INTERNSHIP REPORT

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1) Problem Statement/ Aim:

To build an Ultra sonic touch surface to detect different hand gestures using ultra sonic sensors.

2) Approach to the problem:

Gesture detection can be done by finding the x and y position coordinates of the object/hand which does the movement.

Example gesture 1: Left and Right movement – The increasing X axis movement can be recognised as Left to right movement and vice versa.

Example gesture 2: Up and Down movement – The increasing Y axis movement can be recognised as down movement and vice versa.

Mathematical model to find the coordinates:

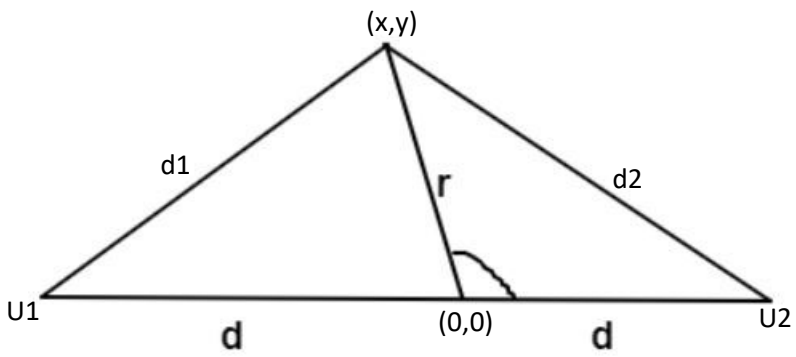


Fig1: Setup to find coordinates

Here, U1 and U2 are the ultra sonic sensors and the object is placed at d1 distance from U1 and d2 distance from U2.

From Apollonius theorem:

$$d_1^2 + d_2^2 = 2(r^2 + d^2) \quad (1)$$

$$r = \sqrt{\frac{d_1^2+d_2^2}{2} - d^2} \quad (2)$$

$$\theta = \cos^{-1}\left(\frac{d^2+r^2-d_2^2}{2dr}\right) \quad (3)$$

$$x = r\cos\theta \quad (4)$$

$$y = r\sin\theta \quad (5)$$

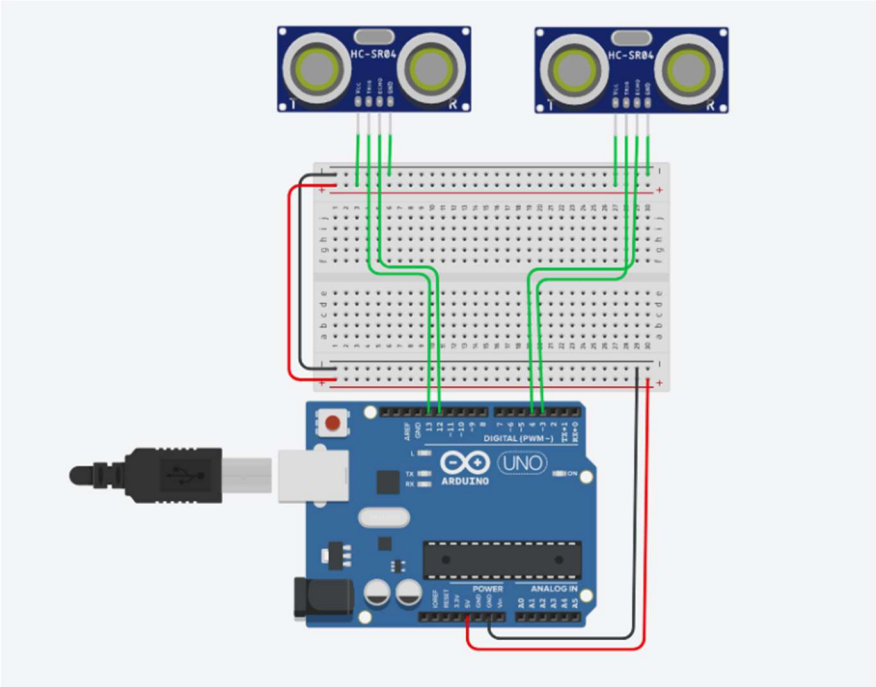
hence from equation 4 and 5, x and y coordinates of the object are obtained.

3) Materials used:

Arduino Uno, Ultra sonic sensor*2, wires, Arduino IDE and any Python IDE.

