Instrumentation Laboratory:
Smart Dustbin

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Abstract — There are a lot of dustbins in a shopping mall and it is a hassle for the cleaners to check all of them one by one whether it is full. Therefore, a smart dustbin with rubbish fullness detection is introduced. Ultrasonic sensor is chosen to be the sensor to detect the distance of the rubbish from the cap of the dustbin to determine the level of the rubbish in the dustbin. Arduino is used for designing and programming the circuit. For Graphical User Interface, LED indicator and LCD is used to display the fullness of the rubbish in the dustbin to the cleaner. The characteristic of the sensor is determined by using different materials to test the detection of the ultrasonic sensor.

I. INTRODUCTION

Distance measurement today is still widely used in human life to achieve many functions. The basis of distance measurement is measuring the length of a unidimensional line between two points that join them together in three-dimensional space. A long time ago, distance measurement could only be measured using a physical ruler or something as reference. To meet the need of distance measurement in electronics, many sensors that use various methods to measure distance have been introduced.

Ultrasonic sensors are commonly used in electronic circuits for their high reliability. Ultrasonic sensors detect the distance using ultrasonic sound waves. The working principle of an ultrasonic sensor is it has a transducer to send and receive ultrasonic pulses, the time taken for the pulse sent out to reflect back is measured to determine the distance of the object.

Graphical user interface (GUI) is a form of user interface that shows the user the graphical icon about a device information for interactions. GUI is designed so that the user can have a graphical format for all the functions the system has which act as a shortcut that is accessible by clicking it instead of input code. GUI has been widely used as it is user friendly because it is easy to operate a system by anyone even though they do not learn how to operate it.

A. Background and Problem Statement

There are a lot of dustbins in a shopping mall and it is a hassle for the cleaners to check all of them one by one whether it is full. Normally, the cleaners check the dustbins by following the schedule. This is inefficient and causes waste of time. It is also energy consuming and a waste of workloads.

B. Solving Approach

Therefore, a smart dustbin with rubbish fullness

detection using distance sensors is introduced. The ultrasonic sensor is chosen to detect the distance of the rubbish from the top of the dustbin as it is more reliable in sensing proximity. A circuit with Arduino is designed to detect and display the fullness of the dustbin to the cleaner. LED indicator and LCD is used to display the fullness of the rubbish in the dustbin as the GUI of the smart dustbin.

C. Objectives

- To design and program a circuit for detection of the fullness of the rubbish in the dustbin.
- To provide a graphical user interface GUI to display data for monitoring purposes.
- To provide the sensor characteristics and responses.

II. PROCEDURES

Tissue paper, paper and bottle were chosen as the rubbish for testing. TinkerCAD was used to connect all the components in the circuit as shown in Fig. 1. Arduino code for the function in detecting the fullness of the rubbish as shown in Fig. 2 was written and uploaded into TinkerCAD. Next, simulation was started and then the object in front of the ultrasonic sensor was adjusted. For physical simulation, components including Arduino Uno, ultrasonic sensor (HC-SR04) and LEDs were connected as shown in Fig. 2. Next, the Arduino code above was uploaded into Arduino Uno using Arduino IDE. Tissue paper, paper and bottle were placed in front of the ultrasonic sensor with a distance of 20, 40, 60 , 80 ,100 and 120 cm. 3 readings of measured distance were recorded for every distance and rubbish types. Graph of measured distance versus actual distance was plotted.

