

Survey on Solid Waste Management Solutions in Urban Areas

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Abstract— Waste management is a big challenge in Urban Cities for most of the countries throughout the world. As long as people have been living in settlements and residential areas, solid waste has been an issue. Waste management is all about how solid waste or garbage can be changed and used as a valuable resource. Solid waste management should be embraced by each and every household across the world. This paper aims at providing effective measures to control the management of waste in Urban Cities. In this IOT based Solid Waste Management technique, the level and weight of waste in the dustbins are detected with the help of Ultrasonic sensor and Force sensor respectively. Moisture sensor is used to detect the water content in the waste. The Authorisor can fetch these information through GSM/GPRS system. Microcontroller is used as an interface between the Sensor system and GSM/GPRS system. The status of the dustbin along with the GPS location is displayed on the Web Page. People in Urban Cities can track the location of the dustbin to throw waste. Also, the sensors will alert them not to throw the waste if the dustbin is full or if wet waste is thrown in the dry bin. This will help in managing the garbage collection efficiently.

Keywords: IoT, Renasas Microcontroller, Ultrasonic Sensor, Force Sensor, Moisture Sensor, GSM/GPRS, GPS, LCD, Amazon Web Server

I. INTRODUCTION

In the present context, the population has been increasing rapidly i.e. 1.37 billion(expected data) people reside in different places of India. [1] The tremendous amount of waste is generated in every place now and then. Solid Waste refers to the unwanted waste generated from the human activities in different areas like residential, commercial and industrial. [2] India will produce 62 million tons of waste and half of the waste are not collected and processed due to which it will become a house for several flies, Mosquitoes will surround the waste and create an unhygienic condition in the surroundings. [3] The generated waste from different areas can cause a serious problem to the environment and can result to several diseases like malaria, diarrhea and jaundice. Not only for the humans, can it also be detrimental to animals as well as to aquatic lives. The garbage is dumped without processing and no effective waste management techniques are implemented for the proper disposal of the waste. All the waste generated should be thrown in the dustbin or disposed properly to maintain a good hygienic surrounding. Due to the rapid development of the urban areas, the population in the urban areas is increasing at a very fast rate. Pollution scales up with the population increase. More number of people result to increase in the pollution as the waste management procedures are not being implemented effectively. Waste management is a two-way process, the government should implement the strict rules and regulations for the proper disposal of the waste and the public should follow all those

rules without failure. The municipal people should be regular in collecting the waste from the residential areas and the waste generated from the industries should be disposed properly. All the people should be aware of the waste management techniques to maintain a clean environment and different kinds of awareness program can be held about the waste management process.

II. EXISTING SYSTEM

With increasing population and higher standard of living, the amount of waste generated in a city per day is in huge quantities. In rapidly expanding cities like Bangalore, waste disposal is a serious issue which has to be managed well which otherwise poses serious health issues, unhealthy environment, pollution of air and soil. Bruhat Bengaluru Mahanagara Paa- like(BBMP) takes the major responsibility of collection and management of waste produced in Bangalore. They provide services like door-step collection, transportation, processing, and recycling. In the primary step of collecting the waste auto tippers and pushcarts have been used. [4] Since dustbins are not located in every place, people start dumping the waste in some open areas which then has to be collected by workers manually. This results in surroundings being left unhygienic and causing health issues to workers as well as the public.

For better management of waste BBMP has included several functions that receive live data.

- Swachha Bharat App is developed for citizens complaints.
- Attendance system for Pourakarmikas, drivers and other workers on a daily basis.
- Live-tracking of waste collection vehicles. [5]

BBMP diversifies the bins for wet and dry wastes for waste sorting purpose. This technique reduces manual and mechanical sorting of mixed waste for workers. They provide a green bin for kitchen and garden waste and a blue bin for garbage like paper, cardboard, plastics. Dry waste can be collected every 3-4 days as there is no issue of pungent smell in the environment. Further, on the collection of waste, it is transported to a place where it can be further processed and recycled. Wet waste is further decomposed and dry waste can be recycled. After transportation, there still might be some waste left behind which can create unhygienic condition until the next collection.

