International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 06 | June 2021 www.irjet.net p-ISSN: 2395-0072

# IOT Based Garbage Monitoring System Using Sensors

**RAJESHRI K TANGADE[1], Dr.Mrs.A.U.JAWADEKAR[2]**

*[1]ME Student, Department of Electrical Engineering, SSGMCOE Shegaon(M.S), India*
*[2]Associate Professor, Department of Electrical Engineering, SSGMCOE Shegaon(M.S), India*

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**Abstract -** *As the population is increases with the growth of the cities, the waste produced also increases. In 21st century there is tremendous increase in garbage including plastic waste of households which is a threat not only for human race but also for earth's environment. In today's sceanrio many cities are still lacking in the area of waste management, particularly , the collection of garbage within the cities. Because of this there is overspill of garbage bins.To provide a solution to this problem, a smart garbage monitoring system is therefore to proposed to tackle the issues faced. Nowdays sanitariness & cleanliness are one of the agitated issues by any state all over the world. This is possible only when the network of smart bins which integrates cloud-based techniques to monitor & analyze data collected to provide predictive routes generated through algorithms for garbage bins.The main purpose of this project is to develop an IOT Based project which is cost-effective system that can monitor the everyday garbage in real time by using smart technology.*

***Key Words***: Ultrasonic Sensors, IOT(Internet Of Things), Garbage monitoring system , Solid & liquid waste collection, Wi-Fi Modem.

## 1.INTRODUCTION

There is tremendous growth population across the world and due to which there is enormous amount of garbage which is generated on a daily basis, that's why the issue of waste management has been a terrible problem in India.
During travelling , hundreds of people are passing the same location around one minute. Almost 60-70% of people are carrying food covers , polythene bags, plastic bottles. If they dispose all them at once, the dustbins will be filled in several minutes. With the popularity of IOT growing and the availability of low cost actuators and sensors, the benefits of this technologies can be used to solve the problems faced in the current method of waste management in cities. Also , in present day waste collection system is a time process and it requires huge labour. IOT has many application such as home, health,, environment and industry. It can also be applied in the field of waste management that would be instrumental in designing smart cities.

In many areas where people are highly affected by the environmental pollution. This leads to very harmful and poisonous effects on the human health. Certain part of the city or an organization, the overflowing of muncipal garbage bins brings daunting and detrimental consequences for suburbs. To overcome such severe problems, there is a need to develop a smart system that safeguards the environment and reduces the human effort by informing the municipality about the filling of bins so that bins can be clean on time.
The system proposed has 3 parts: Part 1 deals with data sensing and acquiring. That can be done when the ultrasonic sensor is placed inside the bin to measure and collect the information such as garbage weight, leftover space in the bins. Part 2 deals with data processing and transmission. Part 3 deals with triggering and alert.

### 1.1 Motivation

We can keep ourself clean and maintain our environment tidy plays a major role on making our country healthy and wealthy. This project helps to clean the garbage as soon as possible when it is nearing the fulfillment of the garbage bin. This prevents the diseases arise due to waste dumping and increases cleanliness of the city. This makes very miserable for India to become Swach Bharat.


**Figure1.1:** Motive of Project

### 1.2 Aim and Objective

To detect the garbage level and compare it with the garbage bins depth. In this project the system informs about the level of the garbage collected in the garbage bins. Main aim is to stop overflow of garbage in bins to overcome this problem a IOT based garbage monitoring system is designed which measures the level of trash in the bin and remotely triggering the required controls using IOT.

Again the main aim of this project is to collect sensor data from each bin and display it on the page using ThingSpeak software.


**Figure 1.2:** The proposed system for garbage monitoring system

### 1.3 The Problem

One of the main concerns with our environment has been a solid waste management which impacts the health and environment of our society. The observation, monitoring and management of wastes is one of the primary problems of the present era. There are lots of flats and apartments which have been built in a rapid urbanization area. There are many problem faced by the residents of the flats. One of them is disposal of solid waste. For example, let's say street A is a busy street and we see that the garbage fills up really fast whereas maybe street B even after 2 days the bin isn't half full. Figure shows an overspilled garbage container in a public place.

