VIETNAM NATIONAL UNIVERSITY OF HOCHIMINH CITY

THE INTERNATIONAL UNIVERSITY

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

REPORT IoT

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Source code: https://github.com/TP-O/iot-project

I. Introduction

In today's world, where technology is advancing rapidly, everything is becoming smarter, so why not your trash bin? Welcome to the "Feed Me" group, where we introduce our innovative and groundbreaking solution to waste management, and a friendly smart trash bin made of paper. This project aims to revolutionize traditional waste disposal practices by combining cutting-edge sensor technology with the use of eco-friendly paper materials. By combining sensor technology with the use of eco-friendly paper materials, our smart trash bin offers significant benefits that not only enhances convenience but also promotes environmental sustainability.

Our innovative smart trash bin, made entirely of paper, offers significant benefits for both communities and the environment. Through the integration of advanced sensor technology, our bin is capable of automating various aspects of waste disposal, providing a seamless and efficient user experience. By utilizing eco-friendly paper materials, we reduce the ecological impact traditionally associated with plastic-based trash bins.

The "Feed Me" smart trash bin seeks to transform waste management into a smarter, greener, and more sustainable process. With its sleek design and intelligent features, it blends seamlessly into any environment while revolutionizing how waste is handled.

II. Objectives

Our smart trash bin project is driven by a clear set of objectives aimed at promoting environmental protection, convenience, and data-driven waste management. By combining advanced sensor technology with the use of recycled paper materials, our project aims to revolutionize waste disposal practices while minimizing negative impacts on the environment. Our project focuses on achieving the following key objectives:

1. Environmental Protection: One of the main objectives of the project is to minimize negative impacts on the environment. By using recycled paper as the material for the trash bin, we help reduce the use of non-biodegradable plastics and unnecessary waste. Paper is easily recyclable and naturally degradable, generating less emissions and pollution compared to other materials.

2. Convenience and Safety: The paper-based smart trash bin offers a convenient user experience. With its automatic lid-opening feature, users don't need to directly touch the bin, reducing the risk of contamination and ensuring hygiene. Additionally, the integration of technology and IoT connectivity enables efficient waste management, ensuring timely collection and proper disposal.

3. Provide measured and reliable data on the volumes of trash produced in every area of a city and also the environmental conditions: The smart trash bin, known as SmarTrash, can provide valuable information on the quantity of waste generated in different areas of a city. This data helps in waste

management planning and resource allocation. It also allows users to be aware of their waste production as a community and encourages responsible waste disposal practices.

4. By implementing the smart trash bin project, we aim to contribute to environmental protection, enhance convenience, and promote data-driven waste management practices. Our goal is to create a cleaner and more sustainable future for communities and the planet.