Likewise Swachha Bharat Abhiyan(2014-2019): Cleanliness campaign was launched on 2nd October 2014, aiming to achieve clean and hygienic India by the next five years. “A clean India would be the best tribute India could pay to Mahatma Gandhi on his 150th birth anniversary in 2019” said Shri Narendra Modi as he launched the mission. [6] The mission has received great support from the citizens. People indulging themselves in activities like garbage treating, sweeping and cleaning their surroundings were the sign of positive responses from people all over the country.

After the launch of the mission, The Swachh Survekshan 2017 was undertaken by Quality Council of India. This programme helped in checking the progress and outcome of the mission. They considered parameters like municipal waste collection and disposal, the behaviour of people, health parameters. [7] There was a reduction in the air-borne diseases as well as water-borne diseases after the launch which could definitely be the result of the mission.

III. PROPOSED SYSTEM

The proposed system offers to monitor the dustbin status using sensors. The system uses IoT technology where things (sensors & devices) are interrelated and transmit the data over the internet which can be viewed from the designed web page. The system includes two dustbins. The first dustbin is used for demonstration of the status of the dustbin and the second one is used to demonstrate segregation of dry and wet waste. The first dustbin is mounted with the ultrasonic sensor at a relatively highest point of the bin. It helps in the detection of trash level in the dustbin. Working principle of the ultrasonic sensor includes transmission of ultrasonic sound waves by a transmitter. When the obstacle is found, the waves are reflected back and sensed by the receiver. This helps in determining the presence of an obstacle from the transmitter. The status of the dustbin (empty or filled) can be determined. This demonstrates volume based sensing of waste. To determine the status of dustbin based on its weight, a force sensor is fixed at the bottom of the dustbin. The force sensor is a device whose resistance changes when there is an application of force, pressure or mechanical stress. [8] It converts the applied force into a measurable quantity. If the quantity exceeds the threshold value, SMS is sent to the administrator to notify them regarding the status of the dustbin being filled. Admin can take further actions like sending the vehicle to the location to collect the trash and empty the bins. This helps in immediate trash collection which reduces open dumping, nuisance, and unhygienic condition.

Wet waste is bio-degradable waste which includes kitchen waste, garden waste, and other organically decomposable waste. This waste should be collected daily which otherwise creates an unpleasant smell and unhygienic environment. Waste segregation is included in the law. This helps in the effective processing of the waste as the waste is already segregated during collection and does not require sorting methods later. Everyone must be educated to segregate the waste by maintaining the separate dustbins for dry and wet waste. In the proposed system, a moisture sensor is equipped in a dry bin. The moisture sensor is used to detect if the moisture content is present in the trash. If the user puts wet waste in a dry bin unknowingly, he is alerted regarding the same by a buzzer. The overall flowchart of the system is shown in Fig 1.