**Figure 1.3:** Overspilled Garbage

### 1.4 The Solutions

There are many solution for this technology that can solve our problem i.e it gives real time indicators of garbage level of dustbin at any time, using this data we can optimise waste collection routes and ultimately reduce fuel consumption also it also trash collectors to plan their daily/weekly schedule. Also in present sceanrio waste collection system is a time taking process and it requires huge labour.

**Figure 1.4.1:** Smart Management System

**Figure 1.4.2:** Smart Bins for Smart City

## 2. Components Used

HC-SR04 Ultrasonic Sensor, Arduino UNO, GSM Module, Connecting wires, ESP8266 Module, Round Bridge, 2 Red LED, Relay BC547, Transformer

### 2.1 HC-SR04 Ultrasonic Sensor

The ultrasonic sensor is define an an electronic device that measures the distance of the target object by emitting ultrasonic sound waves and convert the reflected sound into an electrical signal. It has two main components: the transmitter and the receiver. In order to calculate the distance between the Ultrasonic sensor and the object, the sensor measures the time it takes between the emission of the sound by the transmitter to its contact with the receiver. The formula for this calculation is D = ½ T x C (where D is the distance, T is the time, and C is the speed of sound ~ 343 meters/second).Ultrasonic sensors are also used as level sensors to detect, monitor, and regulate liquid levels in closed containers. The range of ultrasonic sensors is 20mm to 8m measuring range. Application of this sensors are Checking diameter, Detecting obstacles, Edge detection of flat objects, Height and width measurements, Level control, etc.


**Figure 2.1:** Ultrasonic Sensor

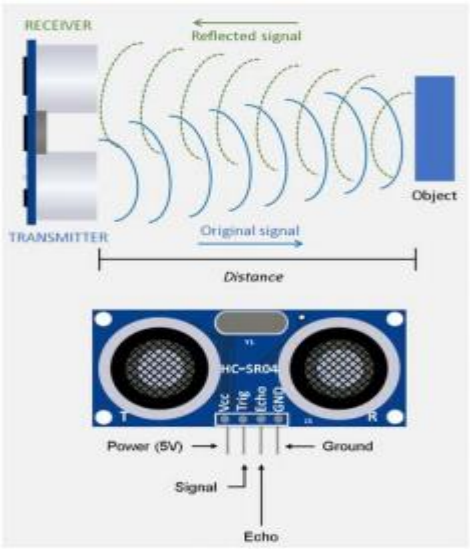


**Figure 2.2:** Pin dig. and working Princple of HC-SR04 Ultrasonic sensor

### 2.2 ESP8266 WiFi Module

ESP8266 is a microcontroller developed by Espressif System and is low cost Serial to Wi-Fi module. It is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network.

It has integrated phase lock loops to lock the output signal of ESP8266 to frequency of inputs to get better results. It has low powered 32-bit CPU which could be use as an application processor. WiFi frequency is 2.1GHz.

Application- IOT has automation using ESP8266, Water monitoring system, Home automation, Tiny robots using ESP8266, etc.

