Smart Dustbin using Arduino with Ultrasonic Sensor, servo motor and LED Alert

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***Abstract*—The dustbins or garbage bins plays a very important part in our day to day life. Especially nowadays, in this smart world we prefer smart dustbin instead of one with more efforts same as an auto(gear-less) car instead of manual one! The main reason behind using this smart dustbin is that you do not need to open dustbin every time by yourself to through a small piece of paper. Therefore, I have thought about making a smart dustbin using Arduino with ultrasonic sensor and servo motor. This smart dustbin will open it's lid if you go near by the dustbin and then you can throw the garbage inside it without opening it by yourself. The additional and an extra smart feature in this existed dustbin is alert with the buzzer or LED light when dustbin is full of trash. Basically, the dustbin with sensor to open it automatically when you need to throw trash into it and buzz it with LED lights when it is full.**

I. Introduction

THE usage of smart dustbin has been increasing as we have moved to the smart world. As we all know the dustbin is necessity for all of us and to make this universe clean, healthy and pollution free. The smart dustbin will motivate users to use dustbin in this smart world without making efforts. This smart dustbin will open the lid when person move closer to dustbin or wave something in front of it. Also it will alert you with buzzer or LED lights when the dustbin is full of trash. Although there are so many similar features for dustbin are available to open it without efforts but the best feature about this smart dustbin or this project is sensing the level of trash in dustbin. This feature is very helpful as the dustbin should not be overflowed, it makes environment unhealthy and place dirty. On the other side in this busy life, people usually miss these small things. Therefore, this smart dustbin alert will help them to empty their dustbin on time. To implement this feature, Ultrasonic sensor has been used. We can also use weighting sensor which will sense the weight of the dustbin and alert you when it is full. While ultrasonic sensor is better as it will sense the level of dustbin so when it is overflowed you will get an alert while weighting sensor senses the weight and sometimes the dustbin is overflowed with boxes and the weight is still not reached to the limit. In this condition it will not alert you which is a drawback. Therefore ultrasonic sensor will work perfectly for this project. To make this smart dustbin mainly we need Arduino, two ultrasonic sensors, servo motor, dustbin with lid. When the ultrasonic sensor attached in front of the dustbin senses the object it will open the lid using servo motor. On the other hand the ultrasonic sensor attached under the lid senses the level of trash and buzz the buzzer or turn on the LED lights to alert you.

II. Problem Definition

The problem of excessively full dustbins and garbage spilling out of with dustbin is making environment unhealthy for every life of the universe. This problem leads to more diseases as insects and mosquitoes on the waste accumulated in this garbage. The main motivation of choosing this project was, make the environment clean with no efforts which will lead to a healthy life to people. Basically, this project will motivate people to use dustbin without making any efforts.

III. Background

The aim of working on this project is to combine two separate features and make a one smart dustbin. There were a some of projects that have been taken as a reference while building this project such as Sourabh Deshmukh as showed his work in github.com where he made a smart dustbin which opens the lid when it senses the object[4]. His project has been used to create similar feature in this project. Also, there are many projects have been found online with the same idea and the same feature of opening the. They have not build the extra feature of alert[2]. Smart dustbin with an alert has been found on youtube.com but it has been created using weighting sensor and the main drawback of that is, if the dustbin is full with light weighted boxes but still you are not getting an alert to empty the dustbin and on the other hand you can not even throw anything into it because of the space. Due to this drawback I have used an ultrasonic sensor which will sense the level of the dustbin and when it reaches to certain level for example till the edge of dustbin it will give you an alert with buzzer or LED. Also the projects I have found online for reference, they are experimenting only one feature in one project while in this project both the features have been combined and created a whole new smart dustbin. This is how this project differs from the existing projects available online.

IV. Design Definition

A. Overview

This project requires two ultrasonic sensors, one to detect objects in front of it, and one to detect the trash level, Arduino UNO for logic processing, Breadboard to make a complete circuit, LED lights or a Buzzer to make an alert, Servo Motor to open the dustbin lid and bunch of Wires with Batteries.

B. Design Process

The design process of this project comprises the components such as ultrasonic sensor, Servo Motor, Arduino board, White

Board, LED or Buzzer and the connection or the Batteries. The Fig 1 of the appendix section represents the block diagram of the project which gives a clear flow of the component connection.

