Smart Dustbin

Section - 3

ECE305: Sensors, Instruments and Experimentation

Group 10

Group members:

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Objective:

The Smart Dustbin Project comes under the domain of Environment, Health, and Hygiene. Through this project, **we aimed to build a working prototype of a dustbin whose lid opens automatically, without any contact when a person comes near it (in the range of 2 - 30 centimeters) to throw the trash**. Since the process is **contactless** it maintains public hygiene and sanitation. Moreover, there are many instances at public places where **the dustbins overflow** because of irregularity in the waste collection from the dustbin (which is usually done by the municipality sanitation workers). **To overcome this issue**, our next target was to **provide a functionality such that when the dustbin is full, it will not open at all if the person comes near it to throw the trash**. Now, a sanitation worker will need to open the bin to empty the contents irrespective of whether it is full. Therefore, **to unload the bin in case it is full we provided a switch** that when pressed will open the lid in any case. And in this case, the lid will continue to remain open until there is an object (hand) in front of the ultrasonic sensor in the predefined range. This product can be useful in all the places where the dustbin is frequently used and minimal or no contact is expected from the user. For example, doctors can use this in an operation theatre, flight attendants can use it while serving the food, it can also be used in public toilets etc. In countries like India, where waste management is a crucial problem, it is important to work further on such products that provide methods to collect the garbage along with maintaining proper hygiene as well as contributing to the environment.

Outcomes:

Using a microcontroller based system, we achieved the **3 functionalities** at the end of this project that we had aimed for.

1. First, we were **able to open the dustbin without any contact** using the ultrasonic sensor (the side sensor). It is programmed to detect the motion in the range 2 - 30 centimeters in front of it and this will open the lid.
2. The second functionality is that **when the dustbin is full** (it reaches a level defined in the code), **it will not open even if there is a movement** in front of the side sensor. This functionality is helpful **to resolve the issue of the overloaded dustbins** which are often seen at public places all around India. The level of the garbage inside the dustbin is sensed using another ultrasonic sensor (the top sensor).
3. Finally, the last functionality is to be able **to unload the dustbin when it is full**. This functionality is needed because when the garbage in the dustbin reaches a particular level, after that it can not be opened even with the motion in front of the side sensor (because of the second functionality). Therefore, in this case to unload the dustbin for reusing it we added a pushbutton in our circuit.

Final Circuit Diagram:

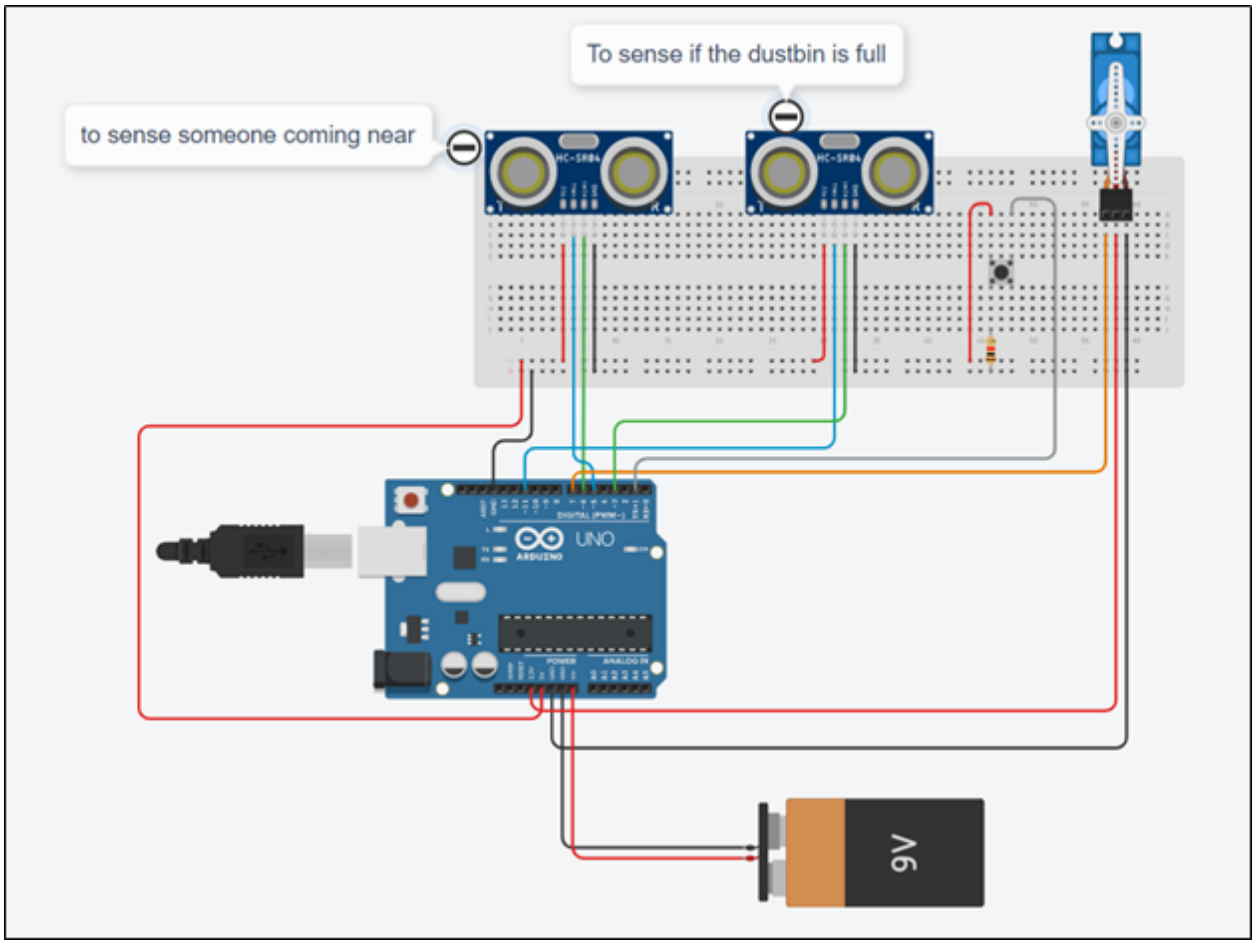

Image1 - Circuit Diagram

Components Used:

- ARDUINO - UNO
- 2 HC-SR04 Ultrasonic Sensors - One on the cylindrical surface (Side Sensor) and the other on the lid (Top Sensor)
- Mini/Micro Servo Motor (9 gms)
- 4-pin push button
- Resistor
- 9 volt power supply
- Jumper wires
- Bread board