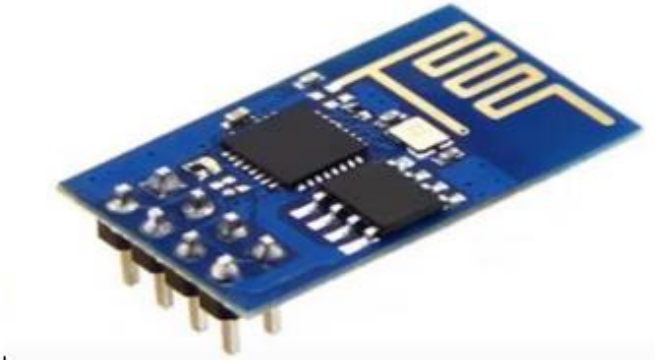

**Figure 2.2:** ESP8266 Wi-Fi Module

### 2.3 Arduino UNO

Arduino UNO is a microcontroller board which depends on the ATmega328P.Arduino's processor basically uses the Harvard architecture where the program code and program data have separate memory. It has two memories- Program and the data memory. Arduino UNO has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. The Atmega328 has 32 KB of flash memory for storing code (of which 0.5 KB is used for the bootloader), 2 KB of SRAM and 1 KB of EEPROM and operates with a clock speed of 16MHz.A typical example of Arduino board is Arduino Uno. It consists of ATmega328 a 28 pin microcontroller. Application- Arduino Uno is used in Do-it Yourself projects prototyping, development of automation system, designing of basic circuit designs, emergency lights for streets.


**Figure 2.3:** Arduino UNO

## 3. Methodology

This IOT Garbage Monitoring system is very unique system which will help to keep the cities clean. This arrangement keeps a watch on the garbage bins and notifies about the level of garbage collected in the garbage bins via a web page. The ultrasonic sensors positioned over the bins to detect the garbage level and relate it with the garbage bins depth. The system makes use of Arduino i.e microcontroller and a ESP8266 modem for sending data. An ultrasonic sensor is placed on the interior side of the bin, the one facing the solid waste. As garbage increases, the distance between the

ultrasonic and the trash decreases. This live data will be send to our microcontroller. Microcontroller then processes the data and sends to Thingspeak with the help of Wi-Fi Module.

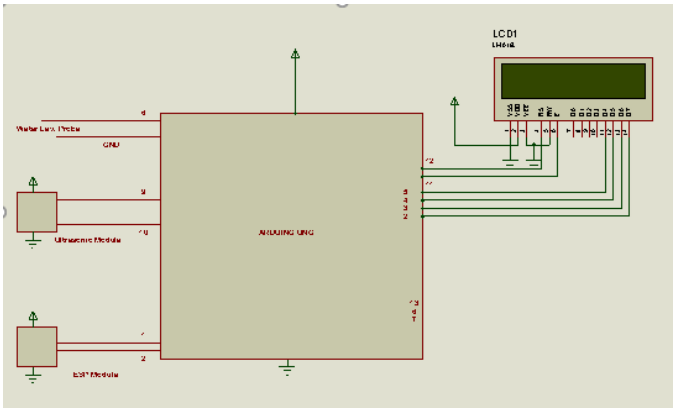

**Figure 3.1:** Pin Diagram

### 3.1 Step-by-Step Process

- The Arduino UNO board is powered by a dc power supply.
- The Arduino board is powered to Ultrasonic Sensor.
- The Wi-Fi module is also powered by the Arduino board.
- The Ultrasonic Sensor sends the ultrasonic waves which travel at the speed of sound i.e. 340m/s at standard room temperature.
- The waves are reflected back when an object is found in their path.
- The duration of travelling wave is then sent back in the form of a pulse.
- This duration is used to calculate the distance between the sensor and the garbage using the equation: Distance=Speed*0.5*Time.
- The Arduino will now measure the level of garbage using the ultrasonic sensor.
- The information will go through different equations and loops in the program in order to come up with the desired garbage levels.
- This information will sent to the Wi-Fi module.
- The Wi-Fi module will process this information and send it to the webpage using ThingSpeak.
- The garbage level is displayed on the web page by using ThingSpeak Software.

