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Internet of Things (IoT)

IoT-Based Smart Waste System Using Blynk Application

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A B S T R A C T

The problem of manual trash cans causes a lack of hygiene for users and scattered garbage due to the volume of garbage bins that have accumulated. Paper and tissue waste is the dominant waste in the campus area and is highly flammable. Due to the lack of manual trash cans, innovation ideas were obtained to make automatic room trash cans and can monitor waste capacity and detect smoke using smartphone applications as the application of the Internet of Things (IoT). The IoT-based smart trash can uses the NodeMCU 8266 as its main control and ultrasonic sensors to detect the distance of the garbage capacity and the distance of the object. Servo motor as a drive for the garbage lid automatically. MQ-2 smoke sensor as a smoke marker, a warning sound through the Buzzer and also the Wifi ESP 8266 module so that it can send notifications via the internet network. Trash cans can be monitored using the Blynk application. The results obtained in this study are that the trash can cover will automatically open when the object is 10cm to 1cm from the trash can. The results of the sensor detection of the full capacity level of the waste are when the garbage is 5cm to 1cm from the sensor. Furthermore, the results of the detection of the MQ-2 sensor, when the smoke capacity exceeds 325ppm, the buzzer will turn on and the system sends a notification message using a Blynk to the cleaning staff's smartphone.

INTRODUCTION

A trash can is a place to temporarily store waste. Some trash cans have a lid on the top to prevent the unpleasant odor emitted by the trash. The problems that arise with ordinary trash cans are that most of them have to be opened manually, which results in a lack of cleanliness for the user [4]. If the trash can is full, but if it is not immediately disposed of in the final container, the rubbish in the trash will be scattered [6]. This is the problem that researchers found in the current system at the Syekh-Yusuf Islamic University (UNIS) Tangerang City. Due to the shortcomings of manual trash cans, an innovation was obtained to create a trash can that can open and close automatically and notify you when the trash can is full [1].

In the campus area, paper and tissue waste is the dominant waste, this type of waste is very flammable, undesirable things that have fatal consequences and are adversely affected by smoke [4]. Smoke is a suspension of small particles (aerosols) in the air caused by imperfect combustion of fuel [3]. One way to prevent fires as early as possible in a room is to use a smoke detection system connected to an application on a smartphone [3]. The application used is the Blynk application "Smart Trash Clean" which can be accessed using a smartphone to the cleaning staff who are responsible at UNIS Tangerang. With this application, officers can monitor the contents of the trash can and receive notifications on their smartphones if the sensor has detected smoke in the trash can.

The MQ-2 smoke sensor as a smoke marker, a warning sound via Buzzer and also the ESP 8266 Wifi module to be able to send notifications via the internet network is what underlies researchers to develop a smart trash can that can not only open automatically without being touched but can also detect smoke. This smart trash can is also equipped with a real-time trash capacity volume detection system with an ultrasonic sensor if the trash can is full and a notification sender in the Blynk monitoring application "Smart Trash Clean" which can be accessed using a smartphone to the cleaning staff.

Smart trash can based on Internet of Things (IoT) uses NodeMCU 8266 as its main control and the trash can will automatically open because the ultrasonic sensor will detect the distance of the object that is about to throw away the trash. Servo motor as the automatic trash can lid driver. LED functions as an indicator when the trash can is available or full. This capacity indicator system is equipped with LCD so that those who want to throw

away trash or cleaning staff can see information in the trash can to anticipate if the smartphone cannot be used. The power source used in this trash can comes from a battery that uses a rechargeable system, so that it can control and see the amount of power, a Digital DC-Voltmeter will complement this tool.

The results obtained from the creation of this smart trash can are that users no longer need to touch the trash can lid directly and maintain cleanliness, then reduce the occurrence of scattered trash due to excessive volume. Researchers have created a trash can tool that can be used for monitoring smoke/burning trash detection through the Blynk application and trash capacity when it is full to the smartphone and LCD. This tool can help someone who wants to throw away trash and cleaners in checking the trash capacity without checking manually by approaching the trash can repeatedly and can prevent fires or the negative impacts of smoke.

METHOD

Design of smart trash bin system based on internet of things using Blynk application. Figure 1 shows the block diagram of the system.

