

Smart Garbage Collector System

Archana Senapati¹Bhupesh Daka²

¹(Department of Computer Science & Engineering, Gandhi Engineering College ,India)

² (Department of Computer Science & Engineering, Gandhi Institute For Technology,India)

Abstract: In many countries maintaining the cities neat and clean has become a great challenge with the growing population. This issue is further leading to diseases. The foul smell that comes from any garbage bin system or from any waste is very dangerous and may lead to dreadful diseases. By announcing that a city is turning to be smart means that the city is maintained neat and clean along with some advanced technology being implemented. Here the concept tells about on the solution being addressed towards the wastage maintenance especially the Garbage Bin system. Internet of Things is emerging with smart applications being proposed for addressing many problems in a smart way. Smart Garbage Bin System is implemented by using the Internet of Things technology

Keywords: Arduino, GPS, LCD, Sensor System, Integration, Smart Garbage Bin, Wi-Fi.

I. Introduction

In most of the countries maintaining the same has become a challenging task. If maintained neat and clean then definitely it's going to be a challenging task to the citizen's health. Many dreadful diseases are being spread in the city due to the bad maintenance of waste. There is too much waste getting collected from medical centers, residential, educational institutions, commercial which have to be disposed in a proper fashion. It is the role of the authorities who have to take corrective action in keeping the society neat and clean. In good olden days most of the developing countries used to maintain a dustbin for every street. The same when got filled up used to get emptied after the residents of the colony or the street used to come forward and report the same. The government should come forward and educate the society with the precautionary measures to be taken to maintain the society utmost clean. The society should be given this information by advertising, distributing pamphlets and conducting sessions. In the same manner the future generation should be made knowledgeable by including sessions with respective to cleanliness and hygiene. There would be bacteria, fungus and virus being enraged at the location of dustbin which got overfilled. Along with hygiene the side effects due to improper hygiene should be known to the society. Especially the foul smell that gets spread from the overfilled garbage leads to dreadful diseases. At the same time dangerous mosquitoes, flies, pig's number get increased due to the foul smell at the garbage. It is very easy for infectious fevers to get spread due to mosquito bites. In most of the locations the garbage which got overfilled is seen being burnt by the locals and this is very harmful. The latest trends in the technology should be utilized to make the life of the citizens more comfortable and safe. In this paper the above problems have been addressed by using the Smart Garbage Bin System [17][6][7][8].

The following are the topics which will be covered in section II: Smart Garbage Bin System Concept [3][20][9][10] and Services III: Advantages of the Smart Garbage Bin System IV: Conclusion

I. Smart garbage bin system concept and services

Smart Garbage Bin System: - This system is proposed for the immediate cleaning of the dustbins. As dustbin is considered as a basic need to maintain the level of cleanliness in the city, so it is very important to clean all the dustbins as soon as they get filled. We will use ultrasonic sensors for this system. The sensor will be placed on top of bin which will help in sending the information to the office that the level of garbage has reached its maximum level. After this the bin should be emptied as soon as possible. The concept of IoT when used in this field will result in a better environment for the people to live in. No more unsanitary conditions will be formed in the city. With the help of this system minimal number of smart bins [8][9][10] can be used around the whole city and the city will still be much cleaner. There has been an extraordinary growth in the number of devices being connected to the Internet since past few years. All these devices connected to the internet are part of the IoT infrastructure which can communicate with each other. The IoT network consists of embedded electronics, sensors and software that allows these devices to send and receive data among each other. The real-time information can be gained regarding the level of the dustbin filled on the system itself. It will also help in reducing the cost as the employees will have to go only at that time when the bin is full. In advanced garbage bin system the level of garbage in bins is detected with the help of ultrasonic sensors, and communicated to the authorized control room through GSM system. Arduino microcontroller is used to interface the sensor system with GSM system. Webpage maintains the everyday status of garbage bin. Only authorized users can view the status of bin. Maintain a server by using Amazon web services which is cost-effective and reliable and it is no