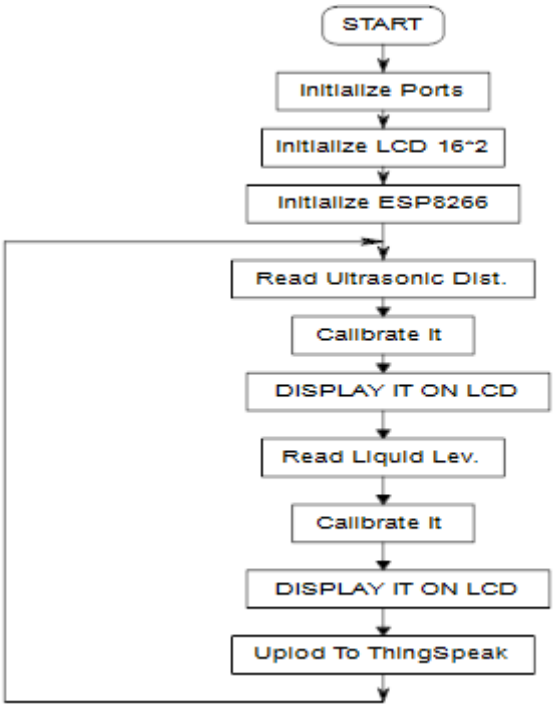


**Figure 3.1.1:** Work Flow

The complete work process can be divided into the following parts: the data sensing, data processing, data uploading, data display and triggering.

1.Data Sensing: Ultrasonic sensor and load cell sense the garbage level and weight of garbage respectively and accordingly send the signal to NodeMCU. By using only an ultrasonic sensor, the exact status of a bin may not be obtaining due to various cases involved in the shape and size of the bin and non-uniform distribution of waste inside the bin. To overcome the problem the weight sensor is integrated into the system to get the exact status of the bin.
2.Data Processing: The data read by the sensors is processed by the microcontroller NodeMCU. Processed data is Garbage Level(in cm) which will be displayed on the serial monitor.
3.Data Uploading: This occurs only when the garbage level and weight of the garbage go past the threshold values. The NodeMCU ESP8266 has an inbuilt WiFi module which also work as transmitter in the system. The frequency at which the data is uploading can be altered by varying the frequency of data sensing.
4. Data Display: The uploaded data can be viewed in Thingspeak software. It store the data along with the time stamps.
5. Triggering: A certain threshold value is set to each parameter. The measured values is uploaded and the trigger is generated only when both the thresholds are crossed.

## 4. IMPLEMENTATION

### 4.1 Hardware Implementation

This project is implemented for rural and urban areas with large as well as small areas, to find out status of dustbin through Internet without even physically seeing dustbins. For small areas, this kind of implementation, only one WeMOS D1 mini along with two ultrasonic sensors connected to it are used. Where as breadboard, connecting wires, micro USB cable and laptop is also used. The physical connections implemented can be seen in fig.