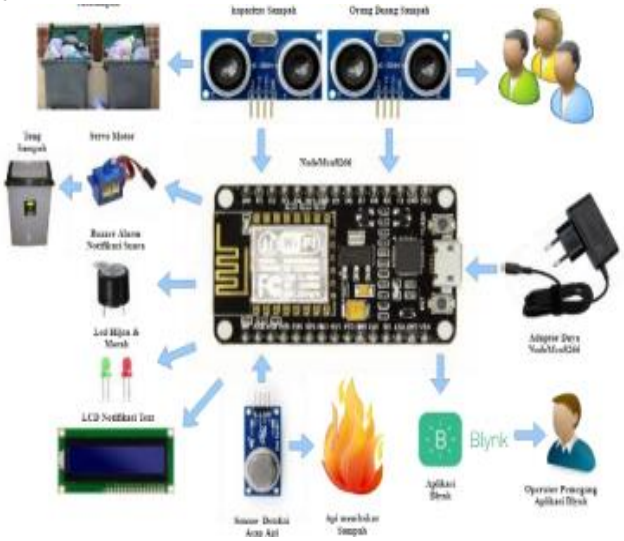

Figure 1. System Block Diagram

How the system works in Figure 1 is when the device is turned on, the device will read the distance of the object approaching the trash can through an ultrasonic sensor installed at the front of the trash can. The data received from the sensor is then processed by the NodeMCU 8266. If the distance of the object detected is less than 10cm, the servo motor will activate and open the trash can cover, but if the distance of the object detected is more than 10cm, the servo motor will close. This servo motor functions to move the trash can cover so that it opens and closes automatically.

In the process of reading the capacity of the trash, the device used is an ultrasonic sensor located inside the trash can. This sensor functions as a tool to detect the distance of full trash, if the trash is detected less than 5cm from the trash can lid then the trash is detected as full, the red LED will light up, the LCD will display a notification message, and the system also sends a notification in the form of a pop-up via the "Smart Trash Clean" application using Blynk.

In the process of detecting smoke from burning garbage, the device used is the MQ-2 sensor located in the trash can. This sensor functions as a tool to detect smoke, if the smoke detected is more than 325ppm from its normal value, which is less than or equal to 300ppm, the trash can is detected as having burning garbage, the Buzzer will turn on, the LCD will display a notification message, and the system also sends a notification in the form of a pop-up via the "Smart Trash Clean" application using Blynk.

Ultrasonic Sensor

Ultrasonic Sensor is a type of proximity sensor that works according to the reflection of the sound waves given, then determines whether or not there is an object in front of the object or the object through the reflection of sound, namely the working frequency in the area above it [9]. The circuit with NodeMCU 8266 can be seen in Figure 2.

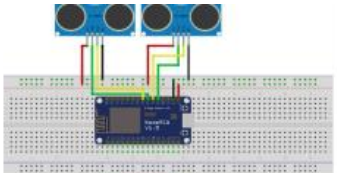

Figure 2. Ultrasonic Sensor Circuit

In Figure 2 the VCC pin on this ultrasonic sensor can be connected to the NodeMCU 8266 on the 3.3 volt pin as a power source, the Trig pin on the sensor is connected to pins D6 and D8 which function as a trigger to generate a signal on the ultrasonic sensor, the Echo pin on the sensor is connected to pins D5 and D7 this pin is used as an indicator or receive to detect the reflected signal from the ultrasonic sensor, the GND pin on the sensor is connected to GND on the NodeMCU 8266 for a negative voltage source. The ultrasonic sensor as an input that will produce data output or HIGH/1 value after being processed in the NodeMCU 8266.

MQ-2 Sensor

The MQ-2 sensor is a smoke sensor used in electronic circuits to detect various types of flammable hydrocarbon gas content such as isobutane (C4H10), propane (C3H8), methane (CH4), ethanol (C2H5OH), hydrogen (H2), smoke and LPG (liquefied petroleum gas) [3]. The circuit with NodeMCU 8266 can be seen in Figure 3.

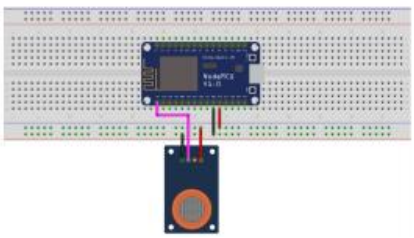

Figure 3. MQ-2 Sensor Circuit

In Figure 3, the VCC pin on the MQ-2 sensor can be connected to the NodeMCU 8266 on the 3.3 volt pin as a power source, the analog pin A0 as a data input pin, the GND pin on the sensor is connected to GND on the NodeMCU 8266 for a negative voltage source. The MQ-2 sensor as an input that will produce data output or HIGH/1 value after being processed in the NodeMCU 8266.

Buzzer

Buzzer is an electronic component that converts electronic signals into sound vibrations. Generally, buzzer is an audio device, usually used for anti-theft alarms, clock alarms, doorbells, truck reverse warnings and other hazard warning devices [10]. The circuit with NodeMCU 8266 can be seen in Figure 4.

