

## Real Time Garbage Bin Capacity Monitoring

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### ABSTRACT

This paper discusses about a garbage bin that can be monitored in real time. The information of the garbage capacity can be obtained in the application that is integrated in the mobile phone. The communication between the garbage bin and the mobile phone is intended to help the garbage collector and the user to monitor the capacity of the garbage in a garbage bin. When it has been overloaded, the collector can manage the garbage by moving the garbage to the other bigger garbage bin. (landfill). This garbage bin has been tested and it could run well. It could open and close its cover as soon as it detected or did not detect the objects. It could also send the information of the garbage capacity to the mobile phone immediately with delay only 0.45-0.47 s.

**Keywords:** Garbage, Garbage bin, Garbage collector, Blynk, and monitoring.

### 1. INTRODUCTION

Garbage has become serious problems in many countries [1]–[4]. The growth of garbage is in line with the increase of the population. The more the population is, the more human activities are. Thus, it leads to the increase in the volume of Garbage [5], [6]. Many problems can be caused by garbage, i.e. it can cause flooding, disrupt the environmental ecosystem, and can cause bad impact to the healthy. One of the problems that occurs in the garbage handling is how to manage the garbage collecting that is spread in many places. Some of the garbage bin is let being full so that it is sometimes flooded to the ground.

The garbage that is splattered out from its garbage bin can cause unpleasant smells, can occur a dirty environment, and can invite the flies. Based on this problem, in this research, a garbage bin is offered. This garbage bin can monitor the capacity of the garbage. When the garbage bin is full, it will give notification by ringing the buzzer. The garbage bin in this research is connected to the mobile phone. This connection makes easy the user to monitor the capacity of the garbage from different places. Before the garbage bin is really overloaded, the garbage collector can move the garbage to the other bigger garbage bin (landfills).

### 2. MATERIAL AND METHODS

The garbage bin in this research consists of some components that can be described as in Figure 1. Each component in Figure 1 has different functions, such as: 1). the power supply has function as a voltage source of the system; 2). Adapter has function to adapt the voltage from the supply to the other system. The power

supply comes from 220 V ac; therefore, an adapter should be used in order to make the supply compatible with the electronic components of the garbage bin system in this research. The power supply of 220 V ac was used in the system in so that it can maximize its work; 3) The Ultrasonic Sensors in this research have functions to detect the objects that are entering or getting closer to the garbage bin. When the objects are being detected, the garbage bin will send a signal to the microcontroller and will also give direct signal to the servo motor; 4). Microcontroller (Arduino Uno) has functions as the brain of the system that processes the data from the sensors; 5). Motor (servo) has functions to move the garbage bin cover so that it can be opened and closed automatically; 6). The ESP 8266 module is used to connect the garbage bin to mobile phone; 7). Mobile phone has functions to display the notification of garbage bin capacity using blynk application.