The schematics and the circuit diagram have been shown in Fig 2 and Fig 3, they are both given in the appendix section. The breadboard has been used to connect the ultrasonic sensors, Servo Motor and LED together. The servo motor and both the ultrasonic sensors are connected to the digital pins on the Arduino board. The LED light has been attached to the breadboard to get an output. In the breadboard (schematics) view, the Arduino board is attached to the breadboard and the breadboard is connected to other components to make the circuit easy and clean to understand. If we see the ultrasonic sensors, the first sensor's vcc connects to the 5V or battery, the TRIG and ECHO ports are connected to digital pin 5 and 6 of Arduino respectively. Likewise, the vcc of the second ultrasonic sensor is attached to the 5V and TRIG and ECHO pins are connected to 9 and 10 Arduino digital pins. and GND for both the sensors goes to the ground directly. For the servo motor the signal point has been attached to digital pin 7 of the Arduino. While power and GND ports are connected to 3.3V and ground respectively. Finally after connecting all these components together the power supply is necessary to see smart dustbin working. Either you can connect this complete circuit to battery or you can use a USB cable to supply the power to the circuit.

C. Build Process

The building process of this smart dustbin was a bit challenging as it uses two ultrasonic sensors for different purposes. After connecting all the components together for the first time the servo motor was opening the lid but not closing it back. After setting up the servo metre code into a for loop with timing it started closing the lid once it opens the lid. Basically, the loop will once turn on the servo motor and after some time delay it will turn off the servo motor. The next problem was with ultrasonic sensors. Both ultrasonic sensor were not working at the same time. Also the ultrasonic sensors are not doing their jobs separately. Both ultrasonic sensors were giving the same output instead of giving different results. To solve this problem, first I have connected the first ultrasonic sensor which will open the lid when it senses the object. After the circuit for first ultrasonic sensor worked properly, the second ultrasonic sensor was attached on the other side of the bread board and the output was turn on the Buzzer when the dustbin is full of trash. While making this connection, after changing almost everything I got to know that my buzzer is not working. Therefore, I have replaces it with the LED lights. So when the bin is full it will turn on the lights instead of the buzzer to make an alert. The project code is simple to understand as it has been written with comments and included in the appendix section. For further details regarding the project such as the build process, design process, libraries, and code, refers to Github repository which can be found in the references section down below [5].

D. Use

The working of this project has been shown below. To see working device or a project, person needs to set the batteries into the battery holder and place the dustbin wherever he/she wants. After connecting everything, you can just use this smart dustbin to throw the trash by just moving forward to dustbin. once the ultrasonic recognises the object it will open the lid and you can throw the trash. Once it has been full of trash it will light up the LED lights to notify you to empty the dustbin. You can power up your dustbin via two ways: First by connecting USB directly to Arduino and second we can connect it to batteries using battery shelf.

Using given steps you can get a clear idea how the device works:

1) Upload the code to Arduino.
2) Power the Arduino using batteries or USB.
3) The smart dustbin will start working when you move closer to it to throw trash it will open the dustbin lid.
4) Also when the level of trash in dustbin is full it will blow the LED lights to give you an alert so you can not throw more trash and empty the dustbin on time.
5) Watching this automatic or smart dustbin would be fun in this smart world.

V. Evaluation

A. Overview

This smart dustbin project is all about maintaining the right distance and testing it using ultrasonic sensors. Testing ultrasonic sensors using different amount of distance helped me to make a final product or a complete device.

B. Prototype

The important feature about this smart dustbin is giving you an alert when the dustbin is full or overflowed with trash. There are lot of similar products or devices have been created outside the world but this one works perfectly fine with less efforts or we can say with no efforts. Moreover, this smart dustbin has two best features in one device, one is opening the lid and another is notify you with an LED when it is full.

C. Testing and Results

To make a final device, there were many several tries and errors while building it. Like the to make an alert, first the buzzer has been used but due to some unknown problem the buzzer was not working. Therefore, I have replaced the buzzer with an LED light. On the other hand, the main problem was finding the accurate distance for both the ultrasonic sensors. While working on measuring the distance, the dustbin was opening the lid if you just pass by the dustbin and do not want to throw the garbage. After so many tries with different distance values finally the convenient distance has been set to open the lid. The similar problem was found with the another ultrasonic sensor which was sensing the level of the trash in dustbin. At the end, I got the final device after several experiments and tries.

D. Assessment

While testing the device, everything was working up to the expectation. The drawback of this smart dustbin or project, if you keep this device on high power for so long it will burn the circuit. Another drawback of the project is it will open the lid if you come too closer to the dustbin and do not want to throw the trash. The strength of this smart dustbin is giving an alert when it is full of trash which means notification to you to empty the bin before throwing the garbage in it.

