Implementation of an Android-based Smart Trash Biot Monitoring System for Residents of Mlangi Hamlet

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ABSTRACT
The problem of waste accumulation is one of the impacts of the increasing population in an area, from the problem of waste accumulation that often occurs, one of the areas focused on is in the Special Region of Yogyakarta, precisely in Mlangi Hamlet, Nogotirto, Gamping District, Sleman Regency. The lack of awareness of some people is one of the causes of the accumulation of waste that is difficult to control. In this case, the waste disposal system that is still manual and boring will certainly cause people to be lazy and bored to throw garbage in its place. Seeing the rapid development of technology in the form of internet connectivity from various electronic devices, the application of the IoT (Internet of Things) concept is expected to be a solution to the problem of garbage accumulation in Mlangi Hamlet, Gamping District, Sleman Regency. Smart trash biot is a term for trash cans that have features with more functions than ordinary trash cans or can be called smart trash cans both in terms of usability and appearance. This system design uses NodeMcu Esp32 as a data processor, Ultrasonic Sensor or HCSR04 as a distance sensor and height sensor for parameters if the trash can is full. Then the data is sent to firebase to be processed and sent to residents' android smartphones as a notification if the trash can is full. It is hoped that this concept can minimize the accumulation of garbage in the community, especially in the Mlangi hamlet area.

Keywords
Internet of Things, Smart Trash Biot , Android, NodeMcu Esp32

1. INTRODUCTION
Waste is one of the complex problems faced by developing and developed countries in the world. The problem of waste is a common problem and has become a universal phenomenon in various parts of the world, including being a problem for big cities in Indonesia. Waste is leftover or used material that is no longer used and comes from various types. The lack of concern of some people towards environmental cleanliness causes the problem of waste to remain a serious problem. If waste is still scattered and poorly managed, the impact returns to the community environment itself. The foul odor caused by piles of garbage and improper management can be a source of disease transmission and clogging of drainage channels and rivers are some of the consequences of the lack of public awareness of environmental cleanliness [1]. So the role of the community is needed to create a clean and healthy environment. Waste officers who are responsible for cleaning trash bins located at several points in the location are needed. However, the supervision of waste bins is still done manually, so that waste officers are required to check the bins by visiting each registered bin in their area. This is an ineffective method, as it will take more time and reduce the performance of the garbage workers in cleaning the bins.

The development of science and technology that is increasingly rapid and growing today also has an impact on the development of technology used by the community in carrying out activities, everything must be done easily and quickly [4]. If you remember the rapid technology that has developed in this era, this problem should have been solved. In 2021 with the title Smart Trash Bin Monitoring System Application Based on the Internet of Things conducted research on the role of IoT in handling cases of garbage accumulation. In that study, a conclusion was obtained which explained that the Iot-based smart trash bin designed can run smoothly so that it is expected to provide information if the garbage is full quickly which is monitored via a website so that it can be useful for officers and people who use the system compiled by Faridi, Maryanah Safitri, and Muhamad Riziq Zulfian.

2. SYSTEM DESIGN
2.1 Flowchart System
Flowchat is a flowchart that illustrates the flow or work process of a system, flowchart is useful in order to understand the flow of the tool that can be explained in the system process [3]. The design of this program is done by making a block diagram or Flowchart first, to make it easier when making the design logic. The following is a flowchart of the system created:

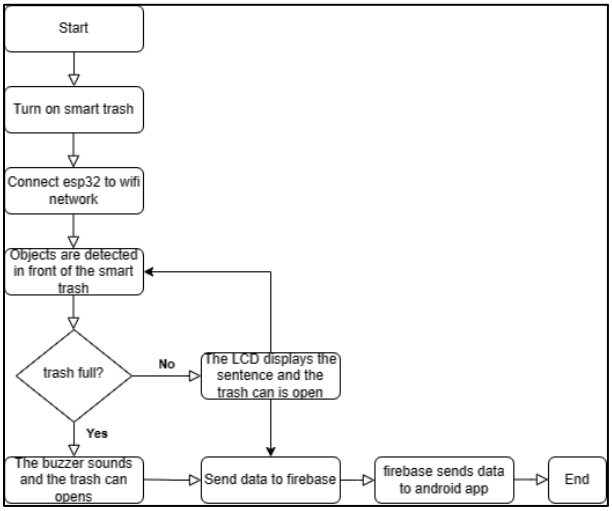

Fig 1: Flowchart System

When the system is turned on, the system will first initialize the parts of the smart trash biot system. After that, the system checks the status of the trash can whether it is full or not. If the trash can is full then the buzzer will sound and if it is not full then when there is an object in front of the trash can the servo will open the trash can then the system will enter the height data of the trash can to be sent to Firebase. The next process is that the data that has been received from the microcontroller is then selected then Firebase sends a notification in the form of trash can data to the android smartphone. When the user's android smartphone will receive data from Firebase, the mobile application will display a notification regarding the full trash height data.