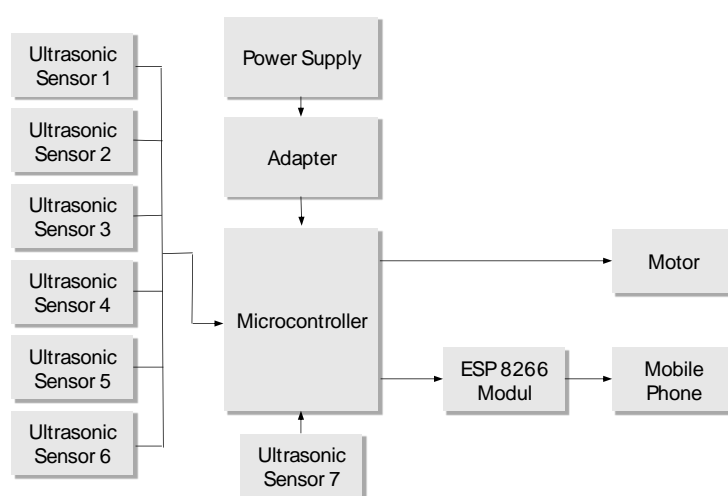


FIGURE 1. Component Connection (a) Input (b) Output

The design of the garbage bin is shown in Figure 2. Six ultrasonic sensors (sensor 1-6) are installed at the top of the garbage bin, i.e. five sensors are installed on the surrounding of the top body of garbage bin (see red circle on Figure 2 (a)), 1 sensor is on the cover of the garbage bin (see yellow circle on Figure 2 (a)). These 6 sensors are designed to detect the objects that get closed to it (person who want to throw the garbage). One sensor (sensor 7) is installed on the opposite side of sensor in yellow circle of Figure 2 (a). It is installed at the bottom of the garbage bin cover (it is not shown in Figure 2). Sensor 7 has function to detect the condition of the garbage. This sensor will send the data it detects to the microcontroller so that it can decide the amount of garbage in the garbage bin (0%, 25%, 50%, 75%, or 100%). Figure 2 (b) shows the installation of the other components of garbage bin (See the orange circle of Figure 2(b)). Each of them is installed at the bottom of the garbage bin. It is intended to keep the components to be free from the wet garbage or liquid that can harm the performance of them. At the top of the components' installation, a plastic cover is used to separate the garbage bin and the components. This plastic separator is designed to be able to be plugged and released easily so that it can let the user to clean the garbage bin. All of the wire and components are fully protected from the materials that can break their properties.

Sensors in this research are symbolized as S, namely: 1) S1 is for sensor 1 that is placed at the left of the garbage bin; 2) S2 is for sensor 2 that is placed at the oblique left of the garbage bin; 3) S3 is for sensor 3 that is placed at the front of the garbage bin; 4) S4 is for sensor 4 that is placed at the oblique right of the garbage bin; 5) S5 is for sensor 5 that is placed at the right of the garbage bin; 6) S6 is for sensor 6 that is placed at the top of the garbage bin; and 6) S7 is for sensor 7 that is placed at the inner side of the garbage bin cover (it is not described in the Figure 2).

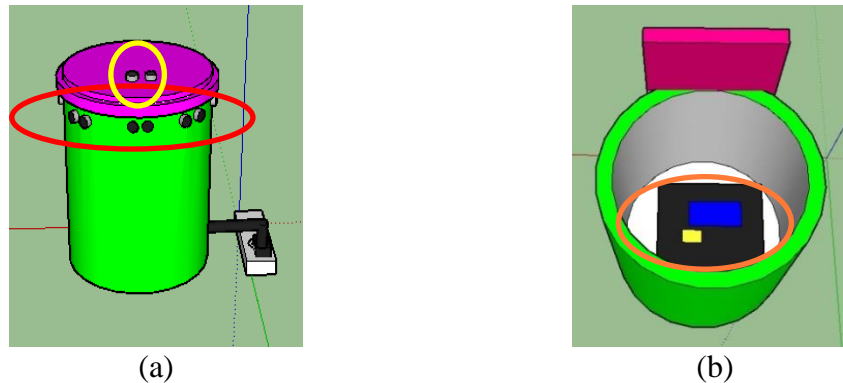


FIGURE 2. Garbage bin proposed in this research (a) ultrasonic sensors placement  
(b) Component Module placement

The flowchart of the garbage bin in this research is shown in Figure 3. The first step of the program is initialization. In this initialization process, the program checks whether all inputs and outputs are installed correctly. The ultrasonic sensors parameters (detection limit values) should be set at the beginning of the program. This value will be the reference of the garbage bin for opening the cover of the garbage bin. In this research, the ultrasonic sensors were set at distance 40 cm (sensor 1-6). When an object is in the range of the sensor's detection limit value, the garbage bin will open its cover. The cover can be opened due to the signal of the ultrasonic sensor that is sent to the microcontroller. The microcontroller then activates the servo motor; thus, the cover can be opened. The cover will be closed automatically after the sensors do not detect the objects after 5 seconds. It means that the objects have move away from the garbage bin. The ultrasonic sensor 7 was set at different distance in order to show the garbage capacity. The setting of the capacity is shown in Table 1. When the sensors detect the capacity of the garbage, it will send the data to the microcontroller. Then, the microcontroller will send the data to the mobile phone trough ESP8266 wifi module using blynk application. In Table 1, it can be seen that the setting of the ultrasonic sensors describes the capacity of the garbage. When the distance of the ultrasonic sensor and the surface of the garbage is 18-20 cm, it indicates that the garbage bin is empty. When the distance is only 0-3 cm, it indicates that the garbage bin is full. Please see again Table 1 for more information.