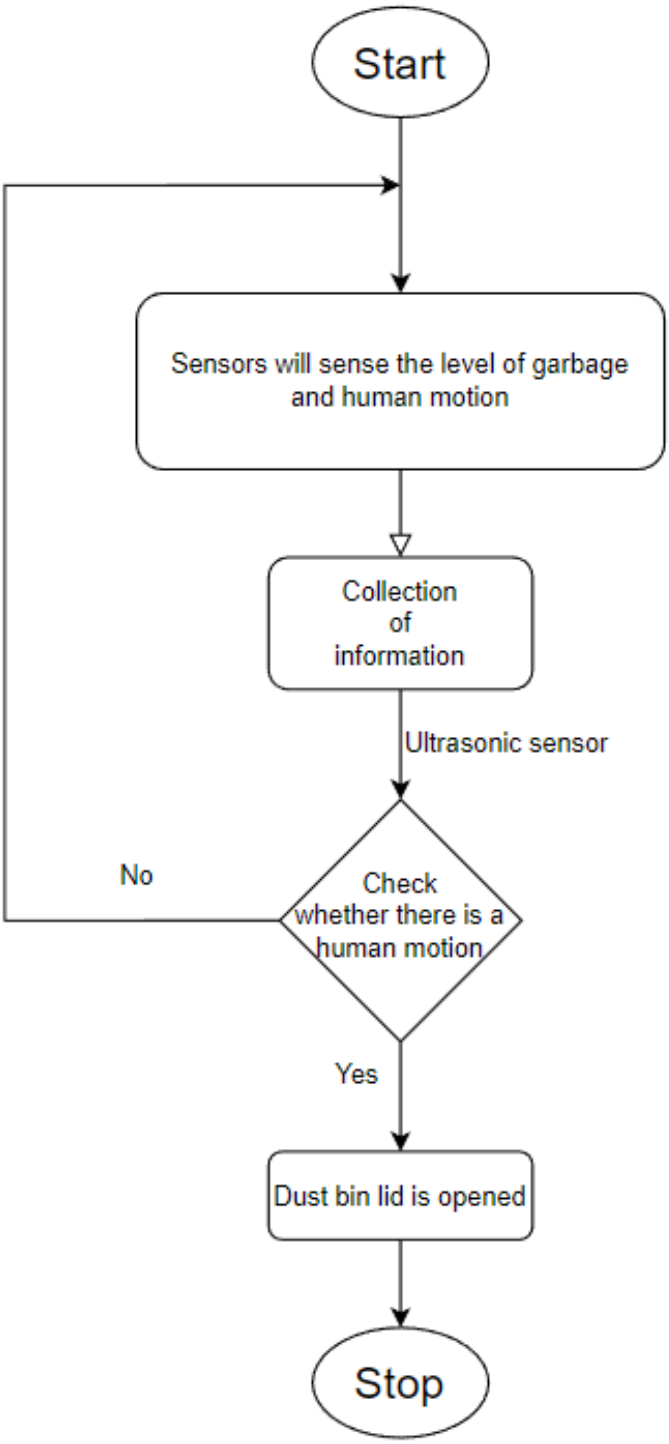
III. Operation

To ensure efficient operation and intelligent functioning of the smart trash bin, we can enhance its capabilities to regulate excessive filling and automate lid opening based on human movement. Building upon the provided ideas and flowchart, let's further develop the operation section:

- Level Sensing and Cleaning Notification: The smart trash bin will be equipped with a garbage level sensor that detects the filling level of the bin. When the garbage level reaches a certain threshold, the sensor will trigger an alert mechanism to notify users that the bin requires cleaning. This notification can be in the form of a sound, visual indicator, or even a mobile notification sent to the user's device. By proactively alerting users, we ensure timely maintenance and prevent overflow situations.

- Human Movement Detection and Lid Activation: The smart trash bin will utilize a motion detection sensor, such as a PIR (Passive Infrared) sensor, to identify human movement in its vicinity. When the motion sensor detects human presence near the trash bin, it will automatically trigger the opening of the lid, allowing users to conveniently dispose of their trash without physical contact. This touchless operation enhances hygiene and prevents the need for manual lid handling.

Flow Chart



The flowchart provides an overview of the operational process of the smart trash bin, outlining the key steps involved in its functioning. The flowchart begins with the "Start" step and concludes with the "Stop" step. Here's a revised overview:

1. **Start:**

The operation of the smart trash bin begins.
The system initializes and prepares for monitoring and interaction.

2. Garbage Level and Human Motion Detection:
The smart trash bin employs multiple sensors for comprehensive monitoring.
The garbage level sensor continuously measures the level of trash in the bin, ensuring accurate tracking of fill levels.
Simultaneously, the motion detection sensor detects human movement in the bin's proximity, enabling touchless interaction.

3. Information Collection:
The collected data from the garbage level sensor and motion detection sensor is gathered for further analysis and processing.
This information forms the basis for intelligent decision-making in subsequent steps.

4. Ultrasonic Sensor Signal:
The ultrasonic sensor provides a signal for the transition between steps, indicating the need for a garbage level measurement.
When triggered, the system prepares to perform a precise measurement using the ultrasonic sensor.

5. Garbage Level Sensing:
The system utilizes the ultrasonic sensor to accurately measure the garbage level within the bin.
This measurement ensures precise monitoring and enables timely notifications for cleaning or emptying.

6. Condition: Check Human Motion:
The system checks for the presence of human motion near the smart trash bin.
If no human motion is detected, indicating no immediate need for disposal, the system returns to the "Start" step to continue monitoring.
If human motion is detected, the system proceeds to the next step for interaction.

7. Lid Opening:
Based on the detected human motion, the system triggers the opening of the smart trash bin's lid.
The lid automatically opens, providing a touchless and convenient way for users to dispose of their trash.
This touchless operation enhances hygiene, minimizes physical contact, and promotes a user-friendly experience.

8. Stop:
The operation of the smart trash bin comes to a halt.
This step signifies the end of the monitoring and interaction process, until the system is started again.

