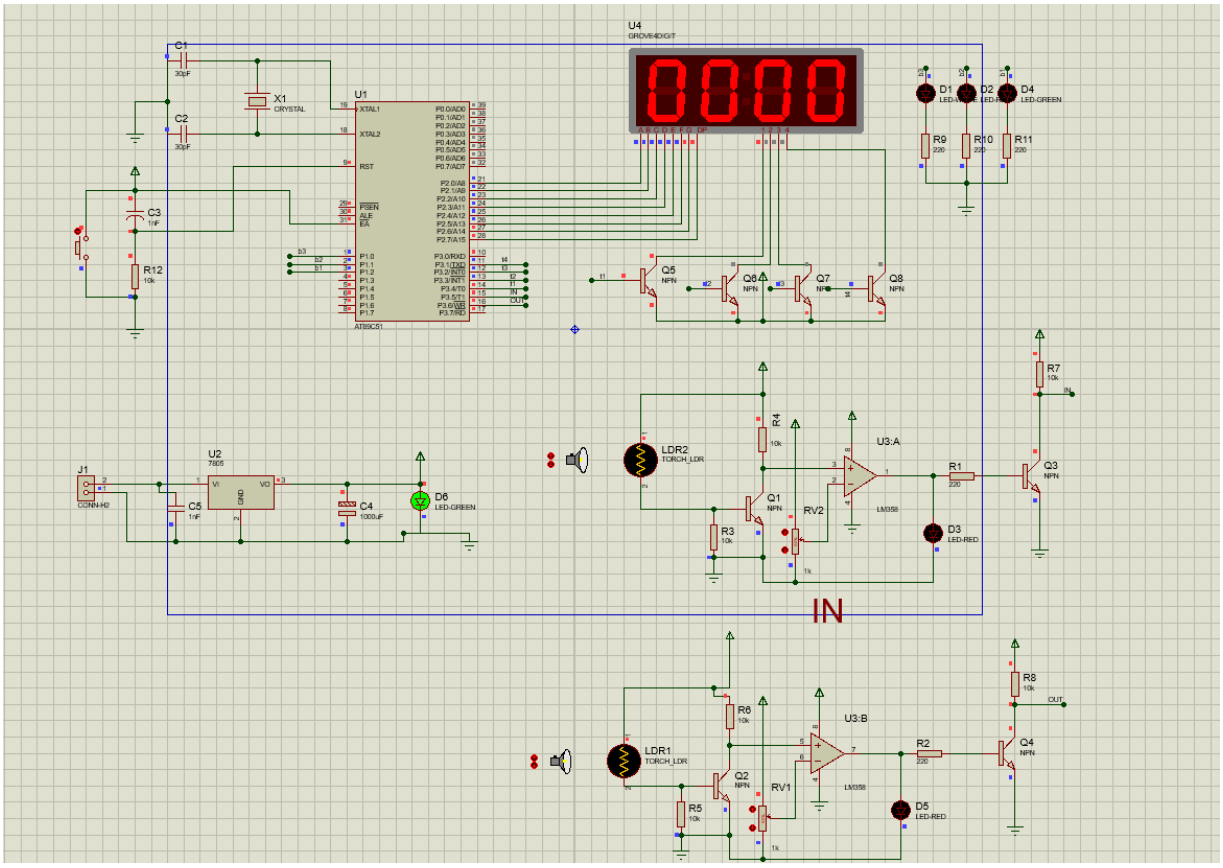
- main(): Used to for the Display block. It will receive the counted value from dem() function, then call lay() function to light the additional led. Then, it will check the counted number received and display on the 7Segment led (up to 9999).

