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Implementation of Internet of Things in Making Smart Trash Bins Case Study Paud Elevate Mbatakapidu

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Abstract

Problem Garbage in Waingapu City, East Sumba, is increasing Serious consequence stacking and mixing trash that is not classified based on types in some locations, such as the Inpres Market, and several place tourism around Waingapu City. Lack of awareness public For throw away trash in its place and facilities limited transportation give impact negative on the environment including pollution land, water and air. Research This aiming For test accuracy IoT technology in classify rubbish organic and inorganic as well as detecting waste volume on prototype place the trash that will created. PAUD Elevate Mbatakapidu made into as location research and testing accuracy place waste. This research has been successfully designed place rubbish clever IoT based which can sorting rubbish organic and inorganic using capacitive proximity sensors and inductive proximity sensors which are then separated using servo motor. Place rubbish this can also monitor the volume of waste at the site rubbish use application blynk . In an experiment conducted by researchers happen error in sorting rubbish organic by 20%, sorting rubbish inorganic by 40%. For monitoring of waste volume at the site rubbish organic 100% successful while place rubbish inorganic No succeed.

Keywords: *Sorting Trash, IoT Technology, Early Childhood, Place Rubbish Automatic*

1. Introduction

Throughout human civilization on earth, waste production has become something that cannot be avoided. Since humans began their activities, both in terms of economy, social and culture, various types of waste have been produced. Waste is used goods or materials that are no longer used or are considered useless so they are thrown away. Waste can come from various sources such as households, industry and the business sector. The problem of waste is something that cannot be avoided because every day humans produce waste. If left alone without being classified by type, waste can have a negative impact on the environment such as the environment becoming dirty, emitting an unpleasant odor and can be a source of disease transmission.
Based on interview data with Mr. Melvi Reimon M. Tiga, S.Si., M.Si as the Young Expert Environmental Impact Control Functional at the East Sumba Regency Environmental Service, he stated that the waste problem also occurs in Kota Waingapu District and Kambera District, East Sumba Regency. This condition is very concerning because there are several points that are used as garbage accumulation sites. This is caused by the community paradigm that assumes that humans have the highest power over nature and the lack of public awareness of the importance of protecting the environment. Many efforts have been made by the government to reduce waste generation, such as conducting socialization, technical guidance, or training for community elements including church women's commissions, groups of decorated mothers and schools, although not all community elements are reached.
Matawai Market, people's harbor, tourist attractions, and fields or locations for activities, become points of garbage accumulation. The main actors who throw away the garbage are adults who are then imitated by children. To change the paradigm and habits of society in managing waste and instill the principle that your waste is your responsibility, it needs to be started early, especially through early childhood education.

Education is one of the most effective tools to instill values of environmental concern. Early Childhood Education (PAUD) is the initial stage of formal education that is very influential in the formation of children's character. By providing a good understanding of the importance of waste management, it is hoped that future generations can be more aware and responsible for the environment.
The application of IoT (Internet of Things) technology in the manufacture of trash bins that classify organic and inorganic waste and detect the volume of trash bin contents can be an effective solution to overcome several waste management problems in East Sumba. In the manufacture of a prototype trash bin that classifies organic and inorganic waste, technology will be provided in the form of proximity sensors to classify waste based on its type, ultrasonic sensors to detect the volume of the trash bin, wemos D1R1 as a microcontroller, blynk which functions for remote control and other supporting technologies.

This study aims to make PAUD Elevate Mbatakapidu a trial location to measure the accuracy of IoT technology in classifying organic and inorganic waste and detecting the volume of trash bins, as an effort to overcome the problem of scattered waste in Waingapu City, East

Sumba. The selection of PAUD Elevate Mbatakapidu is based on the importance of teaching waste management, including sorting, from an early age so that this good habit can be carried over into adulthood. In addition, PAUD Elevate is located on the outskirts of the city, where the community still has minimal understanding of the importance of good waste management. By involving children, it is hoped that it can increase environmental awareness and build good habits for better waste management habits in the future. This study will use the prototype method in the research process.

