IoT based Trash Can Monitoring System for Smart Garden Cleanliness

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Abstract. Garbage is always produced every day, including household trash and many kind of waste. IoT based Trash Can Monitoring System was designed to automatically maintain the garden cleanliness and help to ease the cleaning staff work. This system uses two controlled trash bins with different location identity (ID). There are many devices to build this system, such as NodeMCU microcontroller, Thingspeak as an IoT platform, two ultrasonic sensors to detect the height of trash and approached object, two servo motors to control can cover and disposal outlet, and solenoid as a locking part. The results of this work show that the system designed works well. Location ID of the two trash cans, approached object detection, measurement of garbage height inside the trash can, opening and locking of disposal outlet and cover, work with 100% success rate and all data can be sent to Thingspeak without any error.

1. Introduction

Garbage is produced every day, both waste from organic substances (vegetables, meat, leaves, etc.) or from inorganic substances (plastic, glass, paper, rubber, metal and so on) [1]-[4]. At this time, disposing of garbage is still a problem that is concerning the government and people who care about environmental cleanliness. Lack of awareness to dispose of garbage in its place and uncoordinated disposal from many trash cans also need attention. These problems make people tend to carelessly litter because when they want to throw the trash, it turns out that the trash can is full.

Nainggolen (2018) has designed smart trash can that only can measure the garbage level inside the trash can [5]. When the trash can is full, the cover will automatically locked and no one can put more trash to the can. This system is also capable of sending trash can data to the cleaning staff via Short Message Service (SMS) when the trash can is full. Memon et al. (2019) built automatic trash can which can simply open the cover using ultrasonic sensor [6]. Some technologies related to IoT can be seen in ref [7]-[12].

This work on remote monitoring of trash can and automatic trash can lid opener aims to increase public awareness in making trash in its place and make it easier for cleaning staff to monitor the garbage inside the trash can. This system uses two controlled trash bins to differentiate the location, NodeMCU microcontroller, Thingspeak IoT platform as monitoring server, two ultrasonic sensors to detect the height of the garbage and the approached object, two servo motors to control top cover and automatic disposal cap, and the solenoid as a disposal cap locking system.

The remainder of this paper is organized as follows. Section 2 provides the description of system model used in this work. Section 3 presents results and discussion. It will describe the system performance based on the system success rate. Section 4 provides the conclusion of the work.

2. System Model

Figure 1 shows the system model of this study. The system input comes from the ultrasonic sensor for object detection and the height of the garbage and then processed by NodeMCU. The data read by NodeMCU is then used to drive the actuator. The actuator consists of a top servo motor to drive the top cover of the trash can based on object detection sensor data. Then the data on the height of the garbage is used to drive the servo motor when the garbage is full for 3 minutes and no cleaning staff arrives. Red and green LEDs are used for the indicator of the garbage height. Garbage height data will be sent and displayed on Thingspeak for monitoring.

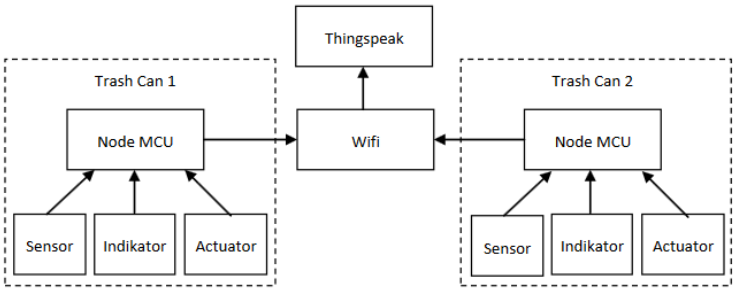

Figure 1. System Model

The model that will be made in this work can be seen in Figure 2. It consist of 2 trash cans that supossed to be separated in different locations. However, it location is simplified into one place with different location ID. Below the two trash cans, it has common disposal container model for disposing the garbage from the full trash can that is not visited by the cleaning staff after the can is full for 3 mi nutes. Each can has two LED indicators. When red LED is on, it means the trash can is full and the cover will be locked.

