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Garbage Bin Monitoring System Based on the Internet of Things at University Dirgantara Marsekal Suryadarma

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Abstract: Garbage is a major problem, because it can harm human health, cause bad odors, and air pollution. With the existence of trash bins, it seems that it doesn't matter because most people prefer to litter, as well as cleaning workers to check the capacity of the trash can who often forget to cause garbage to accumulate so that it can pollute the environment.

To solve the waste problem, especially at universities, a smart campus concept was created to solve the problem of waste management. By utilizing GPS technology, Internet of Things, Wi-fi technology that is already available, and other hardware devices such as Arduino microcontrollers, ultrasonic sensors, and others.

With this concept, it is hoped that the cleaning staff will arrive on time to transport the garbage according to the information from the existing application, where the information has shown the coordinates of the full trash can so that cleanliness and comfort are maintained.

Index Terms: IoT, Smart Trash Box, Location, Smart Campus, Information Systems, GPS

1. Introduction

Garbage is a major problem that is often faced by the people of Indonesia, especially household waste, especially in the process of disposal, management and transportation of waste which is often late, causing an unpleasant odor. The research objective is to create a smart campus concept by utilizing IoT (Internet of Things) technology which is connected to a trash can using android media and a microcontroller as a connecting medium, as a solution to the problem of garbage accumulation [1,2,3,4].

IoT technology is a concept that uses the internet as the main infrastructure network that connects Certain objects and applications of IoT can be clarified into various uses, such as smart home, smart campus and others [5,6].

The limitation in this research is applying IoT technology at the University of Dirgantara Marshal Suryadarma which can contribute to the cleaning staff, because so far there has been no information when the trash can is full. This technology is linked to a GPS location so that cleaners can easily find their location quickly.

It is hoped that by implementing an IoT-based smart campus, the waste problem can be overcome, the campus environment is kept clean and this technology can make human work easier.

A. Smart City / Smart Campus

Smart city / smart campus is city / place by applying the smart city/place concept, [7] to facilitate the people in that place get/ send information quickly and accurately and can share integration direct information with the community other people outside the region.[8, 9]

The campus is a place to gain knowledge, so it requires a clean and comfortable environment from all pollution.

Pollution that often occurs in the campus environment is garbage that is scattered or trash cans that are full but have not been transported by cleaners. This is due to a lack of information for the cleaning staff.

So a smart campus concept was designed with the support of an adequate wi-fi network and internet, [10-14] the combined technology is IoT technology and computer technology that are integrated [15], with the addition of Arduino

devices, GPS and sensors, sensors installed in each trash can around the campus which functions as an indicator of the trash can, the indicator is empty, half full and full.

This concept is used so that when the trash can is full it will send the coordinate points of the trash, to make it easier for cleaning officers to pick up trash so that the cleanliness and beauty of the campus are maintained.

B. Internet of Things (IoT)

Internet of Things is a concept in which certain objects can transfer data over a network without requiring human-to-human or human-to-computer interaction.[16,17]

The Internet of Things is often referred to by its abbreviation, IoT, which has grown rapidly from the convergence of wireless technology, micro-electromechanical systems (MEMS), and also the Internet. [18]

IoT works by utilizing a programming argument, where each of these argument commands can produce an interaction between machines that have been connected automatically without human intervention and without being limited to any distance.[19]

The application of IoT in various fields, especially the environment, to keep the environment clean on campus a concept is made to keep the environment clean by applying IoT.

C. Global Positioning System (GPS)

This signal is received by the receiver on the surface and is used to determine the location, speed, direction, and time. Systems that are similar to GPS include Russian GLONASS, European Union Galileo, India's IRNSS GPS, whose real name is NAVSTAR GPS (Navigation Satellite Timing and Ranging Global Positioning System), which has three segments, namely: satellite, controller, and receiver/user [20]. GPS satellites orbiting the earth, with fixed orbits and positions (exact coordinates), [21] a total of 24 of which 21 are active and the remaining 3 are reserves. To be able to find out a person's position, a device called a GPS receiver is needed which functions to receive signals sent from GPS satellites.

