Garbage Monitoring and Warning System

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***Abstract*—This paper discusses about monitoring the garbage capacity trough mobile phones. The overflow of the garbage from the container as the result of the fullness of the container gives a bad effect in the environments. The stinging smell disturbs the comfort of the human. In addition, the spilled garbage of course will consist lots of germs and bacteria that are not good for human health. Therefore, a monitoring system of garbage capacity that can give warning to the human when the garbage container has been full, is set up in this research. Three Garbage Robots, namely (G-Bot 1, G-Bot 2, and G-Bot 3) are used. Each of the robots sends their data to the mobile phones. Each of the robots can be monitored trough mobile phones using Blynk application. The user can know the condition of the garbage although they are far from the robot. In addition, the G-Bot will send warning notification when it has been full of garbage.**

Keywords—Garbage, Internet of Thing, Monitoring, Robot, Warning

I. INTRODUCTION

The growth population has increasedthe volume of waste from time to time[1]. In recent year, it becomes the world serious problem [2], [3]. Some researchers focused in finding solution for this problem, i.e. by providing early education to children regarding the importance of disposing of garbage in their right place [4], sorting waste [5], doing waste management [6], developing IoT [7], [8], [9], etc.

The garbage can bring both positive and negative impact to the other creatures. Pablo I. Plaza in the article [10]stated that negative impact in the reproduction systems of the animals that live in the garbage dumps was only 19%. Moreover, most of the researchers that investigated about the animals who lived by consuming the garbage [10]gave positive view. They stated that there is an enhancement of body condition, an improvement of reproductive performance, increment of population abundances and survival rates [10]. However, it cannot be denied that the garbage also gives bad impacts to the human, as stated in paper [11], [12], [13]. The fatal effect of the garbage can lead to a serious disease, such as cancer.

As stated above, the garbage that overflows to the street, of course, will bring many problems to the surrounding environment, especially for the human health [14], [15]. In this study, an IoT monitoring system was developed to maximize the performance of garbage bot (G-Bot). Three of G-Bots consisted of two parts respectively, i.e. organic and inorganic were monitored trough mobile phone to ease the human ingetting information aboutthe G-Bot condition. In addition, when it has been full of garbage, the G-bot will warn the human by ringing the buzzer and send notification to the mobile phone.

II. INTERNET OF THINGS APPLICATION

Internet of Things (IoT) offer an ease of use. It is a new innovation of Internet. It can connect not only people to people, as provided by internet, but also all objects [16] that can be connected anytime, anywhere, with anythings and any persons, in any ideal route. IoT has been applied in many areas, for instances in Health [16], [17],smart homes [18],smart cities [19], [20], [21], smart government [22], etc.

In Garbage and waste application, IoT has been implemented in variousparts, such as management system, segregation, planning, monitoring, optimization, and design and evaluation(See Table I).

TABLE I. THE USE OF IOT IN GARBAGE MONITORING

Application	Advantages	References
Management System	The route of the garbage truck can be simplified using the management system in order to economize the time, the fuel, and the human effort.	[23], [24]
Segregation	The recycle process can be more easily when the garbage has been segregated	[25], [26]
Planning	The operational cost can be reduced. and support the smart city	[9], [27]
Monitoring	The environment can be kept clean and fresh.	[28], [29], [30]
Optimization	The garbage management can be optimized.	[31]
Design and evaluation	The performance of garbage management can be enhanced.	[32]

In management systems, Debajyoti Misra[24], used a smart bin that equipped with distance sensor and some of gas sensors. The bin not only sensed the level of the waste but also checked the surround stinky gases. All the information about the bin was interconnected with the web server. The research claimed that by using this management systems, it could save the total expenses and be more economic.

Kruti Dhyani in [25] discusseda review of segragation of the trash, where a segragator was used to segregate the waste. When a metal waste was detected by the sensor, an arm robot took the metal and separate it to different bin. The segragation gives benefit to the recycle process by shorting the time.

In Planning system, Theodoros Anagnostopoulos [9], set up two kinds of trucks for waste collection, i.e. the Low Capacity Trucks (LCTs) and the High Capacity Trucks (HCTs). The HCTs only implemented for the high quantity garbage area, while the LCTs for lowquantity. This model can save the operational cost.