SQL database which is fully managed and known for its scalability and low latencies. It alerts the authorities by sending message using GSM module which contains location of particular garbage bin which is full. Less cost compared to traditional way of collecting the garbage. This Smart Garbage Bin System [1][17] is a very innovative system which will help to keep the cities clean. This system monitors the garbage bins and informs about the level of garbage collected in the garbage bins via a web page. It is very useful to the environment as it prevents the garbage overflow in the streets and notifies the authority about the full status of the bin through message. It is also time consuming and leads to high costs when authorities travel to the location of the bin all the time to check level of bin. So, the government should opt for any similar method like this system for the betterment of the society. The intended audience would be householders, the main focus of this system. Internal groups like staff, senior officers, elected members, and other council staff of the management need to know about the status of the garbage bin in order to take appropriate actions. External groups such as the media, community groups, other local authorities and specific subgroups like community groups, religious and cultural groups, potential partners to help communicate messages such as caretakers, landlords and housing associations. All the components like Arduino Uno, Ultrasonic sensor [2] which is connected to bin, LCD display, GPS tracker, GSM module, Wi-Fi module must be connected properly. The SIM must be inserted properly in GSM module and place the antenna in a proper direction in order to get signal. GPS Tracker works when it gets signals from 3 satellites. So, signal strength in the location must be good. Wi-Fi connection is needed in order to connect to server and update the status of webpage. Maintenance of server which stores the details of garbage bin like level percentage, latitude, longitude, date & time. Any loose connections must be taken care off. Power Supply must be given in the range of 7-20 volts to Arduino. If the range exceeds the given range then there are chances for the device to get damaged. Power supply must be given to GSM module in the range of 12volts. In Arduino there is only one serial pin in order to connect to GPS, GSM and Wi-Fi module, include libraries like AltSoftSerial, Soft Serial packages in Arduino IDE. The below figure 1 and 2 the structure of the Arduino board and the Arduino module is shown. Looking at the board from the top down, this is an outline of parts of the board.

Starting clockwise from the top center:

Analog Reference pin

Digital Ground

Digital Pins 2-13

Digital Pins 0-1/Serial In/Out - TX/RX (dark green) - These pins cannot be used for digital I/O (Digital Read and Digital Write) if you are also using serial communication (e.g. Serial. begin).

Reset Button - S1

In-circuit Serial Programmer

Power and Ground Pins

External Power Supply In (9-12VDC) - X1

Toggles External Power and USB Power (place jumper on two pins closest to desired supply) - SV1

USB (used for uploading sketches to the board and for serial communication between the board and the computer; can be used to power the board) Analog IN Pins 0-5