The way these GPS works is that the most important part of the GPS navigation system is that several satellites are in earth orbit or what we often call in space. There are currently 24 GPS satellites, all of which can transmit signals to earth which can then be captured by the signal receiver or GPS Tracker.

D. Method

This research combines 3 technology concepts, namely the Internet of thinks, GPS, and Smart campus, supported by other components such as sensors, microcontrollers, computers, and other hardware.

The uniqueness of this research is to make Marsekal Suryadarma University Aerospace a unique campus, namely a smart campus, the Marsekal Suryadarma Aerospace University already has good Wi-Fi facilities and its coverage is quite wide, so GPS and IoT technology is combined into a facility to keep the environment clean and beautiful. campus, which is a smart trash can.

This trash can provide height information from the trash that is in it by activating the indicator, empty, half, and full. If the trash can is full, it will send the location of the coordinate point of the full trash can into an application, then the sensor in each trash can gives a signal to the cleaning officer via a message sent to an application, it is hoped that the cleaning officer will immediately transport it. the garbage. and cleaners do not need to find which trash can be taken but have gone straight to the target according to the coordinate position.

2. Research Methods

In conducting this research, there are several stages to complete this research as shown in Fig.1.

The research was conducted at one location using 3 bins, namely empty, half, and full conditions. Each trash can has a sensor installed to provide an indicator of the condition of the trash.

Then design a system that is connected to a GPS so that it can provide the coordinates of the full trash can to cleaners using the (Internet of things) IoT technology [13].

Followed by system testing so that it can be seen how long it takes to send information from a full trash can to the cleaning officer.

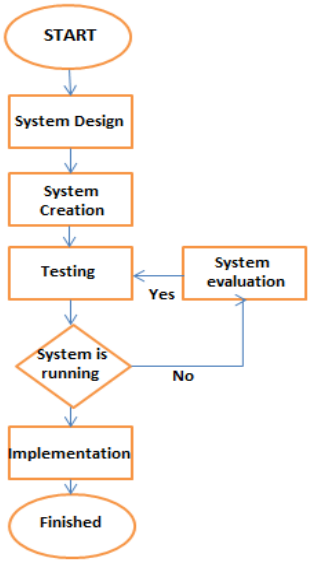

Fig. 1. Flowchart

3. Results and Discussion

A. Current System Analysis

This smart trash box system has 2 functions, namely. The first function is to monitor the condition of the trash, including the height of the trash using an ultrasonic sensor [8]. And the second function is to monitor the location of the trash can be placed using GPS, Monitoring data will be displayed on the application on a PC or Laptop [12].

B. Needs Analysis

At this point, it focuses on functional requirements, non-functional requirements, hardware requirements, software requirements of the systems or tools that have been created.

- Functional Requirements Analysis

The functional requirements of this system or tool include:

1. This tool can be used as a monitoring of the height of the waste.
2. Monitor the location of the trash.

- Analysis of Non-Functional Requirements

The non-functional requirements of this system or tool include:

1. The monitoring and control process of this system is quite easy because it can be controlled from anywhere and anytime. It is enough to connect the device to a wifi network so that it is connected to the internet [22].
2. Improve the impression that the trash can is attractive, easy, and hygienic because no trash comes out through the trash.

- Hardware Requirements Analysis (Hardware)

Hardware requirements (hardware) is an analysis of system requirements that are used to determine the devices needed to support the development process and use of the system to be made. The hardware required is as follows:

1. ESP8266 NodeMCU Module
2. Ultrasonic Sensor (HC-SR04)
3. Shield NodeMCU ESP8266
4. 5V power supply
5. GPS uBlox GY-NEO6MV2

- Software Requirements Analysis (Software)

Software requirements (software), namely the programs needed to perform the instruction process run hardware. So that a system or tool can be created and implemented according to the design, the software is needed. The software specifications required by the system are:

1. The Arduino IDE is used to program the Arduino wifi shield according to the design that has been made [23].
2. Borland Delphi was used to create monitoring applications for research projects [24,25].