2.2 Smart Trash Biot Design

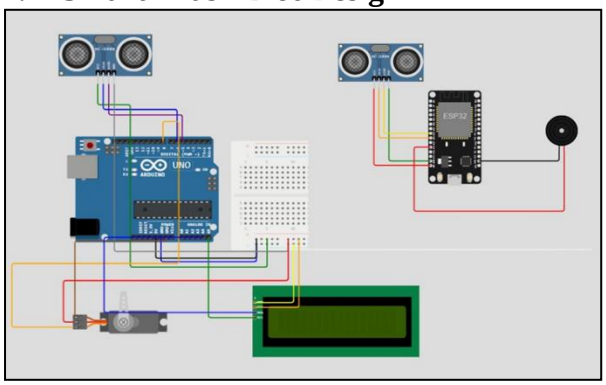

Fig 2 : Smart Trash Biot Design

Before assembling the hardware, the first thing to do is to make a hardware design schematic first. The control system consists of NodeMcu ESP32, Arduino UNO, buzzer, two HC-SR04, lcd I2c and servo motor which functions as a control unit for all input/output activities such as detecting the height distance of the trash can contents, detecting objects to open and close the trash can, displaying trash information, sounding an alarm as a sign that the trash can is full, and sending data to the firebase server.

The following is a 2D modeling of the hardware in the application development made:

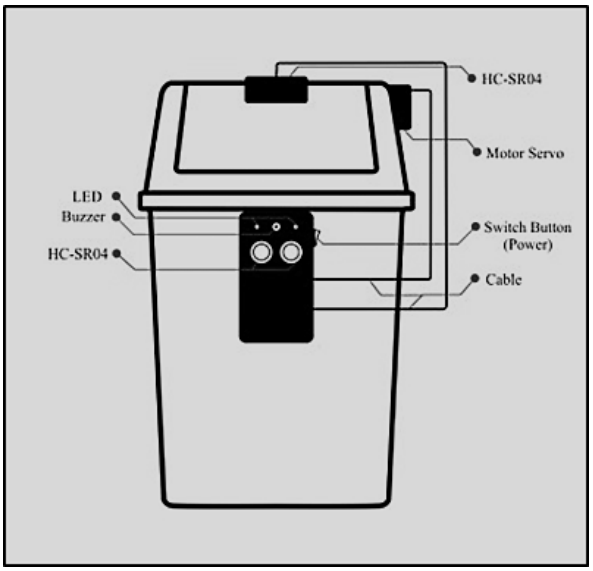

Fig 3 : Smart Trash 2D Modeling Drawing

3. RESULT

3.1 Implementasi Hardware

The following are the results of the overall hardware design of the android-based smart trash biot system.

Fig 4 : Smart Trash biot System Design Results

The picture shows the physical design of the system. Researchers used 1 trash can, 1 NodeMcu ESP32, 1 Arduino UNO, 2 HC-SR04 sensors, 1 servo, 1 LCD, 1 buzzer, and 1 breadboard. In the author's research, the NodeMcu ESP32 and Arduino UNO circuits with HC-SR04 distance and height sensors connected using jumper cables were installed on the trash can. The device has an input of 5 volts. The HC-SR04 sensor as a parameter for the fullness of the trash can sends data to firebase which is then forwarded to the smartphone.

Fig 5 : Sensors And Devices Already Installed

3.2 Implementasi Software

The following are the results of the overall software design of the android-based smart trash biot system.

3.2.1 Splash Screen Interface

Splash Screen is the first page that appears when the user opens the application, after which the login page appears.

Fig 6 : Splash Screen Interface

3.2.2 Login Menu Interface

The login menu is a page that displays a form for users to enter a username and password. If the data entered matches the database, the main menu will appear, but otherwise if the username and password are wrong, a login message will appear.

Fig 7 : Login Menu Display

3.2.3 Main Menu Interface

The main menu is a menu that appears after successful login and users can select the desired menu containing among several menus namely user profile, bin monitoring, database, about, and exit menu.

