Bidirectional Visitor Counter using Microcontroller with Sanitization and Thermal Screening

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Abstract. In the modern world there is continual requirement for automated devices. The COVID-19 pandemic is the expounding global health emergency of our time and the greatest challenge we have faced in many years. Authors have to move on by implementing strong protective measures to reduce the spread of COVID-19. This model is designed and presented in order to count the visitors along with their sanitization and thermal screening. This system can be used in any auditorium, halls, schools, offices, malls etc. Authors have designed a model which can keep a track on number of people entering and exiting from the hall. It sanitizes the visitors entering and exiting from the hall, and check the temperature of each visitor entering in the hall. If the temperature is not according to COVID-19 standards then a buzzer will buzz indicating that visitor cannot enter in hall. Depending upon the sensors interruption the system recognize entry and exit of visitor.

Keywords: Microcontroller, Ultrasonic sensor, Temperature Sensor, Humidity Sensor

1. Introduction

“Bidirectional Visitor counter using Microcontroller with Sanitization and thermal screening” mainly focuses on the security and safety of the visitors. We have already seen bidirectional visitor counter with room light controller that embrace the task of controlling the room lights. Along with that it also counts no. of person’s visiting in the room very precisely [1-4]. The Counter is incremented by one when someone enters the room. And the room lights will automatically be switched ON. When any visitor leaves the room, the counter will be decremented by one value. Then the light will be switched OFF until all the visitors in the room go out. But keeping COVID-19 situation in mind we have done two additional works. Our system not only count the visitors entering and exiting but also, they will be sanitized with the mist sprays mounted on the door frame and also thermal screening of every visitors entering in the hall, room, etc. using IR temperature Sensor,[5] if the temperature is above the normal body temperature then a buzzer will buzz indicating the high temperature. As well as the total number of persons inside the room is displayed on the LCD displays. In addition, we have also used temperature and humidity sensor to track the room condition. It will show actual temperature and humidity of the room on the LCD screen. It will be placed in the room.

2. Hardware Platform

The hardware mostly consists of a Relay module, HC-SR 04 Ultrasonic Sensors, Temperature and Humidity Sensor (DHT11), Arduino Nano, Diaphragm Pump, Infrared Temperature Sensor
(MLX90614), Liquid Crystal Display (LCD). The above parts are being discussed along with their specific functions.

2.1 Relay Module

Relays are most regular used switching device in electronics. There are two important parameters we have to think about the relay. One is the Trigger Voltage; it is a voltage which is needed to turn on the relay i.e. to change the contact from Common-\(\rightarrow\)NC to Common-\(\rightarrow\)NO as shown in fig 1. Here our relay has 5V trigger voltage, but there are also relays with value of 3V, 6V and even 12V. Second parameter is Load Current and Voltage, it is the value of Current or Voltage that the NC, NO or Common terminal of the relay could hold out against, in this case, for DC it is maximum of 10A and 30V.

![Fig.1 5 Pin mini SPDT Relay](image)

2.2 HC-SR 04 Ultrasonic Sensors

An ultrasonic sensor (HC-SR 04) is an electronic device that computes the distance of a object by releasing ultrasonic sound waves. And reflected sound are converted into the electrical signal. Ultrasonic waves travel more rapidly than speed of audible sound. HC-SR 04 have two main components: (i) transmitter (it emits sound by using piezoelectric crystals) and (ii) receiver (it encounters sound which are reflected back from obstacle) shown in below fig 2. To find the distance between the sensor and the obstacles. The sensor measures the time taken between the discharge of the sound by the transmitter to its collision with the receiver. The formula for this calculation is \(D = \frac{1}{2} T \times C\) (where \(C\) is the speed of sound i.e. 343 m/sec, \(T\) is the time and \(D\) is the distance).

![Fig.2 Pinouts of HC-SR 04](image)
2.3 Temperature and Humidity Sensor (DHT11)

DHT11 is a basic ultra-low-cost digital sensor for sensing temperature and humidity. It can be easily interfaced with any micro-controller like Arduino, Raspberry Pi etc… to find humidity and temperature instantaneously. For humidity sensing the capacitor has two electrodes which has a moisture holding substrate and it acts as dielectric in between them. The value for change in the capacitance happens with the change in humidity levels. The IC finds, process the changed resistance values and change it into digital form. This sensor uses Negative Temperature coefficient thermistor for measuring temperature. Which causes a reduction in its resistance value with increase in the temperature. The temperature range of ultrasonic sensor (DHT11) is between 0 to 50 degree Celsius with a accuracy of 2-degree. And the sensors Humidity range is between 20 to 80% along with 5% accuracy. DHT11 is small in size with operating voltage between 3 to 5 volts. The sampling rate of this sensor is 1Hz i.e. it will give one reading for every sec. Its maximum current is 2.5ma while measuring. In fig 3 DHT11 Pins are shown.