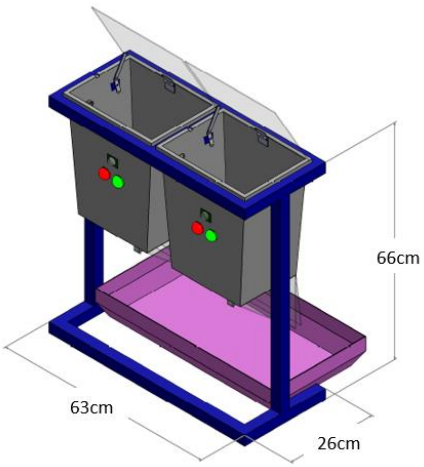

Figure 2. Design of the Hardware Model

The system flowchart can be seen in Figure 3. This flowchart will describe an outline from the beginning to the end process. At the beginning of the process, the top cover is closed, a solenoid condition is OFF (locking the bottom cover), and the system is connected to the internet. Then the ultrasonic sensor checks the load (garbage) of the trash can. When the load in the trash is full, the full

indicator LED will be ON, while the empty indicator LED will OFF. After that, the data on the trash can will be sent to the Thingspeak IoT platform. After 3 minutes, unattended full trash can will dispose of the load automatically to the common disposal container. A time delay of 3 minutes is used for cleaning staff to manually dispose of garbage.

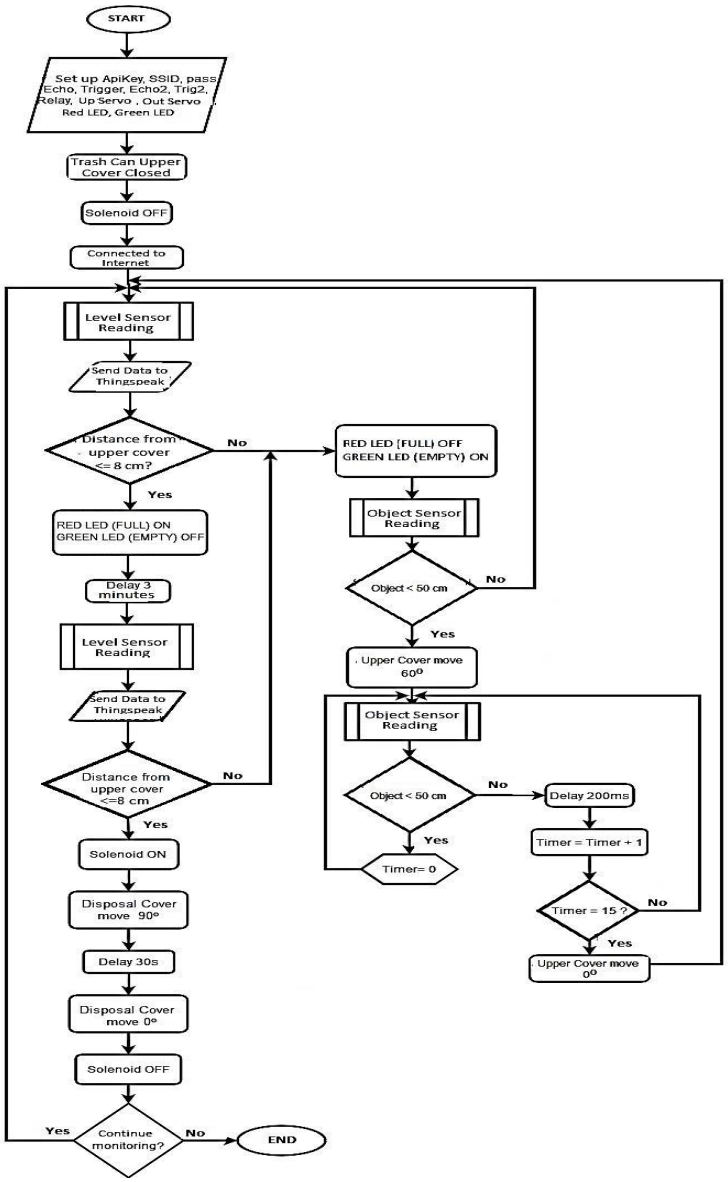

Figure 3. General Flowchart System

3. Result and Discussion

Table 1 shows the test result data of the whole system. This test is used to measure the success rate of the system. Testing the whole system is done by filling the trash can from empty to full, and testing the top cover opening. The testing includes opening the top cover, manual and automatic disposal covers, and finally testing the data transmission to Thingspeak. All the experiments show that the system was able to work in every condition as designed.