In an effort to improve the accuracy of organic and inorganic waste classification and detect the volume of the trash bin, a study was previously conducted by Muhammad N. Havid et al in 2022 with the research title "Design and Construction of a Waste Sorting Tool Based on Organic and Inorganic Types". The results of this study indicate that a combination of several sensors can be used to classify waste and detect the volume of the trash bin.

Based on the existing problems and supported by previous research, the researcher provides a solution to solve the problem by creating a prototype of a trash can that can classify organic and inorganic waste and detect the volume of the trash can using IoT technology. The results of this study are expected to help reduce the accumulation of waste in East Sumba Regency, especially for PAUD Elevate Mbatakapidu. In addition, this prototype is expected to provide an attraction for children to maintain environmental cleanliness, sort waste properly.

2. Studies Literature

2.1. Rubbish

Rubbish is remainder use good living creature humans , animals and plants that are discarded in form solid , liquid or gas because No used again . In Law No.18 of 2008 concerning Management Trash , trash is remainder activity daily humans and /or shaped natural processes solid . Garbage covers various type waste produced from activity domestic , industrial and commercial (Damanhuri & Padmi, 2010) .

2.1.1. Rubbish Organic

Rubbish organic is waste that is of a nature natural produced by the remains good living creature human , animal and also Plants . Types rubbish This covering covering the remains food, leaves fruit , tree branches and dirt Animals . Garbage organic can unraveled in a way natural and contribute to the recycling process repeat in nature.

2.1.2. Rubbish Inorganic

Meyrena & Amelia, (2020) say that rubbish inorganic is type waste produced from industrial processes and from various activity humans , the ingredients of which mixed up with substance chemistry so that difficult For unraveled in a way natural . Garbage This covers various materials that are not originate from living creatures like plastic , metal , glass as well as various material chemistry other.

2.2. Internet of Things

The Internet of Things or known by the abbreviation IoT is a concept that refers to a network of physical objects equipped with sensors, software and other technologies that enable these objects to collect and exchange data via the internet without requiring direct interaction between humans and machines.

2.3. Arduino IDE

Sukarjadi et al., (2017) said that IDE or Integrated Development Environment in a way simple can interpreted as environment integrated For development . Through Arduino IDE , Arduino programming for operate embedded functions through syntax programming . The Arduino programming language (Sketch) has modified For make it easier beginner in Study programming compared to with Language originally . Arduino IDE was developed use Language JAVA programming and equipped with known C/C++ libraries as Wiring that makes it easier input and output operations.

2.4. Blynk

Blynk is a platform for Mobile application designed For control device hard such as Arduino, Raspberry Pi, ESP8266, Wemos D1 and modules similar through internet connection . Blynk allow user For make interface graphic IoT projects with method drag - and - drop widgets , making it very easy used including for beginners . This platform nature flexible and not bound to module certain , so that allow For control various device from distance Far during connected with the internet (Widodo et al., 2019) .

2.5. Microcontroller

Microcontroller is A system computer small designed For control device electronics . Microcontroller usually consists of from component such as CPU, memory and input/output (I/O) in one chip. Component This used in various application including automation , control devices and communications . Microcontroller functioning as For run the program that has been written and uploaded to inside . This program arrange How microcontroller interact with device other hardware such as sensors and actuators . In IoT context , microcontroller become component important Because his ability For connected to the internet which allows automation as well as control distance Far.

2.6. Proximity Sensor

Bahtiar et al. (2019) explain that the proximity sensor is capacitive is the device used For detect existence object without contact physical . Principle how this sensor works based on change capacitance that occurs when object approaching the sensor. Capacitive sensor emit Medan electricity and detect changes in the field which is caused by an object that has characteristic dielectric different . Inductive proximity sensor is a sensor that functions For detect existence object without contact physical , but principle his work different . This sensor use

principle electromagnetic For detect object metal . This sensor produce Medan electromagnetic and detecting change in machine the when object metal like copper or iron approach him.