2. Simulate on Proteus

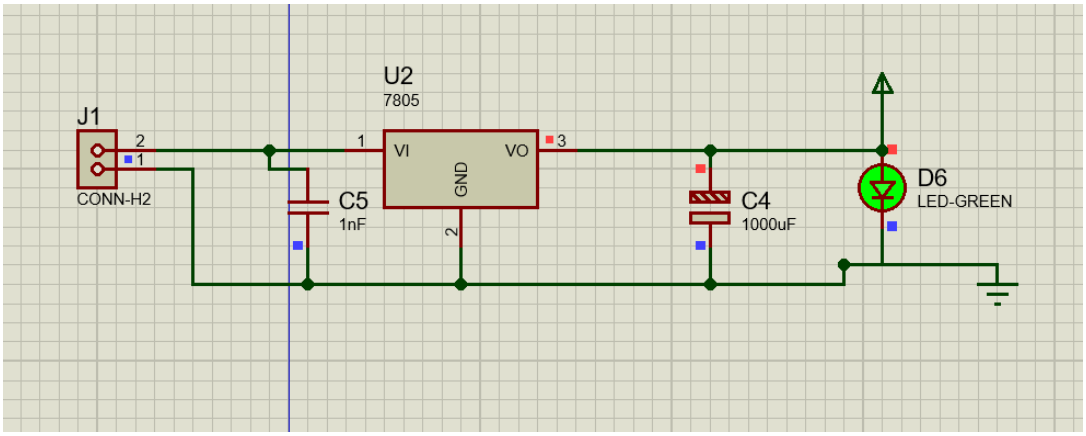
- After converting the Keli Uvision5 code to HEX file, boot it to the microcontroller in Proteus.



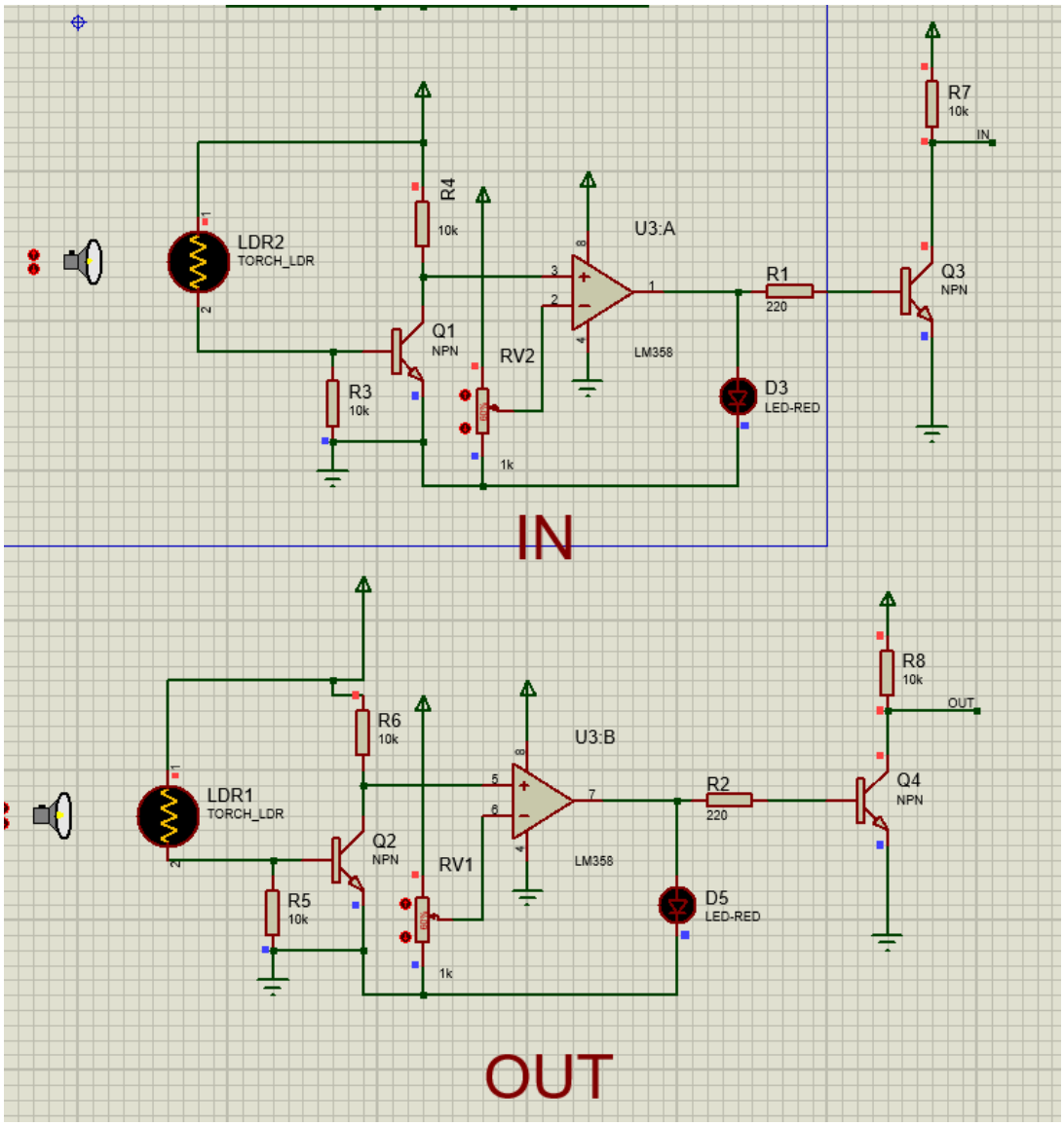
Run the simulation:



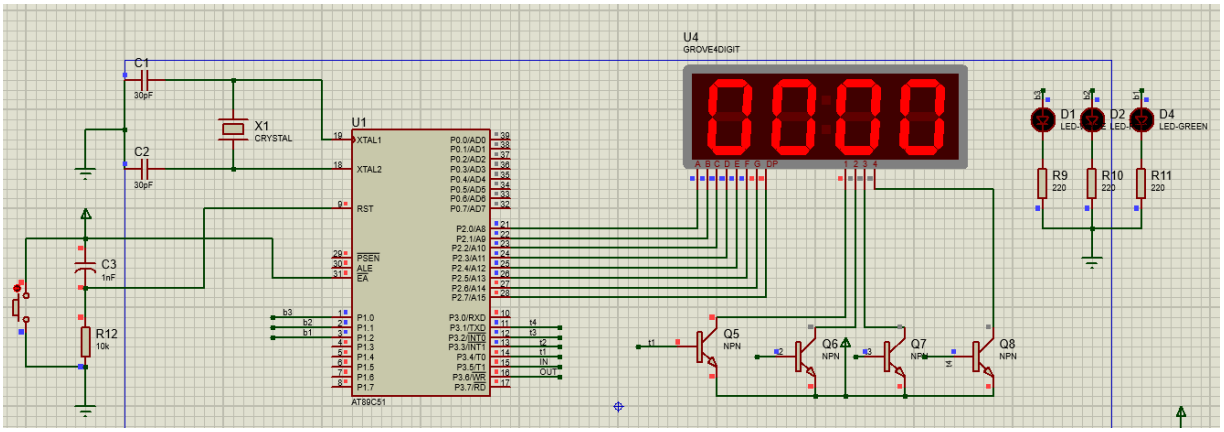
- In the power block: when power is supplied to the circuit, it passes through the LM7805 voltage regulator with filter capacitors, providing power to the system. Green Led is on, which mean power is supplied to the circuit.



- Set the light source in the sensor block in the correct position:

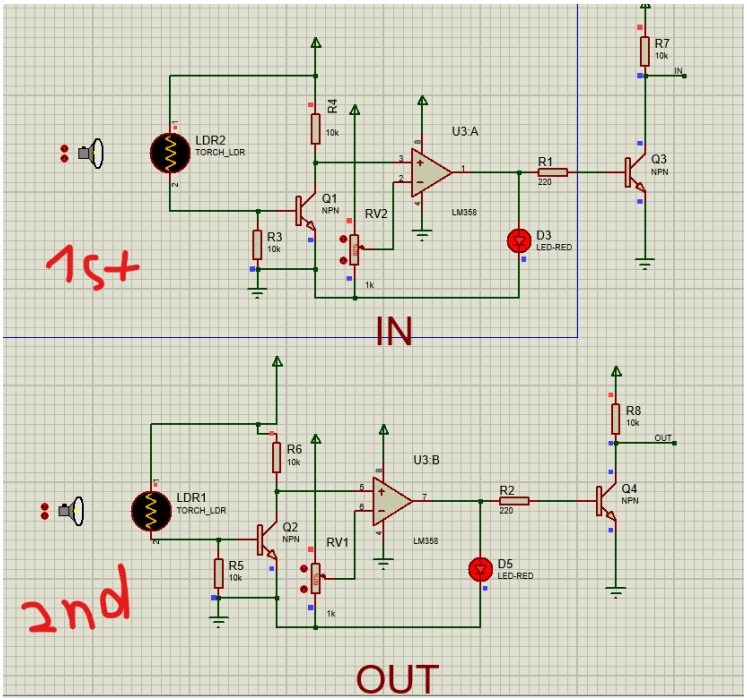


- The system start with '0000'. The three single led on the right (which used to count if the number of people currently pass 1, 5 or 10) is off.

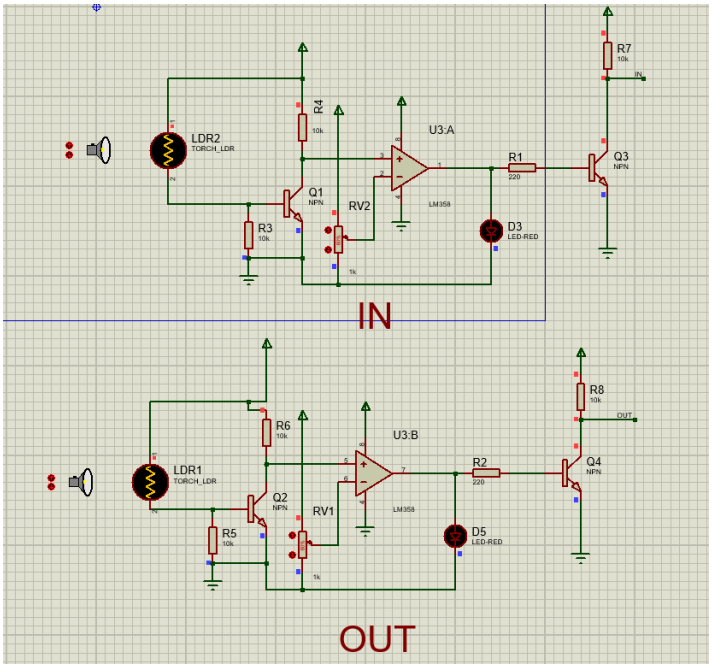


*Simulate a person come in:

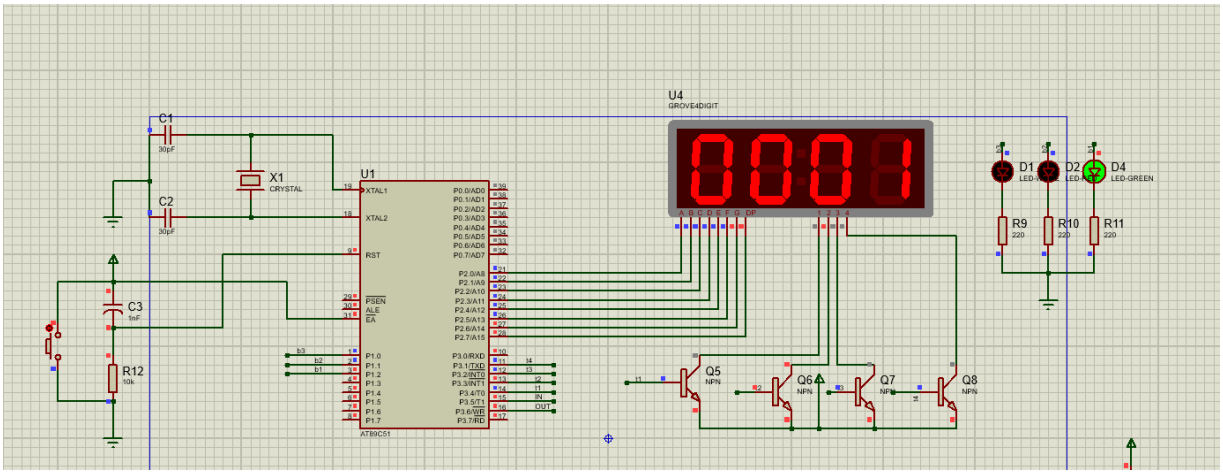
- Move the light source far away from the sensor (to simulate a person pass and block the laser). When a person come in, the light source will first be blocked at IN, then the light source at OUT will be blocked. The D3 and D5 leds are used to indicate the light source is blocked.



