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Smart Garbage Alert System

Sankar. A, Vimal Kumar. K, Vinoj Varma. S, Dr. N. Sathish Kumar
Department of ECE, Sri Ramakrishna Engineering College, Coimbatore, Tamilnadu, India

ABSTRACT

Cleaning the dustbin is an important process which has to be done at regular basis but due to the inconsistency in the filling of waste, sometimes it gets overflowed even before the next cleaning process arrives. It is also observed that the garbage gets accumulated due to irregular removal of garbage present in the dustbin. Here we have figured out a new model for the municipal dustbins which intimates the Centre of municipality for immediate cleaning of dustbin with proper verification. It detects the garbage level in the dustbin using ultrasonic sensor and sends the alert to the server once when the garbage gets filled. After cleaning the dustbin, the driver needs to confirm his work using RFID Tag. RFID reader reads the Tag and checks the level of the dustbin and sends the status of cleaning to the server confirming the work done. The objective of the project was to develop an intelligent alerting system for proper management of garbage. With the objective keeping in front, a micro-controller based embedded system integrated with RFID and IoT technology is developed in this project. A municipal authority can use this type of system and monitor the waste collection status in real time and measure the performance of the team. An Android application is developed and interfaced with a web server to intimate the alerts to the municipality and to perform the remote monitoring of the cleaning process, done by the workers, thereby reducing the manual process of monitoring and verification.

Keywords : Ultrasonic sensor, RFID, IoT, Smart system, Arduino UNO, ThingSpeak

I. INTRODUCTION

The concept of smart city is being deployed in the developing countries. Smart cities possess a sustainable and hygienic environment for a decent quality of life. Here, garbage disposal plays a vital role. By keeping this in my mind a smart dustbin is designed to automatically alert the municipality when the dustbin gets filled.

An embedded system is designed in such a way that it avoids the overflow of the dustbin by sending alerts to the municipality with help of a microcontroller linked with a webserver using IoT. It also includes the verification process after cleaning the dustbin.

Management of Municipal Solid Waste (MSW) is one of the most critical environmental challenges. A lot of polluting sources like haze, emissions are generated from the indiscriminate dumping of MSW. MSW includes household's refusal and solid wastes generated from industrial, commercial and institutional establishments such as hospitals, markets, streets and industry etc. Now-a-days with the increase of population of a country and its rapid growth of urbanization and industrialization, the cumulative volume of MSW and its appropriate management have become more acute to ensure green environment [1].

Bad waste management can easily result in air pollution and soil contamination. They have an adverse effect on human health. It is learnt from the primary survey done in Guwahati, a city in Assam that garbage accumulation causes 41% of the air pollution [3].They cause air pollution which generally leads to various respiratory problems like COPD, asthma etc. Breeding of mosquitoes and houseflies occur mainly in garbage which are a major cause for various diseases like malaria, dengue etc. This also causes headache, nauseous sensation and increase in the stress level. A city with poor sanitation and smelly environment can never be a healthy place to live in. There are about 235 million

people currently suffering from asthma for which foul smelling of garbage is also a vital reason [2].

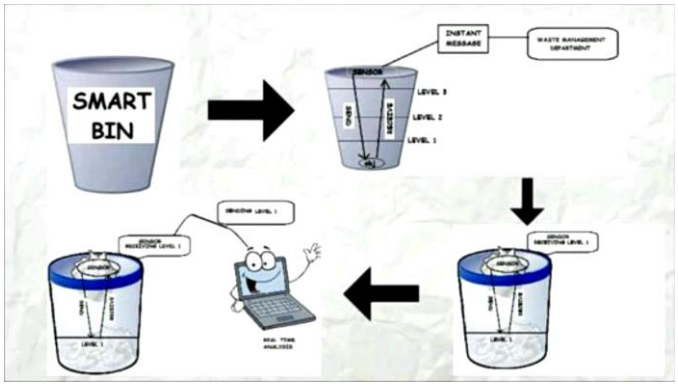

Figure 1. Alert System

In the conventional approach, a number of trucks from the municipal authority are sent to the waste bins to collect the solid waste (SW). The wastes are loaded in the truck and then transported and transferred to the pre-specified locations. However the category of the people involved in collecting and transporting the wastes are usually not responsible enough to make the job well done. Very often the wastes are not collected from each and every waste bin properly due to driver's attitude and fatigue [1].