2.7. Ultrasonic Sensor HC-SR04

Ultrasonic sensors are used For detect distance between position with object whatever there is in front of him without contact with distance 2 cm to 400 cm and accuracy measurement distance reaches 3mm. The HC-SR04 ultrasonic sensor has 4 (four) pins, each labeled Vcc , Trig , Echo and Gnd.

2.8. Servo Motor

Servo motor is type actuator rotary designed with system control bait return that allows arrangement position output shaft in accurate . Servo motors consist of from a number of component such as DC motors, gear systems , circuits control and potentiometer working The same For organize and ensure position end of motor.

2.9. Prototype

Method prototype is approach in development the system used For build initial model from desired system. Prototype This functioning as design functional from system and used For gather bait come back from user before development final system is done. Method This allow user For interact with the system in progress made, so that can to clarify need users, reduce risk system failure end as well as increase involvement user in testing system .

2.10. MQTT

Message Queue Telemetry Transport (MQTT) is protocol designed communication special For application Internet of Things and communications between machine to machine (M2M) operating at the surface level application or screen the seventh designed For send a light message. With use method communication publish/subscribe, the MQTT protocol allows sender (publisher) for send message to the broker who then will distribute it to recipients (subscribers) who have subscribe to the topic certain . This No only reduce pressure on the network, but also increases effectiveness communication between device.

3. Research Method

Elevate Mbatakapidu Early Childhood Education (PAUD) School is one of the formal education institution for children age early located in the village Mbatakapidu , East Sumba Regency . Standing since May 28, 2018 by Charis Foundation. School This has accept support from government through the East Sumba District Education Office . School This is managed by 2 teachers with 17 students consisting of from 11 students boys and 6 students Woman For period 2024/2025 .
Methods used as stages study in study This is as following:

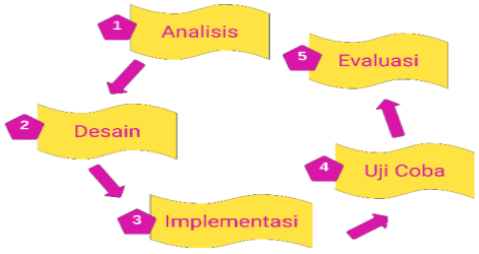

Figure 1: method study

Figure 1 is method research used in research This . Research begins from Analysis For identify problem management garbage , collecting data through interviews , as well as analyze need device hard and soft . Continued with stage design , including design system , schematic tools , sorting tools trash and interface user . After That done Implementation that is making prototype , installation device hard , and development device software . Trial phase done For ensure function system walk with good . Last stage evaluation , test results for evaluate effectiveness system and created report as well as recommendations . If the system Not yet succeed done repair and testing repeat .

3.1. Block Diagram

Block diagram design is visual images used For describe structure and function from system place rubbish clever IoT based .

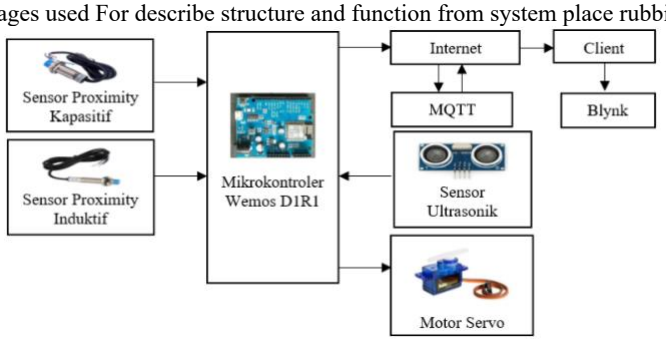

Figure 2: Block Diagram

Figure 2. Is block diagram method Work system place rubbish smart. In the picture the there is a capacitive proximity sensor that works For detect rubbish type organic , inductive proximity sensor that functions For detect rubbish type inorganic , ultrasonic sensors for monitor the volume of waste at the site the waste is then sent to Wemos D1R1 as microcontroller For process and manage the result data sensor reading . result data sorting the will determine servo motor direction in sorting type trash. All the result data reading from these sensors will sent to application Blynk via MQTT, allowing monitoring and control distance away by the user.

