Smart Waste Collection Monitoring and Alert System via IoT

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***Abstract*—The uncollected waste material when the waste bin is full is a common problem nowadays. Thus, an efficient waste management for the waste material is essential in ensuring a clean and green surrounding environment. This paper presents an Internet of Things (IoT) based Smart Waste Collection Monitoring and Alert System to monitor the waste material at the selected site of garbage collection area. The system is implemented using an ultrasonic sensor which is connected to Arduino UNO as to monitor waste bin garbage level. In this system, waste bin depth level will be sent via Arduino Ethernet Shield with an Internet connection to the Ubidots IoT Cloud. The Ubidots store the collected waste bin level data into IoT database and display the waste bin depth level on online dashboard for real-time visualization. The Ubidots Event manager invoke a notification alert to garbage collector mobile phone via a SMS when the waste bin is nearly filled for immediate waste collection. Therefore, the waste collection became more effective and systematic.**

Keywords— Ultrasonic Sensor, Arduino UNO, Smart Waste Collection Monitoring and Alert System, Ubidots.

I. INTRODUCTION

Currently, over 23,000 tonnes of waste is produced each day in Malaysia. However, this amount is expected to rise to 30,000 tonnes by the year 2020. The amount of waste generated continues to increase due to the increasing population and development, and only less than 5% of the waste is being recycled. Despite the massive amount and complexity of waste produced, the standards of waste management in Malaysia are still poor. Hence, the country will face a problem when there is no proper management for this waste collection. As Malaysia is a developing nation and furthermore has comparative issues, for example, legitimate innovations, labour, arrive shortage and different offices which are deficient to adapt to the regularly expanding rate of waste age[1].

An efficient waste material collection is essential to prevent the waste from affecting human health and polluting environment. Large quantities of uncollected waste material are one of the thing that can affect society health and ecological system if it is not properly managed. The country will face a problem when there is no proper management for this waste collection department. As the country grow, waste material also grows too. Hence, one of the problem to solve the uncollected waste problem by knowing when the waste bin is full and ready for waste collection. This information can help the city council to properly schedule their garbage truck for waste collection within their managed area. This will improve the movement of waste collection fleet resources while enhance the efficiency of waste collection system.

Solid waste management is one of major aspect which has to be considered in terms of making urban area environment healthier. It is become necessary and challenging to manage the solid waste with rapid urbanization and increased population growth. An environment will be polluted and dirty if the waste material is not been manage and collected in time. A better waste management solution can helps improving the general wellbeing of a community and built up a better neighborhood. Nowadays, numerous IoT based solution for waste management are implemented to improve the collection of garbage which would ensure healthy environment for life on this green planet, with greater efficiency [2],[3],[4],[5]. Municipalities wanting to achieve cleaner urban environments can implement an IoT based solution [6],[7]. Some of the IoT based solutions [8],[9],[10] for waste management provide a notification alert when the garbage bin reaches its full capacity for immediate waste collection. An IoT based cost-effective system that can monitor the everyday garbage IoT based solid waste management system which enables garbage bin monitoring, dynamic scheduling and routing of garbage collector trucks in a smart city [11],[12]. A review of existing IoT-enabled solutions in smart cites' waste management is done here to bring together the state-of-the-art solution for example in term of self-powered solution.[13],[14].

IoT which is a new platform that is very useful for people in this world. IoT is the core of such revolutionary of growing engines. IoT is possible due to sufficient power supply and internet connectivity[15]. The term of IoT is commonly used to describe a framework where sensors are

connected to objects and help these objects to share their 'digital voice' with the external world over internet connection. In the recent time, IoT has become a compilation of purpose-built networks. There were many IoT platforms such as Blynk, Ubidots, IBM Bluemix and Devicepilots as bidots is chosen as a platform of IoT for this project. Ubidots is a cloud service that offers a friendly and intuitive interface where the users can interact with a variety of devices, ranging from a cell phone or a computer, to an embedded system such as a microcontroller system. In a nutshell, Ubidots is a platform that allows to link different types of devices to a cloud database and save variables that can represent them in a simple and fast way and secure manner.

This paper presents a Smart Waste Collection Monitoring and Alert System (SWCMAS) using IoT technology on Ubidots Cloud. The remainder of the paper is organized as follows. Section II describes the system development and overall design approach. Section III discussed the experimental result of an IoT smart waste collection monitoring and alert system performance. Finally, section IV provides the concluding remarks and point out the ideas for future extension of this work.

