Smart Recycle Bin System based on Wi-Fi and IoT

Noor Salah
University of Mosul/ College of Engineering/
Computer Engineering Department

Rabee M. Hagem
University of Mosul/ Computer Engineering Department
Griffith University/Australia

ABSTRACT
One of the promising areas in the smart systems is the smart home, which has different benefits such as increased security, safety, save energy, time, and money and gives more comfort. In addition it can be used to support and help people with disabilities and special needs elderly people. In this paper part of the outdoor smart home is presented which is the smart recycle Bin. Solid waste accumulation is one of the difficult environmental problems that face many countries around the world. In order to solve this problem, some concept based on (reduce, reuse and recycle) should be used. The smart system suggested in this paper is based on IoT for solid waste management. This system would be alternative to the traditional system that is used in collecting waste. The proposed system in this paper would enforce the people to classify their waste in order to recycle it. The process of waste classification from the source would save time and money. This system should be flexible, effective, and low cost which depends on using Wi-Fi and Internet of Things (IoT). DeviceBit and Blynk are used as platforms for monitoring, controlling and getting real time notifications. Experiments were conducted to demonstrate the feasibility and effectiveness of the proposed system.

General Terms
IoT, Smart Homes, DeviceBit Platform, Embedded system

Keywords
Smart Waste Management, Smart Recycle Bin, Real time

1. INTRODUCTION
Smart recycle bin is part of the smart home systems that saves time, energy and providing comfort for homes owners. Different designs and papers discussed the smart home systems and the smart bins with waste management. In [1] energy saving design to control the energy consumption in houses is introduced based on Zigbee protocols and monitoring the data via SMS and controlling the appliances through the cell phone. Internet of Things (IoT) is introduced in [2] for controlling home appliances via smart phones based on raspberry pi as server system and Wi- Fi as communication protocol. Images can be sent in real time to smartphones. This system may be implemented in many places such as banks, hospitals, labs etc. Two prototypes are presented in [3] for home automation. Bluetooth is used in indoor environment and Ethernet for outdoor. Arduino UNO with Bluetooth is the main automation system that is used in [4]. The main disadvantage of using the Bluetooth is the range limit. PLC system for reducing house energy consumption is presented in [5]. In [6] fall detection system for smart house environment is presented with some interaction voice assistance and camera monitoring to help elderly and disable people. In [7]

two scenarios for smart home are presented. The first one is based on Arduino-Uno with Wi-Fi communication technology. The second one depends on the land-telephone line protocol with field programmable gate array (FPGA) kit as a main controller.

The authors proposed IoT based waste management system, based on Arduino Uno with ultrasonic sensor as well as the Wi-Fi module ESP8266. The garbage level data is sent to the website through the Wi-Fi module ESP8266. GPS module is used to send the location of the filled dustbins to garbage vehicle [8].

Solid waste collection and management system for smart city is introduced. The proposed system in this paper can be deployed in general purpose dustbins places and at public places. The statues of the bins can be monitored remotely over web browser. SMS alerts can be sent to the waste collector vehicle to respective location to collect garbage. Ultrasonic sensors are used and interfaced with PIC microcontroller in addition weight sensor is placed at the base of the dustbin and it is interfaced with a controller to recognize over weight of the junk filled in the dustbin. RF-transmitter encodes the information from PIC and send to Arduino Uno unit which acts as a receiver; it sends the information to RF-collector which is associated with the Arduino Ethernet shield. Arduino Uno collects information received by the collector and transfer on website page through the Ethernet shield [9]. In this paper an implementation of smart garbage management system using IR sensor, microcontroller 8051, LCD and Wi-Fi module is presented [10].

In [11] a proposed waste management system is presented to suggest efficient and optimized routes to collect maximum waste with less cost and fuel. Arduino Uno with Ultrasonic sensor module HC-SR04 and Gas sensor MQ4 which has high sensitivity to methane, which is a major bi-product of waste decomposition, are used. These sensors will sense fill level status and gas present in the bin and report these values to the workstations. GPS and Wi-Fi module are used. The workstations predict estimated fill-up dates for other remaining bins waste. A report is generated from the workstations about waste collection and fuel consumption every day based on the collected data.

Smart recycle bin as part of smart home is presented in this paper based on smart home and IoT. Ultrasonic sensor is used.

2. SYSTEM DESIGN
The suggested smart recycle bin consists of two main parts: one is the monitoring platform which is based on (Android Device Bit) which can be used to monitor the operation of all the smart recycle bins. The second part is the hardware which is represented by the Arduino Mega2560 microcontroller board which represent the core of this system, The (W5100) Ethernet Shield that can be used to connect the proposed system to the internet or the CC3000 Wi-Fi shield, The ultrasonic sensor (HC-SR04) and finally an RGB LED as indicator for the statues of the recycle bin (full, half full, empty) is used. Figure 1 shows the suggested system.