C. System Planning

System design is an advanced stage of analysis and evaluation of an ongoing system, in which this section will describe the system design that will be built before programming into a programming language [24]. In designing a system it cannot be separated from the results of the analysis, because from the results of the analysis a new system can be made to produce a system design.

- System Design Objectives

The purpose of system design, in general, is to provide a general overview to the user about the new system. System design in general is a preparation of the detailed design. In this study, the system design aims to describe in general the design of the smart trash box prototype to the user about the system to be built and identify the components of the information system to be designed in detail.

- Data Flow Chart

The data flow diagram in this study describes how the process of sending data obtained from sensors installed in the trash box to the Borland Delphi application server, then from the server will be displayed on applications that have been installed on a PC or laptop. Fig. 2 shows the data flow diagram.

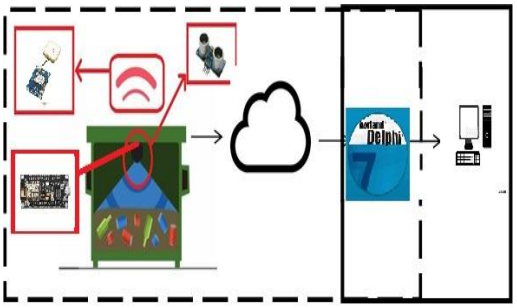

Fig 2. Smart Garbage System Block Diagram

D. Testing

Fig.3 shows the smart garbage application which has 3 main commands namely open the map, update the time limit, and monitor the trash data on the main page.

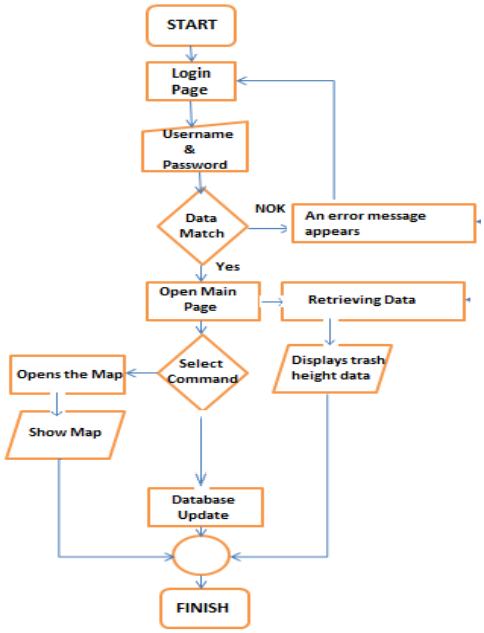

Fig 3. Smart garbage application design

The application will open the login page for the first time it is opened. If the user already has an account, they can log in. After logging in, the user will be taken to the main page.

- Data Flow Diagram

The data that is streamed in the smart garbage application can be seen in the Data Flow Diagram in Fig. 4

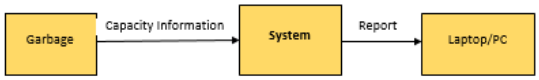

Fig.4. Data Flow Diagram

- Interface Design

To build a "Smart Garbage Monitoring System" it is necessary to design an interface as an illustration of the application to be made, which is as follows:

1. Interface Design Login Page

The login page consists of a username, password to enter the main page. As in Fig. 5, below

Fig 5. Login activity diagram

Fig. 6 shows the login activity diagram for the Delphi program.