Implementation of this smart dustbin can prevent lumping of the garbage for a longer period of time thereby preventing the widespread of diseases to a great extent and promising a clean environment in the city [2].

II. METHODS AND MATERIAL

1. Related Work

A single directional cylinder is suspended next to the lid of dustbin. The piston is free to move up and down vertically inside the dustbin to a certain level. A plate is attached to the cylinder for compressing the garbage. The shape of this plate depends upon the shape of the dustbin. The compressing plate consists of a side hole through which the leaf switch is suspended upside down. The level of leaf switch is placed lower to the maximum level to which the compressing plate can reach down thus even after the switch gets pressed, garbage can be dumped in the dustbin to a certain extent.

The opening of the dustbin is located little higher to that of the threshold level. The opening of the dustbin is covered by a lid that is attached to the inner lateral surface of the dustbin.

Thus when the compressor reaches the maximum level for compression, it blocks the inlet lid such that no garbage from outside can be dumped into the dustbin during the while. Preventive measure is taken in such a way that the garbage do not damage or block the functioning the leaf switch at any case. The materials used for designing the dustbin and the compressor is selected in such a way that it exhibits anti corrosive properties.

The conventional waste collection and management approach has the following problems [4]:

- Lack of information about the collecting time and area.
- Lack of proper monitoring system for tracking all activities related to solid waste management.
- Loss of productivity due to inefficient utilization and unauthorized use of vehicles.
- There is no quick response to urgent cases like truck accident, breakdown, long-time idling.
- There is no quick way to response to client's complaints about uncollected waste.
- There is no analysis of finding best route path of collecting waste.

The proposal in this dissertation focuses on the following objectives [1]:

- To develop an electronic monitoring system for solid waste management.
- The system will have the facility to send SMS to the workers and supervisors.
- To develop a web based GUI so that the system can be accessed from anywhere and information can be viewed by different group of people.

The GUI will have the facility for the citizens to put their complains and comments on the service.