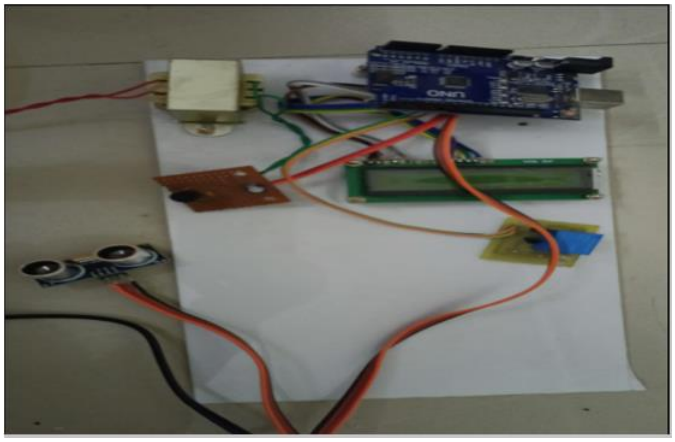

Figure 4.1: Connection Diagram of project

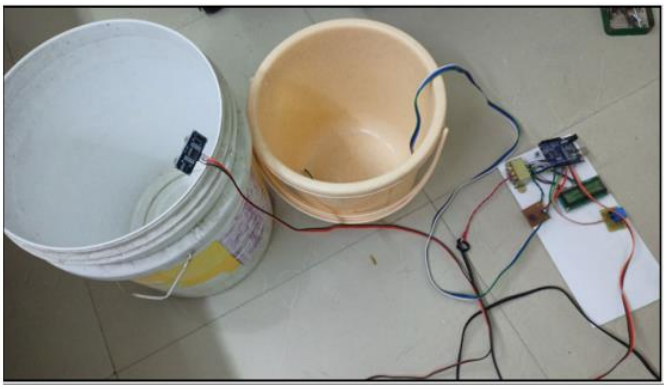

**Figure 4.1.2:** Implementation diagram of project

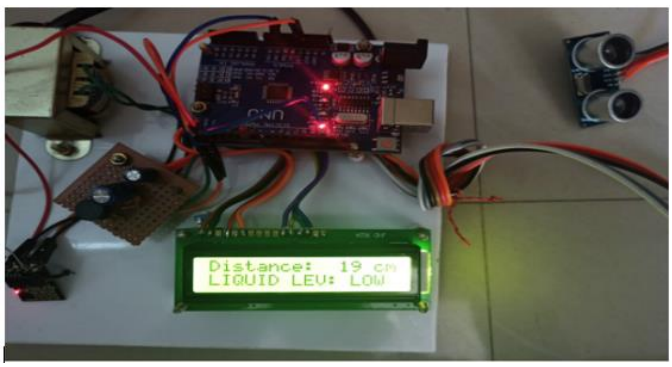


**Figure 4.1.3:** Implementation Outcome

On ThingSpeak software the field is shown by plotting the graph and the ESP8266 WiFi model is used to show the dustbin status. The ultrasonic sensor is used at the top of the bin 1 for detection of solid waste and the probe is insert in the liquid bin for detection of liquid level. The VCC and GND pins of sensor 1 and sensor 2 attached to 5V and ground pin on WeMos. Echo and Trigger pin of Ultrasonic sensor is connected to D3 & D4 pins of WeMOS resp.

### 4.2 Software Implementation

To aggregate, visualize and analyze live data streams in the cloud we use ThingSpeak which is an IOT analytics platform service. With the help of Thingspeak one can get visualizations of data posted by your devices to ThingSpeak. One can do online analysis and processing of data with the use of the ability of Thingpeak to code in MATLAB With the ability to execute MATLAB code in ThingSpeak .ThingSpeak is often used for prototyping and proof of concept IOT systems that require analytics You can send data to ThingSpeak from your devices, create instant visualization of live data, and send alert. Optionally, you can to manage your data, and you can build your own front end for your clients and customers to log in to with Thingspeak.

In an automated way Thingspeak charts the data that you send it, so you can remotely monitor your devices or equipment from anywhere. You can see your data from any web browser or mobile device. You can share read only views of your data with clients and peers that you need. At broad level many IOT systems can be described using the diagram below :

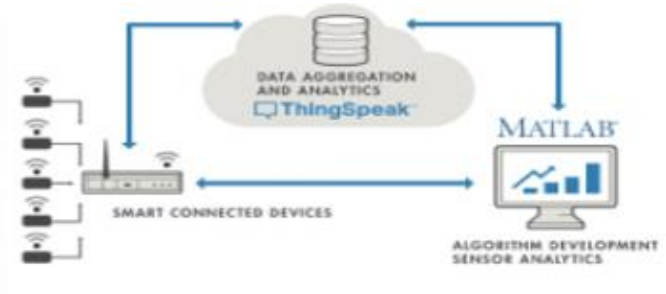


**Figure 4.2:** Block diagram of ThingSpeak

### ThingSpeak Features

One can aggregate, visualize and analyze live data streams in the cloud with ThingSpeak. Few of the main capacities of ThingSpeak involve the ability to:

- Collect data in private channels
- Share data with public channels
- Event Scheduling
- Analyze and visualize your data with MATLAB
- In an automated way process your data and message using services like Twilio or Twitter.
- Visualize your sensor data in real-time.
- Aggregate data on-demand from third-party sources.

ThingSpeak works with:

1. MATLAB
2. Arduino
3. ESP8266 Wi-Fi Module
4. Raspberry Pi

## 5. RESULT

The output of this project should have been the values of the distance, which we were supposed to get via a ThingSpeak Software. The proposed system uses a more powerful and efficient microcontroller and the data is uploaded to the cloud when the sensor detected the threshold value. The data which is collected is stored in the cloud and can be used for predicting the waste generation. Automatic execution of commands and triggers help to supply apt values of the garbage levels resulting in better garbage collection.

