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Smart Waste-Bin Monitoring System

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***Abstract*—** *Waste-bin close to residential have become a scene to be hold and required urgent attention. Often times the position of these waste-bins within the residence are accompany by flies, rotten smell of dumb waste and severe types of harmful insects due to lack of proper waste management. In this paper, we propose a smart waste-bin monitoring system that creates awareness to the authority and also the resident. This paper suggest a frame work based on application of Internet of things where sensor device can be used to monitor waste-bin through web using internet connectivity. The sensor used in this research is an ultrasonic sensor that monitored waste based on the ultrasound wave at frequency of 40 KHz. It senses the object and then bounces back to the sensor to determine the distance of the waste-bin level. The device is cost-effective and will promote a hygienic environment if implemented.*

***Keyword*—** *Monitoring, smart, internet connectivity, ultrasonic, hygiene, environment.*

I. INTRODUCTION

Waste management has become one of the ace of modern planning of urbanization of fast growing cities like Abuja, Nigeria due to the increase in population and the evolutions of industries. This is common in most developed cities in the world. The waste created from different sources can lead to environmental pollution, spread of infectious diseases and increase the health hazard among the people if an organize and efficient solid waste management is not put in place. Various environmental activities has been established to check against waste disposal in the environment such as the monthly environmental sanitation which provides waste dump to each houses, shops, public and private institutions and on the street so as to keep the environment clean. The process has not really kept the city clean, as most of the refuse were littered and shattered around the surrounding of the waste dump. In order to maintain a clean and hygienic environment, we propose a smart waste-bin monitoring system. The proposed system monitor the waste level in the waste dump in real-time at any given time. The introduction of waste-bin monitoring system in our environment will enable effective planning in collecting waste, be cost-effective and surely promote a healthy environment for all.

II. LITERATURE REVIEW

The review of work [1-3] uses RFID in monitoring and managing waste collection activities as a method of reducing costs, time and human effort. The waste littered and shattered around the waste dumps were also on surveillance using cost-effective cameras [2] and IR sensor [4] to maintain a healthy living in the surroundings. The exploitation of wireless sensor technologies in managing waste and guarantying a hygiene society was employed in [5, 6]. The sensor nodes used were weight, level, temperature and humidity, all embedded using smart Metering v2.0 board from Libeum. The system comprises of microcontroller with built-in accelerometer that read all data transmitted to the receiver from the sensor through GPRS and Zigbee communication media. The received data were stored on a database and displayed using a developed web application. The research work of [7] implemented waste bin monitoring system based on ARM 7 for collecting garbage. The same two combination of methods was adopted as in [5] above except that the research uses GSM and Zigbee instead of GPRS. The sensors used were placed in the waste bin to indicate the level of the garbage. When the waste bin is filled up to the height of the sensors. The sensors triggered the ARM 7 controller to send SMS to the truck driver using GSM technology which brings the attention of the truck driver to that particular waste bin. The work of [8] uses network of sensors to manage the waste collection of an entire city. The focus of the research was to analyze the large amount of data visualized at real-time in order to gain an insight about the status of the waste bins around the city. The manipulation of geospatial and IoT technologies [9] as pilot study for reliable smart city and M2M solution using ultrasonic sensor was implemented by [10]. The research was used to monitor waste collection operators to ensure there is an effective service delivery based on terms and condition of their contract.

III. METHODOLOGY

The proposed smart waste-bin monitoring system has six (6) sections namely; the sensing unit, processing unit, display unit, WiFi unit, the power supply unit and the web unit as illustrated in Fig. 1. The circuit diagram in Fig. 2 display the electronic connection among the component used.