Monitoring of the garbage could give benefit of the environment. It could be kept cleaned and fresh. The condition of the garbage can be monitored trough the mobile phone. In [29], a Garbage box was designed to be connected to a Prize Box. They communicated each other. When there was someone threw garbage to the garbage box, the prize box would gave out candy as the prize for one who has threw the garbage in right place. The quantity of garbage and candy was monitored by phones.

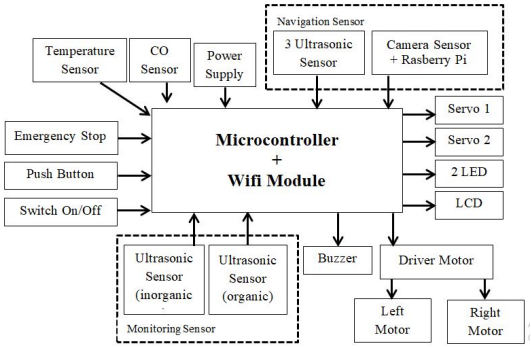
In optimization, Jose M. Gutierrez [31], used a special algorithm and the real data GIS for optimizing the garbage management. 4 models, i.e. Trashcans filling, modelling, creation modelling, route creation, and economic model were set up. The optimization establihed gave an efficient routes collection that can minimize the time and the cost.

In Design and evaluation, Zongguo Wen [32], proposed system that involved a smart truck provided with RFID, camera, weight sensor, and GPS module. The performance of the truck was recorded. It is useful for deciding which route should be executed by the truck. This design can enhance the garbage management system.

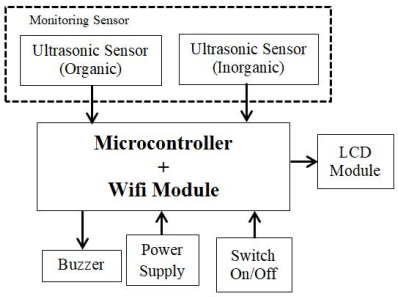
Warning the human about the garbage condition gave the human a chance to take care of the garbage container. The warning system of the garbage in general connected with the monitoring system, as proposed in this research. When the distance sensor detected that the level of the garbage has been over the allowed level, the system will give the warning and notification.

III. EXPERIMENTAL SETUP

The complete block diagram of Garbage Robot (G-Bot) of this research was composed of two parts, i.e. navigation and monitoring, as shown in Fig. 1 (a).



(a)



(b)

Fig. 1. Block Diagram of G-Bot One

In this paper, the Navigation is not really essential as in the authors previous work [33]–[35]The focus of the research in this paper is only in the monitoring part as shown in Fig.1 (b).

The concept of the G-Bot in this study is different with the authors' previous work[36]. The G-Bot concept is presented in Fig. 2. All mobile phones can communicate with the G-Bot by downloading the blynk application that has been designed in this research. The barcode of the application can be seen in Fig. 3. The G-Bot application can be installed easily trough the following steps:

1. Download Blynk App trough these following link: http://j.mp/blynk_Android or http://j.mp/blynk_iOS.
2. Touch the QR-code icon and point the camera to the code (Fig. 4).
3. Enjoy the app.

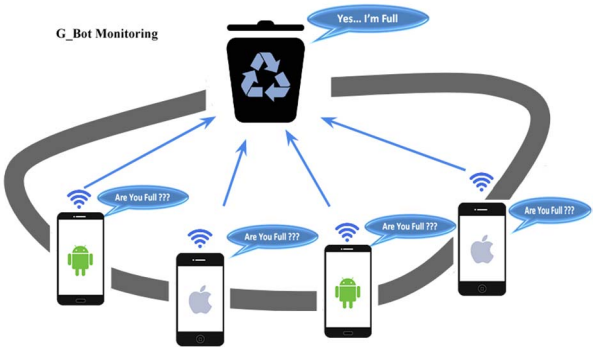
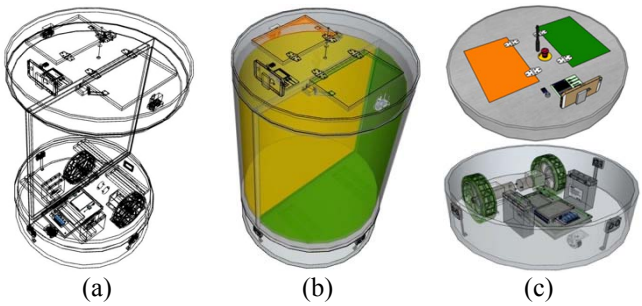


Fig. 2. G-Bot Concept

Fig. 3. Barcode of the G-Bot application



(a) (b) (c)

Fig. 4. Designs of G_Bot One (a) The construction, (b) The Inner container display, (c) The top and the bottom.