Table 2 shows testing result of garbage height at location 1. The measured garbage height value is the same as the value read by the sensor. However, when the trash was around 49cm high, the sensor failed to read the data. Based on the characteristics, the ultrasonic sensor has the ability to read a minimum distance of 2cm, therefore when the distance between the sensor and the garbage is too close the value read by the sensor will have error. This problem is also happened at location 2.

Table 1. Overall System Test Result

Trash Can Indicator		**Object Status**		**Automatic Disposal Cover**		**Upper Cover**		**Send Data**	
Location 1	Location 2	Location 1	Location 2	Location 1	Location 2	Location 1	Location 2	Location 1	Location 2
Full	Not Full	Not Detected	Not Detected	Yes	No	Closed	Closed	Yes	Yes
Full	Not Full	Not Detected	Detected	Yes	No	Closed	Opened	Yes	Yes
Not Full	Full	Not Detected	Not Detected	No	Yes	Closed	Closed	Yes	Yes
Not Full	Full	Detected	Not Detected	No	Yes	Opened	Closed	Yes	Yes
Not Full	Not Full	Detected	Not Detected	No	No	Opened	Closed	Yes	Yes
Not Full	Not Full	Not Detected	Detected	No	No	Closed	Opened	Yes	Yes
Not Full	Full	Detected	Detected	No	No	Opened	Opened	Yes	Yes
Full	Not Full	Detected	Detected	No	No	Opened	Opened	Yes	Yes
Full	Full	Not Detected	Not Detected	Yes	Yes	Closed	Closed	Yes	Yes
Full	Full	Not Detected	Not Detected	Yes	Yes	Closed	Closed	Yes	Yes

Table 2. Testing of Garbage Height, Location 1

Garbage Height (cm)	**Sensor read (cm)**	**Trash Can Indicator**	**Note**
0	47	Not Full	Succesfull
10	37	Not Full	Succesfull
16	31	Not Full	Succesfull
18	29	Not Full	Succesfull
29	18	Not Full	Succesfull
32	15	Not Full	Succesfull
34	13	Not Full	Succesfull
40	7	Full	Succesfull
42	5	Full	Succesfull
49	2512	Not Full	Not Succesfull

Table 3 shows the object detection distance at location 1. This object is representation of the hand of cleaning staff. When the object distance is less than 50 cm, the top cover will open until sensor detects no object around it. When the object distance is more than 50 cm, the top cover will remain close. When the trash can is full, object detection will not work. The same test result also occurs at location 2.

Table 3. Object Detection Distance Test

Object Status	Distance (Cm)	Trash Can Indicator	Trash Can Cover	Upper Servo Motor	Note
Not Detected	100	Not Full	Close	90◦	Succesfull
Not Detected	70	Not Full	Close	90◦	Succesfull
Detected	50	Not Full	Open	0◦	Succesfull
Detected	45	Not Full	Open	0◦	Succesfull
Detected	40	Not Full	Open	0◦	Succesfull
Detected	35	Not Full	Open	0◦	Succesfull
Detected	30	Not Full	Open	0◦	Succesfull
Detected	25	Not Full	Open	0◦	Succesfull
Detected	20	Not Full	Open	0◦	Succesfull
Detected	15	Not Full	Open	0◦	Succesfull
Detected	10	Not Full	Open	0◦	Succesfull
Detected	5	Not Full	Open	0◦	Succesfull
Detected	2	Not Full	Open	0◦	Succesfull

4. Conclusion

The system work well as it was designed. The two trash cans with different location ID successfully send all monitoring data to Thingspeak. Ultrasonic sensor can sense the garbage height correctly, except when the distance of the garbage to the sensor is less than 2 cm. Automatic disposal work as it was designed. It disposes garbage when the trash can is full and there is no cleaning staff arrive within 3 minutes. All the motor servo and solenoid work well as it can automatically open and close cover and locking system. Overall, the system works well with 100% success rate.

Acknowledgments

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