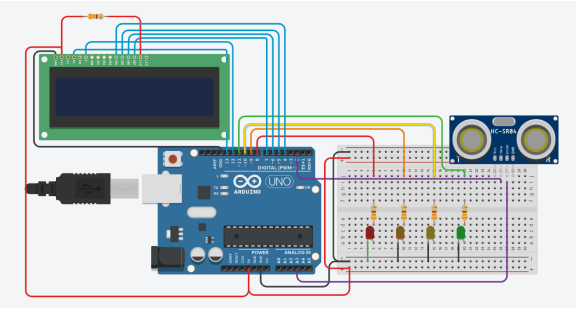

Fig. 1 Circuit design at TinkerCAD

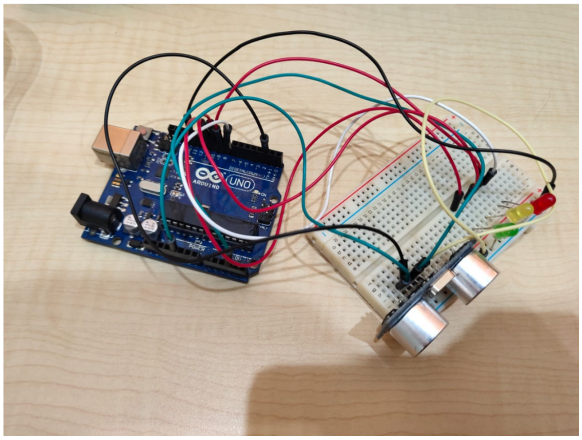

Fig. 2 Circuit connection using Arduino Uno

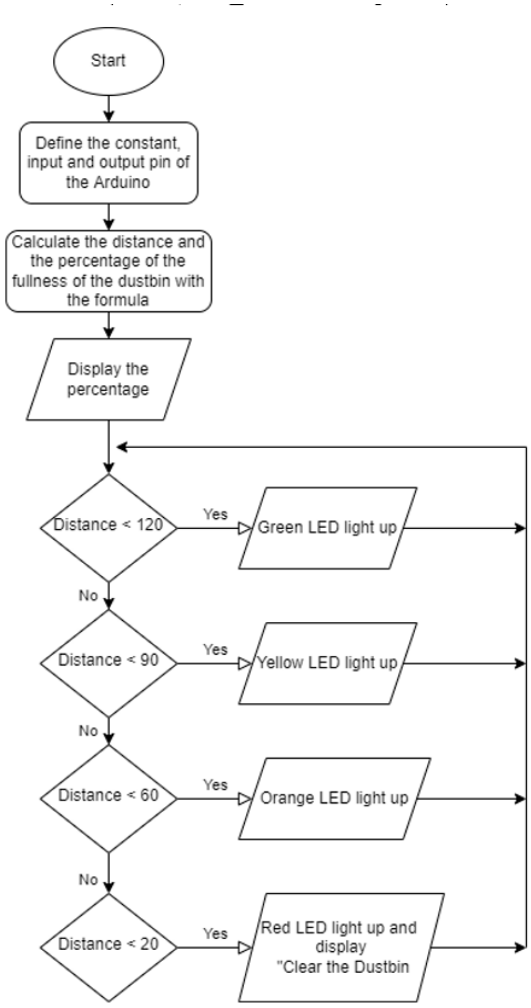

Fig. 3 Flow chart below shows the programming for the GUI.