2. Smart Garbage Alert System

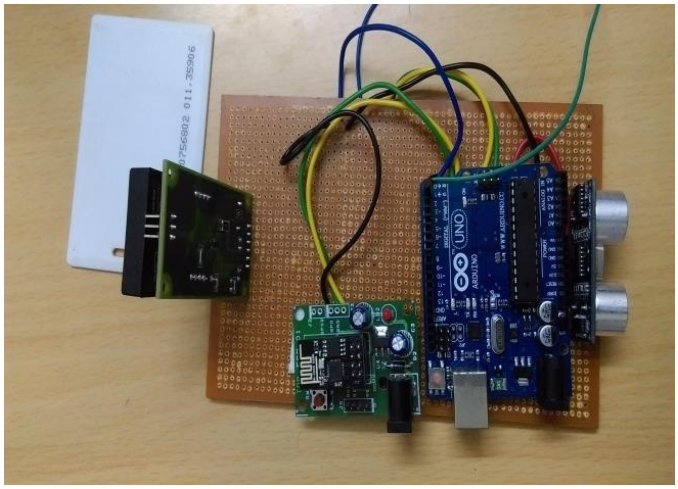

Figure 2. Working Prototype

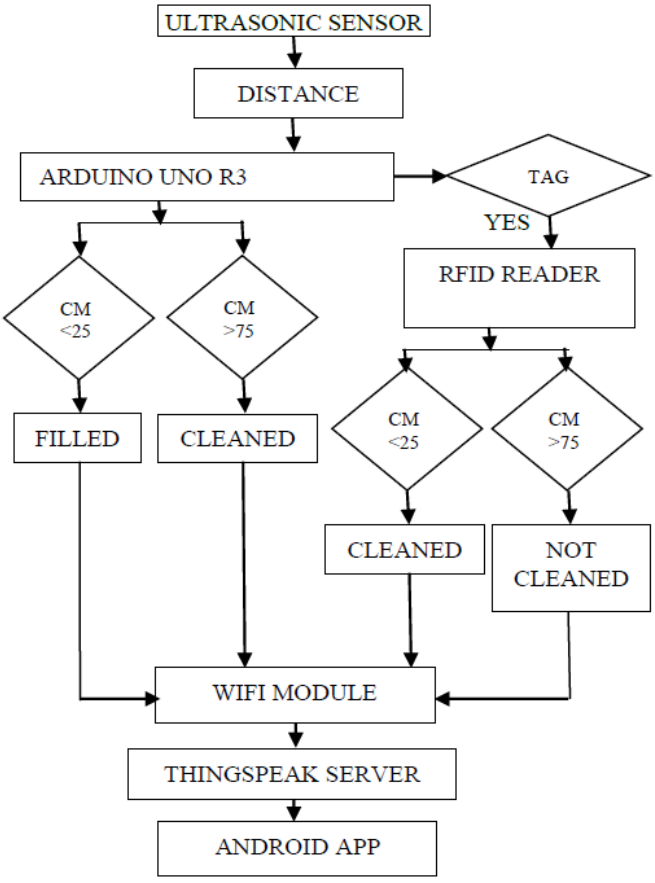

Figure 2. Flow Chart

The ultrasonic sensor sends the distance continuously to the Arduino. Arduino checks the level and sends the alert as “FILLED” when cm <25 and as “CLEANED” when cm >75.

When an RFID Tag Interrupts the Reader, the ultrasonic sensor checks the level again and sends the status of cleaning as “CLEANED” when cm >75 and as “NOT CLEANED” when cm <25.

All the above conditions send the alert/status to the ThingSpeak webserver via WiFi Module and it is viewed in the Android App at the server end.

3. System Design

The system is designed in such a way that it avoids the overflow of the dustbin by sending alerts to the municipality with help of a microcontroller linked with a webserver using IoT. It also includes the verification process after cleaning the dustbin.

A. Block Diagram

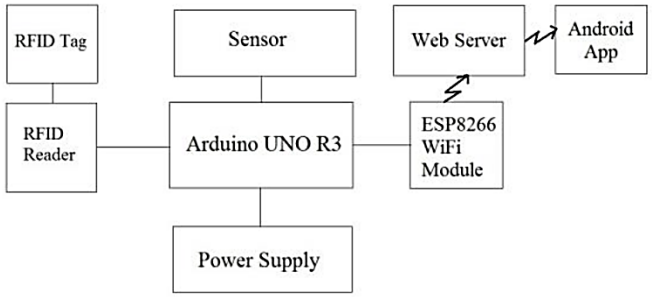

Figure 3. Block Diagram

B. Ultrasonic Sensor

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle of work:

1) Using IO trigger for at least 10us high level signal,
2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.
3) IF the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning.
    - Test distance = (high level time×velocity of sound
    - (340M/S))/ 2

A special sonic transducer is used for the ultrasonic sensors, which allows for alternate transmission and reception of sound waves. The sonic waves emitted by the transducer are reflected by an object and received back in the transducer. After having emitted the sound waves, the ultrasonic sensor will switch to receive mode.The air pressure vibrations makes the diaphragm

move in that microphone, and this diaphragm motion is sensed and converted into an electrical signal (like the sound sensors).

That is the Electrical energy is converted to sound to send the pulse, and then the sound received back is converted to electricity .Thus the time lag between the sent and received sound is used by the brick to estimate the distance to the object. This is how bats also estimate the distance.

Spacing between sensors is determined by their beam angles. The sensors must be spaced so they do not interfere with each other. This interference is sometimes called "crosstalk."

C. Arduino UNO R3

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, 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 a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode. Revision 3 of the board has the following new features:

1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin that is reserved for future purposes. Stronger RESET circuit. Atmega 16U2 replace the 8U2. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform.