Fig. 1: The Proposed System

Each garbage container color represents the type of waste as shown in table 1 below.

Table1: The garbage container color with the type of waste

Garbage Container Color	*Type of waste*
Red	Glass
Green	Biomaterial
Blue	Paper
Orange	Plastic

Figure2 shows the proposed garbage container system using Arduino Mega and CC3000 Wi-Fi shield. This system is based on two main parts. One is the smart recycle bin environment which includes the sensors with the microcontroller and another one is the remote environment that can be used to present the real time data on the phone, tablet or Pc.

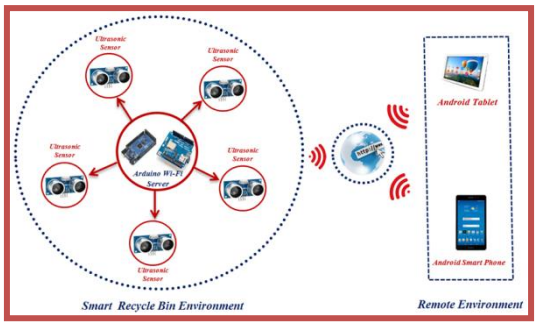

Fig. 2: The proposed recycle bin system using Arduino Mega2560 and CC3000 Wi-Fi shield

The model that is used to simulate the recycle bin real system is shown in figure 3 a, b. The height of the proposed recycle bin is 21cm, this can be increased in the real system. The ultrasonic sensor is built in on the cover of the recycle bin. This sensor measures the distance between the cover and the bottom of the bin. If the reading of the sensor is 21cm this means that the bin is empty and the RGB LED will turn to green. If the reading is 11cm, the bin is half full and the RGB will turn to yellow. Finally if it is full the reading will be 7cm and the RGB LED will turn to red.

The smart recycle bin can be used in different ways and different places: it can be used for big recycle bins that are located in public places or closer to the big buildings. This will be a central recycle bin. This can be identified according to (place name, street number and number of the recycle bin).These recycle bins can be monitored from the cleaning company that provides the instructions to the cleaning team to go to a specific place and specific full recycle bin.

Another system can be used for the recycle bins that are located at homes. Each house will have a smart recycle bin and can be defined as (name of the place, street number, house number) in order to recognize it. These bins can be monitored from the cleaning company as well.

In the two cases above the cleaning company can be monitored the recycle bins remotely and in real time through the (DeviceBit) using a tablet or a phone. Notifications can be sent to the cleaning team in real time using the DeviceBit or Blynk platform. Monitoring the recycle bins in real time will save time and effort for the cleaning team. Also, this will save money through reducing the unnecessary fuel used when the recycle bins are not full. This also will reduce the pollution from the gases produced from the recycle bins cars and reduce indirectly the traffic jam.

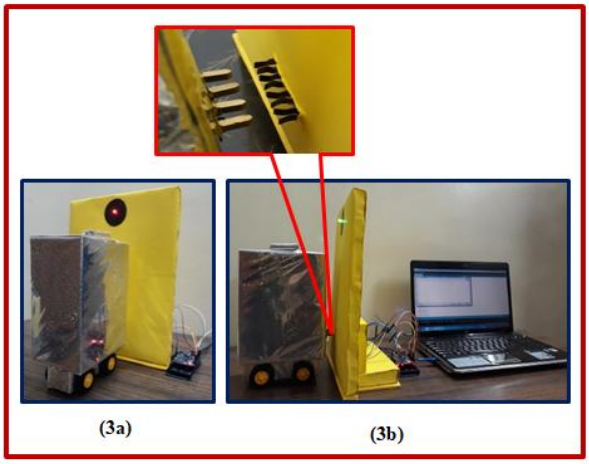

Figure (3a,b): The proposed smart recycle bin

The proposed recycle bin contains 4 pins male that is fixed on the bin body from outside which represents the pins for the ultrasonic sensor. There are also 4 pins female fixed on the wall that is connected with the Arduino board. The people in the cleaning company will disconnect the recycle bin that contains wheels from the wall, empty it, put it back and reconnect it to the wall. There will be no mistakes in this process as the male connector will be connected to the female connector.

2.1 The ultrasonic sensor

The ultrasonic sensor can be used to measure the distance between the sensor itself and different objects. The sensor contains two main parts: the transmitter Tx and the receiver Rx. The transmitter sends the ultrasonic waves in air. These waves will be reflected from an object after touching it and received by the receiver Rx. The speed of ultrasonic waves in air is 340m/s. The distance can be calculated based on the time according to the relation below. Figure 4 shows the ultrasonic sensor.