Coding For Arduino

```
#include <LiquidCrystal.h>

#define trig 2            //attach pin D2 Arduino to pin Trig of HC-SR04
#define echo A3           // attach pin A3 Arduino to pin Echo of HC-SR04
#define GREEN_LED 11      //attach pin D11 Arduino to GREEN LED
#define YELLOW_LED 10     //attach pin D10 Arduino to YELLOW LED
#define ORANGE_LED 9      //attach pin D9 Arduino to ORANGE  LED
#define RED_LED 8         //attach pin D8 Arduino to RED  LED

#define rs 13          //attach pins of  Arduino to LCD pins
#define en 12
#define d4 4
#define d5 5
#define d6 6
#define d7 7

LiquidCrystal lcd (rs,en,d4,d5,d6,d7);

float duration;    // variable for the duration of sound wave travel
float Distance;   // variable for the distance measurement in cm
int precentage;  // variable for the percentage of rubbish level in %
float rubbish_height;
float CheckX;
float Checkingmills;
float TimeXwasTrue;

void setup() {
  Serial.begin(9600);               // Serial Communication is starting with 9600 of baudrate speed
  pinMode(trig, OUTPUT);            // Sets the trigPin as an OUTPUT
  pinMode(echo, INPUT);             // Sets the echoPin as an INPUT
  pinMode(GREEN_LED, OUTPUT);     // Sets the green led  Pin as an OUTPUT
  pinMode(YELLOW_LED, OUTPUT);   // Sets the yellow led Pin as an OUTPUT
  pinMode(ORANGE_LED, OUTPUT);  // Sets the orange led Pin as an OUTPUT
  pinMode(RED_LED, OUTPUT);    // Sets the red led Pin as an OUTPUT
  lcd.begin(16,2);
```

```
}

void loop() {
  digitalWrite(trig, LOW); // Clears the trigPin
condition
  delay(2);
  digitalWrite(trig, HIGH);
  delay(15);  // Sets the trigPin HIGH (ACTIVE)
for 15 microseconds
  digitalWrite(trig, LOW);
  duration = pulseIn(echo, HIGH); // Reads the
echoPin, returns the sound wave travel time in
microseconds

  // Calculating the distance in cm ,, the velocity
of sound =340 m/s = 0.034 cm/us
  Distance = (duration*0.034)/ 2; // Speed of
sound wave divided by 2 (go and back)
  percentage = 100-(Distance*100)/120;
  rubbish_height = 120 - Distance ;

  if (Distance < 120 ) {
    digitalWrite(GREEN_LED, HIGH);
  }
  else {
    digitalWrite(GREEN_LED, LOW);
  }
  if (Distance < 90) {
    digitalWrite(YELLOW_LED, HIGH);
  }
  else {
    digitalWrite(YELLOW_LED, LOW);
  }
  if (Distance < 60 ) {
    digitalWrite(ORANGE_LED, HIGH);
  }
  else {
    digitalWrite(ORANGE_LED, LOW);
  }
  if ( Distance < 20) {
    digitalWrite(RED_LED, HIGH);
  }
  else {
    digitalWrite(RED_LED, LOW);
  }

  Serial.print("Rubbish height:");
  Serial.println("cm");

  Serial.print("DustbinLevel:");
  Serial.print(percentage);
  Serial.println("%");

  lcd.clear();      // print water level in LCD in %
  lcd.setCursor(0,0);
  lcd.print("DustbinLevel:");
  lcd.print(percentage);
  lcd.println("%");
  delay(500);

  lcd.print("Rubbishheight: ");
  lcd.print(rubbish_height);

  if (percentage > 80){
    CheckX == false;
          // if rubbish level >80% shown on lcd
   if (percentage > 80 && CheckX == false ){
          CheckX = true;
     TimeXwasTrue = millis();
   }
  Checkingmills = millis();

if ( CheckX && Checkingmills - TimeXwasTrue
>= 5000 ) {
    Serial.println("Clean the Dustbin");
    lcd.setCursor(0,1);
    lcd.print("Clean the Dustbin");
     delay(1000);
}}
if (percentage <80){
    lcd.print("");
  }
}
```