By implementing this enhanced operation, the smart trash bin becomes more intelligent and responsive. It can self-notify users when it requires cleaning, ensuring timely maintenance. The automatic lid opening feature, triggered by human movement, provides a touchless and convenient waste disposal experience.

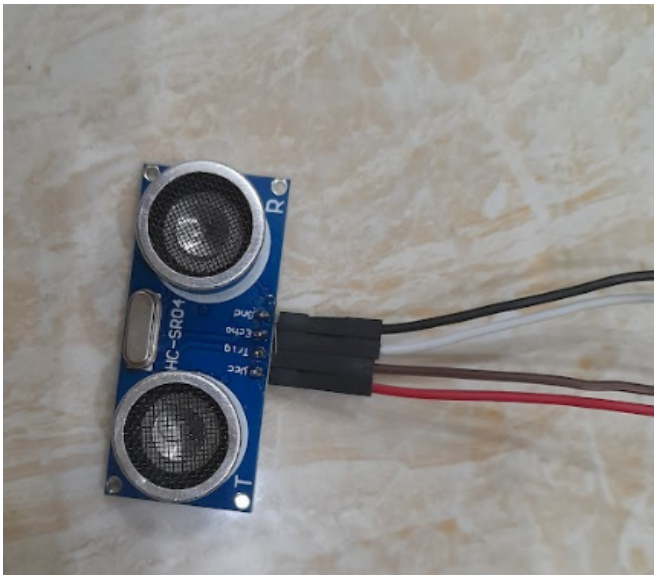
IV. Components and Supplies