II. System Development

In this section, a brief explanation regarding on the project development and methodology will be described. This project proposed a system to control a waste material from overflow from the waste bin and alert is send to cleaner for waste collection. Using the anticipated system, monitoring of the waste collection status could be monitored effectively. This project designates a technique in which could monitor the garbage level at regular intervals as overflow of the bin can be prevented. The filling level of the garbage in the dustbin and its original level height could be sensed/ monitored by the ultrasonic sensor. Programming in the Arduino UNO is done in such a way that once a particular level of filling is sensed, information as a message is sent to the user, requesting for cleaning of the dust bin.

Referring to the block diagram in Figure 1 below, the developed system consists of a 1) sensor node that implemented using an Arduino Uno board connected with Arduino Ethernet Shield, HCRS-04 ultrasonic sensor and buzzer; 2) Wired router that interconnected the sensor node to Ubidots IoT Cloud platform and 3) Ubidots Cloud platform that consist secured IoT devices organization.

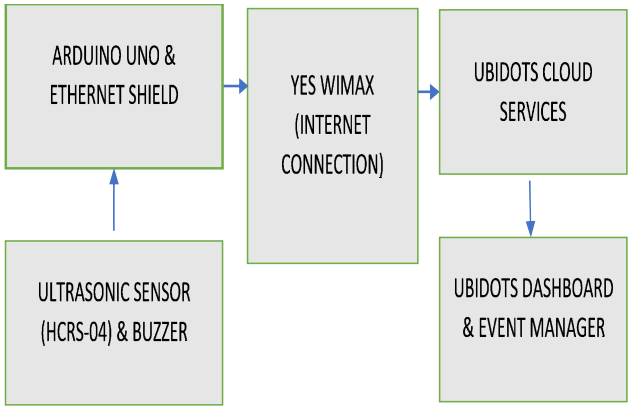

Fig. 1. Block diagram of SWCMAS

Ubidots Dashboard to display and visualize the waste bin depth level data and Ubidots Event manger to notify an alert to consumer via telegram/sms on smartphone when the waste bin is nearly filled.

The system development consists of hardware and software development phase. In hardware development phase, the Arduino Uno is use as a microcontroller for the sensor node. The sensor node is interface with Ultrasonic sensor for detection of the waste bin depth.

A. System Hardware Development

Figure 2 above shows the schematic diagram for connection of Arduino Uno and Ultrasonic sensor. The pin that is used is all digital pins, hence no usage of analog pins. The ground pin of ultrasonic sensor must be connected to ground pin of Arduino Uno to avoid short-circuit. The trig pin and echo pin is connected to (digital) pin 8 and (digital) pin 9 respectively. The RJ45 cable also is connected from Arduino Ethernet Shied to YES WiMAX router for wired internet connection.

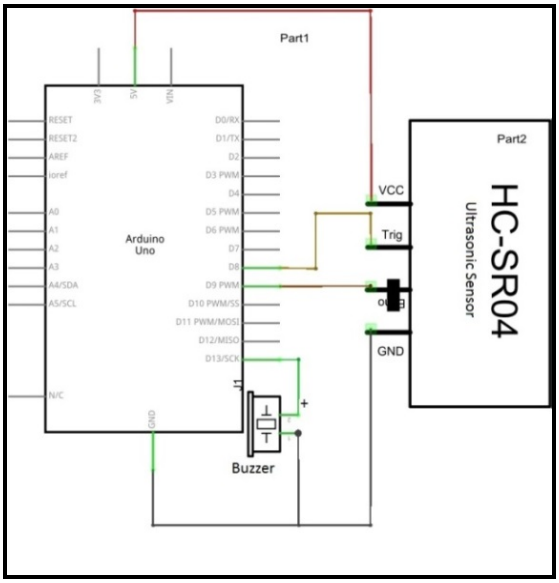

Fig. 2. Schematic diagram of SWCMAS

The ultrasonic sensors are placed at the top of the bin or at the lid of the waste bin as shown in Figure 3. When the waste is started to be filled, the Ultrasonic sensor starts emitting sound waves. At one side is the transmitter and other is the receiver, which measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the ultrasonic sensor and the object. It comes as a whole with an ultrasonic transmitter and collector module. The distance can be calculated with the following formula:

$$\text{Distance } L = 1/2 \times T \times C \quad (1)$$

where L is the distance, T is the time between the emission and reception, and C is the sonic speed. (The value is multiplied by 1/2 because T is the time for go-and-return distance.).