4) Hardware Setup:

Connect the circuit according to the following diagram



5) Snippet of Code:

Arduino code:

```
float
X,Y;
        void setup() {
            Serial.begin(9600); // Starting Serial Terminal


            pinMode(13, OUTPUT);   //trig pin of first ultra sonic sensor needs to be
        connected to pin 13 of Arduino
            pinMode(12, INPUT); //echo pin of first ultra sonic sensor needs to be
        connected to pin 12 of Arduino

            pinMode(3, OUTPUT); //trig pin of first ultra sonic sensor needs to be
        connected to pin 3 of Arduino
            pinMode(4, INPUT); //echo pin of first ultra sonic sensor needs to be
        connected to pin 4 of Arduino
        }

        void loop()
        {
        Track();
        Serial.print(X); //to print X coordinate
        Serial.print(“,”);
        Serial.println(Y); // to print Y coordinate
        }


        void Track()
        {
           float d1,d2,theta;
           float dist=81; //distance between any extreme similar points of the  ensor in
        mm

           digitalWrite(13, LOW);
           delayMicroseconds(2);
           digitalWrite(13, HIGH);
           delayMicroseconds(10);
           digitalWrite(13, LOW);
           d1 = pulseIn(12, HIGH);
           d1=d1*343/2000; //finding distance between object and ultra sonic sensor 1


           delay(10);
           //pins for sensor 2 need to be uploaded
```

```
          digitalWrite(3, LOW);
          delayMicroseconds(2);
          digitalWrite(3, HIGH);
          delayMicroseconds(10);
          digitalWrite(3, LOW);
          d2 = pulseIn(4, HIGH);
          d2=d2*343/2000; //finding distance between object and ultra sonic sensor 2

        theta=acos((((d1*d1)+(dist*dist)-(d2*d2)))/(2*d1*dist)); //finding the angle

        if(theta<3 && theta>0){
          X=d1*cos(theta)+ dist/2; // y coordinate
          Y=d1*sin(theta); // X coordinate
        }
        else{X=220;Y=-80;}
        /*Serial.print(d1);
        Serial.print("\t");
        Serial.print(d2);
        Serial.print("\t");
        Serial.print(theta*180/3.14);
        Serial.print("\t");
        Serial.print(X);
        Serial.print("\t");
        Serial.print(Y);
        Serial.print("\n");*/
        delay(10);

        }
```

Running the above code in Arduino ide gives the X and Y coordinates of the object in real time through serial monitor.

The X and Y coordinates thus obtained is used to find the gesture using the following python code:

```
import
serial
         import numpy
         import matplotlib.pyplot as plt
         arduinoData = serial.Serial('com5', 9600)
         plt.ion()
         cnt=0
         Xpresent = 0
         Ypresent = 0
         Xpast = 0
         Ypast = 0
         I = 0
         j = 0
```

```
k = 0
y = 0
n = 0
m = 0
while True:
    while (arduinoData.inWaiting()==0):
        pass
    ard = arduinoData.readline()
    X,Y = ard.decode().split(‘,’)
    Xpresent =int(float(X))
    Ypresent =int(float(Y))
    if (Xpresent!=220) and (Ypresent!=80):
        if Xpresent > Xpast:
            I = i+1
        else:
            y = y+1
        if Ypresent < Ypast:
            j = j+1
        if Ypresent > Ypast:
            k = k+1
        elif Ypresent == Ypast:
            m = m+1
    else:
        n = n+1
    cnt=cnt+1
    while cnt==10:
        highest = max(I,y,j,k,n)
        if highest == i:
            print(I,’,right’)
        elif highest == y:
            print(y,’,left’)
        elif highest == k:
            print(Ypresent,j,k,’,up’)
        elif highest == j:
            print(Ypresent,j,’,down’)
        elif highest ==n:
            print(n,’,none’)
        elif highest ==m:
            print(m,’,no mov’)
        cnt = 0
        I = 0
        j = 0
        k = 0
        y = 0
        n = 0
        m = 0
```

```
                    Xpast = Xpresent
                    Ypast = Ypresent
```

The results would show object movement/ gesture.

6) Results and Constraints

Results shown very less accuracy in gesture detection due to following reasons:

1) Error in Sensor measurements
2) Noise in sensor measurements
3) Very less area of functioning where the mathematical model stays true.

7) Future Scope and Conclusion

From various studies, it can be noted that up to three gestures including Up/down movement, Left/right movement, circular movement could be done by considering sensors as independent from each other but the area of operation would be very less due to the triangular mode of operation of ultra-sonic sensors. Decreasing the error in sensor measurement by using 4 ultra-sonic sensors instead of 2 needs to be studied. Building a ultra-sonic touch surface would be a lost cost replacement for other gesture detection methods used in IoT sectors now.