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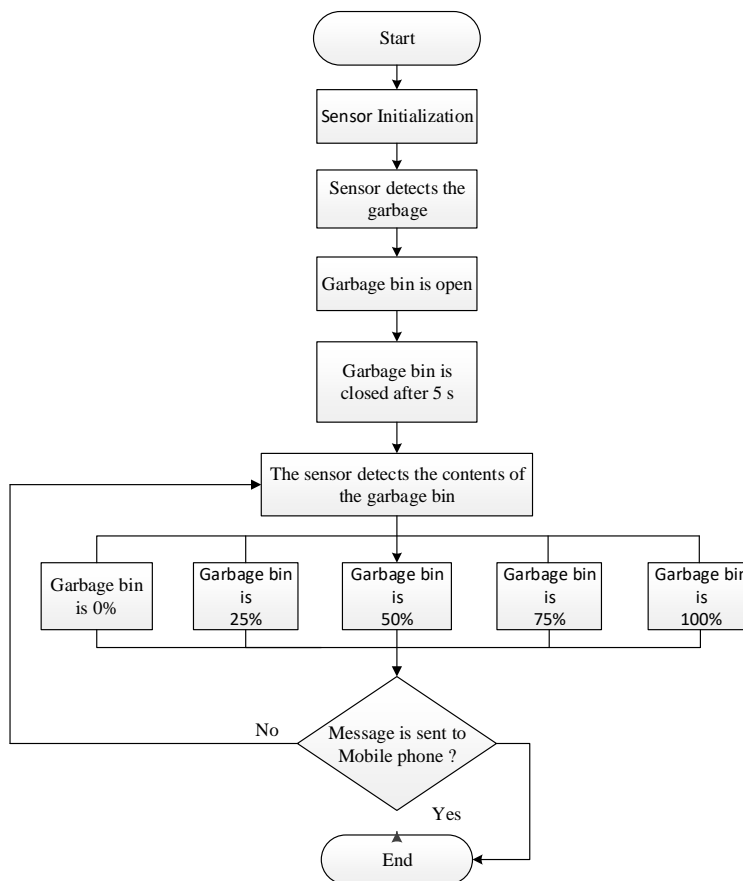


FIGURE 3. Flowchart of the garbage bin monitoring system

TABEL 1.  
Sensor 7 setting for garbage capacity monitoring

No.	Distance to The Garbage (cm)	Garbage Capacity (%)
1.	2-3	100
2.	4-7	75
3.	8-12	50
4.	13-17	25
5.	18-20	0

### 3. RESULT AND DISCUSSION

At first experiment, the performance of the garbage bin sensors was tested. The experimental sensor 1-6 data is shown in Table 2. The object (person) was placed at different position and distance from the sensor. In Table 2, it can be seen that the object may be detected not only by one sensor but of some sensors. It was programmed that the systems could accept the rule of opening the garbage bin cover when one of the sensors (sensor 1-6) was active. The use of 6 sensors in the body and the cover of the sensors were intended to make sure that the cover will be open although the object come from many angles. It was programmed to be able to detect

the arrival of the objects in 360° position. In experiment number 6 in the Table 2, the object came from the back side of the garbage bin where there is no ultrasonic sensor placed at the body of it. Therefore, the object (in this case hands) was designed to be detected by the sensor 6. When the users of garbage bin raised their hand to the top of the cover, the sensor 6 will detect it, then the motor will open the cover. From the experiments in Table 2, it can be seen that, the garbage bin ultrasonic sensors 1-6 worked well. They can detect the objects and can send the data well to the microcontroller, so that the motor can move to open the cover of the garbage bin.