- Then, move the light source back to the old position (Which mean the person has passed the door)

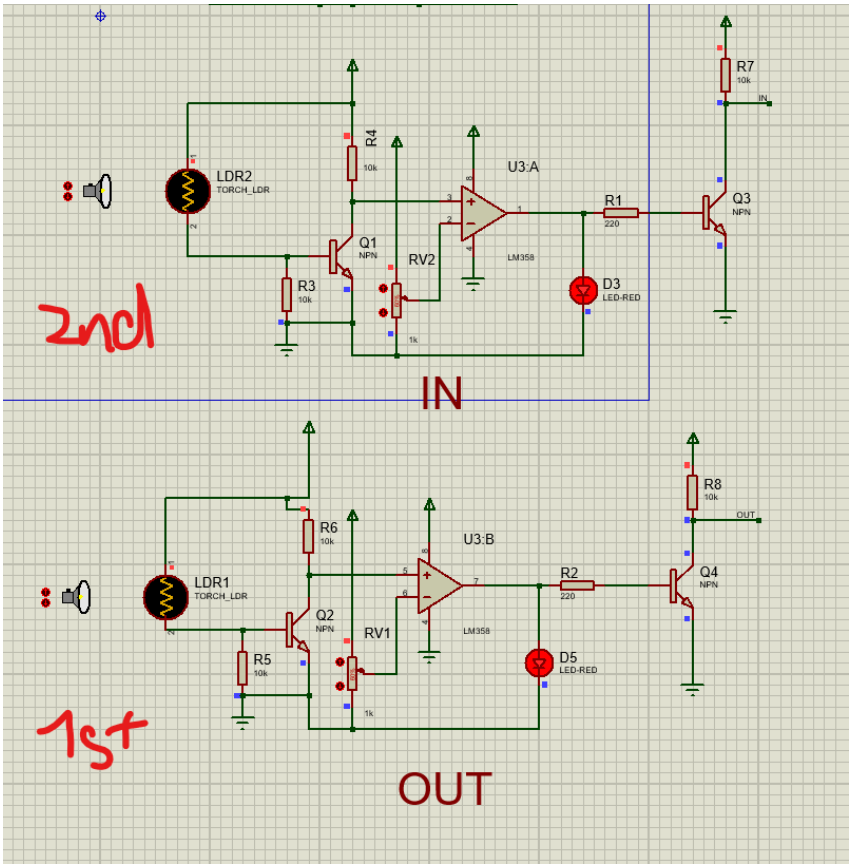


- The system has counted the number of people come in up by one. Also, the single green led will light up (because the number of people in the room is <5)