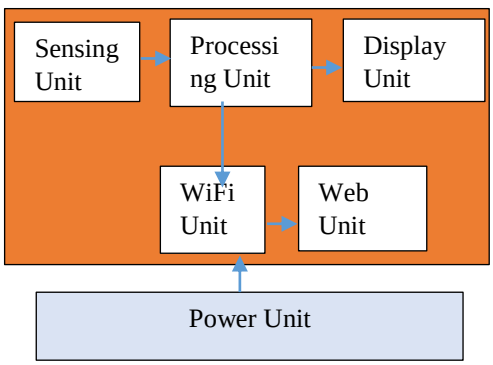

Fig. 1. The Block Diagram of Smart Waste-bin monitoring system

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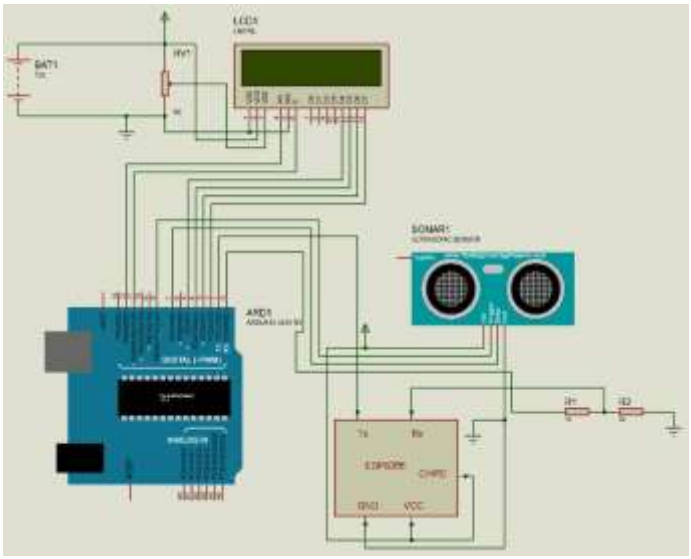

Fig. 2. The circuit Diagram of an IoT-based Waste Monitoring System

A. Sensing Unit

The sensing unit consists of the ultrasonic sensor. The ultrasonic Sensor is used to measure the distance with high accuracy and stable. It can measure distance from 2cm to 400cm or from 1 inch to 13 feet. It emits an ultrasound wave at the frequency of 40 KHz in the air and as it senses the object then it will bounces back to the sensor. The sensor has two openings on its front (like a tiny speaker and tiny microphone). One opening transmits ultrasonic waves while, the other receives them. The ultrasonic sensor uses this information along with the time difference between sending and receiving the sound pulse to determine the distance to an object.

B. Processing Unit

The processing unit consists of the microcontroller. The microcontroller acquires information from the sensor and processes it. It receives data and compares it with the threshold level generated and accordingly, output the information on the display unit. The microcontrollers used in this research is the Arduino Uno (ESP8266). The microcontroller has an interface for Wi-Fi module for the purpose of transmitting the processed information on the internet.

C. Display Unit

The display unit is a liquid crystal display (LCD). There are several types but the adopted dispay unit in this research is 16x2 LCD display. It displays the output information from the microcontroller as illustrated in Fig. 1 and Fig. 2.

D. The Wi-Fi Unit

The Wi-Fi unit provides means of transmitting the information through the gateway to the cloud (Thingspeaks) where the web is located. During the configuration of the microcontroller, the name of the access point and password alongside the cloud destination server (www.thingspeak.com) address were all configured.

E. The Web Unit

The web unit used in this research is an online server named Thingspeak. The server allow creation of channels using API read and write key generated [] for every stored information. The information collated can be plotted graphical and analysed as the waste-bin is monitored real-time.

F. The Power Unit

The power supply unit uses a 12V battery to power the entire system. However, the ESP8266 Microcontroller makes use of a lesser voltage and therefore the voltage that is delivered to the ESP8266 is reduced considerably.

G. Working Principle

The microcontroller is the processing core of the system that executes all the functions. The ultrasonic sensor in the sensing unit measure the distance of the waste in the waste-bin in relative to the threshold value (i.e. 75% of the waste) using the time difference between emission and reception. The ultrasonic wave of high frequency sound pulse at regular intervals is used. The ultrasonic sensor sense and continue to measure the waste until the waste level increases and reaches the threshold. At this moment, the distance between the ultrasonic sensor and waste is smaller. Then the Ultrasonic sensor will trigger the microcontroller to process the information by displaying the information on the display unit and also on the web interface for the residence and waste collector to see the waste status through the WiFi communication media where the authority concern can be prompted and actions can be taken. The ultrasonic sensor is placed within the interior of the lid of the waste-bin. The information is also display on the screen of the display unit as the microprocessor sends the information. Fig. 1 and Fig. 2 illustrate the block diagram and circuit diagram of the proposed system.

