Design of Wireless Garbage Monitoring System using Raspberry pi

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***Abstract*— The garbage volume increases proportionally to the degree of progression in the economy of a country: It increases rapidly in the countries, where there are rapid increase of housing capacity and industrial locations. Garbage is considered a big challenge facing by all countries. It affects human health by causing diseases. The objective of this study is to design a wireless monitoring system for garbage containers, that assists to reduce the risks of overflowed garbage that spread out of the container. The design of the system is based on Raspberry Pi and consists of ultrasonic sensor with alarm circuit. Moreover, the design provides wireless monitoring of the garbage in the trash container via Wi-Fi technology. It includes database system for saving data. The system was tested experimentally in two different operating cases: when the container was empty and when it was full. The overall results reveal that the system works correctly, and all the obtained results were shown in the web page. The results proved that this monitoring system can help in reducing the problems of garbage problems by providing continuous monitoring of the garbage container status.**

***Index Terms*— Monitoring; Raspberry Pi; Electronic design**

I. INTRODUCTION

The term 'garbage' refers to any unwanted and useless materials that humans decide to throw away [1][2]. The classification of garbage depends on the nature of population. For example, people who are living in the developed countries often have higher organic contents than those living in the developing countries [3]. Un-collected garbage causes a lot of problems that affect human's health, such as increasing gas emissions, as it provides good ground for insects and animals, such as rats to produce leachate, which can cause pollution of ground and surface water sources [4]. Depending on the source, there are different types of garbage, such as house waste, industrial waste, biomedical waste, electronic waste, radioactive waste and commercial waste [5].

Keeping the environment clean in urban areas and high-capacity cities is expensive as it requires good management to transport the garbage. Garbage management is an essential service in all societies. The ordinary system of collecting garbage without using monitoring system has many problems, such as wasting fuel and time as well as creating environment problems that lead to health problems. A good monitoring system may lead to successful garbage management system because it provides the required information of the garbage volume in each region. Although most of the developed countries have spent highly in the operation of waste management, only 50% to 80% have been generated [6]. Modern technology plays an essential role in developing effective monitoring systems and assisting in saving time and reducing the cost of operation. Internet of things is a network that enables different physical devices to connect with the Internet [7]. It is used widely in monitoring systems, such as monitoring weather, temperature, and water level. In this paper, raspberry pi technology is used to design a garbage monitoring system, in addition to database system to save the continuous information of the garbage collection.

II. RELATED WORKS

The significance of this paper is demonstrated in the structure of the proposed system that used a modern control device and its operation mechanism that used Wi-Fi connection. Further, the proposed database system is useful for future garbage management planning. Dhaya et al. [8] in his paper presented an IoT garbage monitoring system that displayed the status of the garbage bin, lacking a database. Further, the use of Arduino controller, which requires the Ethernet module to connect via Internet needs additional cost. Kale et al. [9] presents GSM modem and Arduino controller to provide garbage monitoring by sending a GSM massage to specified number to inform the level of garbage in the bin. A design of monitoring garbage was proposed in Benish et al. [10]. It used AVR Atmega328 microcontroller, and only the status (empty, full) of the basket is shown over the internet. The use of microcontroller is required, and Wi Fi module is used to provide the Internet connection. Harshita et al. [11] presented an IoT monitoring system of garbage bins. Although the paper did not show a clear block diagram and real results, the system used a microcontroller in the bin to receive data from a sensor and sends it to microcontroller that functions as a central unit, which then sends to the raspberry pi unit. These three stages require additional cost, and the connection between each stage was done by using RF module. Twinkle et al. [12] show an Arduino design of garbage monitoring that used ultrasonic sensor with a GSM interface.