The mechanical design of the G-Bot is presented in Fig. 4. The ultrasonic sensors that were placed under the cover at the top of the G-Bot act as the distance sensors for detecting every level of the garbage changing. The height of the organic and inorganic container in the G-Bot is 58 cm. The ultrasonic sensors were placed in the 60 cm away from the base of the containers. The setting of the garbage level and percentage is presented in Table II.

When the distance of the ultrasonic sensor and the height level of the garbage is 60 cm away, the capacity of the garbage is 0%. In this condition, the sensor detects no garbage appears in the container of the G-Bot. On the other hand, when the distance of the ultrasonic sensor and the height level of the garbage is 6 cm away, the capacity of the garbage is 90%. The fullness of the garbage is set only 90 %. It is meant to give space of the G-Bot, so that the top of the G-Bot not to be exposed to the garbage directly. Thus, the cleanliness of the cover can be achieved.

TABLE II. THE DISTANCE AND PERCENTAGE SETTING OF G-BOT

Kind of trash	The distance between sensor and trash (cm)	Percentage of trash (%)	Information
Organic /Inorganic	60	0.00	Empty
	55	8.33	Empty
	50	16.67	Empty
	45	25.00	a quarter
	40	33.33	a quarter
	35	41.67	a quarter
	30	50.00	a half
	25	58.33	a half
	20	66.67	a half
	15	75.00	three-fourth
	10	83.33	three-fourth
	6	90.00	Full

The G-Bot worked based on the flowchart in Fig.5. The wifi should be connected at the beginning of the process. The ultrasonic sensors detected the garbage and send the data to the application every 5 seconds. When the garbage is full, the alarm in the G-Bot will be active, and the Blynk application will send the notification to the user that indicate the garbage is full. However, when there is no internet connection, the system will not run, and of course send no data to the smart phones.

Some of the data that can be displayed in the mobile phones (when there is internet connection) are presented in Fig. 6. Three of the G-Bots were monitored in the mobile phone. The organic and inorganic data from each of the G-Bots are presented in one screen. This information make the human to beeasy to monitor and to make decision which G-Bot that can be used to throw the garbage and which of the G-Bot should be taken care (should be depleted and cleaned). Each of the data in Fig. 6 was taken from the smart phone displays. The different condition of G-Bot was presented in that figure. In Fig. 6 (a) Only the organic of G-Bot 01 was filled of garbage (90%). In Fig 6 (b), all of inorganic of G Bot was filled 25% of Garbage. In Fig 6 (c) and (d), The inorganic of G-Bot 01, and organic of G- Bot 02 were empty. There was no garbage detected by the sensors.