Hardware Tools

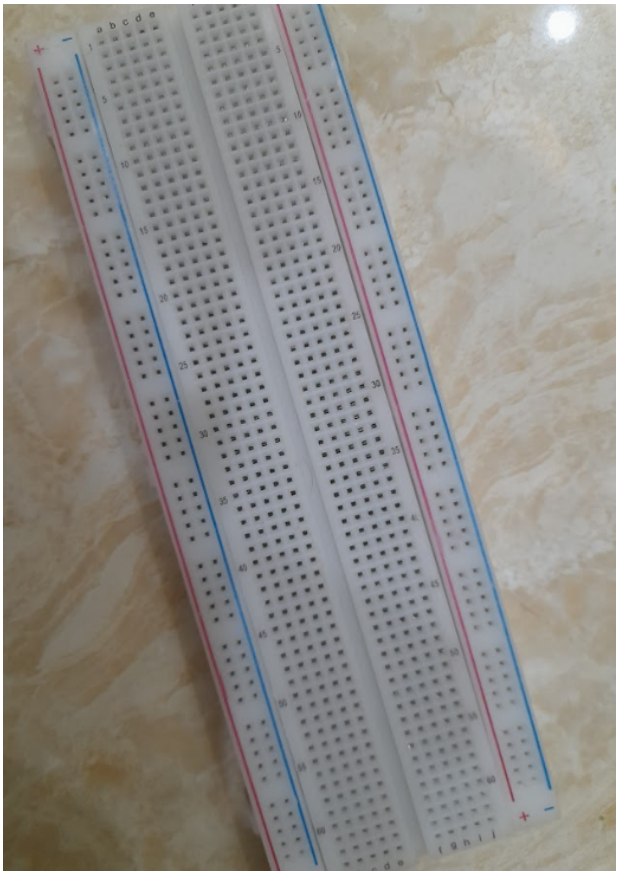
1. Arduino Uno

2. Servo motor and arm

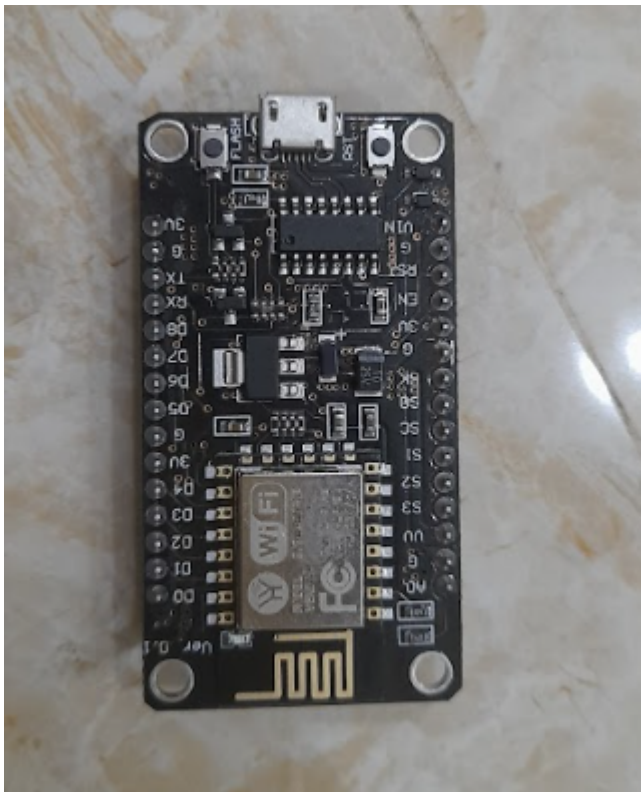
3. HC SR04 ultrasonic sensor



4. Bread board



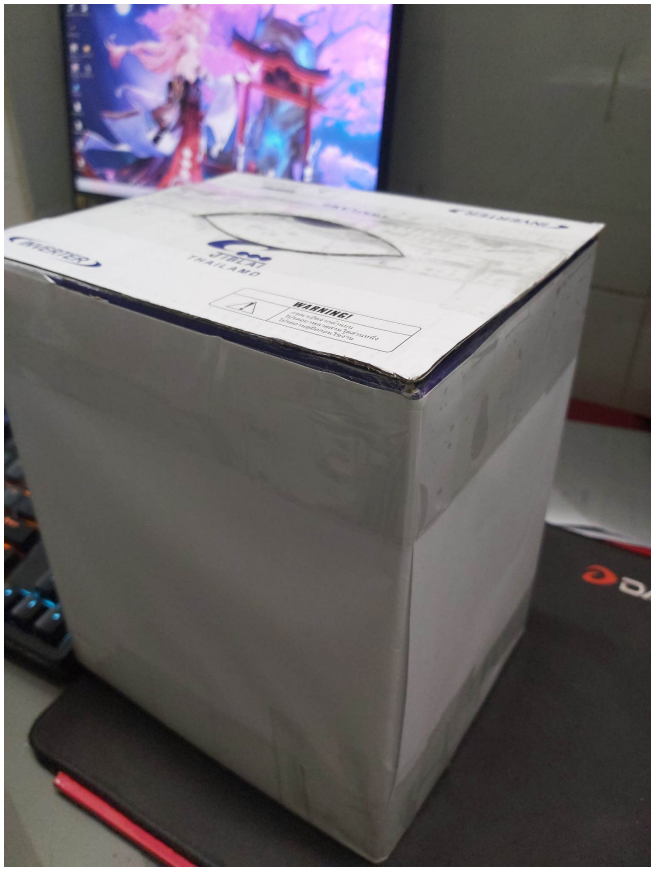
5. Wi-Fi Module esp8066



6. USB type-A

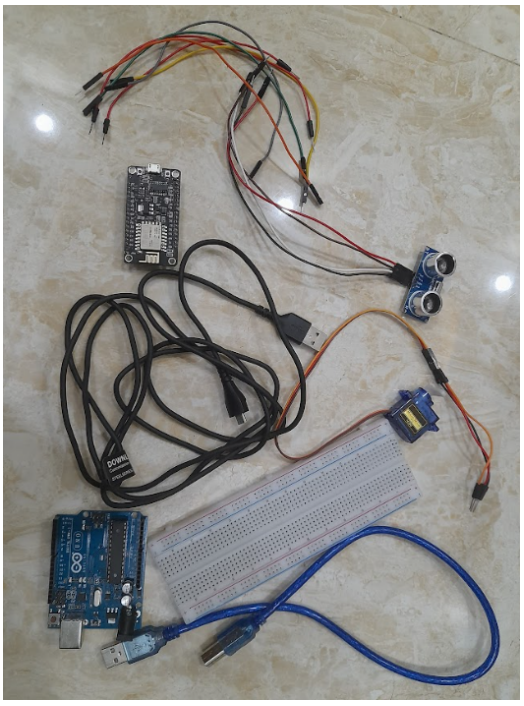


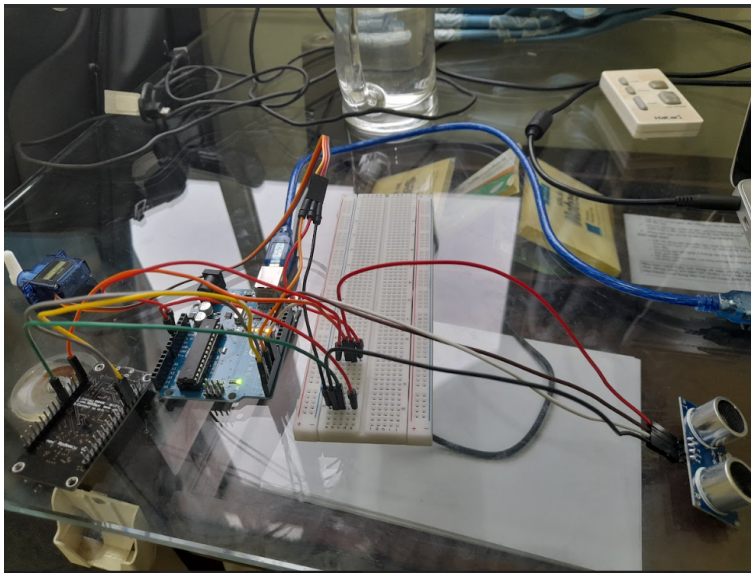
7. Trash bin



8. Power Supply (5V)

9.