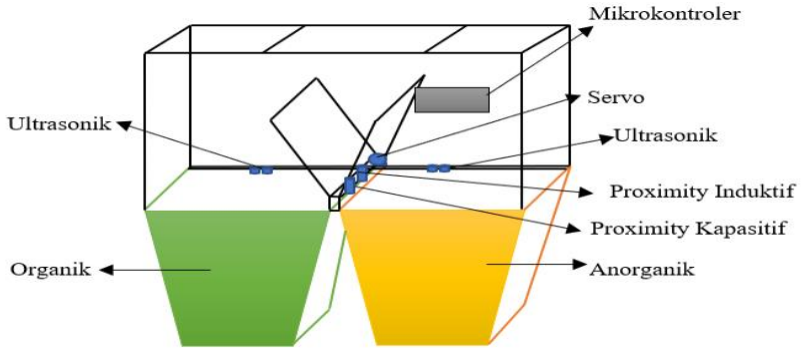

Figure 3: Place model rubbish

Figure 3. Is a model of the place rubbish clever IoT -based that identifies and sorts rubbish in a way automatic . Trash will entered into the place rubbish through mouth place the garbage that then identified the type via proximity sensor. If the result identification rubbish show rubbish organic , then the servo will to move Sorter to place rubbish organic even so on the contrary . On the system place rubbish clever This IoT- based , ultrasonic sensor functioning For detecting waste volume in place the garbage that then will send the data to user through application Blynk.

3.2. Workflow system place rubbish clever

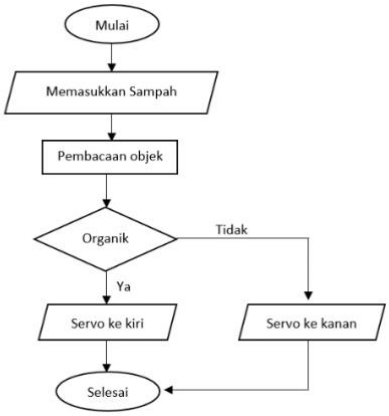

Figure 4: flow separation rubbish

Figure 4. illustrates channel sorting organic and inorganic waste use it IoT technology . The process begins from enter the garbage that then identified or read by the proximity sensor. If the trash including organic type then servo will move to left For to drop rubbish to place rubbish organic . If the waste including inorganic , eat servo will move to right For to drop rubbish to place rubbish inorganic .

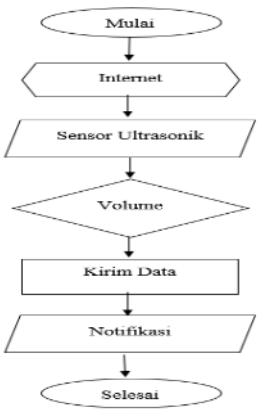

Figure 5: Flow monitoring rubbish

Figure 5 illustrates about the process of detecting the volume of a place rubbish clever via ultrasonic sensor . Started from initialization the system that consists of from ultrasonic sensor initialization and initialization Wi-Fi connection and applications blynk . After that to be continued with Detection of waste volume by ultrasonic sensor based on distance between the sensor and surface garbage . The results of reading the volume of garbage will sent to application Blynk .