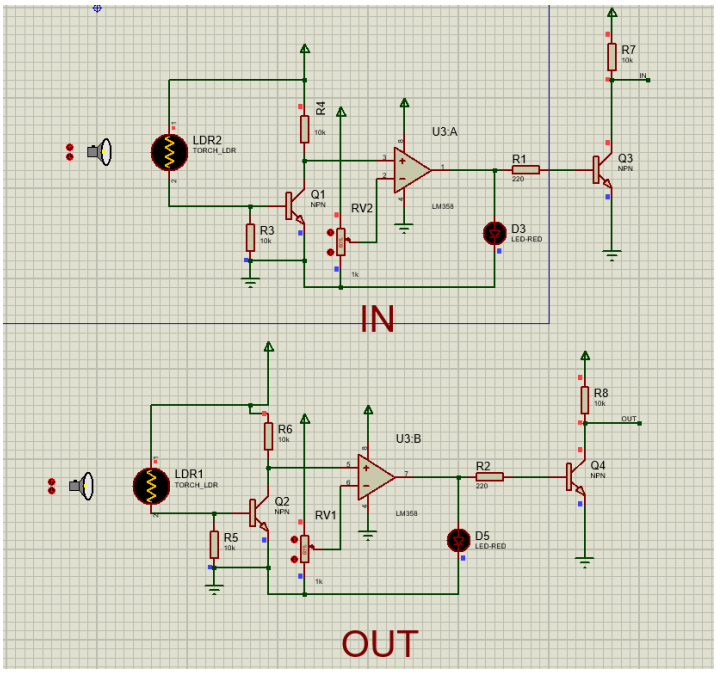


*Simulate a person come out:

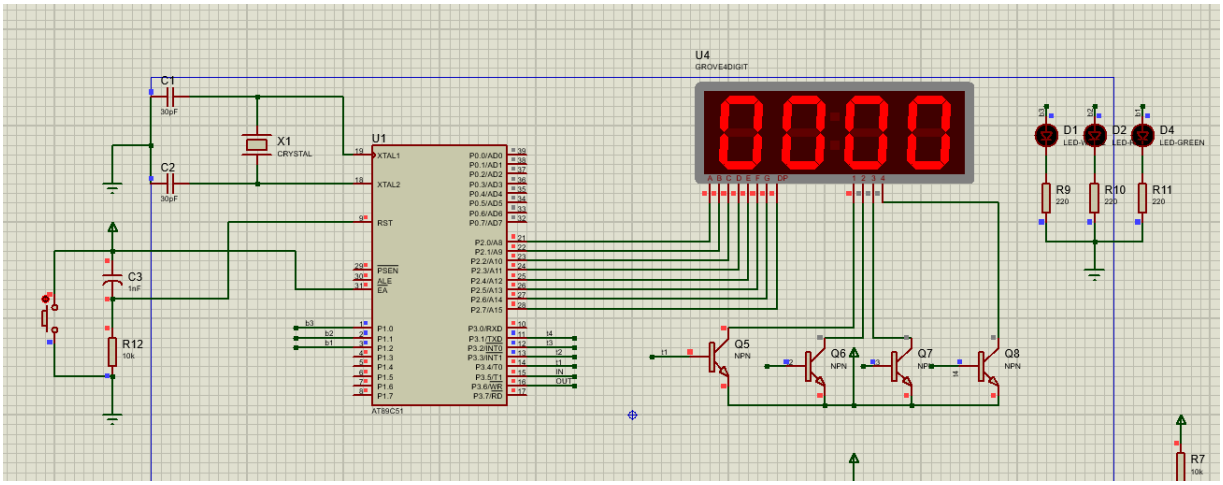
- Do the opposite, move the light source away from the sensor in the correct order (OUT, then IN) to simulate a person get out of the room from inside.