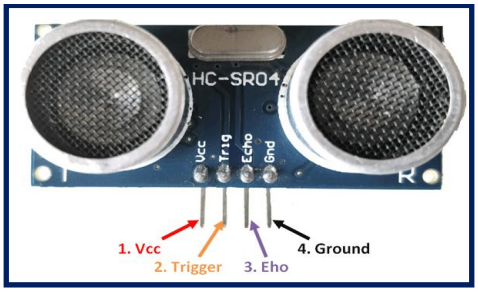

Fig.4 the ultrasonic sensor

Distance between sensor and body = Speed * (Time/2)

The ultrasonic sensor used in this paper is HC-SR04 that contains 4 pins (Vcc, Trig, Echo and GND). This sensor works as below:

The microcontroller sends a high pulse with a width at least of 10 µs. When this pulse enters the Trig pin, the sensor will send 8 ultrasonic waves through the Tx Pin with frequency of 40 KHz and the state of the pulse on the echo pin will be changed from low to high. When the Rx received the ultrasonic waves the state of the Echo pin will change from high to low. The microcontroller will start receiving the pulse on the Echo pin and calculate the time. This time represents the time for sending and receiving the ultrasonic waves through Tx and Rx respectively. The distance then can be calculated from the time according to the equation. Fig. 5 shows the working principle of the ultrasonic sensor.

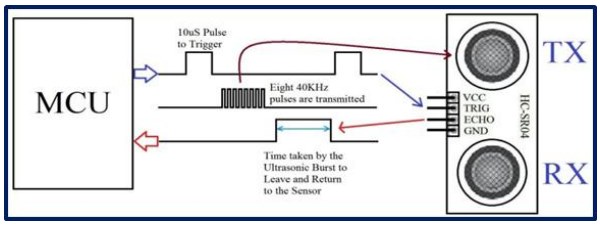

Fig.5 The Working Principle of the Ultrasonic Sensor

3. RESULTS AND DISCUSSION

After setting up the sensors in the DeviceBit platform as public places and homes categories, each sensor should be defined with the place of the recycle bin and its number. Each recycle bin has a unique number depends on its position. Figure 6 shows the setting for the recycle bins in different locations with the real time reading from five recycle bins that are used in this paper. Figure 7 shows the real time data from different recycle bins on mobile phone using DeviceBit and Blynk platforms for real time notification when any recycle bin becomes full. Conditions for the notifications can be adjusted.

