Smart Dustbin – Crowd Sourced Dustbin Management and Incentivization Cloud Based Framework

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Abstract. Garbage disposal in assigned spaces like dustbins is essential for maintaining clean surroundings. Moreover, the local municipality or assigned authority have to manage those dustbins by timely emptying them. Unused or overloaded dustbins create unhygienic conditions for people as well as ugliness to that place leaving bad smell and sight. Several solutions propose educating and motivating people to use dustbins. There are also IOT based solutions to track dustbin usage and alert authority for emptying a filled dustbin. In this work, we propose a crowdsourcing-based simple and low-cost solution that combines encouraging people to use dustbins and track dustbin location and usage in a single framework. Idea is to incentivize usage of the dustbin and have people scan the encrypted QR code generated dynamically on the dustbin along with audio-visual encouragement prompts. We have successfully created and tested both the hardware and software framework.

Keywords: Smart Dustbin, Crowdsourcing, Sanitation, Maps, Web Application

1 Introduction

A common saying goes – Cleanliness is next to Godliness. Everyone likes clean surroundings. Use of dustbins in public areas by the public is very important to maintain cleanliness. At the same time, timely emptying of dustbins is crucial as it both allows for effective use as well as adds to the motivation of people to keep using the dustbins for garbage disposal.

Recent government initiatives in India like Swachh Bharat Abhiyan [ref] encourage people by spreading awareness regarding cleanliness and sanitation. However, their challenge is lack of volunteers from the public side. So the government is ready to provide all kind of support to startups which have the potential to overcome this problem [1].

From the recent analysis, we have found that the dustbins are not maintained properly they are spilling out and putting the locality in the grip of poor sanitation [2]. And it requires lots of manpower to match the need of waste management of the current population. Rather than increasing the manpower in waste management organization it requires a smart system to make use of the available manpower [3].

There are many existing works in this field. They employ weigh sensors and IR sensors to detect the level of garbage in the bins [4]. To communicate the status of the dustbin existing methodology is to use GSM or WiFi based communication system [5][6][7][8]. Such technologies are dependent upon external infrastructure that may not be available at all time and places, for example, remote areas, train compartments etc.

So, our approach is to use crowdsourcing. Crowdsourcing is a sourcing model in which individuals or organizations obtain goods and services. These services include ideas and finances, from a large, relatively open and often rapidly-evolving group of internet users; it divides work between participants to achieve a cumulative result [9].

Recently in railway stations like New Delhi, Indian Railways has installed bottle crushers. When passengers drop the bottle in the bottle crusher he will get a cashback after entering his/her mobile number [10][11]. Similarly, in England, a scheme is being proposed to encourage recycling and cut plastic waste, which would see customers in England pay more for drinks in the shops. Customers will then be able to claim the money back if they return their drinks containers to be recycled [12]. So similarly, we can also implement this kind of methodology to attract people to use dustbins.

We propose a low-cost smart dustbin that uses crowdsourcing for resource management driven by a cloud-based platform that incentives users, helps manage dustbins as well as track usage of dustbins allowing predictions using Ma-chine Learning helping drive crucial decisions like how many and what size dustbins to place at what location etc.

2 Dustbin Design

2.1 Dustbin model

Figure 1 shows the initial design of the dustbin. Sensors and the circuit will be placed under the cap of the bin.

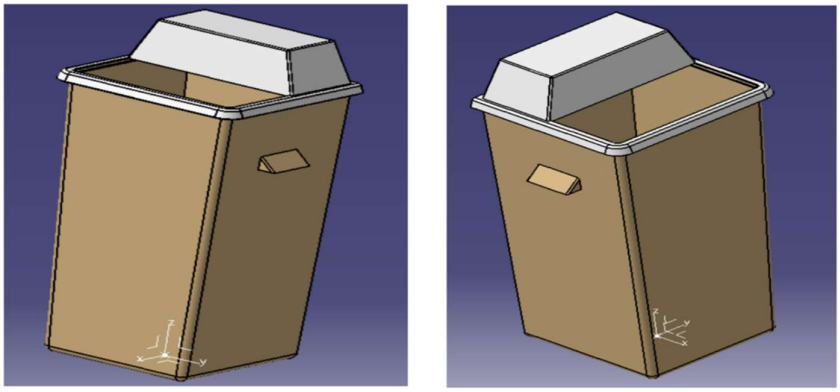

Fig. 1. Model Design of a Smart Dustbin

2.2 Circuit Diagram

Figure 2 describes the entire circuit of the system. We use the following modules in the circuit.