E. Next step

There are some modifications or extra features we can add to this project. Instead of opening the lid using an ultrasonic sensor, we can just put a button or replace the ultrasonic sensor position from front to top so when we pass by the dustbin it will not open the lid. In short it only opens the lid when we actually need to throw the trash and for that we can push the button or wave the hand on top of the dustbin. The another feature we can modify is an alert. We can use LED display with LED lights or buzzer to show different messages such as "Dustbin is Full", "The weight of the dustbin is xyz", etc. The best feature we can add to this project is GPS. When you use this project for big cities, you can add GPS system with an application for every dustbin along with this alert feature. For example, if there are 100 dustbins in different area of the city and the garbage management team needs to collect all trash from every dustbins after some counted days. Instead of this system we can add GPS to every dustbin so when the dustbin is full it will notify you on the application with GPS. The person has to empty that garbage bin only instead of doing that for all the bins. It will be less time consuming and effortless as compared to a current existed system.

VI. Milestones

Have faced below milestones while working with this project.

A. First Milestone

- The problem with understanding every components and gathering all the other required material to make this project. This milestone was completed successfully as professor have explained about almost every component during the class such as Arduino UNO, Breadboard, Servo motor, LED lights, etc.

B. Second Milestone

- The position of first ultrasonic sensor. While adjusting the position of the ultrasonic sensor to sense the object and open the lid was a big task as it should be convenient for all kind of people. This has been successfully attached on the front side of the dustbin after reading some user reviews and seeing existing projects online.

C. Third Milestone

- Setting up the servo motor. The servo motor was opening the lid but not closing it back. To solve this problem I had to understand the code for Servo motor. The loop for servo motor was running only once so it was opening the dustbin lid using the thread. While it was not running for the second time therefore the lid was not coming back to the position once it opens. To execute this properly, I have tried changing the loop value, making the separate loop for both tasks, combine it in one loop. At the end I got the perfect code which was running Servo motor as expected.

D. Forth Milestone

- Separating the tasks of both Ultrasonic sensors. The big milestone was both the ultrasonic were giving the same outputs while they had to perform different task and give separate outputs. When you wave your hand in front of first ultrasonic sensor it was turning on the LED lights as it should open the lid instead of giving an alert. To solve this issue I had to change the position of the code for both ultrasonic sensors' task. After changing the code sections both the sensors started working properly.

E. Fifth Milestone

- Complete Working demo of the prototype. While demoing the complete prototype the device was working perfectly as expected. The only drawback was it was opening the lid if you just pass by the dustbin. This problem is with the distance and the position of the ultrasonic sensor. This might be solved if we change the position from front to top of the dustbin. But it might be not convenient for everyone to use this smart dustbin.

VII. Team Roles

This project has been done only by me (Srushti Vaghani) and no teammates were involved in this project. All the project work including project selection, research, hardware design, prototype testing, GitHub documentation/writing the paper and programming all in whole was done solely by me in order to perform smooth functioning of the prototype.

VIII. Conclusion

As we all know, in today's world people prefer smart and effortless devices due to their busy life. Also the population and unhealthy environment are the big concerns. To maintain environment clean and healthy this smart dustbin will be useful. The proposed completed project which is a Smart dustbin using Arduino with Ultrasonic sensor and Servo motor will be easier, comfortable, less time consuming and convenient to use for people. As it name suggests this smart dustbin opens the lid when you want to throw trash without touching it or making any efforts and also it will give you an alert by blowing the LED light when the trash level of dustbin reaches to certain height.