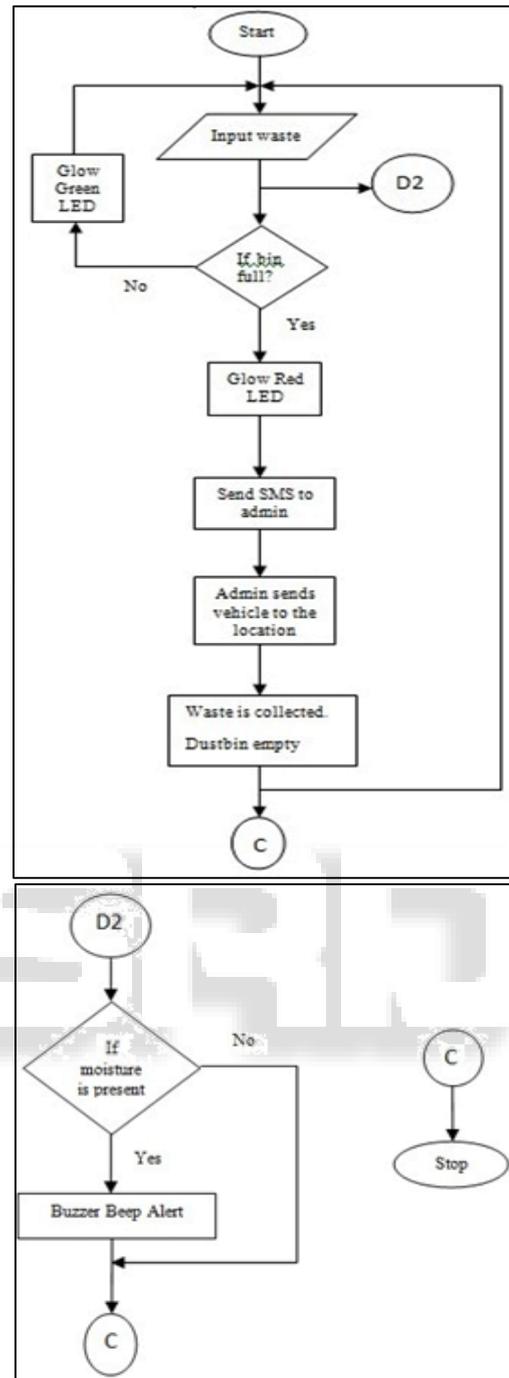


Fig. 1: System flowcharts showing the alerting process when the waste bin is full(top) and the wet waste is wrongly put in the dry waste bin(bottom)

IV. RELATED WORK

A. Micro-controller

The Micro-controller controls the working of the entire Project. All the other devices are connected to the Micro-controller. A program is embedded within the Micro-controller that helps it to take action based on the inputs provided by the output of the sensors. [9] It is used as an interface between the Sensor system and GSM/GPRS module. Renesas Micro-controller is used here. The IC name of this Micro-controller is R5F100LE. The main IC is divided into three sections: Power section, Controller section,

Communication section. Power section includes Voltage divider that maintains the voltage level 5-12V, Capacitors that stores the charges and LED that is used for power indication. Controller section includes 11 ports where input values are given out of which Port 2 is used to sense the input values from sensors and Port 7 and Port 0 are connected to LCD. Communication section is used to establish communication between the system and hardware. NAND flash is connected to the communication section which dumps the code from the system.

B. Ultrasonic Sensor

This sensor is used to monitor waste in the dustbin. It detects the level of waste in the dustbin. It is very accurate in detecting small objects. It is cheap, robust and is able to work in critical conditions like dirt and dust. The response of sensors is not dependent on the surface structure of the object, the color of the object, etc. Considering all these requirements and parameters the Ultrasonic sensor can be used for level detection. This sensor is placed at the top of the dustbin such that it covers the entire area of the dustbin. The Ultrasonic sensor works on the property of sound and frequency. There are two terminals of sensor: Echo and Trigger. Echo transmits the waves and these reflected waves are captured by the trigger. The trigger sends these captured waves to the Micro-controller which takes an immediate action upon receiving it. Ultrasonic sensors emit short, high-frequency sound pulses at regular intervals of time. [10]

C. Force Sensor

This sensor is used to measure the weight of waste in the dustbin. Force sensors are the devices which are used to convert an applied force to a quantity that can be measured. They are placed at the bottom of the dustbin. These are pressure sensing buttons. Once the pressure is applied on the sensors the status is displayed on the LCD.

D. Moisture Sensor

This sensor is used to estimate water content in the dustbin. It is made up of two electrodes. The moisture content around the electrodes is read by these sensors. Current is passed across the electrodes and the resistance to the current determines the moisture content. If the moisture content is more, resistance will be low and thus more current will pass through it. On the other hand when the moisture is low the sensor module outputs a high level of resistance. This sensor has both digital and analogue outputs. Digital output is simple to use but it does not give accurate results like analogue output. [11]

E. LCD (Liquid Crystal Display)

It is mainly used to visualize the output of the application. The status of the dustbin is displayed on the LCD monitor. It is connected to the Micro-controller to check the output of different modules interfaced with it. [9] Thus LCD plays a vital role in our project to see the output and to debug the system module wise in case of system failure in order to rectify the problem.