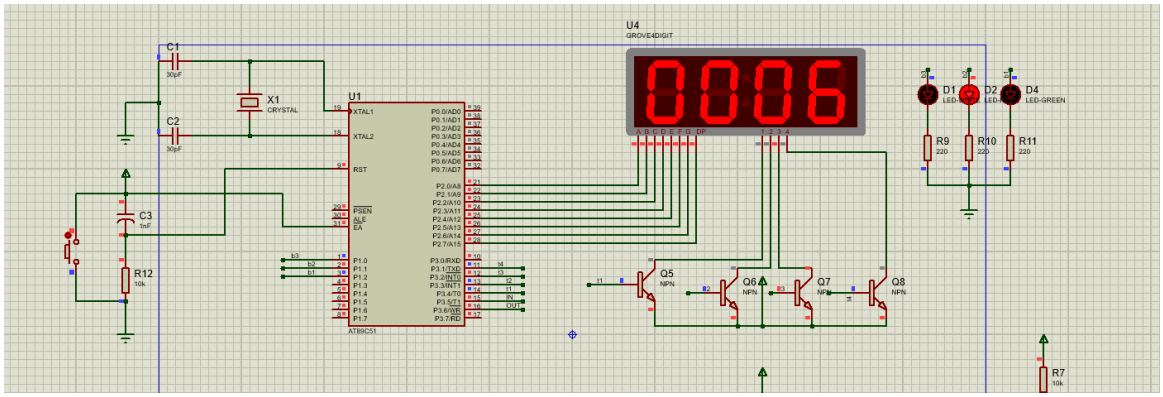
- Then, move the light source back to normal position.



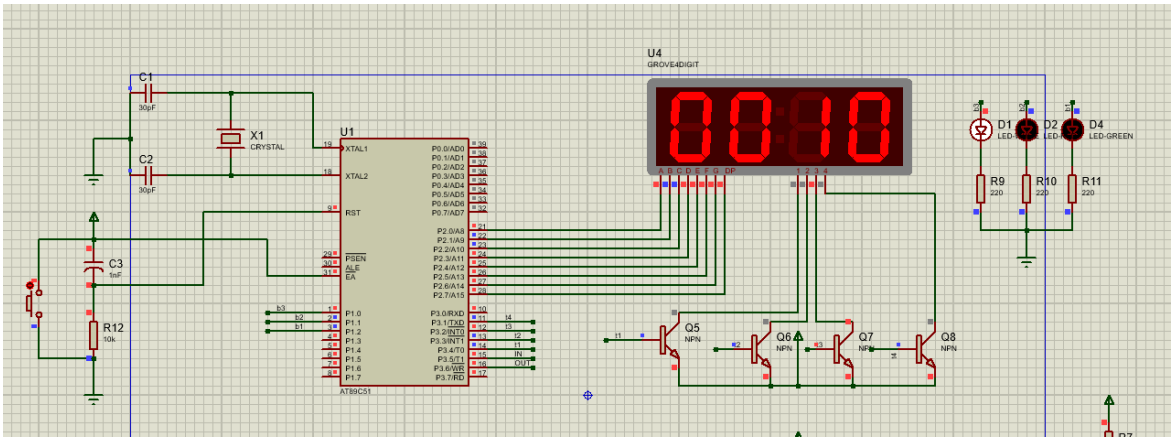
- The system has count the number down by one. Also, the single led on the right has turned off.



- If the number of people come in the room pass 5, the Red led on the right will turn on:



- If the number of people inside the room is 10 or above, the White led on the right will turn on:



Chapter 6: CONCLUSION

The system is capable of counting the number of people get in and out of the room using Microcontroller 8051, laser sensors, leds and some other components. This system does not required a person to control or help it counting up or down, with power on, it can count automatically. Our team had researched from many sources and experiment countless times to create a suitable system for doing those tasks. There are

some disadvantages that the system could be improved in the future, like it can not count the people in and out at the same time. In conclusion, the system has solve the task of counting number of people come in and out of a room, suitable for small classrooms and offices requirement.

Reference

[1] S. Mondala, "Home Engineering A Report on Bidirectional Visitor Counter using IR sensors and Arduino Uno R3," April 2016. [Online]. Available: https://dokumen.tips/engineering/a-report-on-bidirectional-visitor-counter-using-ir-sensors-and-arduino-uno.html?page=1.

[2] S. Sangwan, "EngineersSolution," 23 12 2013. [Online]. Available: https://www.youtube.com/watch?v=aUcuIDUJVA4.

[3] M. Farooq, A. Shakoor, "ARM based Bidirectional Visitor Counter and Automatic Room Light Controller using PIR sensors," ASTESJ, 2016.