Appendix A

Diagrams and Pictures

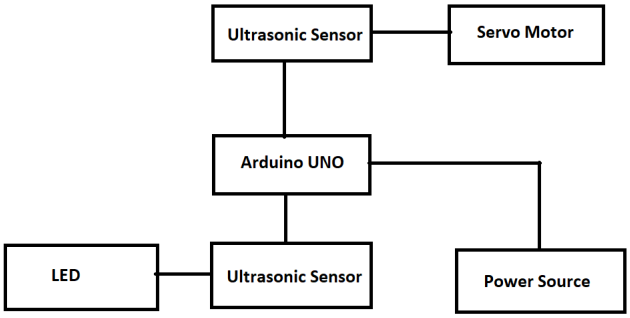

Fig. 1. The block diagram with essential components used in this project

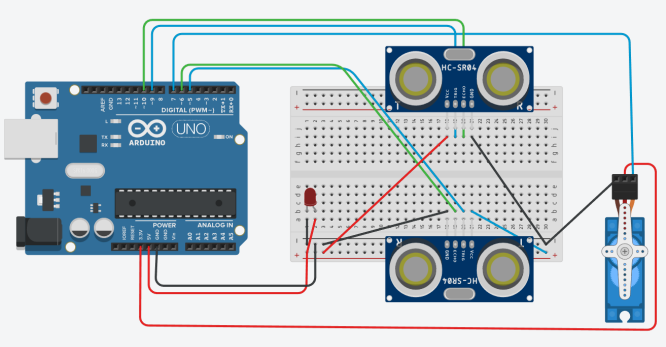

Fig. 2. The schematics of the Smart Dustbin

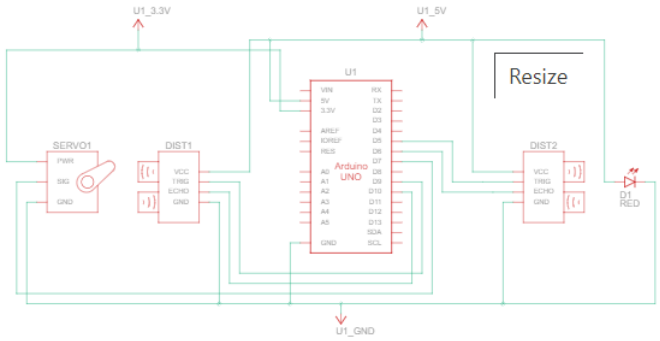

Fig. 3. The circuit diagram of the Smart Dustbin

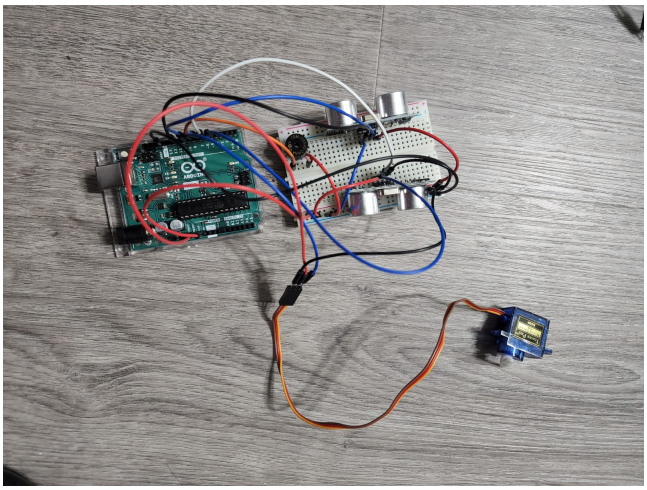

Fig. 4. The complete circuit of the Smart Dustbin without Dustbin

Fig. 5. The front view of the Smart Dustbin with first Ultrasonic Sensor

Fig. 6. The top view of the Smart Dustbin with Servo Motor

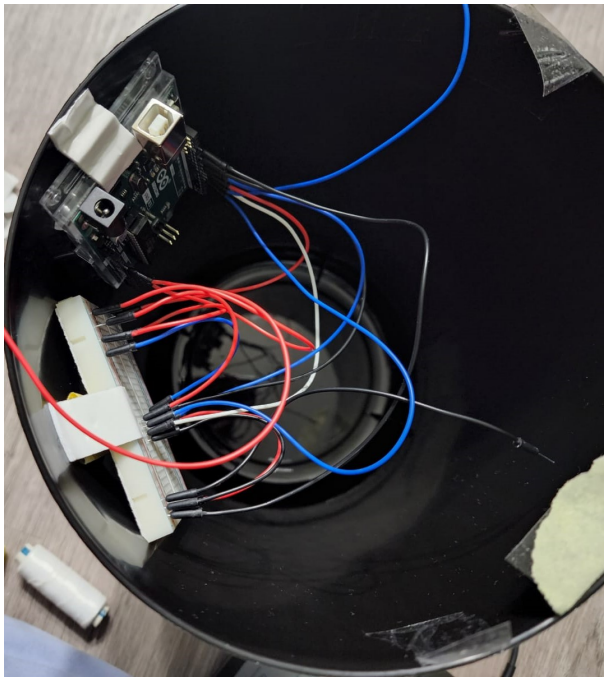

Fig. 8. The inside view of the Dustbin

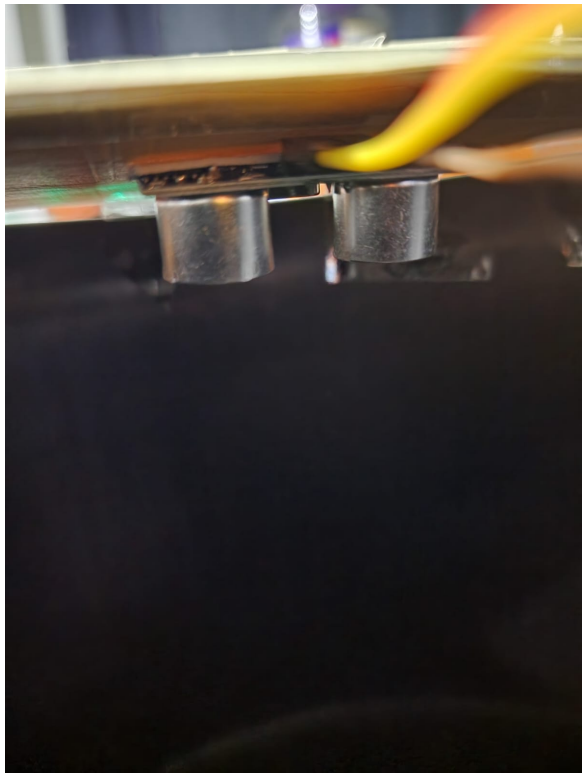

Fig. 7. The view under the Dustbin lid with second ultrasonic sensor

Fig. 9. The complete Smart Dustbin

A Source Code

```
#include <Servo.h>   //servo library
Servo servo;
Servo servo2;
int trigPin = 5; //5
int echoPin = 6;   //6
int servoPin = 7;  //7

int trigPin2 = 9;
int echoPin2 = 11;
int ledPin = 8;

int led= 10;
long duration, dist, average;
long duration2, dist2, average2;
long aver[3];   //array for average

long aver2[3];   //array for average


void setup() {
    Serial.begin(9600);
    servo.attach(servoPin);
    pinMode(trigPin, OUTPUT);
    pinMode(echoPin, INPUT);
    servo.write(0);         //close cap on power on
    delay(100);
    servo.detach();

    Serial.begin(9600);
    servo2.attach(ledPin);
    pinMode(trigPin2, OUTPUT);
    pinMode(echoPin2, INPUT);
    servo2.write(0);         //close cap on power on
    delay(100);
    servo2.detach();
}

void measure() {
  digitalWrite(10,HIGH);
  digitalWrite(trigPin, LOW);
  delayMicroseconds(5);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(15);
  digitalWrite(trigPin, LOW);
  pinMode(echoPin, INPUT);
  duration = pulseIn(echoPin, HIGH);