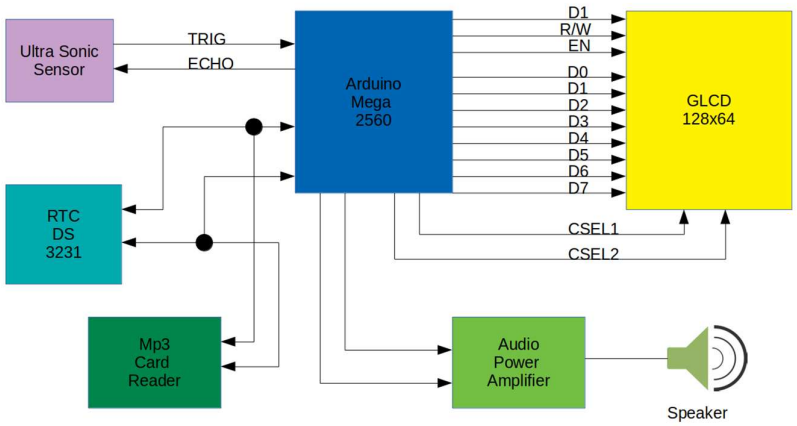

Fig. 2. Circuit of the System

2.3 DS3231 Real Time Clock

The DS3231 is a low-cost, highly accurate Real Time Clock which can maintain hours, minutes and seconds, as well as, day, month and year information. Also, it has automatic compensation for leap-years and for months with fewer than 31 days.

The module can work on either 3.3 or 5 V which makes it suitable for many development platforms or microcontrollers. The battery input is 3V and a typical CR2032 3V battery can power the module and maintain the information for more than a year. The module uses the I2C Communication Protocol which makes the connection to the Arduino Board very easy. So all we need is 4 wires, the VCC and the GND pins for powering the module, and the two I2C communication pins, SDA and SCL.

2.4 Ultrasonic Sensor

It emits ultrasound at 40 000 Hz which travels through the air and if there is an object or obstacle on its path It will bounce back to the module. Considering the travel time and the speed of the sound you can calculate the distance.

The HC-SR04 Ultrasonic Module has 4 pins, Ground, VCC, Trig and Echo. The Ground and the VCC pins of the module needs to be connected to the Ground and the 5 volts pins on the Arduino Board respectively and the trig and echo pins to any Digital I/O pin on the Arduino Board.

In order to generate the ultrasound, you need to set the Trig on a High State for 10 µs. That will send out an 8 cycle sonic burst which will travel at the speed sound and it will be received in the Echo pin. The Echo pin will output the time in microseconds the sound wave traveled.

For example, if the object is 10 cm away from the sensor, and the speed of the sound is 340 m/s or 0.034 cm/µs the sound wave will need to travel about 294 u seconds. But what you will get from the Echo pin will be double that number because the sound wave needs to travel forward and bounce backward. So in order to get the distance in cm, we need to multiply the received travel time value from the echo pin by 0.034 and divide it by 2.

2.5 Graphic LCD(128 X 64)

Graphic 128×64 LCD displays are based on (monochrome) LCD technology, yet they offer interesting graphical capabilities because every pixel is individually GRAPHICS LCD addressable. These displays are more complicated to program than the 'common' 16×2 or 20×4 LCD displays that present two or four rows of fixed character positions. The payoff is a presentation with considerable flexibility thanks to the existence of built-in characters and, in software for the Arduino, an extensive u8g graphics library, i.e., the same library that supports display of graphics on OLED displays. Here we discuss the wiring of an ST7920 based 128×64 graphical 12864B LCD breakout display. This display is used to present data collected with a Dallas DS18B20 temperature sensor and a DHT11 relative humidity sensor.

2.6 Arduino Mega 2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila. ICSP header is a remarkable addition to Arduino Mega which is used for programming the Arduino and uploading the code from the computer.