3.3 Series Schematic

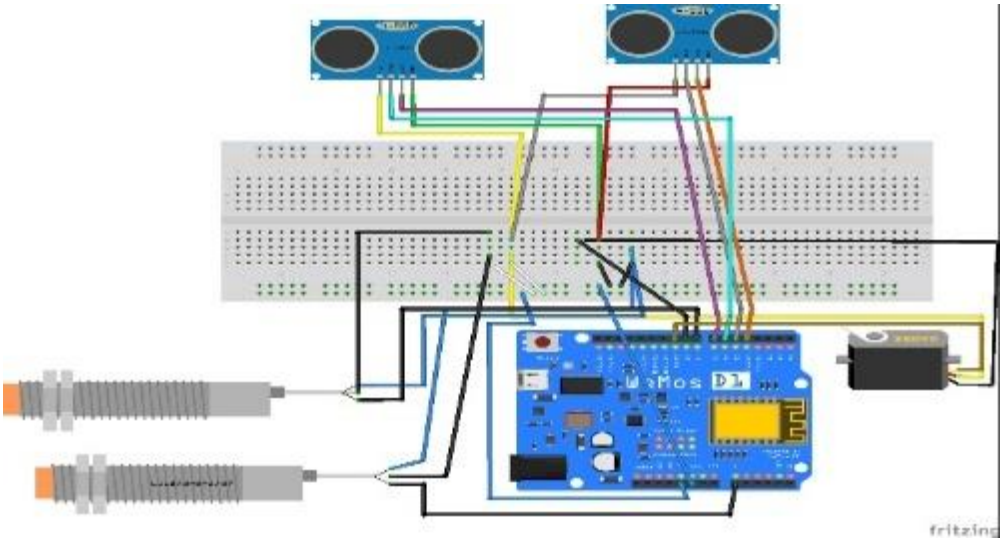

Figure 6: series schematic

Figure 6 illustrates about the process of detecting the volume of a place rubbish clever via ultrasonic sensor . Started from initialization the system that consists of from ultrasonic sensor initialization and initialization Wi-Fi connection and applications blynk . After that to be continued with Detection of waste volume by ultrasonic sensor based on distance between the sensor and surface garbage . The results of reading the volume of garbage will sent to application Blynk .

Table 1: Connections series schematic

No	Schematic Design	
	Component	**Pin Connection**
1	Wemos D1R1	
	5V	+ Breadboard
	GND	- Breadboard
2	Ultrasonic Sensor Organic	
	VCC	+ Breadboard
	GND	- Breadboard
	TRIG	D2 Wemos
	ECHO	D3 Wemos
3	Ultrasonic Sensor Inorganic	
	VCC	+ Breadboard
	GND	- Breadboard
	TRIG	D4 Wemos
	ECHO	D5 Wemos
4	Capacitive Proximity Sensor	
	VCC	+ Breadboard
	GND	- Breadboard
	OUT	A0 Wemos
5	Inductive Proximity Sensor	
	VCC	+ Breadboard
	GND	- Breadboard
	OUT	D6 Wemos
6	Servo Motor	
	VCC	+ Breadboard
	GND	- Breadboard
	OUT	D7 Wemos

4. Results and Discussion

```
#define BLYNK_TEMPLATE_ID "TMPL6h8hcF1-p"
#define BLYNK_TEMPLATE_NAME "Monitoring Tempat Sampah"
#define BLYNK_AUTH_TOKEN "J-KFAKrLS2esvdKXO4TkprU3vYABkfjp"
#include <Servo.h>
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

// Informasi WiFi
char auth[] = "J-KFAKrLS2esvdKXO4TkprU3vYABkfjp";
char ssid [] = "ambu"; // Nama WiFi
char pass [] = "Ambuuu14";
Servo myServo; // Membuat objek servo
const int triggerPin1 = D2; // Pin untuk Trigger Ultrasonik 1 (Organik)
const int echoPin1 = D3;    // Pin untuk Echo Ultrasonik 1
const int triggerPin2 = D4; // Pin untuk Trigger Ultrasonik 2 (Anorganik)
const int echoPin2 = D5;    // Pin untuk Echo Ultrasonik 2
const int kapasitifPin = A0; // Pin untuk Sensor Proximity Kapasitif (Analog)
const int induktifPin = D6;  // Pin untuk Sensor Proximity Induktif (Digital)
const int servoPin = D7;     // Pin untuk Servo
const int Torganik = 150; // Ambang nilai untuk sampah organik
const int Tanorganik = 100; // Ambang nilai untuk sampah anorganik

void setup() {
  Serial.begin(115200);
  myServo.attach(servoPin); // Menghubungkan servo ke pin
```