III. DATA, RESULTS AND SIMULATIONS

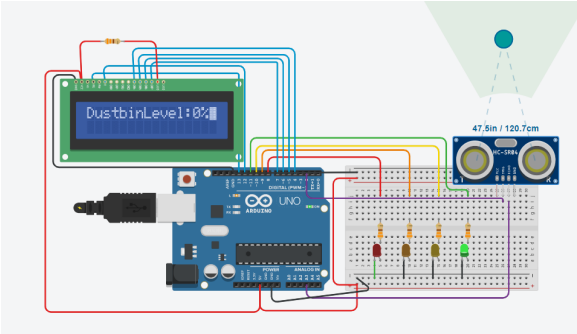

Fig. 4 When the dustbin is not full

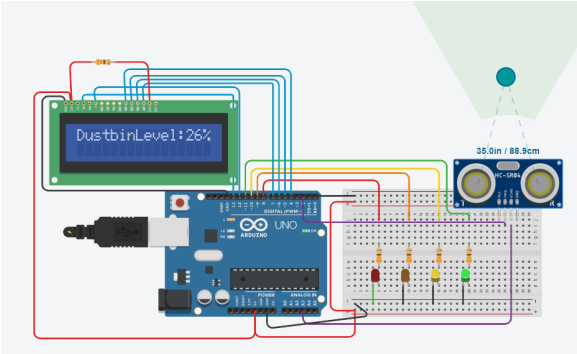

Fig. 5 When the dustbin is partially full

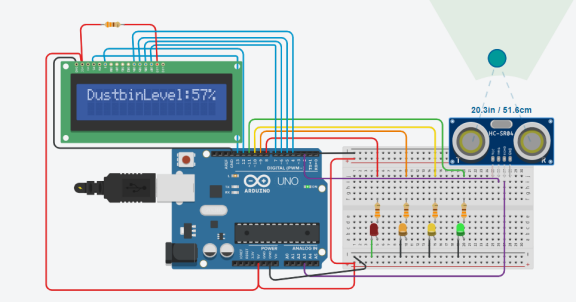

Fig. 6 When the dustbin is almost full

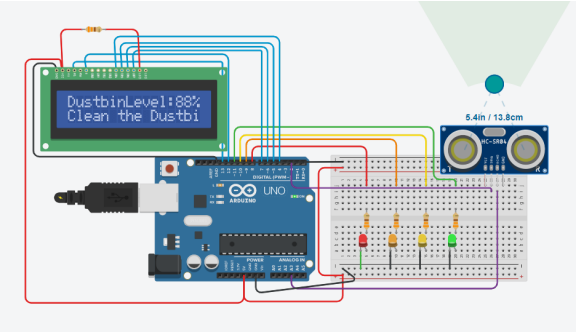

Fig. 7 When the dustbin is full

Actual distance (cm)	Bottle			avg.	Paper			avg.	Tissue paper			avg.
20	20.33	21.20	19.94	20.49	18.90	21.23	20.21	20.11	22.20	22.56	21.08	21.95
40	40.82	40.55	39.78	40.38	37.88	39.66	38.91	38.82	40.22	38.37	40.19	39.59
60	59.94	59.77	59.26	59.66	45.53	58.75	59.89	54.72	60.71	59.03	60.21	59.98
80	79.58	79.32	79.97	79.62	55.81	78.56	79.76	71.38	20.50	79.53	79.61	59.88
100	99.63	99.43	99.88	99.65	97.34	96.93	99.95	98.07	99.43	98.60	99.64	99.22
120	118.83	118.75	118.83	118.80	117.71	118.00	118.29	118.00	118.54	118.75	119.56	118.95

IV. DISCUSSION

A. Problem faced

In building the circuit using hardware, we face the problem that we cannot connect the Arduino with the LCD and the LED indicator that show the level is not stable. For the connection of the LCD, it is a LCD keypad Shield that is different from the simulation that was done by us. We searched for the connection for LCD keypad Shield to the Arduino from the online resource but it failed to function properly. We also requested assistance from our supervisor but we cannot find the datasheet of the component because it is a bit aging. We decided to use the display from the Arduino application on the PC to display the data that should be displayed by the LCD.

For the LED indicator that is not stable, it is affected by the surrounding of the sensor such as wind as the sensor is sensitive, we wait for a few minutes and take the average value when recording the data of the experiment.

To be more user friendly, the GUI can further design that when the rubbish of the dustbin is almost full, it will inform the cleaner through the phone but we have limited knowledge about the application and IOT so it can not be done.

B. Discussion on the result

Three readings were taken for all three types of rubbish to obtain an average reading for every distance. Hard surface such as bottle has high repeatability as it has consistent results. Paper and tissue papers have a softer surface and might be affected by winds which causes a low repeatable result. Therefore, the distance of a hard surface is more suitable to be measured using an ultrasonic sensor as it does not absorb sound waves like a soft surface does. Besides, every tested distance was measured and marked on the table using a tape measure for a more accurate result. Actual distances measured using the tape measure were compared to the measured distances measured by the ultrasonic sensor using a graph. Based on the graph of measured distance versus actual distance, we can see that soft surface material like paper and tissue paper has a higher standard deviation compared to hard surface material like bottle.