  dist = (duration/2) / 29.1;    //obtain distance
}
void measure2() {
  digitalWrite(10,HIGH);
  digitalWrite(trigPin2, LOW);
  delayMicroseconds(5);
  digitalWrite(trigPin2, HIGH);
  delayMicroseconds(15);
  digitalWrite(trigPin2, LOW);
  pinMode(echoPin2, INPUT);
  duration2 = pulseIn(echoPin2, HIGH);
  dist2 = (duration2/2) / 29.1;    //obtain distance
}
void loop() {
  for (int i=0;i<=2;i++) {   //average distance
    measure();
    measure2();
   aver[i]=dist;
   aver2[i]=dist2;
    delay(10);              //delay between measurements
  }
 dist=(aver[0]+aver[1]+aver[2])/3;
 dist2=(aver2[0]+aver2[1]+aver2[2])/3;
 Serial.print(dist2);

if ( dist<50 ) {
//Change distance as per your need
 servo.attach(servoPin);
  delay(1);
```

```
 servo.write(0);
 delay(3000);
 servo.write(150);
 delay(1000);
 servo.detach();
}
if ( dist2<20 ) {
//Change distance as per your need
 digitalWrite(ledPin, HIGH);
}
if ( dist2>10 ) {
//Change distance as per your need
 digitalWrite(ledPin, LOW);
}
Serial.print(dist);
}
```

REFERENCES

[1] Pavan Kumar Reddy chinthakunta1 , R Shiva Sai Rama Krishna, K. S. S. Naga Teja and S. Sunanda (2019), Smart Dustbin Using ARDUINO, Ultrasonic Sensor Servo Motor, Available at: http://ijrad.com/docs/v3n4/10.pdf

[2] Syazwan Sabri (2021), SMART DUSTBIN USING ARDUINO WITH ULTRASONIC SENSOR AND SERVO MOTOR Available at: https://www.youtube.com/watch?v=rByHoOvbrtg

[3] Tanu Nanda Prabhu, University of Regina (2019), Available at: https://urcourses.uregina.ca/pluginfile.php/3188539/mod_resource/content/1/Example%20Write-up.pdf

[4] Sourabh Deshmukh (2017), Smart Dustbin , Abailable at: https://github.com/sourabhdeshmukh/Smart-Dustbin

[5] Srushti Vaghani (2022), Smart Dustbin using Arduino with Ultrasonic Sensor, servo motor and LED Alert, Abailable at: https://github.com/srushtivaghani/Smart-Dustbin