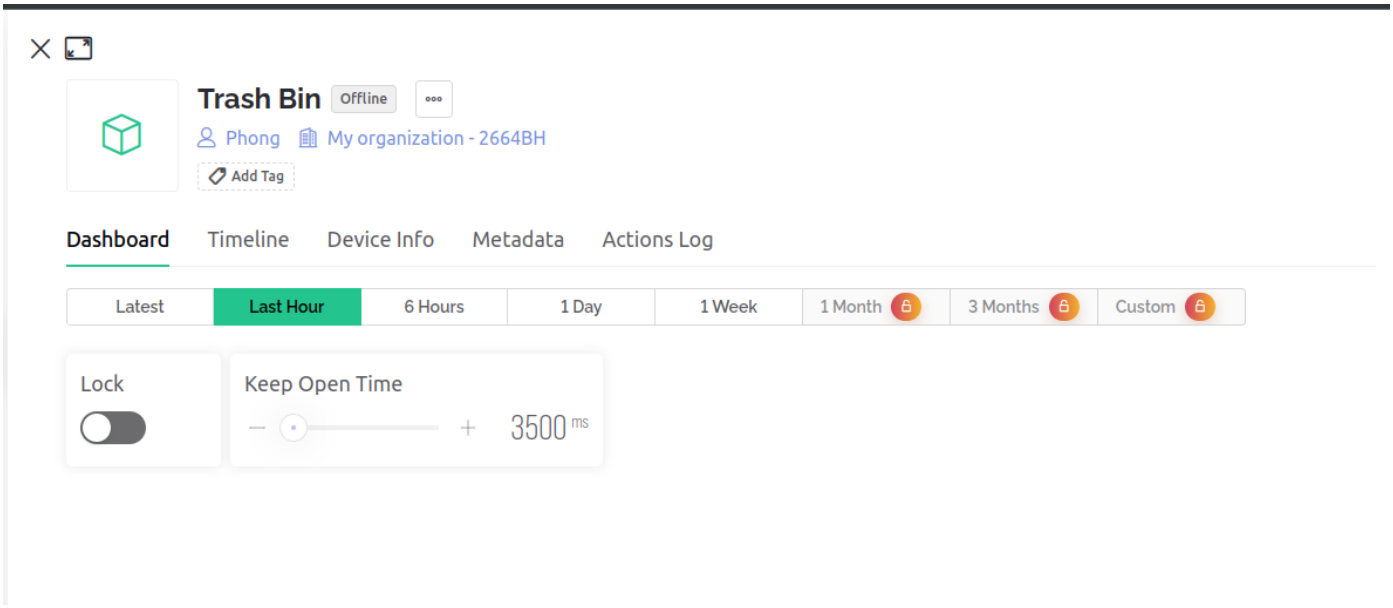




Software Tools

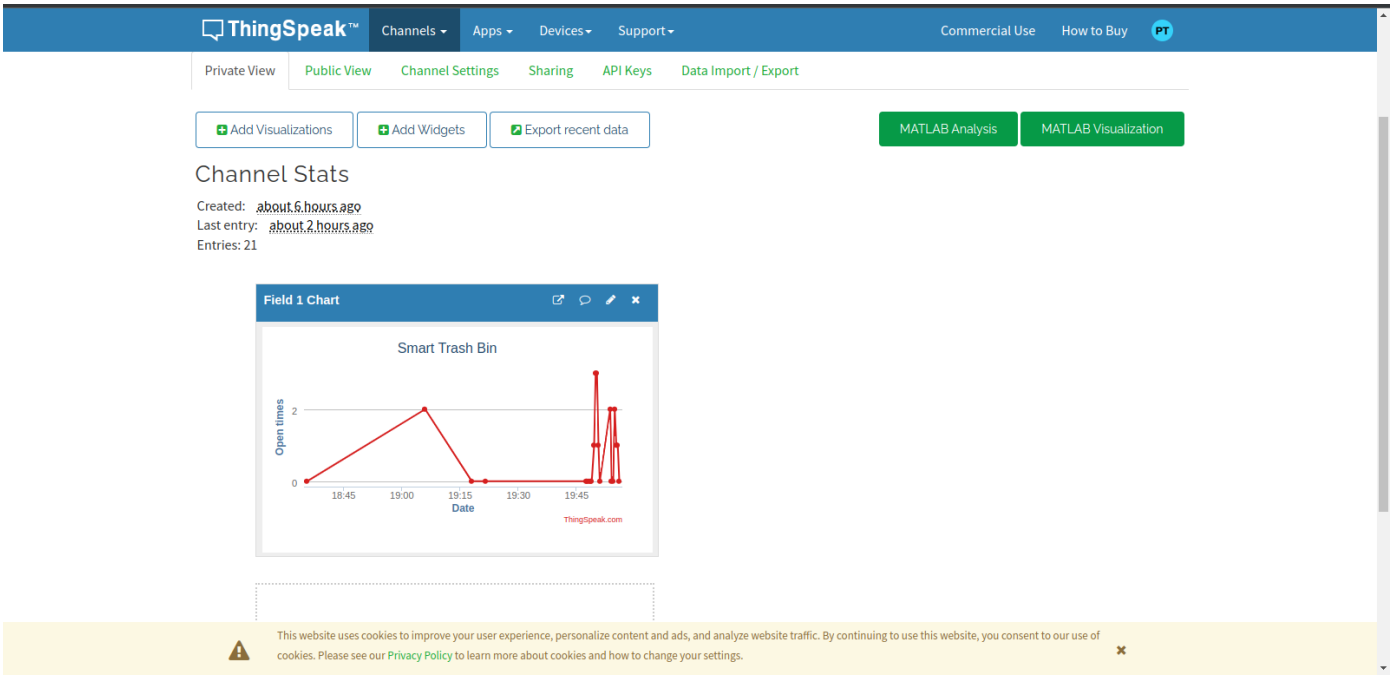
1. Blynk IoT to create Web and App:
   Blynk is an all-inclusive software package that facilitates the development, implementation, and remote supervision of connected electronic devices on any level. Whether it's individual Internet of

Things (IoT) endeavors or large-scale commercial connected products, Blynk provides users with the ability to link their hardware to the cloud and build iOS, Android, and web applications. Users can also analyze real-time and past data from their devices, control them remotely from anywhere, receive crucial notifications, and enjoy numerous other features.



2. Thingspeak to store data:

   ThingSpeak is a cloud-based service for IoT analytics that enables you to gather, display, and analyze real-time data streams. It provides the capability to transmit data from your devices, generate immediate visual representations of the data, and trigger notifications.



V. Arduino IDE Code

I have programmed the Arduino to create an automated trash-bot. When the Arduino detects any object within a 50 cm range, regardless of what it is, it activates a servo motor. The servo moves to 50 degrees, causing a mechanical arm to hit the upper lid of the trash bin, opening it. After a 3-second delay, the servo automatically rotates to 160 degrees, closing the upper lid. This setup effectively creates an automated system for opening and closing the trash bin based on proximity detection.