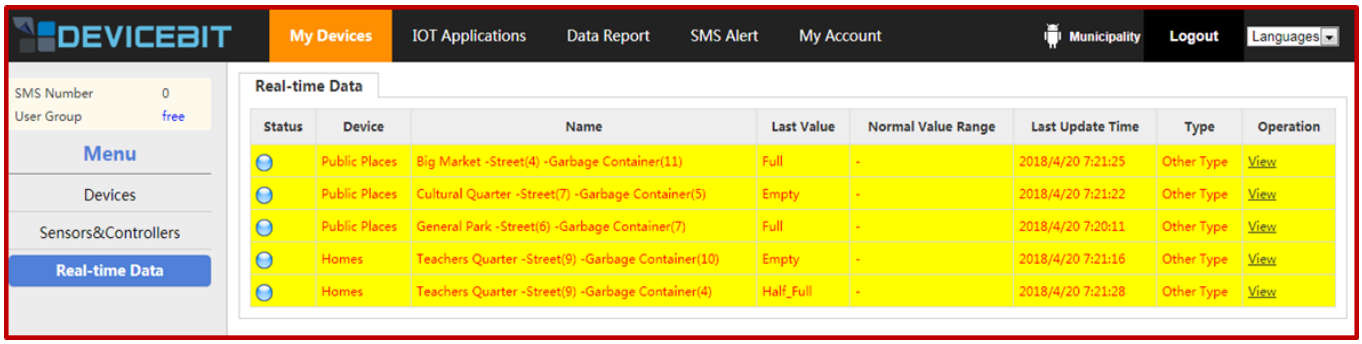

Fig. 6: Real time data reading from different recycle bins on PC

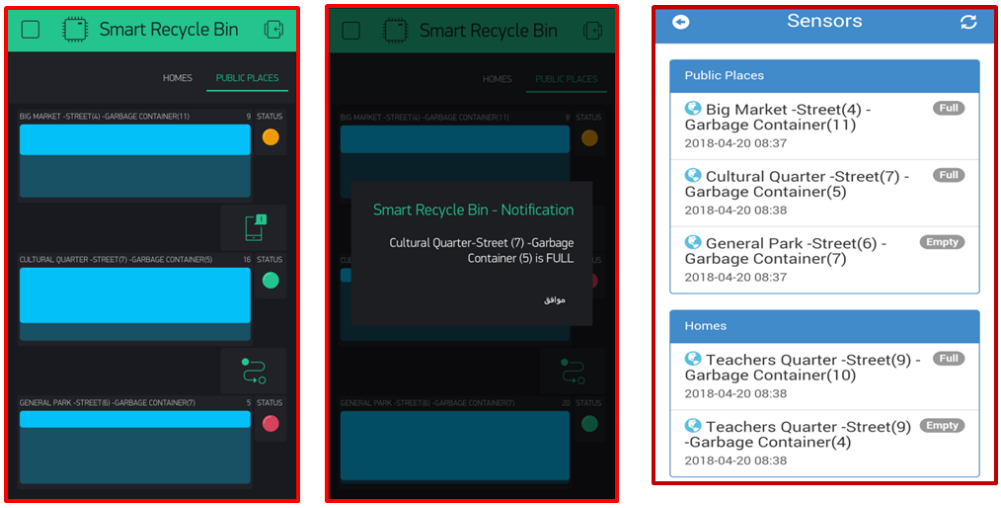

Fig. 7: Real Time Data Reading from different Recycle Bins on Mobile Phone using DeviceBit and Blynk for Real Time Notification

4. CONCLUSIONS

Smart recycle bin is proposed in this paper based on Wi-Fi and IoT. Arduino Mega is used as the main microcontroller with CC3000 Wi-Fi shield. Ultrasonic sensor is used as the input device and RGB LED as the output device. DeviceBit and Blynk are used as the main monitoring and controlling platforms. Experiments are conducted. Data including the statues of the recycle bins can be monitored in real time. Notifications on mobiles can be sent. The results have been

proved the reliability and feasibility of the proposed system. The proposed system is designed to be affordable, scalable so that new devices can be easily integrated into the system, and also to be user friendly. Future work can include adding GPS system to find the exact location of the recycle bin. This will save time and money.

5. REFERENCES

[1] MOSER, K., HARDER, J. & KOO, S. G. Internet of things in home automation and energy efficient smart home technologies. Systems, Man and Cybernetics (SMC), 2014 IEEE International Conference on, 2014. IEEE, 1260-1265.

[2] TARIQ, T. Smart energy management in a smart environment using a mobile device. Computer & Information Technology (GSCIT), 2014 Global Summit on, 2014. IEEE, 1-5.

[3] MANDULA, K., PARUPALLI, R., MURTY, C. A., MAGESH, E. & LUNAGARIYA, R. Mobile based home automation using Internet of Things (IoT). Control, Instrumentation, Communication and Computational Technologies (ICCICCT), 2015 International Conference on, 2015. IEEE, 340-343.

[4] GOKCELI, S., TUĞREL, H. B., PIŞIRGEN, S., KURT, G. K. & ÖRS, B. A building automation system demonstration. Electrical and Electronics Engineering (ELECO), 2015 9th International Conference on, 2015. IEEE, 56-60.

[5] FLOREA, A. & BĂNCIOIU, I. Future house automation. System Theory, Control and Computing (ICSTCC), 2015 19th International Conference on, 2015. IEEE, 699-704

[6] GREENE, S., THAPLIYAL, H. & CARPENTER, D. IoT-Based Fall Detection for Smart Home Environments. Nanoelectronic and Information Systems (iNIS), 2016 IEEE International Symposium on, 2016. IEEE, 23-28.

[7] SOLIMAN, M. S., DWAIRI, M. O., SULAYMAN, I. I. A. & ALMALKI, S. H. 2017. Towards the Design and Implementation a Smart Home Automation System Based on Internet of Things Approach. International Journal of Applied Engineering Research, 12, 2731-2737.

[8] MANGESH, N., SWAPNIL, K., AVINASH, P. & AVINASH, G. 2017. Iot Based Waste Management for Smart City. International Journal of Advance Research, Ideas and Innovations in Technology, 3, 247-250.

[9] NIRDE, K., MULAY, P. S. & CHASKAR, U. M. IoT based solid waste management system for smart city. Intelligent Computing and Control Systems (ICICCS), 2017 International Conference on, 2017. IEEE, 666-669.

[10] BANDAL, A., MANKAR, R., NATE, P., POWAR, R. & S.A.JADHAV, P. 2017. Smart Wi-Fi Dustbin System. International Journal of Advance Engineering and Research Development, 4, 336-339.

[11] BOROZDUKHIN, A., DOLININA, O. & PECHENKIN, V. Approach to the garbage collection in the "Smart Clean City" project. Information Science and Technology (CiSt), 2016 4th IEEE International Colloquium on, 2016. IEEE, 918-922.