2.7 Audio Power Amplifier with Speaker

The audio power amplifier amplifies the weak audio signal coming from the Arduino shown in Figure 3. Pre-recorded voice signal "*Thank You, Have a Nice Day"* is stored in the memory, sending to the audio power amplifier that amplifies the audio signal and sends to the speaker, whenever smart dustbin is used.

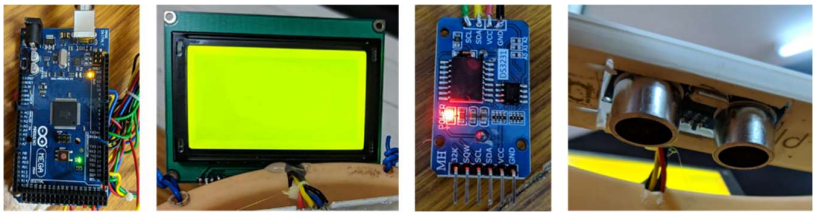

Fig. 3. From left to right. (a) Arduino Mega 2560 , (b) GRAPHIC LCD(128 X 64) , (c) DS3231 Real Time Clock , (d) Ultrasonic Sensor

2.8 Cloud Based App design

The flow chart in the Figure 4 describes one of the use cases of application, where the users, whenever throw waste in the smart bin, they are requested to scan the QR-code, thus recording their thoughtful actions and further crediting them for it. This motivates the citizens towards being more responsible, and protecting their surroundings.

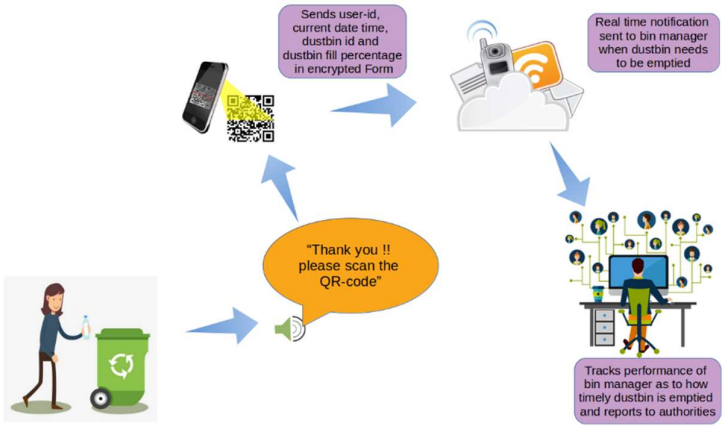

Fig. 4. Flowchart representing the real-time usage of the mobile app

2.9 Class Diagram

The class diagram in the Figure 5 depicts the relation among various classes in the application. The developer has a weak association with the admin, and the admin has an is-a relation with the user (because the user is, himself, a super user). The admin and the dustbin classes have a strong association since each of the dustbin objects cannot exist without the admin choosing it to.

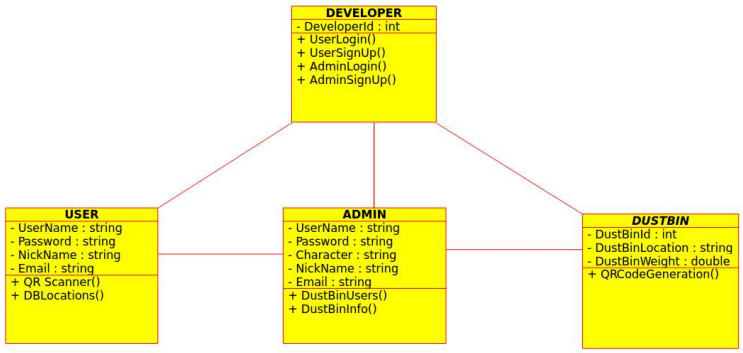

Fig. 5. Chart Diagram

2.10 Technologies Used

HTML, CSS and JavaScript are used in the front-end development of the application, and the back-end is built in the Django framework. Google Maps API is used to locate smart dustbins in real-time. The web application is converted into a mobile app using PhoneGap.

3 Results

We have successfully made the bin and the app and tested its working in real-time. See Figure 6 & Figure 7.