Furthermore, a GUI was designed and provided to the cleaners to be aware of which dustbins are full and needed to be cleaned. LED indicators and LCD were added to monitor the level of the dustbin. LEDs were used to show the four level of the fullness of the rubbish, when green LED was lighted up, the dustbin was almost empty, when yellow LED was lighted up, the dustbin had a few rubbish, while when orange LED was lighted up, the dustbin was almost full and when red LED was lighted up, the rubbish was full in the dustbin.The LCD would show the percentage of the fullness of the rubbish in the dustbin and when the rubbish bin was full it would show an instruction message to clear the rubbish. As shown in Fig. 8, a message of “Clean the Dustbin” will be displayed when the dustbin has reached a fullness of 80% or above.

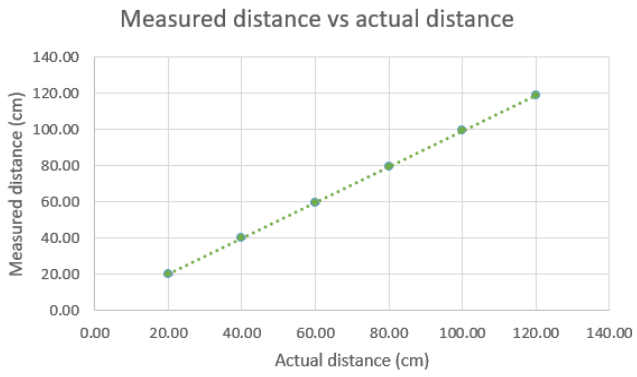

Fig. 8 Graph for bottle

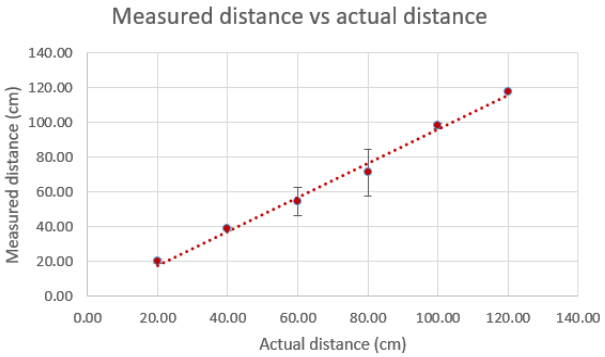

Fig. 9 Graph for paper

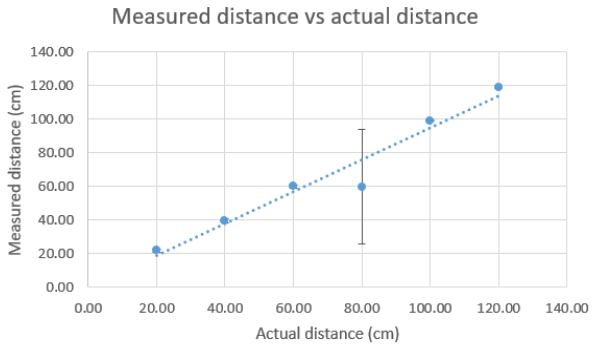

Fig. 10 Graph for tissue paper

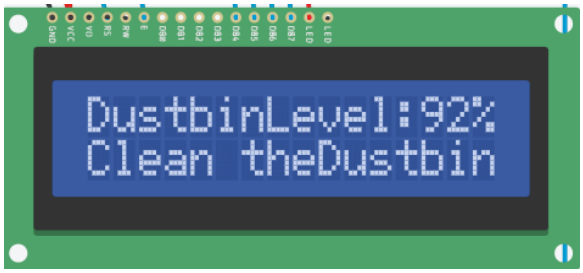

Fig. 11 LCD display for GUI purpose

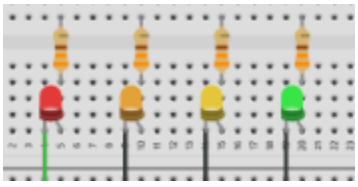

Fig. 12 LED indicator for GUI purpose

V. CONCLUSION

We can conclude that the detection system of the fullness of the rubbish in the dustbin was designed and built successfully. Besides, the system worked properly and GUI was provided for data displaying and monitoring purposes.

VI. REFERENCE

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