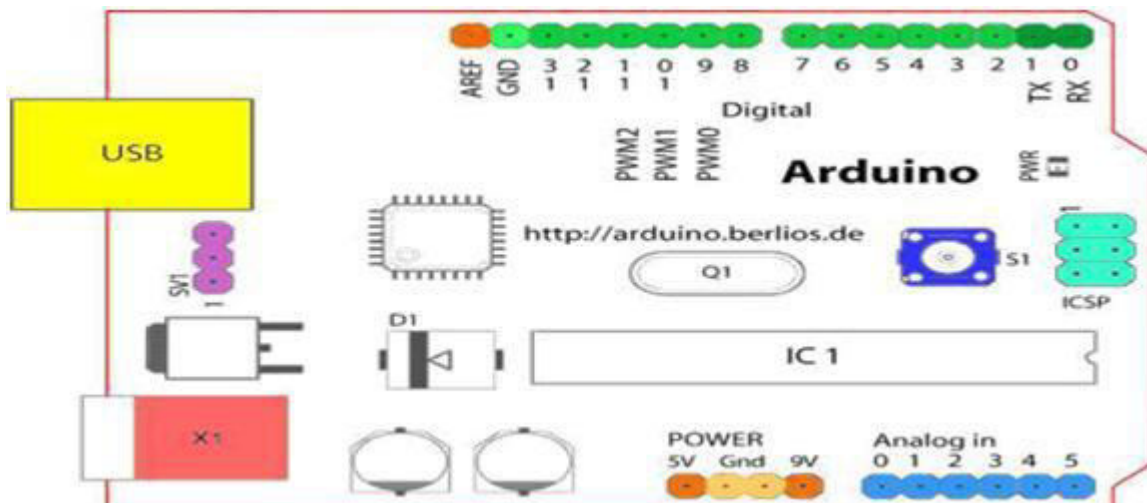


Figure 1. The Structure of Arduino Board with Pin details



Figure 2. Arduino module

The ultrasonic sensor [11] seen in below figure 3 and 4 measures the distance to an object by using the sound waves. It measures distance [16] by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. It is possible to calculate the distance between the sonar sensor and the object by recording the elapsed time between the sound wave being generated and the sound wave bouncing back. It is important to understand that some objects might not be detected by ultrasonic sensors. This is because some objects are shaped or positioned in such a way that the sound wave bounces off the object, but are deflected away from the Ultrasonic sensor [11]. It is also possible for the object to be too small to reflect enough of the sound wave back to the sensor to be detected. Other objects can absorb the sound wave all together (cloth, carpeting, etc), which means that there is no way for the sensor to detect them accurately. These are important factors to consider when designing and programming a robot using an ultrasonic sensor. It has four pins. Two are VCC and GND which will be connected to the 5V and the GND of the Arduino while the other two pins are Trig and Echo pins which will be connected to any digital pins of the Arduino. The trig pin will send the signal and the Echo pin will be used to receive the signal. To generate an ultrasound signal, you will have to make the Trig pin high for about 10us which will send a 8 cycle sonic burst at the speed of sound and after striking the object, it will be received by the Echo pin. Global System for Mobile Communication (GSM) [12] device shown in figure 5 is a set of ETSI standards specifying the infrastructure for a digital cellular service. The standard is used in approx. 85 countries in the world including such locations as Europe, Japan and Australia. [12]Any GSM network operator SIM card is accepted by GSM modem as well as it acts like a mobile phone. Advantage of this modem is that there is RS232 port, which is used for communication purpose also used for advanced embedded application. Application like SMS handling, transferred data, etc. For wireless data transmission GSM is used. Radio waves perform vital in GSM. In GSM, [12] Data is send as well as receive by using radio Waves. AT command Instruction is used for Modem control. GSM is connected to Micro-controller. Message is send to that authority who takes appropriate action. GSM is low cost device and provide short message services.

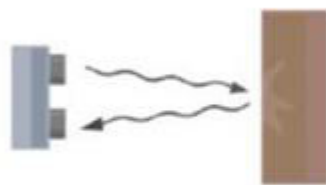


Figure 3.Ultrasonic sensor operation



Figure 4. Ultrasonic sensor

LCD stands for Liquid Crystal Display [13] shown in figure 6 is “specialized” for being used with the microcontrollers, which means that they cannot be activated by standard IC circuits. They are used for writing different messages on a miniature LCD. The model described here is for its low price and great possibilities most frequently used in practice. It is based on the HD44780 [13] microcontroller and can display messages in two lines with 16 characters each. It displays all the alphabets, Greek letters, punctuation marks, mathematical symbols etc. In addition, it is possible to display symbols that user makes up on its own. Automatic shifting message on display (shift left and right), appearance of the pointer, backlight etc. are considered as useful characteristics. The below table 1 describes the pin structure of the LCD. ESP8266 is a Wi-Fi [14] module seen in figure 7 which will give the projects access to Wi-Fi or internet. It is a very cheap device but it will make

your projects very powerful. It can communicate with any microcontroller and make the projects wireless. It is in the list of most leading devices in the IOT platform. It runs on 3.3V and if you will give it 5V then it will get damage. The ESP8266 has 8 pins; the VCC and CH-PD will be connected to the 3.3V to enable the Wi-Fi.

Table 1 Description of pins present in Liquid Crystal Display

Pin no.	Symbol	External connection	Function
1	V _{ss}	Power supply	Signal ground for LCM
2	V _{cc}		Power supply for logic for LCM
3	V _o		Contrast adjust
4	RS	MPU	Register select signal
5	R/W	MPU	Read/write select signal
6	E	MPU	Operation (data read/write) enable signal
7-10	DB0-DB3	MPU	Four low order bi-directional three-state data bus lines. Used for data transfer between the MPU and the LCM. These four are not used during 4-bit operation.
11-14	DB4-DB7	MPU	Four high order bi-directional three-state data bus lines. Used for data transfer between the MPU
15	LED+	LED BKL power supply	Power supply for BKL
16	LED-		Power supply for BKL



Figure 7. Wi-Fi module



Figure 8. GPS Tracker

Interfacing the ESP shield with Arduino Uno:

First connect the Arduino Uno to the Computer or Laptop to check which COM port will be used to burn the program from the computer or laptop. This provides power to the Arduino Uno.

Next supply the power to the ESP shield (supply only 3.3V to the ESP shield using level converter) which is going to be used for the program. For ESP programs, only 2 pins, RX and TX are to be used mainly. So we require only these two pins of the Arduino Uno. These pins are pins 0 and 1 of the Arduino Uno. Next burn the required program in The Arduino Uno using the software. Then connect the ESP shield to Arduino such that RX, TX of the shield is connected to the TX, RX of the Arduino Uno. With this the interfacing gets completed.