IV. Results

The pictorial image of the proposed smart waste-bin monitoring system and the designed webpage of the thingspeak is shown in Fig. 3 and Fig. 4 respectively. The information about the level of the waste in the waste-bin was monitored using ultrasonic sensor and displayed on the LCD. The readings on the LCD changes as the level of the waste increases from 0.25 to 0.5 to 0.75 and then to full level respectively. The smart waste-bin only works with Internet connection in order to send the status of the waste-bin data to the Web interface.

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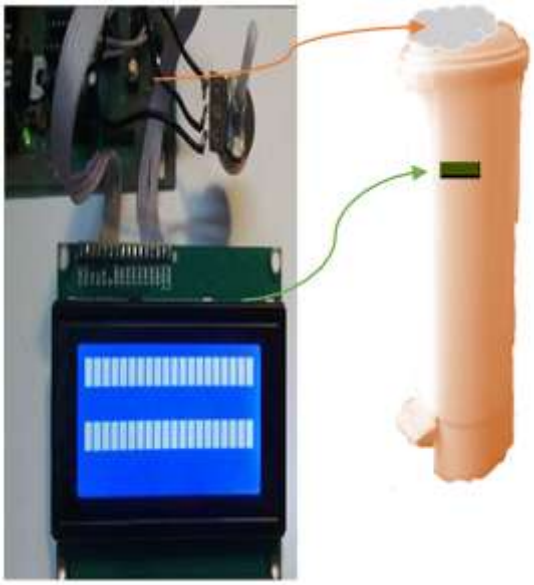

Fig. 3. Pictorial Image of Proposed Smart waste-bin monitoring system

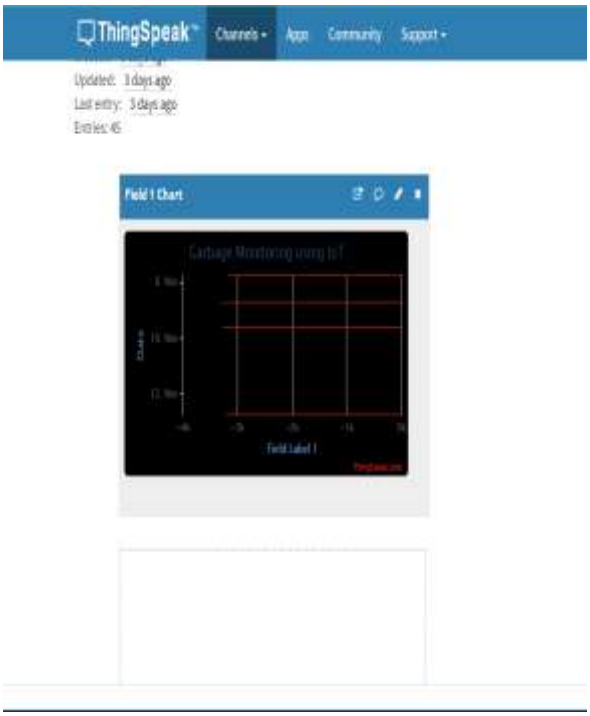

Fig. 4. The webpage of the Thingspeak server

V. CONCLUSION

The implementation of smart waste-bin was achieved. The system can be improve by integrating an intelligent camera, SMS notification and GPS technology to the smart waste-bin. The camera can be used to upload the pictorial situation of the waste-bin and the environment while SMS notification and GPS provides the coordinate location and SMS alert to the authority and the residence on the status of the waste-bin. Also a customer complaints module can be added to register all complain and issues faced with the waste-bin.

The smart waste-bin monitoring developed was cost-effective, efficient and reliable. If the device was adopted it would enhance waste collection and provide safety environment and service delivery.

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