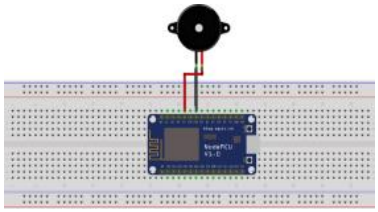

Figure 4. Buzzer Circuit

In Figure 4, the digital D4 pin is the data output pin, the GND pin on the buzzer is connected to GND on the NodeMCU 8266 for a negative voltage source. The buzzer is the data output or HIGH/1 value after the data input is processed by the NodeMCU 8266.

Servo

A servo motor is a device with a set of gears, a control circuit, and a potentiometer consisting of a DC motor, a set of gears mounted on the DC shaft slows down the speed of the shaft rotation and increases the torque of the servo motor. When the motor is running, the resistance changes with the potentiometer which determines the position of the Servo motor rotation [10]. The circuit with NodeMCU 8266 can be seen in Figure 5.

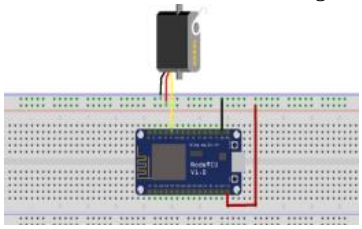

Figure 5. Servo Circuit

In Figure 5, the VCC pin on this servo can be connected to the NodeMCU 8266 on the 3.3 volt pin as a power source, the digital pin D0 as a data output pin, the GND pin on the sensor is connected to GND on the NodeMCU 8266 for a negative voltage source. The servo as a data output or HIGH/1 value after being processed in the NodeMCU 8266.

LCD & I2C and LED

LCD screen is a very efficient data display media. To display characters on the LCD screen, several additional function sets are required. To make it easier for users to use it, several electronics companies have produced LCD modules [5].

LED is a class of diode family made of semiconductor materials. And the color of light emitted by this LED is widely used in the type of semiconductor material used. [8]. The circuit with NodeMCU 8266 can be seen in Figure 6.

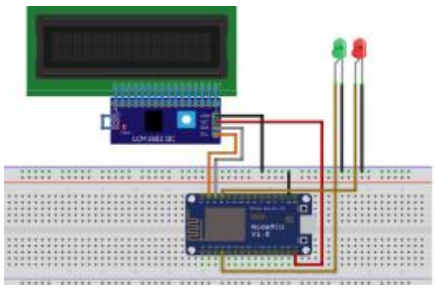

Figure 6. LCD & I2C and Led Circuit

The VCC pin on the LCD and I2C can be connected to the NodeMCU 8266 on the 3.3 volt pin as a power source, the digital D1 pin as the SCL pin and the digital D2 pin as SDA, the GND pin on the LCD and I2C is connected to GND on the NodeMCU 8266 for a negative voltage source.

LCD and I2C as the output data in the form of text notifications after being processed in NodeMCU 8266. Pin 10 Green Led and pin D3 Red Led as data output pins, GND pin on Led is connected to GND on NodeMCU 8266 for negative voltage source. Led as data output or value HIGH/1 after data input is processed by NodeMCU 8266.

NodeMCU 8266

NodeMCU 8266 is a freely accessible derivative module based on the IoT platform. This component contains firmware processed on the Wifi SoC ESP8266 expression system and hardware based on the ESP-12 module. The firmware uses the Lua scripting language. Lua and C languages have the same programming logic, but different syntax [7]. Figure 7 shows the physical form of the NodeMCU ESP8266.

Figure 7. NodeMCU ESP8266

Blynk

Blynk is an IOS and Android operating system platform as a control for Arduino, Raspberry Pi, ESP8266 modules and other similar devices via the Internet [2]. This application can be used to manage hardware, view sensor data, data storage, visualization, etc. Figure 8 shows the design of the monitoring display using the Blynk application.

Figure 8. Monitoring display design

System Prototype

The implementation results based on the IoT-based smart trash bin prototype design using the Blynk application can be seen in Figure 9 and the application for monitoring in Figure 10.

(a) (b)

Figure 9. Front and rear view of the trash bin
(a) Front view
(b) Rear view

In Figure 9, it can be explained that the processing system media is divided into two, namely the system controller or processor, and input-output. The media as the controller or system processor is the NodeMCU 8266 which will produce input and output data. Notification of information or notification to Blynk on the user's smartphone as an Internet of Things (IoT) media.

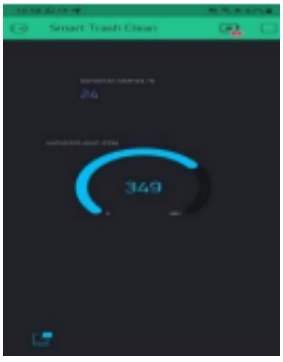

Figure 10. Implementation of monitoring display

From Figure 10. It can be explained that the monitoring display results show indicators of smoke capacity (ppm) and waste capacity in real time using Blynk as the media.