So if a GPS [15] receiver is tracking signals from multiple satellites, it converts these into a position that can be used for navigation by using a mathematical process called trilateration. The GPS receiver figures both of these things out by analyzing radio signals transmitted from the GPS satellites and timing how long it takes for the signal to travel from the satellite to the receiver. If a GPS receiver cannot do this for at least four satellites, it will not be able to figure out where it is. The below diagram shows the deployment diagram of the system along with the block diagram of Smart Garbage Bin system.

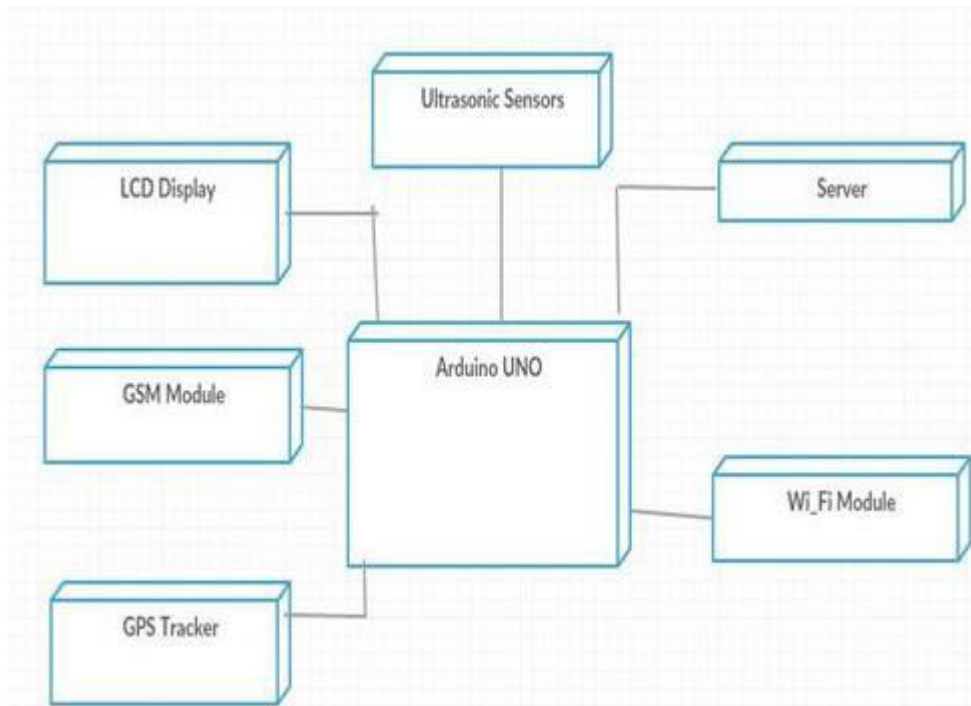


Figure 9. Deployment Diagram of Smart Garbage Bin System

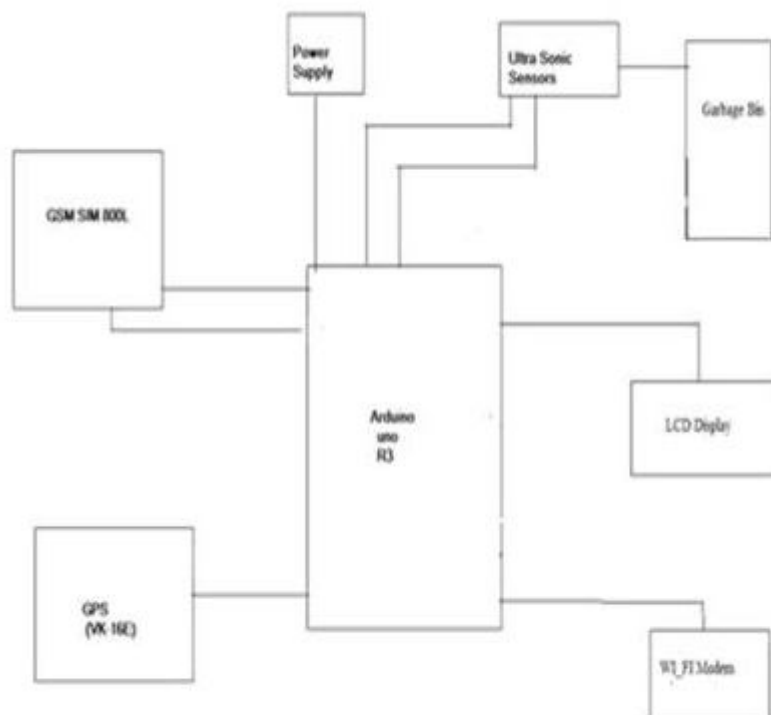


Figure 10. Block Diagram of Smart Garbage Bin System

II. Testing smart garbage bin system

Test Case ID 1:

Assumptions:

Check the board configuration as Arduino Uno and select the port and include all the libraries necessary like NewPing , AltSoftSerial.