![DHT11 Digital Relative Temperature and Humidity Sensor](image1)

2.4 Arduino Nano

Arduino Nano is a type of microcontroller board which is shown below in fig 4. It has been designed by Arduino.cc. It can be construct with a microcontroller such as Atmega328. Its Operating voltage is 5V. ATmega328P Microcontroller belongs to 8-bit AVR family. Recommended Input voltage (Vin) is between 7V to 12V. Its I/P and O/P Pins are 22. Digital pins are 14 (out of 6 provide PWM output) and Analog I/P pins are 6 from A0 to A5. Power consumption is 19 mA. DC Current on I/O Pins is 40 mA. Flash memory is 32 KB (2KB is used for bootloader). SRAM is 2 KB & EEPROM is 1 KB. Frequency (Clock speed) is 16MHz.

![Components and Pinouts of Arduino nano](image2)
2.5 Diaphragm Pump
A diaphragm pump (membrane pump) converts motors mechanical energy into dynamic pressure of the pumped fluid. Basically, it is composed of two main parts:

1) Pumping unit: This unit transforms the mechanical energy into fluid pressure.

2) Transmission: It transmits the mechanical energy from the motor into the pump.

2.5.1 Pumping Unit
The pumping unit of a diaphragm pump comprise of: suction valve, diaphragm, delivery valve and pumping chamber as shown in fig 5.

![Fig.5 Components of Pumping Unit](image)

2.5.2 Transmission
The rotational drive shaft (A) receives the energy from the engine that can be combustion, electric or hydraulic. The rotational movement shown by curved arrows in fig 6 is converted into oscillatory motion shown by straight arrows. It has been produced by a (B) connecting rod-crank system. Which connects the shaft to the (C) piston which runs in the core of a cylinder or (D) sleeve as shown in fig 6. The transmission system is extremely alike to the two-stroke combustion engine. With the dissimilarity that in the combustion engine the power is transferred from the piston to the shaft. But in case of the pump, power is transferred from the shaft to the piston and then to the diaphragm.

![Fig.6 Rotation of Shaft](image)
2.5.3 Diaphragm
The diaphragm is a hard rubber disc. It is screwed and fixed on the top of the piston with the help of a bolt and a fixing disc. It helps in keeping it aligned throughout its strokes. The diaphragm is the main part of the pump because it has two crucial purpose that are given below:

1) It divides the pumping chamber from the transmission system. And prevent the liquid from coming into exposure to the mechanical parts and oil which would lead to significant damage risks to the pump.

2) It on the other hand expands and collapses the volume of the pumping chamber. This way it enables the pumping actions.

2.6 Infrared Temperature Sensor (MLX90614)
MLX90614 is used as a contactless digital (IR) Temperature sensor shown in fig 6. This sensor computes the temperature range of -70 to 382.2 degrees Celsius. The higher the temperature, the higher IR energy is emitted. MLX90614 uses Infrared Rays to estimate the temperature of the human being without any body contact. It communicates and interface with a microcontroller using the I2C protocol.

Specifications of Infrared Temperature Sensor (MLX90614)
1) Its Operating Voltage is 3.6V to 5V (available in 3V and 5V version)
2) Its Supply Current is 1.5ma
3) Its Ambient Temperature Range is 40° C to 125°C
4) Temperature Range is from 70° C to 382.2°C
5) Accuracy is 0.02°C
6) Field of View (FOV) is 80°
7) Distance between object and sensor: 20cm approx.

Fig.7 Infrared Temperature Sensor MLX90614

2.7 Liquid Crystal Display (LCD)
Liquid Crystal Display (LCD) screen is a flat-panel electronic display module. Which uses light modulating property of liquid crystal having a wide range of applications. The basic module which is very frequently used in various appliances and circuits is a 16x2 LCD display [1]. These LCD modules are favoured over the seven segments and further multi segment LEDs. The main reasons being: easily programmable; LCDs are economical; have no restriction of displaying special and even the custom characters (unlike in seven segments), animations and many more. A 16x2 LCD is shown in fig 8 along with its pinouts. Its operating voltage is 4.7 volts to 5.3 volts and current consumption is 1ma. Each character is build by a 5x8 pixel matrix box. It can display 16 characters per row and there are 2 such rows. It can work on both 4-bit and 8-bit mode. And it is also an alphanumeric LCD display that can display both alphabets and numbers. This LCD has two registers, called as Command and Data. The command register is used to stores the command instructions given to the LCD. It is an instruction given
to LCD to do a predefined task such as clearing its screen, initializing it, controlling the display, setting the cursor position etc. On the other hand, data register stores the data that has to be displayed on the LCD. The data is the ASCII value of the character that has to be displayed on the LCD screen. A 16x2 LCD is available in blue and green Backlight.

Fig.8 16x2 LCD display Module Pinouts

3. Methodology
In this paper we have split the model into 3 main sections. It will perform their individual tasks. When a visitor enters in the hall, the temperature check will be performed. If temperature is under standards, sanitization section will perform its task and then counter will increase. The system is rooted on the basics of interruption of the sensors. Each section is discussed separately.