III. RASPBERRY PI DEVICE

Raspberry pi is a low-cost small single board computer, developed in the United Kingdom [13][14][15]. It is widely used in industrial applications, specifically in IoT monitoring systems [16][17]. Several models of Raspberry pi have been developed after the development of A followed by model B in 2012. An improved model of Raspberry pi, called as model B+ was released two years after the

introduction of model B. This model was smaller in size than model B. In the same year, 2014, Model A+ was released. Since that date, the development of raspberry Pi had been continued rapidly, in which the Raspberry pi 2 had been released in 2015. The generation of raspberry pi 3 was released in 2016 starting by model B, which contains on-board 802.11n Wi-Fi, Bluetooth and USB connection. In 2018, the Raspberry pi 3 model B+ was launched. It has a faster processor and Ethernet and contains dual-band 802.11ac Wi-Fi (100 Mbit/s). Raspberry pi 4 model B was released in 2019. The raspberry 4 is provided with faster processor of 1.5 GHz and 64-bit quad core. It has two USB2.0 ports and two USB3.0 ports. It also has on-board 802.11ac Wi-Fi with full gigabit Ethernet.

IV. METHODOLOGY

The block diagram of the system is shown in Figure 1. The ultrasonic sensor transmits the measured level of the garbage to the Raspberry pi, which determines the status of the basket either to be full or empty. The web page received the status of the basket from the Raspberry Pi via Wi-Fi. All received values are sent via Wi-Fi to the web continually, which are stored in the data base section. Raspberry Pi, then decides either to make an alarm or not. An alarm beep is issued when the container is full. The status of the container is shown as full for small level values. The experiment overviewed two cases:

- Case 1: The container status is referred as empty when the garbage level is within the allowed height.
- Case 2: The container status is referred as full, which indicates that actions need to be taken to empty the garbage container.

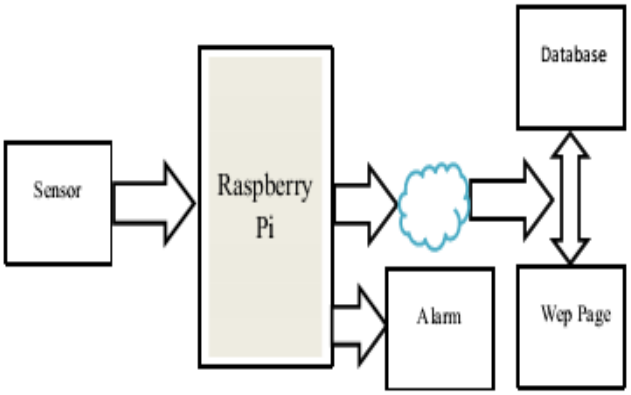

Figure 1: Block diagram

The hardware schematic includes the main parts of the circuits, such as the Raspberry pi is shown in Figure 2. It has a simple structure; therefore, it can be considered as a low-cost design. It consists of control circuit, ultrasonic sensor and alarm device.

Figure 2: Hardware

V. SOFTWARE STRUCTURE

The proposed system gives a real time indicator of the garbage level in a trash container and displays the garbage level in the container at any given time by processing the measured level of the sensor. This system also helps to overcome the waste of time and fuel in garbage collection. In this monitoring system, the trash site is routed to the operating center via internet, which shows the status of the trash; hence, reducing fuel consumption. It also allows garbage collectors to plan their daily/weekly pick-up schedule. An ultrasonic sensor is used for detecting the container status, which is classified as either full of garbage or empty.

The while-loop statement used to define the repetition time measuring of each status is as follows:

- While GPIO input (ECHO) == 0
- Pulse _ start == time.time( )

The python code used to define the status of the electronic basket depending on the measured value of the sensor, which specifies the remaining distance in the basket. The if statement is used to define the levels of the basket (Low, High). This definition is presented in the following code, as shown in Figure 3.

```
Status = distance – 0.5
Dist = str(D) + “cm”
x = open (‘tempt.txt’, ‘w’)
x.write(Dist)
if status > 5 and status < 10:
   x = open (‘status.txt’, ‘w’)
   x.write (‘Empty’)
   GPIO.output (Buzzo, False)
else:
   x = open (‘status.txt’, ‘w’)
   x.write (‘Full’)
```