a)

```
  myServo.write(90); //posisi awal
  pinMode(triggerPin1, OUTPUT);
  pinMode(echoPin1, INPUT);
  pinMode(triggerPin2, OUTPUT);
  pinMode(echoPin2, INPUT);
  pinMode(kapasitifPin, INPUT); // Analog input
  pinMode(induktifPin, INPUT);  // Digital input

  // Inisialisasi WiFi
  Serial.println('\n');
  WiFi.begin(ssid, pass);
  Serial.println("Menghubungkan ke ");
  Serial.println(ssid);
  Serial.println(" ... ");

  int i = 0;
  while (WiFi.status() != WL_CONNECTED){
    delay(1000);
    Serial.println(i++); Serial.print(' ');
  }
  Blynk.begin ("J-KFAKrLS2esvdKXO4TkprU3vYABkfjp", "ambu", "Ambuuu14");
}
void loop() {
  Blynk.run(); // Menjalankan Blynk
  // Mengukur volume sampah untuk tempat sampah organik
  long duration1, distance1;
```

b)

```
long duration1, distance1;
digitalWrite(triggerPin1, LOW);
delayMicroseconds(2);
digitalWrite(triggerPin1, HIGH);
delayMicroseconds(10);
digitalWrite(triggerPin1, LOW);
duration1 = pulseIn(echoPin1, HIGH);
distance1 = (duration1 * 0.034) / 2; // Menghitung jarak dalam cm
// Mengukur volume sampah untuk tempat sampah anorganik
long duration2, distance2;
digitalWrite(triggerPin2, LOW);
delayMicroseconds(2);
digitalWrite(triggerPin2, HIGH);
delayMicroseconds(10);
digitalWrite(triggerPin2, LOW);
duration2 = pulseIn(echoPin2, HIGH);
distance2 = (duration2 * 0.034) / 2; // Menghitung jarak dalam cm
// Membaca nilai dari sensor proximity kapasitif dengan analogRead
int Vkapasitif = analogRead(kapasitifPin);  // Baca nilai analog
int Vinduktif = digitalRead(induktifPin);   // Membaca nilai digital
// Debug prints untuk melihat nilai sensor
Serial.print("Volume Sampah Organik (cm): ");
Serial.println(distance1);
Serial.print("Volume Sampah Anorganik (cm): ");
Serial.println(distance2);
// Mengirim data ke Blynk
```

c)

```
  int Vinduktif = digitalRead(induktifPin);   // Membaca nilai digital
  // Debug prints untuk melihat nilai sensor
  Serial.print("Volume Sampah Organik (cm): ");
  Serial.println(distance1);
  Serial.print("Volume Sampah Anorganik (cm): ");
  Serial.println(distance2);
  // Mengirim data ke Blynk
  Blynk.virtualWrite(V1, distance1); // Kirim jarak organik ke Datastream Organik V1
  Blynk.virtualWrite(V2, distance2); // Kirim jarak anorganik ke Datastream Anorganik V2
  // Logika deteksi sampah
  if (Vkapasitif > Torganik) { // Jika nilai kapasitif melebihi ambang batas, deteksi sampah organik
    Serial.println("Jenis Sampah: Organik (deteksi oleh sensor kapasitif)");
    myServo.write(180); // Gerakkan servo ke posisi untuk sampah organik
    delay(1000); // Tunggu 1 detik agar servo bergerak dengan sempurna
    myServo.write(90); // Kembali ke posisi awal
  }
  else if (Vinduktif == LOW) { // Jika sensor induktif mendeteksi sampah anorganik
    Serial.println("Jenis Sampah: Anorganik (deteksi oleh sensor induktif)");
    myServo.write(0); // Gerakkan servo ke posisi untuk sampah anorganik
    delay(1000); // Tunggu 1 detik agar servo bergerak dengan sempurna
    myServo.write(90); // Kembali ke posisi awal
  }
  delay(3000); // Tunggu 3 detik sebelum pembacaan berikutnya
}
```

d)

Figure 7: program

In the picture there is a program that identifies type organic and inorganic using capacitive proximity sensors and inductive proximity sensors and grouping them rubbish organic and inorganic using servo motor based on results proximity sensor identification and monitor the volume of waste at each location rubbish using an ultrasonic sensor later can monitored by users through application Blynk .