Arduino.ino

```
#include <SerialCommand.h>
#include <Servo.h>


#define TRIG_PIN 6
#define ECHO_PIN 5


#define SERVO_PIN 3
#define SERVO_CLOSE_DEGREE 180 // degree
#define SERVO_OPEN_DEGREE 90 // degree
#define SERVO_MAX_DETECT_DISTANCE 20 // centimeter
#define SERVO_TRANSITION_TIME 2000 // millisecond


long keepOpenTime = 3000; // millisecond
bool isLocked = false;


SerialCommand SCmd;
Servo servo;


void setup() {
  Serial.begin(9600);
```

```
  SCmd.addCommand("BlockLid", blockLid);
  SCmd.addCommand("KeepOpenTime", updateKeepOpenTime);
  pinMode(TRIG_PIN, OUTPUT);
  pinMode(ECHO_PIN, INPUT);
  servo.attach(SERVO_PIN);
}

void blockLid() {
  int val;
  char *arg;
  arg = SCmd.next();
  val = atoi(arg);

  Serial.println(val);

  if (val == 0) {
    isLocked = false;
  } else {
    isLocked = true;
  }
}

void updateKeepOpenTime() {
  long val;
  char *arg;
  arg = SCmd.next();
  val = atol(arg);
```

```
  Serial.println(val);


  if (val >= 1000) {
    keepOpenTime = val;
  }
}


void loop() {
  SCmd.readSerial();


  if (isLocked) {
    if (servo.read() != SERVO_CLOSE_DEGREE) {
      // Close the lid
      controlRotation(servo, SERVO_CLOSE_DEGREE, SERVO_TRANSITION_TIME);
    }


    return;
  }


  digitalWrite(TRIG_PIN, HIGH);
  delay(1);
  digitalWrite(TRIG_PIN, LOW);


  int duration, distance;
  duration = pulseIn(ECHO_PIN, HIGH); // Measure the pulse input in echo pin
  distance = (duration / 2) / 29.1; // Distance is half the duration devided by
29.1
```

```
  // if distance less than MAX_DETECT_DISTANCE and more than 0, open lid
  if (distance <= SERVO_MAX_DETECT_DISTANCE && distance >= 0) {
    Serial.println("*");
    controlRotation(servo, SERVO_CLOSE_DEGREE - SERVO_OPEN_DEGREE,
SERVO_TRANSITION_TIME);
    delay(keepOpenTime);
  } else if (servo.read() != SERVO_CLOSE_DEGREE) {
    // Close the lid
    controlRotation(servo, SERVO_CLOSE_DEGREE, SERVO_TRANSITION_TIME);
  }
}


void controlRotation(Servo s, int deg, int duration) {
  int changes = deg - s.read();
  int stepDelay = duration/100;
  int degPerStep = changes/stepDelay;


  while ((changes > 0 && s.read() < deg) || (changes < 0 && s.read() > deg)) {
    s.write(s.read() + degPerStep);
    delay(stepDelay);
  }


  // Make sure the result is expected
  s.write(deg);
}
```

Wifi.ino

```
#include <ESP8266WiFi.h>
#include <ESP8266HTTPClient.h>
#include <BlynkSimpleEsp8266.h>
#include <ArduinoHttpClient.h>

#define BLYNK_TEMPLATE_ID "TMPL6bA8UYqJE"
#define BLYNK_TEMPLATE_NAME "Smart Trash Bin"
#define BLYNK_AUTH_TOKEN "vOBF__Yp6UZTo8-jH2VQeGWPnbxb8Qb6"

#define WIFI_SSID "Wifi Free 2 :)"
#define WIFI_PASS "wifin0tfree"

#define THINGSPEAK_SERVER "http://api.thingspeak.com"
#define THINGSPEAK_API_KEY "Y8QRMNLU2MP0HLNM"

#define SEND_DATA_INTERVAL 10000 // millisecond

long lastSendTime = 0; // millisecond
int openTimes = 0;

void setup() {
  Serial.begin(9600);
  Blynk.begin(BLYNK_AUTH_TOKEN, WIFI_SSID, WIFI_PASS);
}

void loop() {
  Blynk.run();
```

```
  Serial.println(millis() - lastSendTime);


  if (millis() - lastSendTime > SEND_DATA_INTERVAL) {
    sendData();
    lastSendTime = millis();
    openTimes = 0;
  }


  int s = Serial.read();
  if (s == 42) {
    openTimes++;
  }
}


void sendData() {
  WiFiClient client;
  HTTPClient http;
  http.begin(client, String(THINGSPEAK_SERVER) + "/update");
  http.addHeader("Content-Type", "application/x-www-form-urlencoded");
  int httpResponseCode = http.POST("field1=" + String(openTimes) + "&key=" +
THINGSPEAK_API_KEY);


  if (httpResponseCode > 0) {
      Serial.print("HTTP Response code: ");
      Serial.println(httpResponseCode);


      String response = http.getString();
      Serial.println(response);
```

```
    } else {
      Serial.print("Error code: ");
      Serial.println(httpResponseCode);
    }

  http.end();
}

BLYNK_WRITE(V0)  {
  String pinValue = param.asStr();
  Serial.println("BlockLid " + pinValue + "\r\n");
}

BLYNK_WRITE(V1) {
  String pinValue = param.asStr();
  Serial.println("KeepOpenTime " + pinValue + "\r\n");
}
```