Figure 3: Python Code

The operating mechanism is shown in Figure 4. The ultrasonic sensor is installed at the top of trash basket, and it is used to measure the available remaining distance of basket from the top of the trash. The user of the system can

set a threshold value according to the size of trash basket. If the remaining distance in the trash basket was less than this threshold value, it means that the trash basket is full of garbage. Then the system will show a message "Basket is Full". When the remaining distance in the basket is more than the threshold value, the system will show the required level of the remaining distance of the trash container to be filled up by the garbage. In this case, its status is empty.

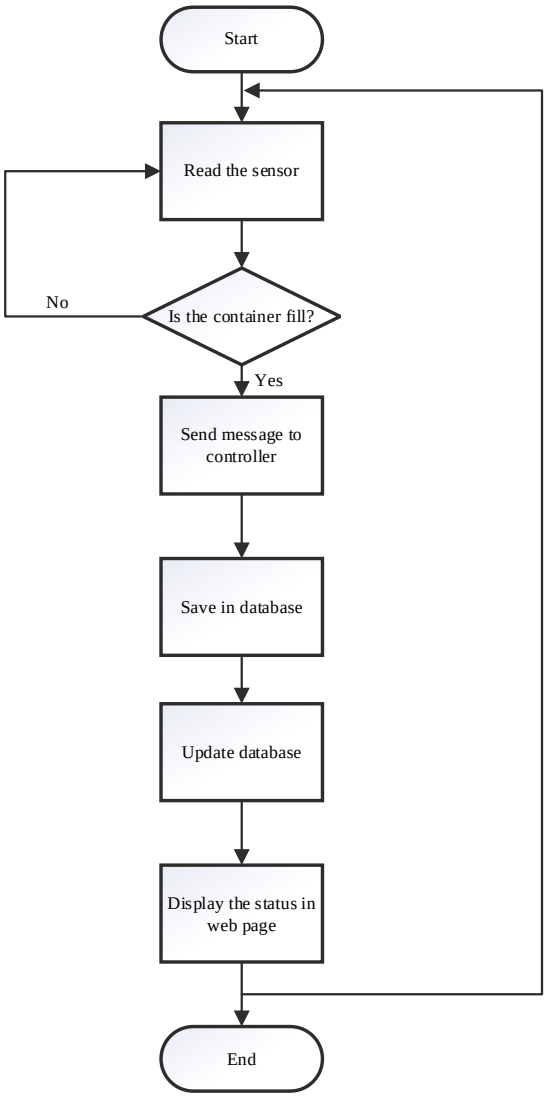

Figure 4: Algorithm

The bash code as shown in Figure 5 is used to identify the monitoring web and define the database parameters of the basket (level, Date, Time).

```
#!/bin/bash
python ultrasonic.py
DATE = `date '+%Y -%m -%d -%H -%M -%S' ` " "
value = `cat temp.txt` && echo $value
status = `cat status.txt` && echo $status
xdg.open https://confervoid.implemen.000webhostapp
exit 0
```

Figure 5: Bash Code

The data base information is useful for continuous monitoring, especially for the government's future planning of garbage collection system. The steps that users must follow to enter the system are shown in Figure 6. The system starts by running the bash code to open the monitoring page, then the web page displays all the information of the bin.

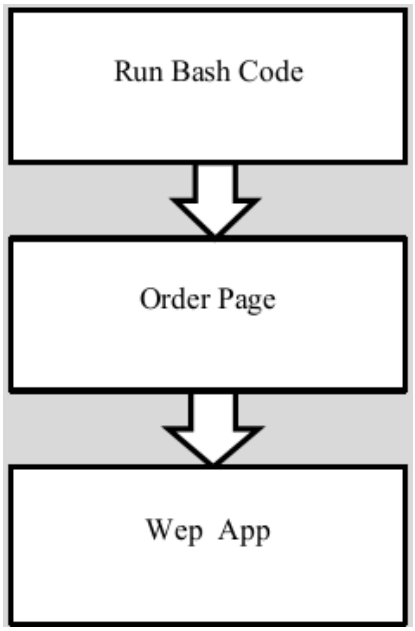

Figure 6: User steps

When a user continues using the basket even when it is full, there will be an overflow of the garbage and it will spread out of the container. In this system, an alarm is triggered when the container is full. The operation step of the alarm is shown in Figure 7.