Figure 8: View beginning blink

The image is appearance beginning interface Blynk . Users can see the volume of waste in the place rubbish through application Blynk . The sensor is at a height of 40cm from base place rubbish .
Has been successfully created place rubbish clever IoT based which can sorting rubbish organic and inorganic in a way automatic as well as monitor the volume of waste at the site rubbish use application Blynk.

Table 2: Experimental data

NO	Types of Waste	Classification	Capacitive Proximity Sensor (Organic)	Inductive Proximity Sensor (Inorganic)
1.	Lime leaves	Organic	Detected	Not detected
2.	Wet Wipes	Organic	Detected	Not detected
3.	Coin	Inorganic	Not detected	Detected

4.	Banana	Organic	Detected	Not detected
5.	Milk Can	Inorganic	Not detected	Detected
6.	Sprite Cans	Inorganic	Not detected	Detected
7.	Plastic spoons	Inorganic	Not detected	Not detected
8.	Papaya Skin	Organic	Detected	Not detected
9.	Paper	Organic	Not detected	Not detected
10.	Aqua Bottle	Inorganic	Not detected	Not detected

The table is the data of waste detection results with 10 waste samples consisting of 5 organic waste samples and 5 inorganic waste samples using capacitive proximity sensors and inductive proximity sensors. The following are the results of sensor accuracy in grouping waste:

a. Organic waste

From the data above, it is known that 4 out of 5 organic waste samples were detected according to the waste classification. So the accuracy of the sensor in detecting waste:

$$\text{Error}(\%) = \left(\frac{\text{Nilai Referensi} - \text{Nilai Terukur}}{\text{Nilai Referensi}}\right) \text{x } 100$$

$$\text{Error}(\%) = \left(\frac{5-4}{5}\right) \text{x } 100$$

$$\text{Error}(\%) = 20\%$$

It can be concluded that the accuracy of the capacitive proximity sensor in grouping organic waste has an error of 20% or a success rate of 80%.

b. Inorganic waste

From the data above, it is known that 3 out of 5 inorganic waste samples were detected according to the waste classification. So that the accuracy of the sensor in detecting waste.

$$\text{Error}(\%) = \left(\frac{\text{Nilai Referensi} - \text{Nilai Terukur}}{\text{Nilai Referensi}}\right) \text{x } 100$$

$$\text{Error}(\%) = \left(\frac{5-3}{5}\right) \text{x } 100$$

$$\text{Error}(\%) = 40\%$$

After grouping rubbish based on types , applications Blynk IoT will display results measurement of waste volume at the site waste that is done by ultrasonic sensors . With Thus , users can with easy monitoring waste volume in a way real-time . Here is appearance Blynk IoT :

Figure 9: View blink results waste volume monitoring

Results of measuring the volume of waste at the location rubbish organic Already in accordance between display on application and measurement actually. While For place rubbish inorganic, ultrasonic sensor No can detect waste volume.

4. Conclusion

In this research, it has been successfully designed place rubbish clever IoT based which can sorting rubbish organic and inorganic using capacitive proximity sensors and inductive proximity sensors which are then separated using servo motor. Place rubbish this can also monitor the volume of waste at the site rubbish use application blynk . In an experiment conducted by researchers happen error in sorting rubbish organic by 20%, sorting rubbish inorganic by 40%. For monitoring of waste volume at the site rubbish organic 100% successful while place rubbish inorganic No succeed.

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