ES116 Final Project

Piezoelectric Crowd Management System

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***Abstract*—The main goal of this project is to design and develop a device that is used for crowd management by counting the number of people entering crowded places using Piezoelectric sensors and a LCD(16x2). The sensors utilizes the human generated pressure to detect the prescence of people passing and the count of people is displaced on the LCD. The theory behind this project is based on piezoelectric effect. The materials required also include an Aurdino UNO R3. The procedure involves programming the Arduino board to interface with the piezoelectric sensors and the LCD display.**

Keywords—Piezoelectric sensors, LCD display, Arduino UNO R3, Piezoelectric effect, Human presence detection, Arduino programming.

I. Introduction/Aim

To devolop a device for crowd management by counting the number of people entering the crowded areas based on the voltage genrated using pieozoelectric sensors.

II. Theory

A. *Piezoelectric Sensor:*

Piezoelectric sensors are electronic components that are able to convert a mechanical into an electrical signal. Piezoelectric sensors work on the principle of the piezoelectric effect. In a piezo electric sensor:

1. A piezoelectric crystal is placed between two metal plates which do not conduct an electric current.
2. Human pressure on metal plates apply stress to the crystal. Electric charges forced within the crystal are out of balance. Excess negative and positive charges appear on opposite sides of the crystal face.
3. The metal plate collects these charges and produces a voltage.

This voltage is measured using Arduino UNO R3 and the code. If the this output voltage exceeds 2V a count of people is added and LCD displays the count.

B. *Liquid Crystal Display(16x2):*

The LCD screen is a commonly utilized display component in microcontroller projects such as those involving Arduino. It features 16 columns and 2 rows, providing the capacity to showcase up to 32 characters simultaneously. Communication between the LCD screen and the microcontroller occurs through parallel data lines and control signals.
Functioning on the principle of displaying characters through a matrix of pixels, each character is composed of pixels arranged in specific patterns.
In order to showcase characters on the LCD screen, the microcontroller transmits commands and data to the display controller via parallel data lines and control signals. These commands encompass instructions for setting the display mode, clearing the screen, and positioning the cursor, while the data transmitted to the LCD screen consists of the characters intended for display.

III. Materials Used

The model requires the following materials:

1. Liquid Crystal Dislay(16x2)
2. 14 Piezoelectric sensors
3. Arduino UNO R3
4. Bread Board
5. Resistance(
6. LED lights(1 Red, 1 Green)
7. Buzzer
8. Power Supply

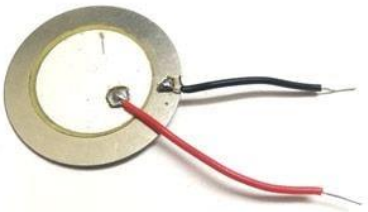

Figure 1: Piezoelectric Sensor

Figure 2: Arduino UNO R3

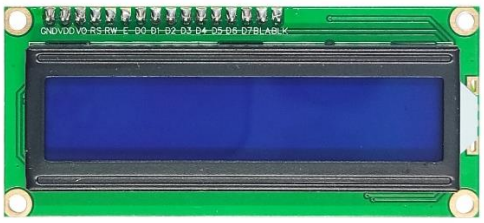

Figure 3: LCD (16x2)

IV. PROCEDURE

The following are the steps which we followed:

1. Fourteen piezoelectric sensors are connected in parallel on a board(it acts a base) whose positive(+ve) end is connected to A1 Analog pin of Arduino UNO R3 and the negative(-ve) end is connected to the ground pin of Arduino UNO R3.
2. Now the LCD was also well setup by connecting its 5 digital pins viz. 12, 11, 5, 4, 3, 2 by referring to the Arduino UNO R3 documentation and is connected breadboard accordingly.
3. And also in the bread board the positive ends of Red LED, Green LED and the Buzzer are connected to 8,13 and 9 digital pins of Arduino UNO R3 and their negative ends are grounded.
4. Using the Arduino IDE the Figure 4 code is run in Arduino UNO R3 and at it is then connected to the power supply.

```
#include <LiquidCrystal.h>
// Define the pins for the LCD
const int rs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
// Define the pin for the piezoelectric sensor array
const int sensorPin = A0;
// Define the pin for the LED
const int ledPin = 13;
const int redLedPin = 8; // Pin for the red LED
// Variables
int sensorValue; // Value read from the sensor
float voltageThreshold = 2.0; // Voltage threshold in volts (1000mV)
int peopleCount = 0; // Counter for people entering the room
bool countEnabled = true; // Flag to indicate if counting is enabled
void setup() {
  // Initialize the LCD
  lcd.begin(16, 2);
  // Print initial count on LCD
  lcd.print("People count:");
  lcd.setCursor(0, 1);
  lcd.print(peopleCount);
  // Initialize LED pins
  pinMode(ledPin, OUTPUT);
  pinMode(redLedPin, OUTPUT);

  // Initialize serial communication
  Serial.begin(9600);
}

void loop() {
  // Read the sensor value
  sensorValue = analogRead(sensorPin);
  // Convert sensor value to voltage (0-5V range)
  float voltage = sensorValue * (5.0 / 1023.0);
  // Check if counting is enabled
  if (countEnabled) {
    // Check if the voltage is above the threshold
    if (voltage > voltageThreshold) {
      // Increment people count
      peopleCount++;
      // Update LCD
      lcd.clear();
      lcd.print("People count:");
      lcd.setCursor(0, 1);
      lcd.print(peopleCount);
      // Print count to serial monitor
      Serial.print("People count: ");
      Serial.println(peopleCount);
      // Blink LED
      digitalWrite(ledPin, HIGH); // Turn on LED
      delay(500);
      digitalWrite(ledPin, LOW); // Turn off LED
      // Wait until the pressure is released before counting again
      while (voltage > voltageThreshold) {
        sensorValue = analogRead(sensorPin);
        voltage = sensorValue * (5.0 / 1023.0);
      }
      // Check if people count exceeds 100
      if (peopleCount >= 10) {
        // Display "People exceed" on LCD
        lcd.clear();
        lcd.print("People exceed");
        // Blink red LED
        for (int i = 0; i < 5; i++) {
          digitalWrite(redLedPin, HIGH);
          delay(500);
          digitalWrite(redLedPin, LOW);
          delay(500);
        }
        // Disable counting
        countEnabled = false;
      }
    }
  }
}
```

Figure 4: The Arduino IDE Code

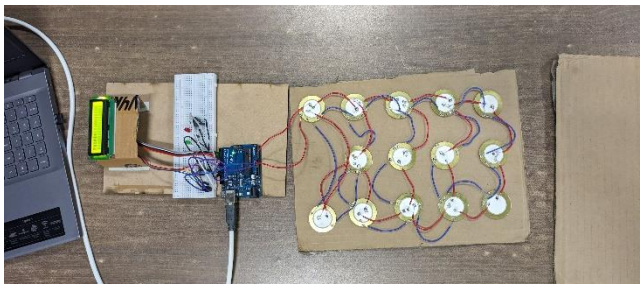

Figure 5: Piezoelectric Crowd Manager(Enitre setup)

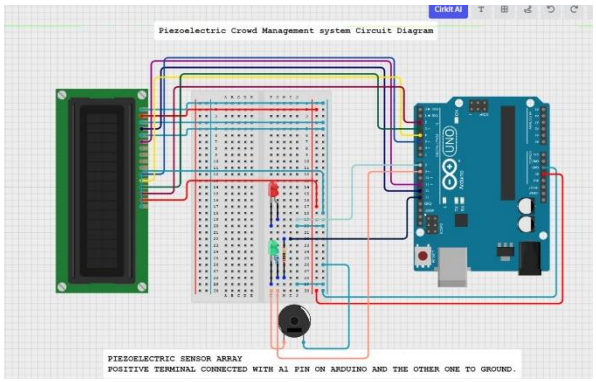

Figure 6: The circuit diagram

V. RESULTS

As when the pressure is exerted on the Piezoelectric sensors and when the output voltage exceeds 2V then the Green LED blinks and a beep sound will be produced and the count of people is displayed on the LCD as “PEOPLE COUNT:”.

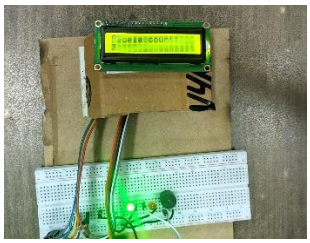

Figure 7: People Count: 3

And if the people count is greater than the upper limit then the Red LED blinks and a more sharp buzzer sound will be produced. The LCD will be displaying “PEOPLE EXCEED”.

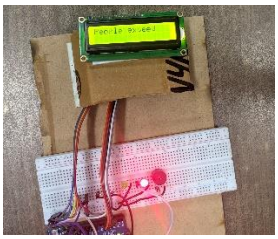

Figure 8 : People Exceed

VI. DISCUSSIONS

When the prototype was being made we initially planned to keep the LCD only but as we progressed, we thougt to add Red and Green LEDs to grab attention and later we also included a Buzzer which makes different noice for each

LED. This drastically improved our device authenticity and Alerting is made better.

Furthermore,this device of ours is simply a prototype and the setup of Aurdino, Bread Board and LCD must be closed and kept properly at a decent distance from the piezoelectric sensors and the sensors must also be protected properly such that they are not damaged due to excess pressure.

Finally,the probable places our device could be used are in public transportation like buses, trains etc., so that only the number of people the vehicle could hold are present.