ES-116
Final Project
Ultrasonic People Counter

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***Abstract*—The aim of this project is to design and develop a bi-directional people counting ultrasonic sensor using a 16x2 LCD display. The sensor utilizes ultrasonic waves to detect the presence of people, and the LCD display shows the number of people passing in and out of a specified area. The theory behind the project is based on the principle of ultrasonic sensing, and the instruments required include an Arduino board, ultrasonic sensors, and a 16x2 LCD display. The procedure involves programming the Arduino board to interface with the ultrasonic sensors and the LCD display.**

I. Aim

TO develop a bi-directional ultrasonic sensor for counting number of people entering and exiting an area.

II. Theory

A. The Ultrasonic Sensors

Ultrasonic sensing is based on the principle of sound waves that travel through the air at a frequency above the range of human hearing. The sensor emits ultrasonic waves that bounce off objects and return to the sensor. The time it takes for the sound waves to return to the sensor is used to calculate the distance of the object from the sensor. The ultrasonic sends has four pins: Vcc, Trig Pin, Echo Pin, and Gnd. The Trig Pin produces a 10 microsecond pulse of ultrasonic waves that hit and reflect back from a surface. The reflected waves are then picked up by the Echo Pin of the sensor. This pin records the duration of pulse for going and coming back in milliseconds. The distance (in cm.) is then calculated as:

$$d = \frac{(t * 0.034)}{2} \tag{1}$$

The 343 m/s accounts for the speed of sound in air.

B. 16 x 2 LCD Displays

A 16 x 2 LCD screen is a common type of display used in many projects involving microcontrollers such as the Arduino. It consists of 16 columns and 2 rows of characters, allowing for the display of up to 32 characters at a time. The LCD screen communicates with the microcontroller through a set of parallel data lines and control signals.

The LCD screen operates by displaying characters in the form of a matrix of pixels. Each character is made up of a set of pixels arranged in a specific pattern. The display controller on the LCD screen is responsible for interpreting the data sent from the microcontroller and generating the appropriate pixel patterns for each character to be displayed.

To display characters on the LCD screen, the microcontroller sends commands and data to the display controller. These commands and data are sent through the parallel data lines and control signals. The commands include instructions to set the display mode, clear the display, and set the cursor position. The data sent to the LCD screen includes the characters to be displayed.

III. Instruments Required

Following is the list of instruments used in the project:

- 3 Arduino Uno Boards
- 2 Ultrasonic Sensors
- A 16 x 2 LCD Display
- 3 Breadboards
- Jumper Wires
- Power Supply

Fig. 1: Ultrasonic Sensor

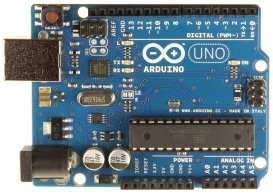

Fig. 2: Arduino Uno Board

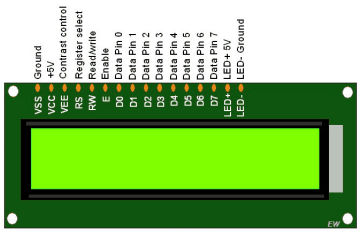

Fig. 3: 16 x 2 LCD Screen

IV. Procedure

Following are the steps that were undertaken to achieve this project:

1) Two ultrasonic sensors are mounted on two separate breadboards with Vcc and Gnd connected to two separate Arduino. For sensor 1, its TrigPin and EchoPin were connected to the pins 6 and 7 respt. of master Arduino. And for the sensor 2, these were pins 8 and 9.
2) The TrigPin and EchoPin of both the sensors were attached to the same master Arduino Board on which the code was uploaded.
3) The LCD was well setup by connecting its 5 digital pins viz. 12, 11, 5, 4, 3, 2 by referring to the Arduino documentation. It had its separate breadboard.
4) All the three Arduinos were powered up from supply of a laptop.
5) The code was setup with the self-created counter algorithm using the **current** and **previous** variables and the bi-direction algorithm using the **flag1** and **flag2** variables.

```
bool condition1 = ((current1 >= previous1) && (
    previous1 > 0) && (abs(current1 - previous1) > 5
    0));
  if (condition1){
    flag1++;
    if (flag1 > flag2)  {
      count++;
      lcd.clear();
      lcd.print("ENTERED!");
      lcd.setCursor(0, 1);
      lcd.print(count);
    }}
  previous1 = current1;
```

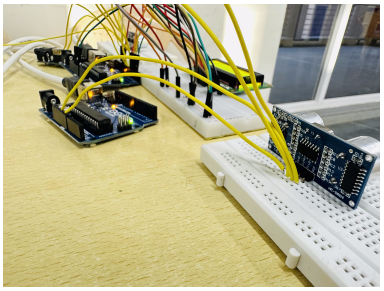

Fig. 4: Ultrasonic Sensor with its Vcc, Trig, Echo and Gnd Pins connected to Arduino 1

V. Results

1) When items were passed from Sensor1 to Sensor2, the LCD displayed an increase in Counter value with the message "ENTERED!".
2) On reversing the direction of the movement of items, "EXITED!" message was displayed with the Counter value decreasing by 1.

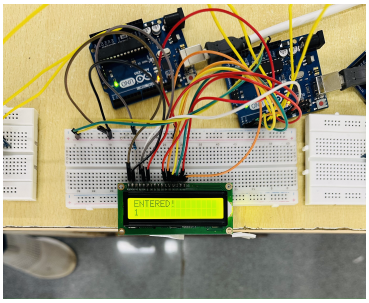

Fig. 5: Target "ENTERED!" message

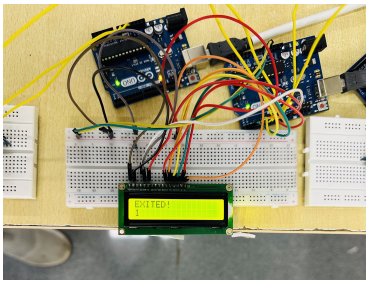

Fig. 6: Target "EXITED!" message

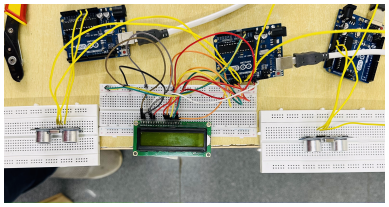

Fig. 7: The Complete Setup

VI. Discussion

Ideally on TinkerCAD, a single Arduino is sufficient to provide the Vcc to both the sensors in parallel, but we observed that there is some drop across one sensor itself, hence we had to put in extra Arduinos. We could have gone for separate 5V Power Supplies from DC batteries. Another interesting observation was made in regards to people counting: any such sensor is highly sensitive to movements. We observed that even the sway of arms gave an error, hence the level of placing the sensors must be such that there is no additional body movement. Moreover, the gap between the sensors must be wide enough to hold an average person's body width. There is still scope for a more robust and ergonomic design for tracking people, but this project may very well be used to track number of items in an assembly line production or train/vehicles during journey.