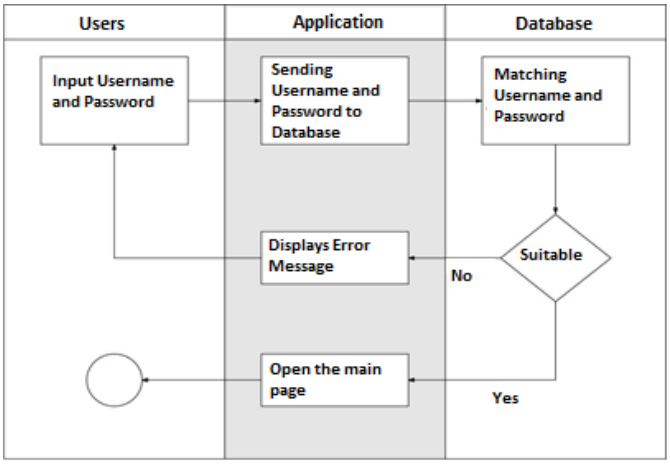

Fig 6. Login activity diagram

The sign-in process takes advantage of the authentication features Delphi provides. The user enters the username and password in the application and is authenticated by Delphi. [25] If the username and password do not match the data registered in Delphi then the application will provide an error message, and if it matches the registered data the application will proceed to the main page. Fig. 7 shows the wrong username and password page contains only a description to try again.

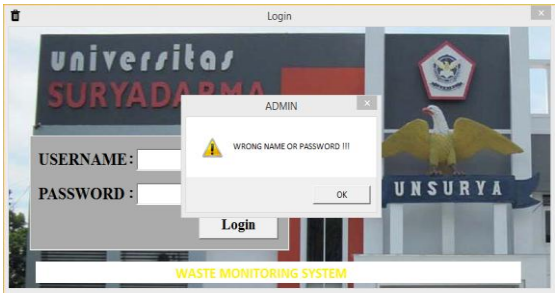

Fig 7. Incorrect Username Password page

2. Main page design

Fig. 8 shows the existing waste status display menu, of the existing trash in the form of the height level of the trash and the time limit for transporting the trash.

Fig 8. Main page view

3. Design map view

Fig 9. shows the map will display a "red arrow" indicating the location of the trash based on the latitude and longitude in the database.

Fig 9. Map view

Fig. 10 shows the map activity diagram for the Delphi application.

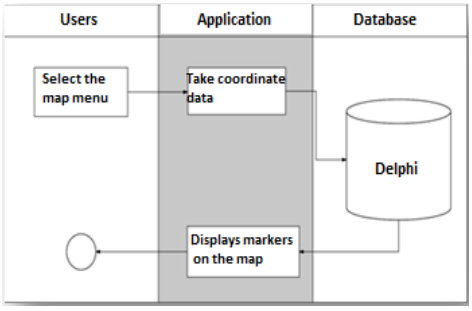

Fig 10. Map page activity diagram

- Testing the login form

Table 1 shows that the test was carried out using the username and password specified by the admin.

Table 1. Testing the login form

No	Testing Components	Expected results	Test image	Status
1	Username and Password not registered	An input error message appears		suitable
2	Registered username and unregistered Password	An input error message appears		suitable
3	Username is not registered and Password is registered	An input error message appears		suitable
4	Registered username and password	Enter the main page		suitable

- Testing the data reading level of the height of the trash

Table 2 shows the Test was carried out to determine the reading of the height of the trash in the application according to the data in the database. Tests are carried out by equating the data on the height of the trash that enters the database with the data displayed in the application.

Table 2. Testing the data reading level of the height of the trash

Testing to-	Result			Status
	Height 0 cm - 4 cm	Height 5 cm - 15 cm	Height16 cm - 30 cm	
1	A notification appears Empty trash can	A trash can notification appears half full	A notification appears Trash can full	suitable
2	A notification appears Empty trash can	A trash can notification appears half full	A notification appears Trash can full	suitable
3	A notification appears Empty trash can	A trash can notification appears half full	A notification appears Trash can full	suitable
4	A notification appears Empty trash can	A trash can notification appears half full	A notification appears Trash can full	suitable
5	A notification appears	A trash can notification appears half full	A notification appears Trash can full	suitable
6	A notification appears Empty trash can	A trash can notification appears half full	A notification appears Trash can full	suitable

7	A notification appears	A trash can notification appears half full	A notification appears Trash can full	suitable
8	A notification appears Empty trash can	A trash can notification appears	A notification appears Trash can full	suitable
9	A notification appears Empty trash can	A trash can notification appears half full	A notification appears Trash can full	suitable
10	A notification appears Empty trash can	A trash can notification appears half full	A notification appears Trash can full	suitable

- Testing the notification level of the trash can level

Table 3 shows that the test was carried out to determine the height level notification features that have been made in the application as expected. The test is carried out in two different conditions, namely when the application is opened and when the application is running in the background with an initial value of 16-30 cm. a notification will appear when the altitude data has passed 6 - 15 cm or 0 - 5 cm from the height of the trash.