RESULTS AND DISCUSSION

At this testing stage, the black box testing method is used, which leads to the functions of the designed system. While the values to be tested based on this black box are Decision table testing and User story testing. The things tested with the black box testing method are as follows:

Component Testing

This test is performed on each component used by the trash bin automatically. This is done to find out whether each component can function. The results of the component tests are shown in Table 1.

No	Components	Voltage	Description
1	NodeMCU 8266	5V – 7V	Functioning
2	Sensor Ultrasonik HC-SR04	3.3V – 5V	Functioning
3	Sensor MQ-2	3.3V – 5V	Functioning
4	Motor Sevo	5V	Functioning
5	LCD I2C	5V	Functioning
6	Buzzer	3.3V – 5V	Functioning
7	LED	3.3V	Functioning

System testing was conducted on the tool with a focus on the ultrasonic sensor response function opening the trash can cover with servo and LCD when an object approaches the trash can. The results of the trash can cover test are shown in Table 2.

Table 2. Trash Bin Cover Test Results

No	Condition (object)	Distance (cm)	Servo	LCD 16x2	Testing Results
1	There is none	-	Off	Welcome	In accordance
2	There is	>10	Off	Welcome	In accordance
3	There is	<10	On	Throw Out the Trash	In accordance

Based on Table 2, the results of the component testing above from the table results are that when no objects are detected, all components will be off and the LCD displays "Welcome". When there is an object but is more than 10cm away, the servo is still off and the 16x2 LCD still displays the message "Welcome", but if there is an object and the distance is less than or equal to 10cm, the servo is on and the 16x2 LCD displays the message "Throw Out the Trash". Figure 11 and Figure 12 show the results of the trash can lid opener test.

Figure 11. Trash bin when there is no object

Figure 12. Trash can when there is an object

Trash Capacity Detection Functionality Testing

System testing was carried out on the device with a focus on the ultrasonic sensor response function trash bin capacity reader with LED and I2C LCD when an object approaches the trash bin and how trash bin capacity data read by the sensor can be sent using the "Smart Trash Clean" application using Blynk.

The results of the component testing above, can be seen the results of when the bin is filled with garbage at a distance of 23cm to 10cm detected by the ultrasonic sensor, then the Green LED lights up and the I2C LCD displays the message "Empty Bin" and there is no message to Blynk. When the bin is filled with garbage at a distance of less than 10cm detected by the ultrasonic sensor, then the Green LED lights up and the I2C LCD displays the message "Full Bin". The results of the LCD display are shown in Figure 13 and the results of the notification to the smartphone using Blynk are shown in Figure 14.

(a) (b)

Figure 13. LCD display
(a) Front view
(b) Rear view

Then the system sends a notification message to the cleaner's smartphone via the Blynk application containing information that the trash capacity is full. This is shown in Figure 14.

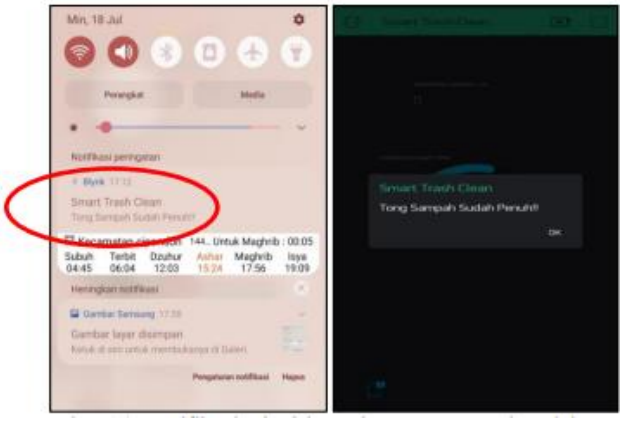

Figure 14. Blynk notification that the trash can is full

CONCLUSIONS

Based on the test results, a conclusion was obtained from the research on the Smart Trash Can prototype connected to the Internet of Things (IoT), namely at the stage of testing the ultrasonic sensor on the trash can cover, data was obtained, namely when the object approaching the trash can is 10cm to 1cm away, the sensor can detect it properly and the trash can cover will automatically open.

At the testing stage of the ultrasonic sensor used to detect the capacity of the trash bin, data was obtained, namely the distance of the trash detected by the sensor can be monitored using the "Smart Trash Clean" application, when the distance of the trash is 5cm to 1cm, Blynk automatically sends a notification message "The trash bin is full" to the cleaning officer.

In the MQ-2 sensor testing process, smoke monitoring with the "Smart Trash Clean" application, when the smoke capacity is more than 325ppm the buzzer is on as a sound notification and the 16x2 LCD displays the message "Trash Burning", and the fire notification will stop when the trash can is in a condition of reduced smoke, namely a capacity of 320ppm after being extinguished and the trash can returns to neutral with a capacity of less than 300ppm.

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