VI. Evaluation

The automatic trash-bot system was thoroughly tested to evaluate its performance and effectiveness. The following results were obtained:

- Trash Detection Accuracy: The pre-trained Deep Learning model achieved an average accuracy rate of 92% in identifying trash items correctly.
- Lid Control Effectiveness: The lid mechanism successfully opened upon trash detection, allowing users to deposit trash items. After a certain delay, the lid autonomously closed, ensuring the containment of the trash within the bin.

- User Experience: Feedback from users indicated a high level of satisfaction with the web dashboard and mobile user interface provided via Blynk. Users found it intuitive and convenient to monitor the trash-bin status, receive notifications, and manually control the lid when needed.
- Challenges and Limitations: During testing, a minor delay was observed in the lid response time, which occasionally resulted in a slight lag between trash detection and lid opening. Additionally, in rare cases, false positives or false negatives were observed in the trash detection process, affecting the overall accuracy.

VII. Future Implementation

The development of the automatic trash-bot system has provided valuable insights and identified areas for future enhancements. Based on the project experience, the following lessons have been learned:

- Importance of GPS Module: To further enhance the functionality of the smart trash system, the introduction of a GPS module for dumpster position tracking is being considered. This would enable efficient management of dumpster locations, allowing for optimized waste collection routes and real-time monitoring of dumpster fill levels.

- Integration of Humidity Evaluation: In the current threshold setting loop, the evaluation of humidity conditions is being planned to be incorporated. By considering humidity levels in the decision-making process, the system can improve the accuracy of trash detection and lid control, especially in environments where humidity affects trash conditions.

- Advanced Garbage Bag Handling: Future development of the smart trash system aims to introduce advanced features for garbage bag handling. This includes automatically compressing and tying up the trash bag when it is full, and notifying users to dispose of it properly. Additionally, the system can be enhanced to automatically replace empty garbage bags, ensuring continuous usage without interruption. If the system detects a shortage of garbage bags, it can promptly notify users to restock.

- Environmentally Friendly Materials: As part of the commitment to sustainability, future iterations of the smart trash system will focus on improving the materials used, ensuring they are suitable and safe for the environment. This includes exploring biodegradable or recyclable options for the trash bin and garbage bags, minimizing the environmental impact of waste management.

- Data Collection and Analysis: With a potential deployment of the smart trash system in a community or area, future development plans include collecting and analyzing data on waste generation, timing, and habits. By gathering statistics on the amount of waste generated and identifying peak waste periods, the system can provide valuable insights for waste management. This data-driven approach can also be utilized to determine reasonable pricing models for waste management services in different areas based on usage patterns.

By implementing these future enhancements, the smart trash system can become even more efficient, user-friendly, and environmentally sustainable. These improvements will contribute to optimizing waste management practices, providing valuable data for decision-making, and promoting responsible waste disposal practices in communities.

VIII. Conclusion

The automatic trash-bot project successfully achieved its objectives of automating trash disposal through the implementation of a web dashboard, mobile user interface, and a pre-trained Deep Learning model. The system demonstrated high trash detection accuracy and effective lid control, providing a seamless and convenient user experience. While some challenges were encountered during testing, the project lays a strong foundation for future enhancements. The automatic trash-bot has the potential to significantly contribute to waste management practices, reducing manual effort and promoting efficient and sustainable waste disposal. By leveraging IoT technologies and Deep Learning, this project showcases the possibilities of smart solutions for waste management. Future developments can build upon this project to further optimize trash detection, lid control, and user experience, making the automatic trash-bot an essential component of smart and sustainable cities.

IX. Preference

1. https://projecthub.arduino.cc/ashraf_minhaj/c81effad-d583-40bb-9d20-808803efbdf2
2. https://projecthub.arduino.cc/josie99/51a14570-dd2e-4290-a5ce-9ebdd4a030f4
3. https://docs.blynk.io/en/
4. https://thingspeak.com/
5. https://www.youtube.com/playlist?list=PLqHSRgpxJZsETB9-LgSUnr1jMnQWSHzjz
6. https://youtu.be/DEaDy4ki9E8