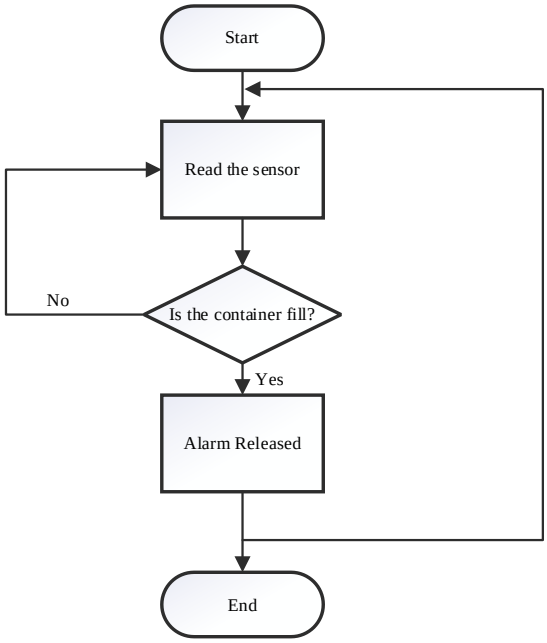

Figure 7: Alarm Algorithm

A whistle is issued based on the transmitted values to the web application page.

VI. Results and Discussions

The smart garbage monitoring system model using the Internet of Things technology was verified experimentally. The experiment showed two cases of container: when it was full of garbage and when it was empty. The status of the container is considered empty as long as the level of the garbage in the container is less than the specified threshold level. The system provides a real time reading of the garbage level and sends it to display on the web page and saves in the database together with the date and time of reading. The basket also contains a whistle to alert if the sensor reads a value, which is greater than the total depth of the container. The alerts are useful to avoid the garbage from overflowing of the container. Raspberry pi sends the value via Wi-Fi to the data base. The values are sent to web application page via Wi-Fi connection and displays directly in the web page. It includes the remain space in the basket, the basket status empty or full and date and time, as shown in Table 1.

Table 1
Database Form

Electronic Waste Basket		
Date and Time	Deep	Status

The ultrasonic sensor is placed on the top of the basket, and it calculates the remain distance available in the basket. The calculation is based on the following simple formula:

$$\text{Distance} = V \times T \quad (1)$$

where: V = The speed of sound wave.
T = The arrive time of the receive wave.

The collected values are directly stored in the database system, then the Raspberry pi controller makes a decision whether to release the sound alarm or not, depending on the status of the container. The alarm will be released when the container is full that is when the level is less than (5cm), as shown in Figure 8.

Electronic Waste Basket		
Date and Time	Deep	Status
24-09-2019 14-45-47	3cm	Full

Figure 8: Full basket

The basket is empty when the value is greater than the reference value (5 cm), as shown in Figure 9.

Electronic Waste Basket		
Date and Time	Deep	Status
14-09-2019 14-49-33	6cm	Empty

Figure 9: Empty basket

The overall results show that the proposed monitoring system is successful in both cases: when the basket was within the accepted level and when it was overloaded.

VII. Conclusion

This paper presented a wireless monitoring design using internet of things. The design was based on Raspberry Pi controller. The system provides a database system to assist in future planning. The system optimized in term of cost because of its simple structure. The obtained results show that the system was working correctly in the case of empty container and full container. In future, more sensors can be added and the system can be connected with control system to manage the operating of the trash cars.

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