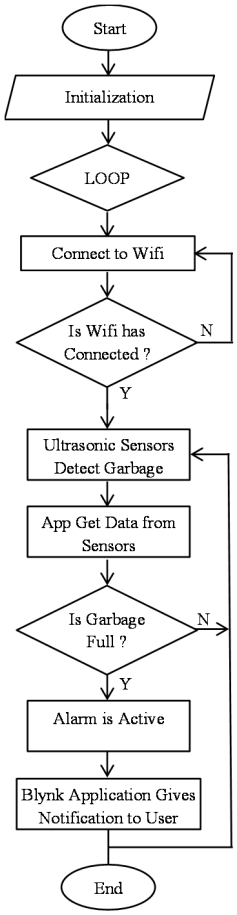
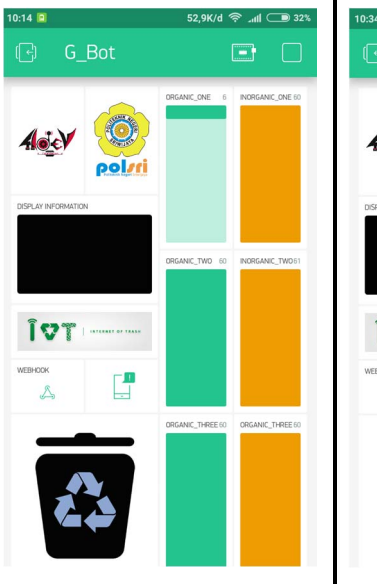
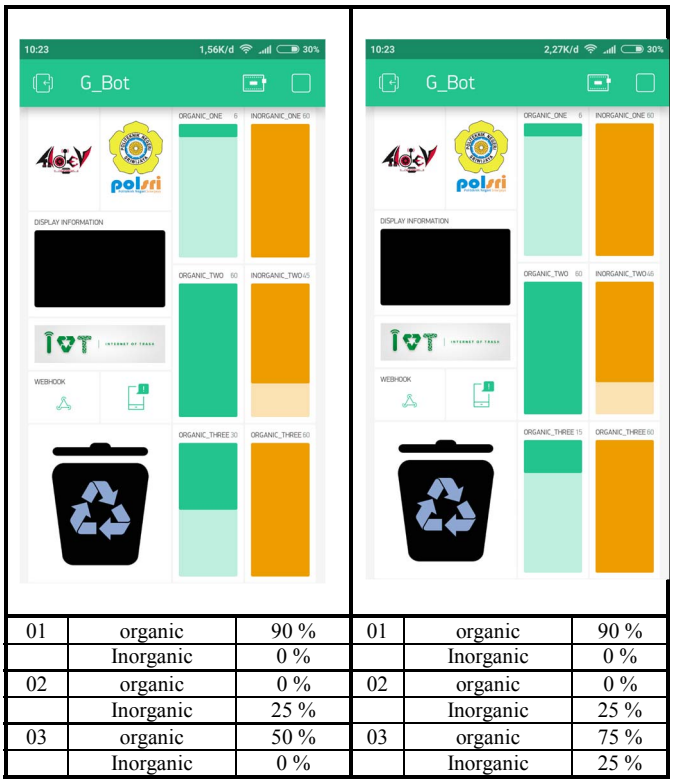


Fig. 5. Flowchart of the G-Bot



01	organic	90 %	01	organic	90 %
	Inorganic	0 %		Inorganic	25 %
02	organic	0 %	02	organic	0 %
	Inorganic	0 %		Inorganic	25 %
03	organic	0 %	03	organic	0 %
	Inorganic	0 %		Inorganic	25 %

(a) (b)



01	organic	90 %	01	organic	90 %
	Inorganic	0 %		Inorganic	0 %
02	organic	0 %	02	organic	0 %
	Inorganic	25 %		Inorganic	25 %
03	organic	50 %	03	organic	75 %
	Inorganic	0 %		Inorganic	25 %

(c) (d)

Fig. 6. The G-Bot data based on IoT system

IV. Conclusion and Future Work

The research of the IoT in this paper has shown success. The 3 G-Bot could send the data correctly and the mobile phone coud receive the data in real time. For future work, the G-Bot will be modified to be able to move to a spesific place by commanding the G-Bot to navigate trough mobile phone. It can make the user to be easier to throw the garbage,The ultrasonic sensor detected every increasing of the garbage level. The garbage (see Fig.6 for the samples) got increment every time when it detected there were additional garbage came into the container. The bright colour of the organic and inorganic (the green for the organic, while the orange for the inorganic) indicated that the garbage was empty

The bright color changed to the fade one when the garbage has filled the container. In Fig. 6 (a), the G-Bot gave the result of organic and inorganic respectively 90% and 0% for G-Bot 01, 0% and 0% for G-Bot 02, and 0%, and 0% for G-Bot 03. It also happens to Fig. 6 (b) – (d), the color changed to the fade one when the garbage came into the container in which indicated that the sensor detected that there were some garbage in the container.

The rise level of the garbage detected that can be monitored in the display of the mobile phones, was inversely proportional to the value of sensors reading. They will be decreased by the time of the percentage of the garbage rise. The capacity of the garbage was full when it reached 90% (6 cm of sensor reading), as indicated by organic of G-Bot 01 in Fig. 6 (a) – (d). In this condition, the alarm rang and the system gave notification to the application that indicated the container of organic container in G-Bot 01 was full.

Acknowledgement

Authors thank to the Indonesian Ministry of Research, Technology and National Education (RISTEKDIKTI) and State Polytechnic of Sriwijaya under Research Collaboration for their financial supports in Competitive Grants Project. Our earnest gratitude also goes to to all researchers in Signal Processing and Control Laboratory, Electrical Engineering, State Polytechnic of Sriwijaya who provided companionship and sharing of their knowledge.

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