Table 3. Waste level notification test

Testing to-	Result			Status
	Height 0 cm - 14 cm	Height15 cm - 24 cm	Height 25 cm - 30 cm	
1	Indicator light up white	Indicator light up yellow	Indicator light up red	suitable
2	Indicator light up white	Indicator light up yellow	Indicator light up red	suitable
3	Indicator light up white	Indicator light up yellow	Indicator light up red	suitable
4	Indicator light up white	Indicator light up yellow	Indicator light up red	suitable
5	Indicator light up white	Indicator light up yellow	Indicator light up red	suitable
6	Indicator light up white	Indicator light up yellow	Indicator light up red	suitable
7	Indicator light up white	Indicator light up yellow	Indicator light up red	suitable
8	Indicator light up white	Indicator light up yellow	Indicator light up red	suitable
9	Indicator light up white	Indicator light up yellow	Indicator light up red	suitable
10	Indicator light up white	Indicator light up yellow	Indicator light up red	suitable

Fig, 11, fig. 12, and fig. 13 show the condition of the until the place is empty, half, and full.

Fig. 11. The trash can indicator is white and an Empty notification appears

Fig. 12. The trash indicator is white and a notification is half full

Fig 13. The trash indicator is white and a full notification appears

- Testing the suitability of the trash bin location

Table 4 shows that the test is done by retrieving location data from the delivery of trash bins in the database. The location data used in the test amounted to five different trash can locations, then see the suitability of the locations on the map that was created in the application and compare them with the coordinates on the google map.

Table 4. Location reading test

Location name	Coordinate	Data from the application	Google map (WEB)	Status
User	"-6.137.683, 106.69291 0"	Latitude : -6.137683 Longitude : 106.692910 Altitude : 29.40 Date : 12/24/2019 Time : 04:00:33.00		suitable
Radit Cell	"-6.137495,106.69 2819 "	Latitude : -6.137495 Longitude : 106.692819 Altitude : 15.10 Date : 12/24/2019 Time : 08:21:29.00		suitable
Chairman House	"-6.137936,106.69 3590 "	Latitude : -6.137936 Longitude : 106.693590 Altitude : 32.60 Date : 12/24/2019 Time : 07:35:05.00		suitable
ZaFakids Fashion Store	"-6.137572,106.69321 6"	Latitude : -6.137572 Longitude : 106.693216 Altitude : 6.20 Date : 12/24/2019 Time : 08:12:46.00		suitable
Ayam Bakar Kreweng	"-6.137307,106.69260 8"	Latitude : -6.137307 Longitude : 106.692608 Altitude : 32.80 Date : 12/24/2019 Time : 07:30:38.00		suitable

4. Conclusion

The test results show that the application features that have been made can run according to their function, from the test results that at the height of the trash can 16 cm - 30 cm the application will display a red indicator with a complete trash can description. and the layout of the trash, if the height of the trash is 5 cm - 15 cm the application will display an orange indicator with a half-full description, the trash height is 0 cm - 4 cm. The app will display a white indicator with an empty trash can.

When the trash bin indicator is full, it only takes 10 minutes for the information to reach the cleaning officer. This IoT technology will continue to monitor the height of each trash can in the environment of Marsekal Suryadarma University Dirgantara, it is hoped that this smart campus concept will take advantage of technological developments, increasingly expanding in residential locations, offices, restaurants. and others, all of which are connected to the sanitation department so that environmental cleanliness stays awake from scattered trash.

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