3.1 Sanitization Section
In this section we have used following components given below: -
1) Ultrasonic sensors
2) Arduino nano
3) Diaphragm pump
4) One Relay module
5) Mist nozzles

The sanitization section is based on the interruption of the ultrasonic sensors. When any visitor comes under the range of ultrasonic sensor i.e. 100 meters, the ultrasonic sensor gets activated and give high signal to the Arduino nano pin. In Arduino we have given delay of 2 seconds. After this the Arduino nano will send command to the relay module. A relay is electrically operated switch which is used in industrial application to provide segregation between high voltage and low voltage circuits [3,4]. The high voltage and low voltage circuits have different voltage rating. One might be a high voltage side and other low voltage side. A relay is electromechanical switch which is used for switching between 5 Volt circuits and 220/120 Volt AC circuits. Now the relay module give signal to the diaphragm pump to start the pumping. It will pump the sanitizer filled in the tank. Whole frame is made from the interconnected pipes in which we have attached mist nozzles. By the help of mist nozzles, the sanitizer will be sprayed on the visitors entering in the hall. In our project we have specifically used mist nozzles because it produces tiny water droplets in the form of fog, which will not harm visitors in any way.

3.2 Bidirectional Visitor Counter Section
The components used in this section are: -
1) Ultrasonic sensor
2) Arduino nano
3) Buzzer
4) Led – Red and Green
Arduino nano is the master controller. In this section when there is interruption on ultrasonic sensor it transmits a high signal to Arduino nano in real-time. Ultrasonic sensor is powered with a 5V DC supply. And fixed on the one-side of the door frame. When signal is high it means that a visitor has entered in the halls and the counter increase by one value. Same when the visitor exits from the room the counter decrease by one value. And the total number of visitors will be shown on the LCD screen.

3.3 Thermal Screening Section
In this section we have used Infrared Temperature sensor (MLX90614). It uses infrared rays to measure the temperature of the body. The IR sensor will be placed on the door frame. When any visitor wants to enter the halls, he/she must stand in front of the door frame for temperature check. If the temperature is according to the COVID-19 Standards. Green led will glow and visitor can enter the hall. If not so he/she will be warned for entering the room.

3.4 Room Temperature and Humidity
To measure the room temperature and humidity we have used DHT11 sensor. It is a digital sensor with low-cost, for measuring humidity and temperature. It is interfaced with Arduino nano. Its operating voltage and current is 3-5 volts and 2.5ma respectively. The temperature and humidity will be shown on the LCD display placed in the room.

4. Result
As we have proposed to make a prototype of system in which it includes thermal screening, bidirectional counting and sanitization. Below table shows the results of the survey we had conducted for 10 visitors at EEE Dept., GLBITM Gr. Noida India. In which we found that there are three visitors which have the temperature >98.6°F. And out of seven, four visitors have not come out so the total visitors in room are four. Sanitization takes place for allowed seven visitors.

| S.no. | VISITORS | THERMAL SCREENING | BIDIRECTIONAL COUNTER | SANITIZATION |
|-------|-----------|--------------------|------------------------|--------------|
|       |           | TEMP=98.6°F | TEMP>98.6°F | IN | OUT |
| 1     | VISITOR 1 | ✔ | ✗ | ✔ | ✗ |
| 2     | VISITOR 2 | ✗ | ✗ | ✗ | ✗ |
| 3     | VISITOR 3 | ✔ | ✔ | ✔ | ✔ |
| 4     | VISITOR 4 | ✗ | ✗ | ✗ | ✗ |
| 5     | VISITOR 5 | ✔ | ✔ | ✔ | ✔ |
| 6     | VISITOR 6 | ✔ | ✔ | ✔ | ✔ |
| 7     | VISITOR 7 | ✔ | ✔ | ✔ | ✔ |
| 8     | VISITOR 8 | ✗ | ✗ | ✗ | ✗ |
| 9     | VISITOR 9 | ✔ | ✔ | ✔ | ✔ |
| 10    | VISITOR 10| ✗ | ✗ | ✗ | ✗ |

Table.1 Result of survey
5. Conclusion

The proposed model offers a low-cost solution for safety in COVID-19 situation. After several rounds of intense trial and error the model is finally completed. We are already aware about the three-system proposed in our project but they are 3 different projects i.e. a. bidirectional visitor counter using Microcontroller, sanitization tunnel, thermal screening gun, but we have connected those three technologies into one single final product. When the visitor enters the room/hall they will pass through three screening process in which their temperature will be checked and if it is < 98.6°F then only it will allow them to pass through the entry gate and if it is >98.6°F then it will not allowed to pass through the entry gate, the number of visitors entering or exiting through the gate and then there will be sanitization process takes place simultaneously.

6. References

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