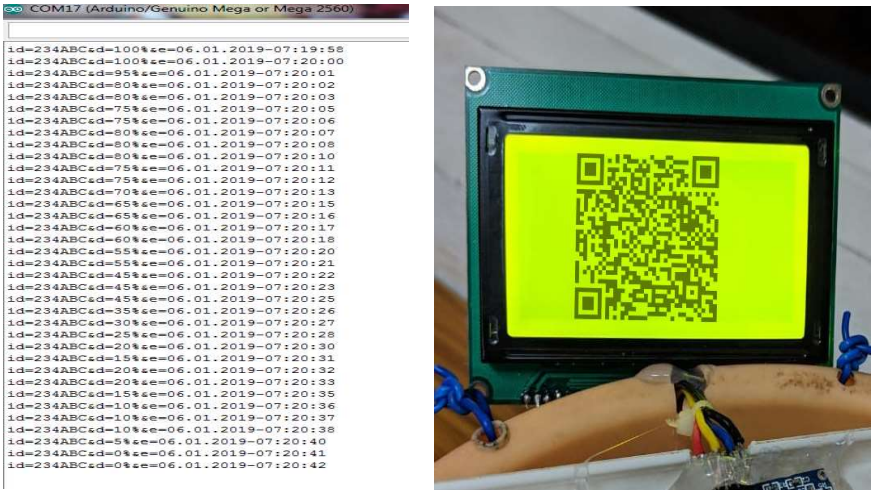

Fig. 6. From left to right (a)Result in Arduino , (b)Encrypted QR-Code generated on GLCD

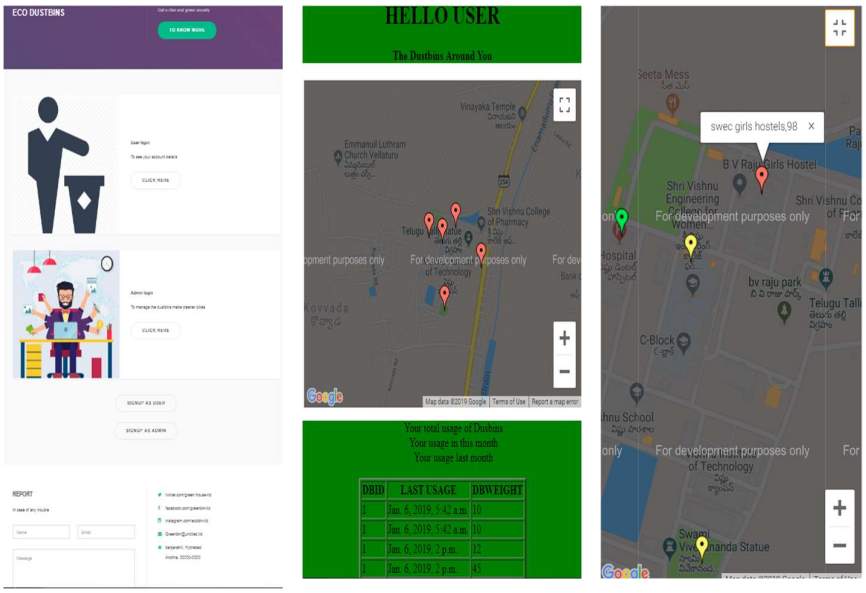

Fig. 7. From left to right. (a) App layout, (b) User interface , (c) Admin Interface

4 Conclusion and Future Work

The dustbins fitted with the QR-code generator can be placed around in the city, and in real-time the data about the height of the wastes in the smart bin can be notified to the nearby municipality to alert them for replacing it. Also, whenever someone throws the waste into the bin, they are suggested to scan the QR-code in their mobiles, so the information is updated on the cloud easily rather than through GSM and Wi-Fi module which are costlier. This benefits the citizen since he is encouraged by giving reward points. On the whole, the remainder of the duties of the people becomes a healthy competition, and they are motivated to keep the city clean and tidy.

We envision to expand our idea by using machine learning to track down the frequency of the dustbin getting full, so that proper prior actions are taken, like using a larger bin, or suggesting the municipality to replace the bin from time to time. Also, we would like to expand our work in the direction of installing a manually operated pedaling system, which further compresses the waste and thus increases the capacity of the bin for considerable time before the bin is emptied or replaced.

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