Procedure:

Connect all the components like Arduino Uno, Ultrasonic sensor to bin, GSM Module, GPS and WI-FI Module.

Expected Result:

It should give the level of garbage bin by using ultrasonic sensor .When the garbage bin is full it should show 0% empty and the LCD will display the message as “GARBAGE IS FULL.” It should automatically update the percentage level of bin, latitude, longitude, date and time. The authority gets the message as link where they can login and view the status.

Actual Result: Same as Expected;

Status: Test Case Passed



Figure 12. Test Case 1 Testing (LCD displays garbage status)



Figure 13 Message received by the authority containing link

Test Case ID 2:

Assumptions:

Check the board configuration as Arduino Uno and select the port and include all the libraries necessary like NewPing, AltSoftSerial.

Procedure:

Connect all the components like Arduino Uno, Ultrasonic sensor to bin, GSM Module, GPS and WI-FI Module.

Expected Result:

It should give the level of garbage bin by using ultrasonic sensor when the garbage bin empty it should show 100% empty. It should automatically update the percentage level of bin, latitude, longitude, date and time.

Actual Result: Same as Expected.

Status: Test Case Passed



Figure 14 Garbage Status is seen the app with 100 % stating it is empty

In the above table the first column shows the percentage of empty of the bin. Then slowly the bin started filling.

Test Case ID 3:

Assumptions:

Check the board configuration as Arduino Uno and select the port and include all the libraries necessary like NewPing , AltSoftSerial.

Procedure:

Connect all the components like Arduino Uno, Ultrasonic sensor to bin, GSM Module, GPS and WI-FI Module. Fill the garbage bin to half of its level.

Expected Result:

It should give the level of garbage bin by using ultrasonic sensor When the garbage bin is filled to half of its level it should automatically update the percentage level of bin, latitude, longitude, date and time.

Actual Result: Same as Expected;

Status: Test Case Passed



Figure 15 LCD displaying the percentage of space left in Garbage Bin

Test Case ID 4:

Assumptions:

Check the board configuration as Arduino Uno and select the port and include all the libraries necessary like NewPing, AltSoftSerial.

Procedure:

Connect all the components like Arduino Uno, Ultrasonic sensor to bin, GSM Module, GPS and WI-FI Module. Fill the garbage bin to more than 80% of its level.

Expected Result:

It should give the level of garbage bin by using ultrasonic sensor When the garbage bin is filled above 80% then It should send the message to authority as we gave the condition as if the garbage is full more than 80% then it should message to authority and it should automatically update the percentage level of bin, latitude, longitude, date and time. LCD displays the percentage of empty space left in the bin.

Actual Result: Same as Expected

Status: Test Case Passed



Figure 16. LCD displaying the status with percentage left empty in Garbage Bin

III. Advantages of smart garbage bin system

The following are the advantages of Smart Garbage Bin System:

This system avoids the overflowing of the garbage from the bin thus by keeping the surrounding hygiene.

It helps the residential areas by maintaining their dustbins without being overfilled.

Reducing the human effort by making multiple calls as this system takes the effort of messaging the status of the bin to the local ward members.

IV. Conclusion

The main objective is to maintain the level of cleanliness in the city and form an environment which is better for living. By using this system we can constantly check the level of the garbage in the dustbins which are placed in various parts of the city. If a particular dustbin has reached the maximum level then the employees can be informed and they can immediately take certain actions to empty it as soon as possible. The employees can check the status of these bins anytime on their mobile phones. This can prove to be a very useful system if used properly. The system can be used as a benchmark by the people who are willing to take one step further for increasing the cleanliness in their respected areas. Ultrasonic sensor [4][5][18][19] is being used in this system to check the level of garbage in the dustbins but in future various other types of sensors [4][5] can be used with the ultrasonic sensor to get more precise output and to take this system to another level. Now this system can be used in certain areas but as soon as it proves its credibility it can be used in all the big areas. As this system also reduces manual work certain changes can be done in the system to take it to another level and make it more useful for the employees and people who are using it.

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