F. GPS(Global Positioning System)

It provides the location of the dustbin to different users. The users will fetch the information from the server in which area

the dustbin is located by comparing the coordinates. The GPS system is widely applied in the digital/electronic map. Integration of GPS technology can display and track the dustbin position in subject digital maps. The coordinates of latitude and longitude as well as the bearing angles between two positions will be generated by the GPS modules.

G. GSM/GPRS

GSM/GPRS module is used to communicate the computer with GSM and GPRS network. GSM stands for Global System for Mobile communication and GPRS stands for general packet radio service. [12] It contains a power supply and communication interface as indicators. A SIM card is required to communicate with the network. It can send as well as receive the SMS. It is used for the duplex communication. With the low power consumption, voice SMS and data information can be transmitted. AT commands is required for communicating with the controller and can be communicated with serial communication. [12] With the help of AT commands, we can achieve the following tasks

- We can send the SMS and the signal strength can be monitored.
- The charging status and the charge level of the battery can also be monitored.
- The SMS can be read, written and deleted.
- The phone book entries can be searched and read. [13]

In the embedded systems, it is the commonly used communication module. An external device or PC card can be a GSM module. The SMS that can be processed by the GSM module per minute is very low. GSM is a circuit switch technology whereas GPRS is a packet switch technology. The GPRS has high data transmission speed compared to GSM. The Model used is SIM800C.

H. AWS

AWS is Amazon web service, cloud computing platform provided by the cloud. It provides infrastructure as a service (IAAS), Platform as a service (PAAS), Software as a service (SAAS). A cloud computing model PAY-AS-YOU-GO was first introduced by AWS which provided throughput, computational and storage functionality to the users. [14] For the computer capacity amazon elastic cloud compute provides virtual server which are called as instances. The dozen of instances types with the different capacity and size, specific workloads types and application has been offered by the elastic cloud compute. To maintain the health and the performance, AWS provides an Auto Scaling Tool. AWS also includes Amazon lightsail, which provides virtual private server, AWS Batch which processes a series of jobs. AWS Lambda can be used by a developer which will run the code for applications and services automatically and for the PAAS, and one can use AWS Elastic Beanstalk. [14] A scalable object for the data backup is provided by the Amazon Simple Storage Service.

The Data is stored by the IT professional and are being filed as S3 Objects which can range upto GB. Money can be saved with the help of S3 through its infrequent access storage tier or by using Amazon Glacier for Long-Term Cloud Storage.

V. CONSTRUCTION

In this system, waste is being monitored by using different sensors in the two different dustbin. The system is composed of micro-controller ultrasonic sensor, force sensor, moisture sensor, GSM/GPRS, LCD, GPS and AWS. A device that detect and respond to some type of input from the physical environment is called as sensor. [15] The first dustbin is mounted with the ultrasonic sensor at the top and the force sensor at the bottom. It is used to demonstrate the volume and the weight of the waste. The ultrasonic sensor is used to detect the level of the waste in the dustbin which is volume based. The ultrasonic sensor contains the 4 pins VCC, trigger, Echo pin and GND pin. The ultrasonic sensor contains the two transducers –transmitter and the receiver. The transmitter will emit the ultrasonic waves of 40 KHZ, these waves travel through the air and when they are blocked by the object it gets reflected back and is absorbed by the receiver. [16] The VCC pin used is to power on the ultrasonic sensor and the trigger pin is the input to the sensor. LED lights are used in the dustbins to indicate whether it is empty or full. If the dustbin is full, Red LED lights will glow. The force sensor is used to measure the weight of the dustbin which is weight based. Force sensor is used to convert the applied force to a quantity that can be measured. It comes in a coin like structure and the generated volt values will be displayed in the LCD.