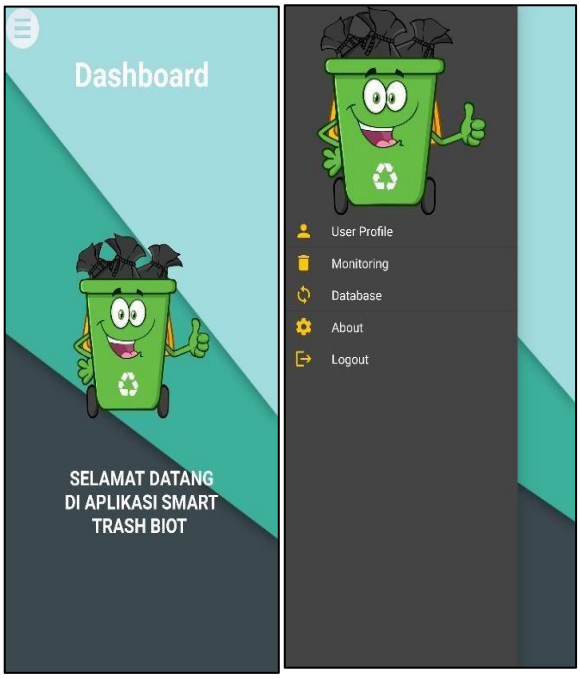

Fig 8 : Main Menu Interface

3.2.4 User Profile Interface

The user profile menu is a menu that displays the profile of the application user containing name, username, address, email and telephone number.

Fig 9 : User Profile Interface

3.2.5 Monitoring Menu Interface

The monitoring menu is a menu that will display the trash can data that will be monitored if you click this menu, the house that will be monitored will appear and then proceed to the profile of the occupants of the house, just check the height of the garbage whether it is full or not.

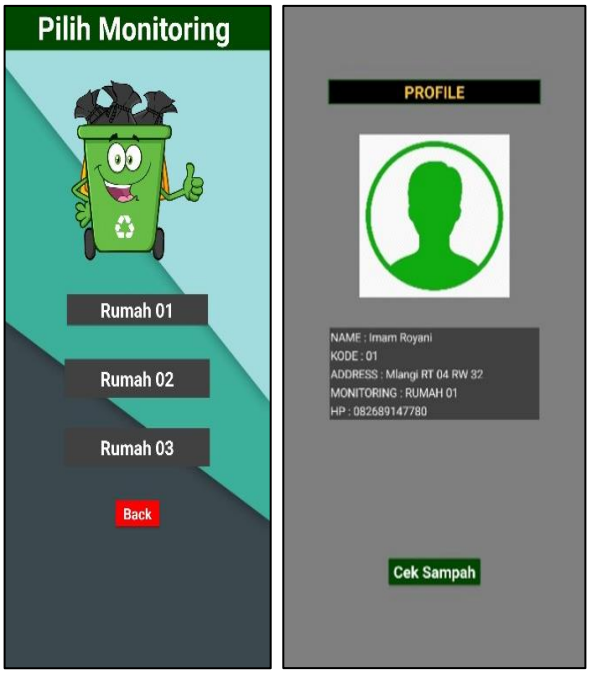

Fig 10 : Monitoring Menu Interface

3.2.6 Database Menu Interface

The database menu is a menu that displays the results of monitoring on smart trash biot, here the application will directly display the page selecting the user database and then move the page to firebase to immediately see the results in realtime.

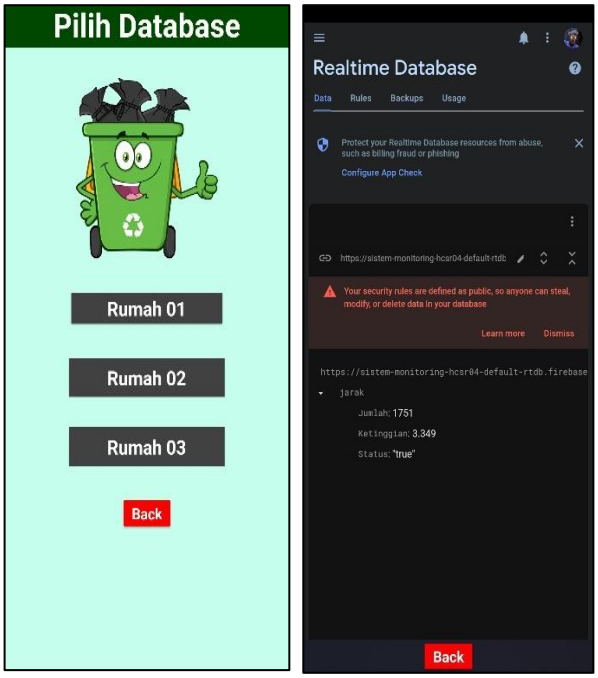

Fig 11 : Database Menu Interface

3.2.7 About Menu Interface

The about menu is a menu that contains pages that explain the functions of the application and the application version.