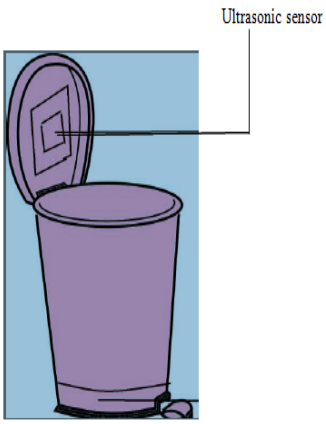

Fig. 3. Waste Bin Model

Figure 4 shown the waste bin at the selected site. The ultrasonic sensors are placed at the top of the bin. The step of the collection data will be repeated as using the waste bin model. The data or information is collected and send to Ubidots platform.

Fig. 4. Waste Bin at Selected Site

B. Software Development and Configuration

In software development and configuration phase, the MAC and IP address of sensor node have to be obtained and configure into Arduino program for sending the waste bin depth level to Ubidots IoT Cloud.

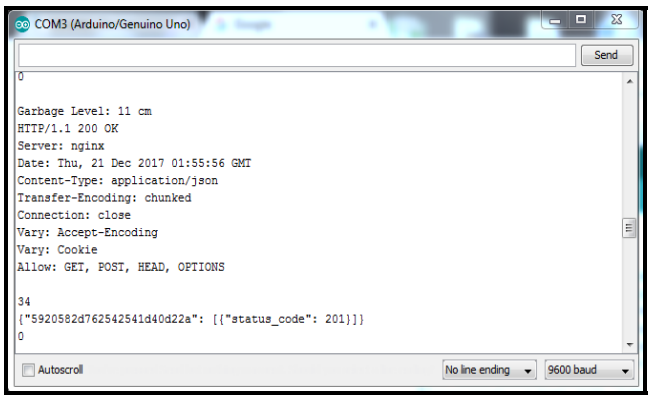

Fig. 5. Ultrasonic sensor data publish to Ubidots Cloud

Figure 5 shows the the waste bin depth level data collection from the sensor node and publish the collected data using MQTT protocol connection to Ubidots platform in Arduino IDE. Figure 5 also shows that the transfer-encoding for this project is chunked and vary in accept-encoding and cookie. The connection is established as the connection from the Arduino IDE and Ubidots website is close.

After many steps of microcontroller coding using Arduino, Node configuration, Arduino Ethernet Shield configuration, the data is finally collected and sent to Ubidot IoT Cloud. Then, the project proceeded by configuring Ubidots platform IoT organization. The interface of Ubidots is user-friendly and ensures quick visualization of the multiples of interest.

By using this platform, you can create an event or warning messages, send them to a mobile device and configure the device to execute a control action. The system will alert the user and will send a message to user through cell phone via Wi-Fi. The device must be built in the Ubidots platform to take the devices API ID as to synchronize with Arduino IDE coding. Within Ubidots, the data can be retrieved in an instant. The event will be created as shown as Figure 6 below to notify the user when the waste value is less than 4 cm.

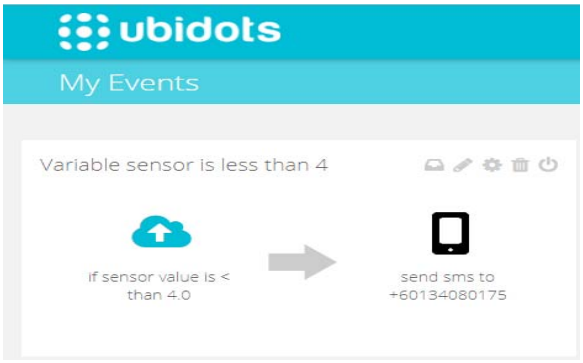

Fig. 6. The Event Setup for SMS notification Alert

III. RESULT

This section shown the results of data gathered during this project implementation. All of the data and information details were collected to evaluate the system performance. The result consists of two parts. The first part is an Ultrasonic sensor distance result that indicate the depth level of waste bin data display in the serial monitor on Arduino IDE. The second part is obtained from depth level of waste bin data collection through IoT Cloud on Ubidots Dashboard which is an online display. By creating a device in Dashboard, we can collect and store the waste bin depth level data on the specified device. The notification alert can be invoked when certain value of device data changes more or less from the specified value.

A. Arduino IDE results

Figure 7 shows the result on the serial monitor on Arduino IDE that indicate the depth level of waste bin data.