D. RFID Reader

RFID tag is a small device which stores and sends data to RFID reader. They are categorized in two types – active tag and passive tag. Active tags are those which contain an internal battery and do not require power from the reader. Typically active tags have a longer distance range than passive tags. Passive tags are smaller and lighter in size than the active tags. They do not contain an internal battery and thus depend on RFID reader for operating power and certainly have a low range limited up to few meters.

The microchip stores the unique ID and incorporates the necessary logic circuitry for functioning of the tag. It has an internal EEPROM to store the unique ID.

The antenna receives power and RF signals from the RFID reader and sends those signals to the chip. The chip receives those signals, computes them and sends back the data to RFID reader.
To recognize the identity of an RFID tag, RFID reader sends radio signals which is captured by the coil (working as antenna) for the tag. The coil receives these signals as alternating current and passes to the chip. The chip extracts both the power and the information from this alternating current. By communicating with the non-volatile memory of the chip that stores unique id as well as other information, it sends back the required signal to the antenna which is then transmitted to the RFID reader.

Further, the reader will transmit the tag ID to the external device by serial communication. A wide range of reader modules are now available. The most common and easy to use reader is EM-18. This module read the RFID passive tag and sends the tag ID to the Arduino microcontroller.

Just like you can tune a radio in various frequencies for listening to different channels, RFID readers and tags need to be tuned in to a same frequency for communication. RFID system uses various frequencies but most common and popularly used frequency is low, high and ultra- high frequency. Low frequency is around 125 KHz, high is around 13.56 MHz and ultra- high

varies between (860-960) MHz. Some applications also make use of microwave frequency of 2.45 GHz. It is imperative to choose right frequency for an application as radio waves work different at various frequencies.

E. ESP8266-01 WiFi Module

Figure 4. ESP8266-01 WiFi Module

ESP8266 offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor.

When ESP8266 hosts the application, and when it is the only application processor in the device, it is able to boot up directly from an external flash. It has integrated cache to improve the performance of the system in such applications, and to minimize the memory requirements. Alternately, serving as a Wi-Fi adapter, wireless internet access can be added to any microcontroller-based design with simple connectivity through UART interface or the CPU AHB bridge interface.

ESP8266 on-board processing and storage capabilities allow it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. With its high degree of on-chip integration, which includes the antenna switch balun, power management converters, it requires minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area.

Sophisticated system-level features include fast sleep/wake context switching for energy-efficient VoIP, adaptive radio biasing for low-power operation, advance signal processing, and spur cancellation and radio co-existence features for common cellular, Bluetooth, DDR, LVDS, LCD interference mitigation.

F. Android Studio

Android Studio is the official IDE for Android app development, based on IntelliJ IDEA. On top of IntelliJ's powerful code editor and developer tools, Android Studio offers even more features that enhance your productivity when building Android apps, such as:

- A flexible Gradle-based build system
- Build variants and multiple APK file generation
- Code templates to help you build common app features
- A rich layout editor with support for drag and drop theme editing
- Lint tools to catch performance, usability, version compatibility, and other problems
- Code shrinking with ProGuard and resource shrinking with Gradle
- Built-in support for Google Cloud Platform, making it easy to integrate Google Cloud Messaging and App Engine

III. RESULTS AND DISCUSSION

A. ARDUINO IDE OUTPUT

The Arduino is programmed based on the 4 levels set in the dustbin:
• Level 1 (>75 cm) – Cleaned
• Level 2 (50 cm to 75 cm) – (25 -50)%
• Level 3 (25 cm to 50 cm) – Above 50%
• Level 4 (<25 cm) – Send Alert

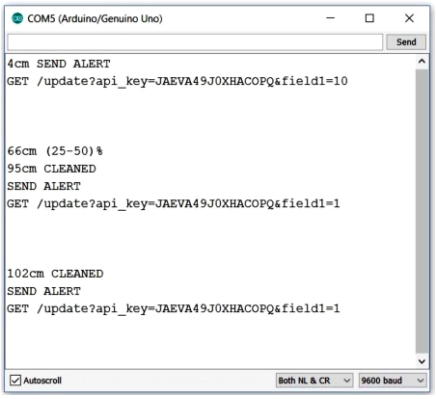

Figure 5. Output for Alerts

The Interrupt from the RFID Tag causes rechecking of the level and it displays the status of cleaning done by the cleaner