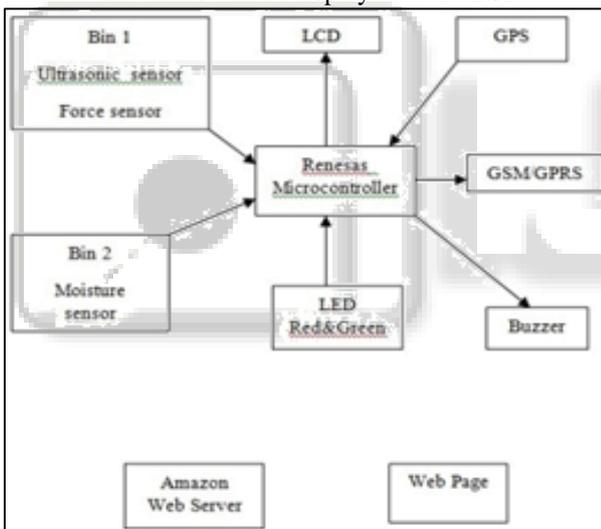


Fig. 2. Block diagram showing hardware and software components of proposed system

In the case of force sensor, one threshold value will be fixed and if the measured value exceeds the threshold value, SMS notification will be sent to the user indicating that dustbin is filled. A certain pressure has to be applied on the force sensor to generate the volt values in the LCD. ADC are used to convert the analog to the digital values. The formula to convert ADC is :

$ADC = ((V_{ref} * 5V) / 2^n - 1) * 1000$ where V_{ref} = analog value and $n = 10$ bit

$ADC = (V_{ref} * 5V) / 2^{10} - 1) * 1000$ $ADC = (V_{ref} * 5V) / 1023) * 1000$

In the second dustbin the moisture sensor is fixed in the bin which is used to detect the moisture content in the dustbin. If the dry waste is put in the wet bin, then the buzzer will beep to alert the user. All the sensors are connected to the micro-controller which is used to control all the devices.

The location of the dustbin is updated through the GPS. It will be uploaded directly along with the measured sensor value to the Amazon Web Server through GPRS(IOT). The sensor system is interfaced with the GSM system with the help of the micro-controller. The hardware component will send the data to Amazon Web Service with the IP address and the information can be viewed in a form of a web page. Data fetched from the GPRS along with the location from the GPS is displayed on the web page. The web page will display the status of the dustbin in a tabular format along with the location of the dustbin i.e. google map. Block diagram in Fig 2 shows the overall hardware and software components of the proposed system.

VI. RESULTS AND OUTCOMES

Dustbin1 is mounted with ultrasonic and force sensors. When the user puts waste into the bin, it shows green light indicating that the dustbin is not yet filled. After reading the sensor data, if the status is filled red LED glows indicating the user not to put waste anymore. LCD is used to display the status as shown in the Fig 3:



Fig. 3: Dustbin status



Fig. 4: Dustbin Status when threshold limit exceeds

The admin receives SMS notification about the status of the dustbin and its location. Further, admin can take actions like sending vehicle to the location for immediate collection of waste which avoids open-dumping of waste. The data is also sent to the server and can be viewed on the web page in the form of tabular columns. Google map is used to locate the dustbins. Dustbin2 is a dry bin in which moisture sensor is fixed. If the input waste contains moisture, it is detected by the sensor and the user is alerted regarding the same by buzzer. This helps in creating awareness among people about segregation of dry and wet waste

VII. CONCLUSION

Human ways of life have placed pressure on the environment and have caused an imbalance in the ecosystem by the production, consumption and wastage of natural resources.

Most countries have major effects on the environment due to the generation of Solid Waste with economic development since the natural resources are used, and waste and pollution are produced. Therefore, the concern towards the management of Solid Waste for sustainable development has increased.

The IOT based Solid Waste Management system provides the best way to help the people to maintain the city

clean by using the application to locate the dustbins in Maps. The application also provides the status of the different dustbins, if they are empty or completely full. This methodology checks corresponding intended information from different sensors on the Web page to help oversee the bin status. The proposed system would be able to monitor the Solid Waste Management process.

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