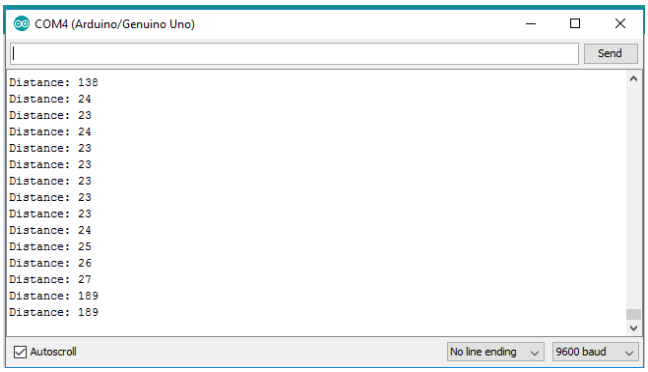

Fig. 7. The Ultrasonic Sensor Distance Measurement Result

B. *Ubidots Dashboard results*

The performances of this waste collection monitoring system can be monitored through Ubidots Dashboard. The data or information of the distance value can be view in raw, average or overall. The data and information that is collected is from waste bin from the selected site. The data will be sends from Sensor node through Arduino Ethernet Shield to Ubidots devices that had been created. Figure 8 shows the graph of the collected data of distance between garbage level and the waste bin lid while Figure 9 shows the value of the depth of the garbage level to the lid chronological order as the waste bin is nearly full.

Fig. 8. Waste bin depth level data graph at Ubidots

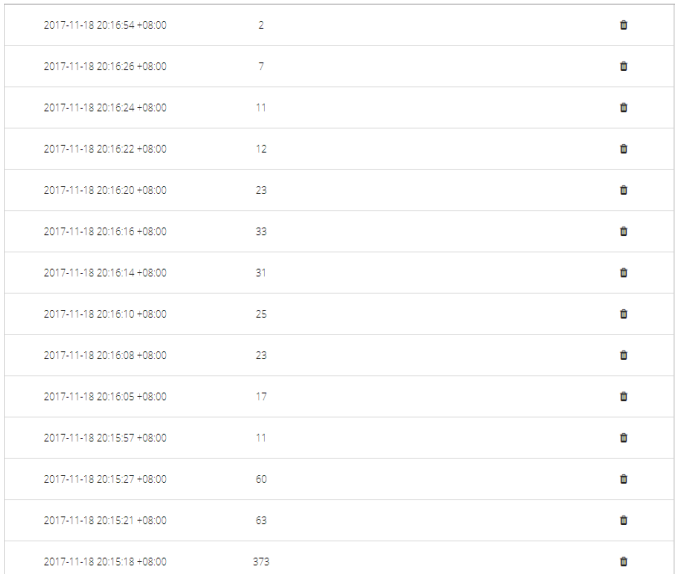

Fig. 9. The Waste bin depth level on Ubidots Cloud

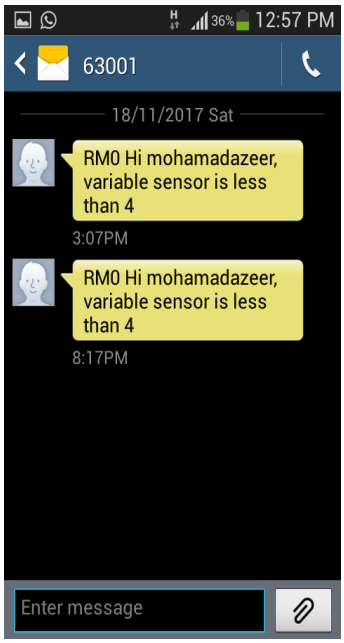

Fig. 10. Alert SMS Message from Ubidots.

As the garbage level increase, the distance between the waste bin lid with ultrasonic sensor will decrease Once the level of distance less than the determined value (4 cm), Ubidots will alert and send message to authorized person in form of SMS as shown in Figure 10.

IV. Conclusion

In this paper, we propose a new solution to enhance waste collection efficiently using the Arduino Uno with Arduino Ethernet Shield technology and ultrasonic sensor systems. In this proposed system, the garbage overflow of garbage can be avoided and managed efficiently. This will intimate or send SMS or email to the authorized person through Ubidots platform. The garbage managing system and the facility of collecting the garbage presently doesn't fit to the current requirement. Hence better facility of collecting garbage and transportation should be provided. Since, this system provides the information when the bin gets completely filled with garbage, it reduces the number of times the arrival of vehicle which collects the garbage. This method finally helps in keeping the environment clean. Thus, the waste collection is made more efficient.

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