Fig 12 : About Menu Interface

3.2.8 Garbage Check Menu Interface

The garbage check menu is a menu that displays the results of monitoring on smart trash biot containing data, the height of the garbage to determine whether the garbage is full or not, and the status of the garbage if false then the garbage is still safe not full if the status is true means the garbage is full.

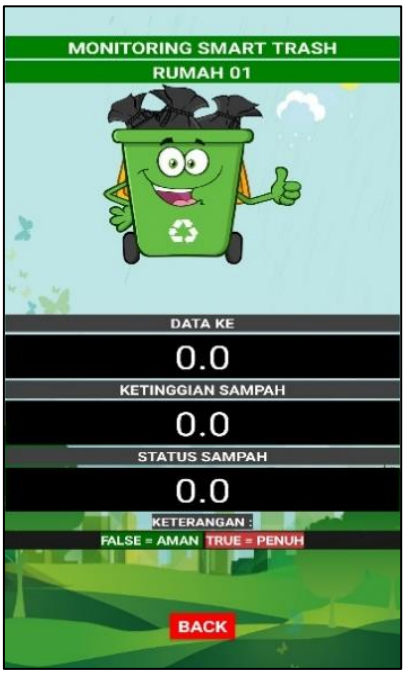

Fig 13 : Garbage Check Menu Interface

3.2.9 Logout Menu Interface

The Logout menu is a menu that is displayed if the user selects logout here the user can press yes if they want to continue to exit the application and the no button if they do not leave the application.

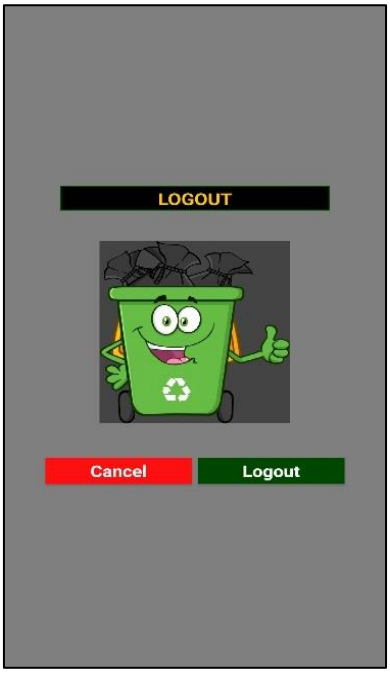

Fig 14 : Logout Menu Interface

3.2.10 Firebase Result

3.2.10.1 Firebase view if firebase is safe or not full.

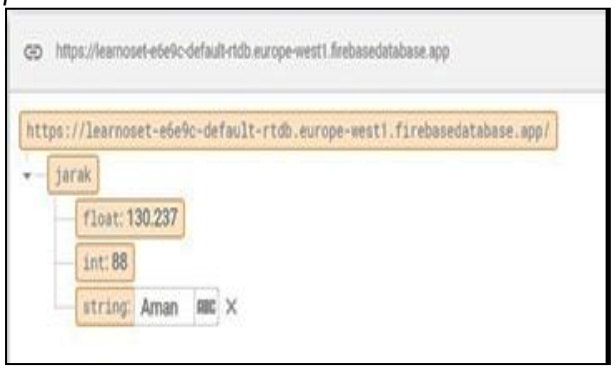

Fig 15 : Firebase Secure

3.2.10.2 Firebase view if firebase is full.

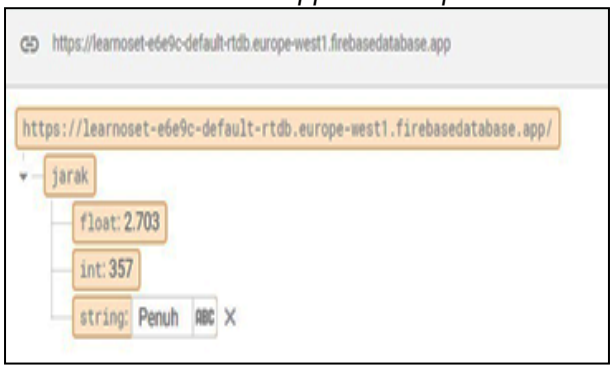

Fig 16 : Full Firebase

4. SYSTEM TESTING

System testing is the process of examining hardware and software systems to determine whether the system is suitable and in accordance with what the researcher wants. Testing is done by conducting experiments to see possible errors that occur from each process. First test the input and output of hardware and see all components or modules work according to the expected function. Then testing is continued on the android smartphone application by testing each page and making sure there are no more errors in the application.