- (>75 cm) – Cleaned
- (<25 cm) – Not Cleaned

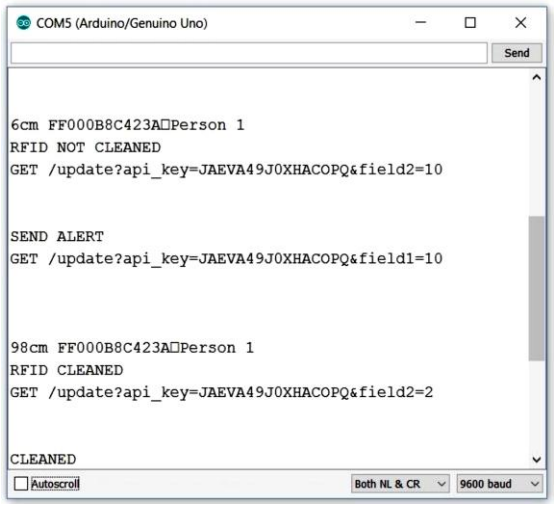

Figure 6. Output for Status

B. ANDROID APP OUTPUT

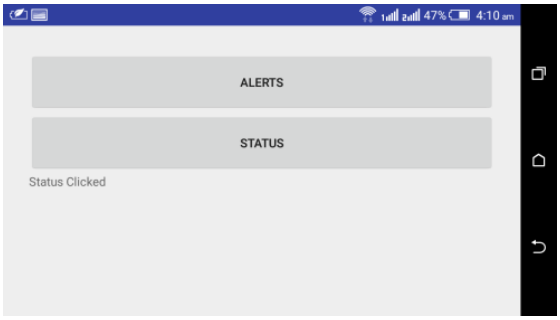

Figure 7. Homepage of the App

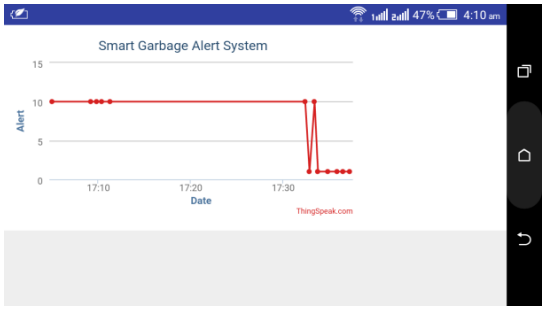

Figure 8. Alerts page of the App

The chart shows the level of the dustbin received from the Arduino. Value 10 denotes that the dustbin is "Filled" and the value 2 denotes that the dustbin is "Cleaned".

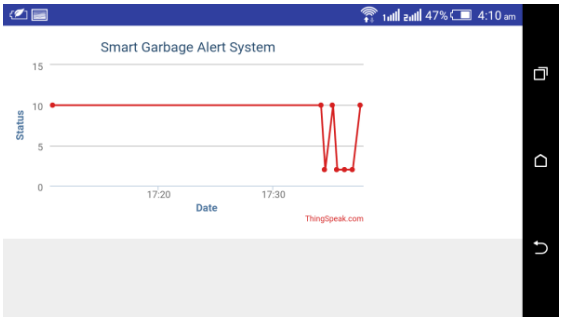

Figure 9. Status page of the App

The chart shows the status of the dustbin after cleaning at the time of interruption caused by the RFID Tag. Value 10 denotes that the dustbin is "Not Cleaned" and the value 2 denotes that the dustbin is "Cleaned".

IV. CONCLUSION

The objective of the project was to develop an intelligent alerting system for proper management of garbage. With the objective keeping in front, a micro-controller based embedded system integrated with RFID and IoT technology is developed in this project. A municipal authority can use this type of system and monitor the waste collection status in real time and measure the performance of the team. This project can be further improved with the addition of new features such as Message to the cleaner, Push notifications in the app, displaying text instead of the chart and framing the shortest route based on the location of filled dustbins.

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