Bidirectional Visitor Counter

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Problem statement:

We require a system that will count the number of people present within a room by tracking the number of people entering or leaving the room. The counter that does this function will increment the number by 1 when a person enters and will decrease the number by 1 when a person exits the room.
For example, if 10 people have entered and 7 have left the room, the counter must hold the value 3.

Ideation and Planning:

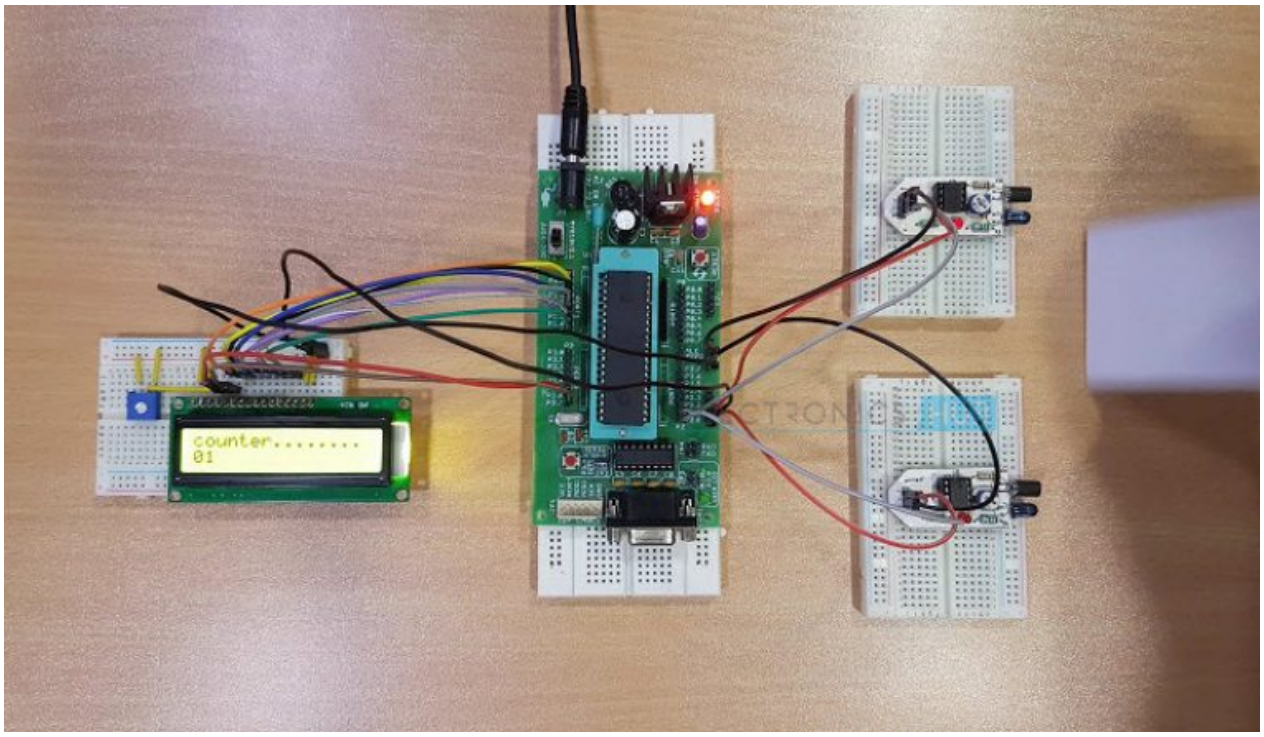
Choosing the right sensor:

The following methods for detecting a person entering or exiting the room are possible,

InfraRed sensing mechanism	Using a reflective type IR sensor. For the duration that the IR sensor is blocked by a person, the output of the sensor remains HIGH.	Cheap, easy to use and come with an attached potentiometer that helps adjust sensitivity (distance adjust).
Ultrasound Sensor mechanism	This is very similar to the IR mechanism. The receiver gets ultrasound signals only when the person is reflecting back sound waves.	Costly, very accurate in distance measurement

InfraRed sensing is better suited for the project because

- ➔ It cuts cost
- ➔ The project requires distance adjustment and also doesn't need accurate measurement of distances. The Ultrasound sensor returns junk values (unexpected values) when there are too many obstacles (like different people, doors, walls nearby).
- ➔ The ultrasound also requires an input pulse. Since we are unaware of when a person enters or exits, it is difficult to implement an ultrasound sensor. We have to come up with some continuous clock pulse of inputs and we must also set a threshold for output detection. This process is heavily based on trial and error.



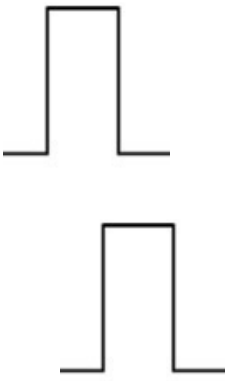
An image of the project working

The IR sensor mechanism:

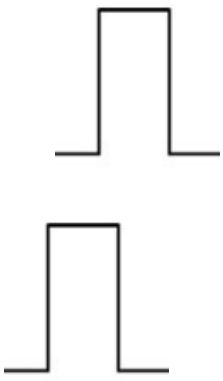
Two IR sensors are used to implement the project. The IR sensors are attached to one side of the entrance.

As discussed earlier, the IR sensor outputs a HIGH signal when it is blocked by a person. Since the sensors are arranged one after the other, say S1 is near the outside of the room and S2 is near the inside, the output will not become HIGH simultaneously.

When a person enters, S1 will become HIGH before S2 and S1 will also be the first to drop to LOW. The exact opposite happens when a person leaves the room.



S1 and S2 signals when a person enters a room



S1 and S2 signals when a person leaves the room

The counter is controlled using this difference in S1 and S2 signals.
So, we can calibrate the counter to work based on either the positive or negative edge of the signals. If we compare the positive edges,

1. S1 HIGH before S2 means an increment by 1
2. S2 HIGH before S1 means a decrement by 1

If we take the negative edge into consideration instead,

1. S1 LOW before S2 means an increment by 1
2. S2 LOW before S1 means a decrement by 1

The Display:

The count is actively displayed using a 16x2 LCD screen. This serves as the final output of the system.

Improvements to the Project:

A possible limitation of the above mentioned arrangement of IR sensors is:
The counter gets confused when people enter and exit almost simultaneously. The signal patterns may represent one of the above images, however the number of people who actually went through the door might be different.
Consider a simple case where one person enters and one person exits at the same time. Even in this trivial case, which pulse is going to lead the other is completely left to chance. Ideally the counter must report no change after this event. But sometimes it is incremented and sometimes it gets decremented.
Overcoming this issue might not only require a change in the planning, but also might need some change in the way entering and exiting is allowed.

An alternate solution:

- ➢ The first step would be to partition the door into 2 parts, one for entry and one for exit. People must enter only from one side of the door and people must exit only from the other side. A solid partition might not be necessary.
- ➢ Now the project only requires one IR sensor for each partition of the door. Instead of comparing two signals to determine an entry or exit, the counter just needs to wait for a HIGH pulse from the sensor to change its value.
- ➢ A HIGH pulse from the entry sensor will increment the counter by 1. A HIGH pulse from the exit sensor will decrement the counter by 1.
- ➢ The IR sensor position in this setup will also change. The IR sensors need to be placed on top of the door in each partition. This ensures that the sensors once again don’t get affected by simultaneous movement of people.

The Prototyping Phase:

The prototype needs:

- 8051 microcontroller
- 2 IR sensors
- LCD 16x2 display
- Resistors and capacitors of different values