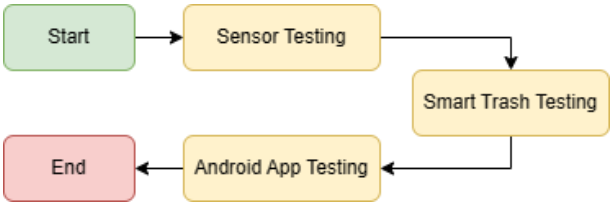

Fig 17 : System Testing Chart

The system test used in this research is Black Box. Black Box testing is testing the device in terms of functional specifications without testing the design and program code. Testing is intended to find out whether the functions and outputs have run as desired.

4.1 Sensor testing

An ultrasonic sensor is used to measure the volume inside the bin. The ping ultrasonic sensor is a 40 khz sensor manufactured by Parallax. The advantage of this sensor is that it only requires 1 signal (SIG) in addition to the 5v and ground lines. The PING sensor emits ultrasonic waves according to the control of the controlling microcontroller (pulse trigger with a min tout of 2 us) [5]. Sensor testing to measure the accuracy of the distance measured by the sensor by comparing the distance measured using a ruler or ruler and the distance displayed on the serial monitor in this case stored in firebase realtime, as can be seen in the table below.

Table 1 Sensor testing

Distance using a ruler (cm)		Distance displayed (cm)	
Distance Sensor	Height Sensor	Distance Sensor	Height Sensor
5	5	5	5
10	10	9	10
20	20	19	20
30	30	28	29

From the table above it can be seen that the distance detected by the two HC-SR04 ultrasonic sensors measured by the ruler and the distance displayed on the serial monitor has a difference at a distance of 10 cm, 20 cm and 30 cm while for a distance of 5 cm the measurement of the ruler is the same as the distance displayed on the serial monitor.

So that from the table above it can be seen that the farther the distance of the object measured by the HC-SR04 ultrasonic sensor, the more different the measurement results are from the distance measured using a ruler, which means that the farther the distance, the less the accuracy of the HC-SR04 ultrasonic sensor.

4.2 Smart Trash Testing

Testing of the Smart Trash monitoring feature is carried out to test whether the functions in this monitoring process are

running properly and correctly [6]. The following tests are carried out to determine the suitability of the tool response with the expected indications and responses.

Table 2 Smart Trash Testing

Trial Number-	Distance (cm)		Trash Can Response
	Distance Sensor	Height Sensor	
1	5	5	Servo opens, buzzer sounds
2	10	10	Servo opens, buzzer goes off
3	15	15	No response
4	20	3	Servo turns off, buzzer sounds
5	1	15	Servo opens, buzzer goes off

In the table of trash can response test results above, it can be seen that the results of this test show that the trash can provides a response where when the two sensors detect the same distance of 5 cm, the servo will open the trash can and the buzzer will sound, otherwise if the distance is different, the response given also varies depending on the distance.

4.3 Android Application Testing

The test results in the table below are obtained by testing the ultrasonic sensor that measures the distance of the fullness of the trash can then see the remaining height and status displayed on the mobile application.

Table 3 Android Application Testing

Trial Number-	In-App Display	
	Remaining Height (cm)	Status
1	1	False (Aman)
2	5	False (Aman)
3	10	True (Penuh)
4	25	True (Penuh)
5	30	True (Penuh)

Based on what we can see in the table, it can be seen that the Mobile application has displayed data from firebase and provided the desired response, namely if the residual height is less than or equal to 5 cm, the trash can will notify if it is full through the android application.

5. CONCLUSIONS

After successfully designing, developing, and integrating the hardware, software, and delivery system of the prototype altitude and notification system tool into an integrated system, the conclusions obtained in this research are:

1. When an object is detected in front of the trash can, the trash can will open, but if the trash can is full, the trash can will sound a warning buzzer. As expected the tool functions properly.
2. The application displays data on the height of the contents of the trash can and the status of the trash can in the house of residents of Mlangi Hamlet RT 04 correctly.
3. The device can send notifications to users when the trash can is full.

For further development in the smart trash device section, a garbage sorting feature can be added between organic and non-organic waste using additional proximity and servo sensors and then in the application software section can also display a capacity comparison graph between organic and non-organic waste.

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