Code:

```
/*Servo motor related initialisation*/
#include <Servo.h>   //servo library
Servo servo;
int servoPin = 7;    //defining the servo pin through which we control the motor behaviour

/*Ultrasonic sensors related initialisation*/
/*Trig pin is used to trigger the ultrasonic sound pulses. */
/*Echo pin produces a pulse when the reflected signal is received*/
int trigPin_side = 5;
int echoPin_side = 6;
int trigPin_top = 11;
int echoPin_top = 3;

/*Switch related initialisation*/
int switch_in = 1;
int switch_state=0;

/*Variables required for calculation related to both Ultrasonic sensors*/
float duration_side, dist_side; //variables for first sensor (side sensor) that detects presence related to action of throwing garbage
float duration_top, dist_top;  //variables for second sensor (top sensor) that detects the bin being full
float avg_side[3];   //array for 3 measured values of the first sensor (side sensor)


void setup() {
   Serial.begin(9600);
   servo.attach(servoPin);

   /*Defining the input-output states of the pins*/
   pinMode(trigPin_side, OUTPUT);
   pinMode(echoPin_side, INPUT);
   pinMode(trigPin_top, OUTPUT);
   pinMode(echoPin_top, INPUT);

   pinMode(switch_in,INPUT);

   digitalWrite(switch_in,LOW);    //Initially the switch_in is set as LOW

}

/* Function to measure distance of object from the sensor attached to bin wall (side ) */
void measure_side() {
    // the next 5 lines are for sending out signal from "trig" that "echo" measures
```

```
    digitalWrite(trigPin_side, LOW);
    delayMicroseconds(5);
    digitalWrite(trigPin_side, HIGH);
    delayMicroseconds(15);
    digitalWrite(trigPin_side, LOW);

    pinMode(echoPin_side, INPUT);

    duration_side = pulseIn(echoPin_side, HIGH); //this echo pin senses the reflected signal;
duration_side is the time between trigger and reception of the signal
    dist_side = ((duration_side)/2) / 29.1;    //dist_side is obtained as distance from the time
taken for the reflected signal to come to echo
}



/* Function to measure distance of object from the sensor attached to bin lid top */
void measure_top() {
    // the next 5 lines are for sending out signal from "trig" pin that the "echo" pin later
measures
    digitalWrite(trigPin_top, LOW);
    delayMicroseconds(5);
    digitalWrite(trigPin_top, HIGH);
    delayMicroseconds(15);
    digitalWrite(trigPin_top, LOW);

    pinMode(echoPin_top, INPUT);

    duration_top = pulseIn(echoPin_top, HIGH); //this echo pin senses the reflected signal;
duration_top is the time between trigger and reception of the signal
    dist_top = ((duration_top)/2) / 29.1;    //dist_top is obtained as distance from the time taken
for the reflected signal to come to echo
}


void loop() {

    switch_state=digitalRead(switch_in);  //check if the switch is pressed

    if(switch_state == HIGH)  //if the switch is pressed
    {

        servo.attach(servoPin);
        delay(1);
        servo.write(0);   //open the dustbin lid irrespective of whether it is full
        delay(10000);
```

```
        servo.detach();

    }
    /* We take three samples of distance from the side sensor for better accuracy. This ensures that the lid doesn't open by sensing someone walking by;
     *  but only someone who is there for some time.
    */
    //Storing 3 distances (that are to be averaged for better accuracy) in the array 'avg_side'
    for (int i=0;i<=2;i++) {
        measure_side();
        avg_side[i]=dist_side;
        delay(10);  //delay between measurements
     }

     dist_side=(avg_side[0]+avg_side[1]+avg_side[2])/3;    //the final distance is equal to the average of 3 measured distances

/* The distance of garbage from the top ultrasonic sensor is taken from a single sample because there are less chances of inaccuracy
 *  and using average of some values would lead to slower decision making.
 */
     measure_top();   //the distance of garbage from second lid is measured to check if the bin is full



    if((dist_top)>10){     //if the bin is not full
        if ( ((dist_side)<30)) {  //and if someone is in close proximity

            servo.attach(servoPin);
            delay(1);
            servo.write(0);               //then open the lid for 5 seconds
            delay(3000);
            servo.write(150);
            delay(1000);
            servo.detach();
        }
    }


    Serial.println(digitalRead(switch_in));

}
```

Formula used to calculate distance from ultrasonic sensor:

$$distance = (duration/2) / 29.1$$

The formula is derived from the common formula for distance, i.e, speed * time. In this formula, instead of value of speed of sound, value of "$1/speed\ of\ sound$" in microseconds per centimeter is used. The distance thus obtained is divided by 2 since *duration* is that of sending the pulse and also receiving it on the other end. It therefore covers the same distance twice. We thus obtain the distance of the object from the ultrasonic sensor in centimeters.

Pictures of actual circuit and the project along with the required explanation:

We initially used only one **ultrasonic sensor (HC-SR04)** that was programmed **to detect the hand movement in front of the cylindrical part of the dustbin**. Therefore, if there is a (hand) movement (or any object present) in the **range of 2 – 30 centimeters** (the 30 centimeters upper limit is defined in our code and in general, the measuring range for an ultrasonic sensor is 2 - 500 centimeters), it will detect that and rotate the servo motor (connected to pin 7 of Arduino) by 150 degrees to open the lid. And after a delay of 3 seconds, it will close the dustbin lid. We refer to this sensor as a **'Side Sensor'** as in the final project, it is on the cylindrical side of the dustbin. The image below is the circuit for that part:

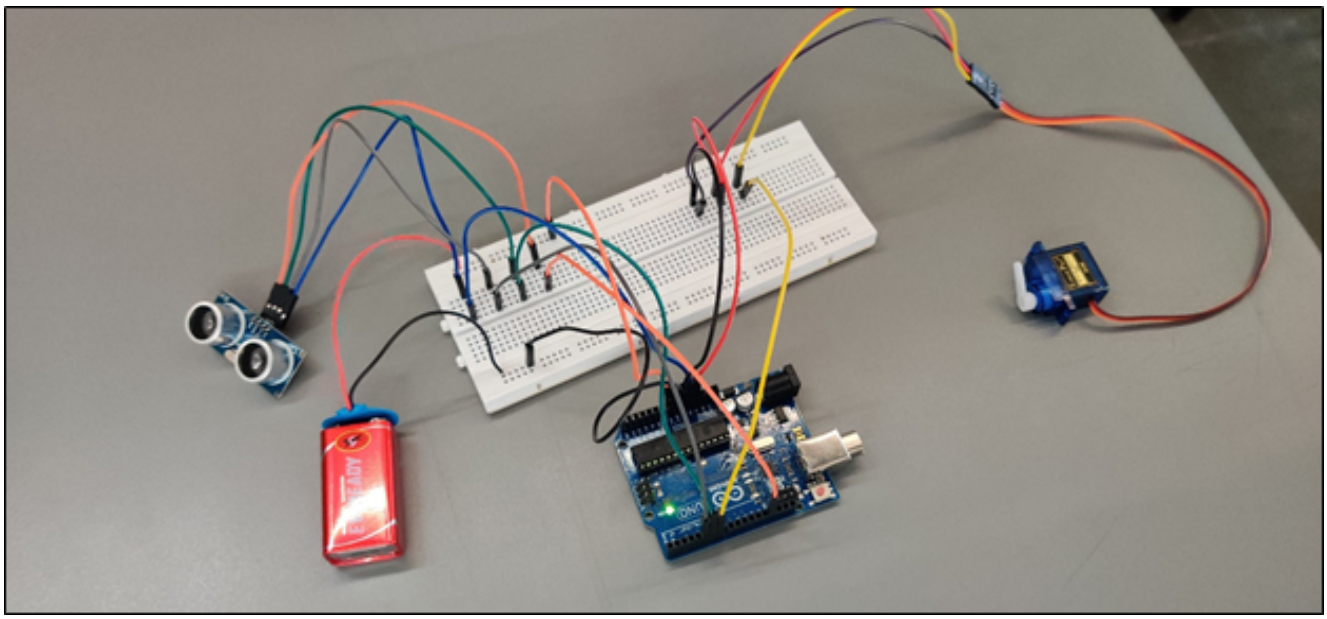

Image 2 - Initial Circuit (without top sensor and the switch)

Further, we integrated this hardware on a dustbin, and we added a few more parts to function the dustbin in a better manner. We inserted another **HC-SR04 ultrasonic sensor on the lid** of the

dustbin that is able **to check whether the garbage level in it is full or not** in the dustbin (see top views in the images below). When the **level is full** (the waste is less than 10 centimeters from the lid), our program will **not let the lid open even if there is a motion near the previously attached sensor**.

Further, we added **a 4-pin pushbutton** in the circuit. On pushing this button, **the lid will always open (no matter what the waste level is)**. It will remain in this open state and will close only when the motion is detected near the sensor on the cylindrical surface. Practically, this functionality can be useful when the dustbin is full and it needs to be emptied for using it again. In this case the dustbin will not open with the help of the sensor and therefore it has to be opened using the pushbutton. The image for final project is as shown below:

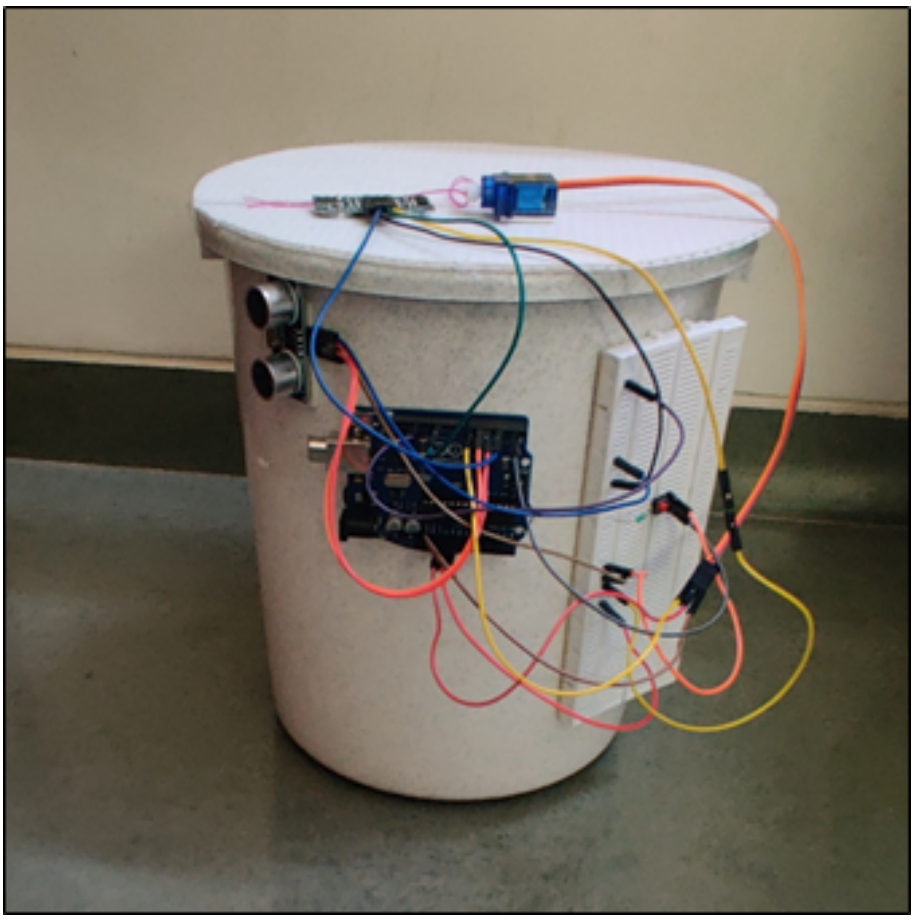

Image 3 - Final Project

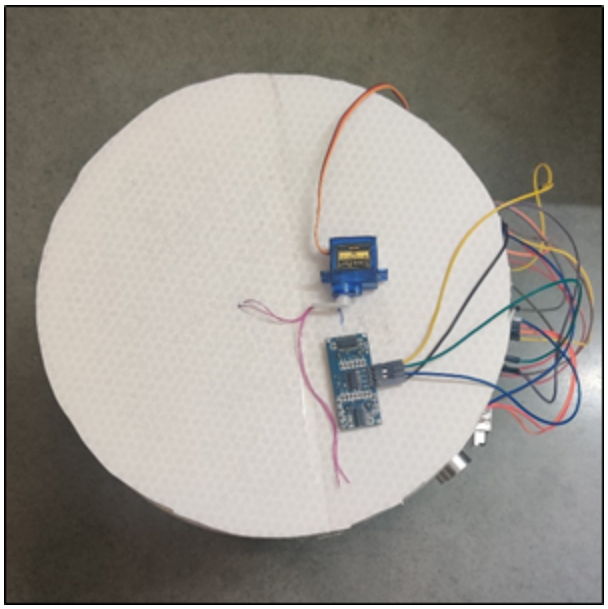

Image 4&5 - Top views

Reference:

Fahad, E. (2021, August 19). Smart dustbin using Arduino, ultrasonic sensor, and servo motor. Retrieved November 12, 2021, from https://www.electroniclinic.com/smart-dustbin-using-arduino-ultrasonic-sensor-and-servo-motor/

Pandey, M., Gowala, A., Goswami, M., & Bora, D. (2020, August 08). (PDF) smart dustbin using Arduino. Retrieved November 12, 2021, from https://www.researchgate.net/publication/343530056_SMART_DUSTBIN_USING_ARDUINO