TABEL 2.  
Experimental data of sensor 1-6

No.	Distance (cm)	Object Position	Ultrasonic Sensor						Garbage Bin Cover Condition
			S1	S2	S3	S4	S5	S6	
1.	10	Left	On	On	On	Off	Off	Off	Open
	20		On	On	On	Off	Off	Off	Open
	30		On	On	Off	Off	Off	Off	Open
	40		On	On	Off	Off	Off	Off	Open
	>40		Off	Off	Off	Off	Off	Off	Closed
2.	10	Left Oblique	Off	On	On	On	Off	Off	Open
	20		Off	On	On	On	Off	Off	Open
	30		Off	On	On	On	Off	Off	Open
	40		Off	On	On	Off	Off	Off	Open
	>40		Off	Off	Off	Off	Off	Off	Closed
3.	10	Front	Off	Off	On	On	On	Off	Open
	20		Off	Off	On	On	On	Off	Open
	30		Off	Off	On	On	On	Off	Open
	40		Off	Off	On	On	On	Off	Open
	>40		Off	Off	Off	Off	Off	Off	Closed
4.	10	Right Oblique	Off	Off	Off	On	On	On	Open
	20		Off	Off	Off	On	On	On	Open
	30		Off	Off	Off	On	On	On	Open
	40		Off	Off	Off	On	On	Off	Open
	>40		Off	Off	Off	Off	Off	Off	Closed
5.	10	Right	Off	Off	Off	Off	On	On	Open
	20		Off	Off	Off	Off	On	On	Open
	30		Off	Off	Off	Off	On	On	Open
	40		Off	Off	Off	Off	On	On	Open
	>40		Off	Off	Off	Off	Off	Off	Closed
6.	10	Top (using hand as Object)	Off	Off	Off	Off	Off	On	Open
	20		Off	Off	Off	Off	Off	On	Open
	30		Off	Off	Off	Off	Off	On	Open
	40		Off	Off	Off	Off	Off	On	Open
	>40		Off	Off	Off	Off	Off	Off	Closed

The next experiment was focused on the sensor 7. The data obtained in this experiment was shown in Table 3. The garbage was measured its height using ruler, while the ultrasonic sensor detected the distance between the surface of the garbage and the sensor 7 itself. The additional of the garbage height and the distance of Table 3 should produce 20 cm that indicates the real measurement, however, some of the calculation shows that their addition produce 21 cm or 22 cm. This happened due to the surface of the garbage was not flat, therefore, there was a difference in the

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result. In experiment when the height of the garbage was 19 and 20 cm, the ultrasonic sensors was also unable to read the garbage capacity. Therefore, in this garbage bin monitoring systems, it was also accomplished with the warning system, i.e. buzzer in the garbage bin and also indicator in the mobile phone before it was really full of the garbage.

**TABEL 3.**  
Experimental data of sensor 7

No	Real reading	Sensor 7 reading	Mobile phone display	Status
	Garbage height (cm)	Distance (cm)	Capacity (%)	
1.	0	20	0	success
2.	3	18		success
3.	5	16		success
4.	6	15	25	success
5.	8	12		success
6.	9	13	50	success
7.	11	9		success
8.	13	7		success
9.	16	5	75	success
10.	17	4		success
11.	18	3	100	success
12.	19	2040	undefined	fail
13.	20	1976	undefined	fail

**TABEL 4.**  
Experimental data of sending the commands to mobile phones.

No.	Garbage height (cm)	Garbage volume (%)	Open the garbage bin cover		Close the garbage bin cover		Send data to mobile phone	
			Yes	No	Yes	No	Yes	No
1.	2-3	0 %	√		√		√	
2.	4-7	25 %	√		√		√	
3.	8-12	50 %	√		√		√	
4.	13-17	75 %	√		√		√	
5.	18-20	100 %	√		√		√	

**TABEL 5.**  
Time needed to send the data to mobile phone

No	Distance (m)	Time		Duration (s)	Status
		Sending	Receiving		
1	1	10 : 06 : 15	10 : 07 : 00	0.45	Sent
2	10	10 : 12 : 15	10 : 13 : 02	0.47	Sent
3	40	10 : 17 : 15	10 : 18 : 00	0.45	Sent
4	100	10 : 22 : 15	10 : 23 : 01	0.46	Sent
5	1000	10 : 28 : 15	10 : 29 : 02	0.47	Sent

The next experiment was focused on the sending the command to the mobile phones. The ability of the garbage bin to communicate with the mobile phone was recorded in TABLE 4. The garbage bin sent the data when it detected the change in the garbage capacity. It could send all of the change as indicated in the 0% - 100 % shown in TABLE 4. The opening and closing the garbage bin cover were also tested in this experimental step. The data in TABLE 4 shows that all of the objects can be detected well by the garbage bin. TABLE 5 shows the time needed by the mobile phone in responding the data sent by the garbage bin. The time needed is around 0.45 – 0.47 second.

#### 4. CONCLUSION

From the experiments conducted in this research, it can be concluded that the garbage bin proposed in this research has run well. It could open and close its cover as soon as it detected or did not detect the objects. It could also send the information of the garbage capacity to the mobile phone immediately with delay only 0.45-0.47 s.

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