- Waste Level detection inside the dustbin.
- Transmit the information wirelessly to local authorities.
- The data can be access anytime and from anywhere.
- The real time data transmission and access.
- Avoids the overflows of dustbins.

### 5.1 Result Analysis for Empty Bin

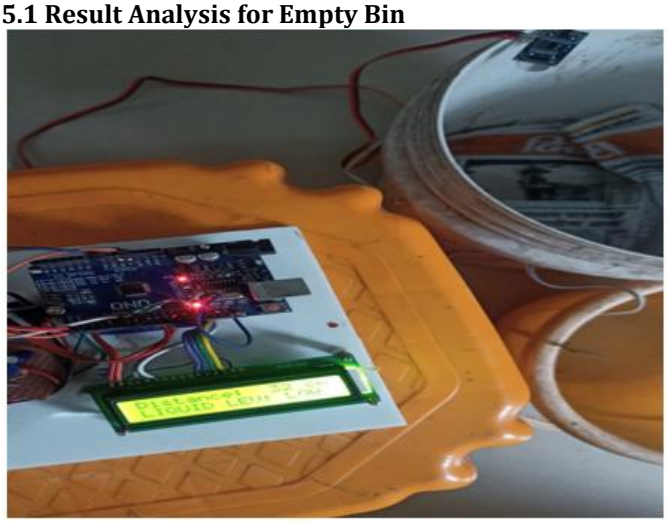

**Figure 5.1.1:** Empty Bin Output

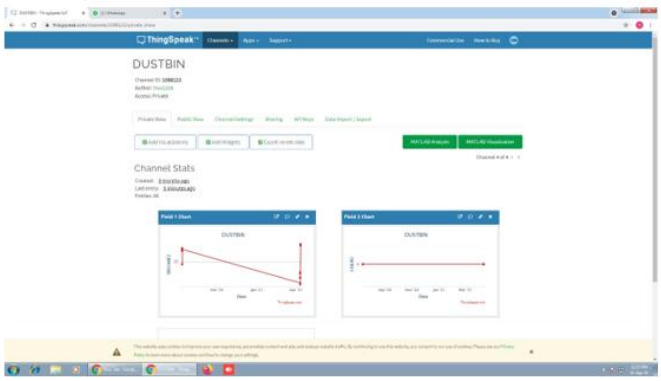


**Figure 5.1.2:** Result Analysis for Empty bin using ThingSpeak

The IP address which is received on the Serial Monitor is now placed into a web browser. The commands that were set up in the code will now be displayed as per the reading of the sensors.

- As shown, the sensor detects the dustbin being empty, hence the message conveying the same is displayed on the screen.
- In fig 5.1.1 shows the output of empty bin using all the equipment and show the level of the bin that is as the trash increases, the distance between the ultrasonic and the trash decreases. Hence the LCD shows the bin is empty.
- Figure 5.1.2 shows the result for empty bin using ThingSpeak software, here the graph plot against distance Vs time i.e if the bin is empty then the graph shows the distance is 20cm for solid level. And if the bin is empty for liquid waste then it shows the distance is '0'.

### 5.2 Result Analysis for Full Bin

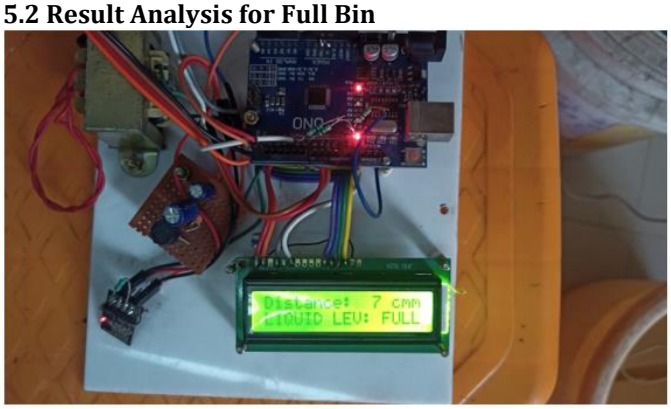


**Figure 5.2.1:** Result Analysis for Full bin

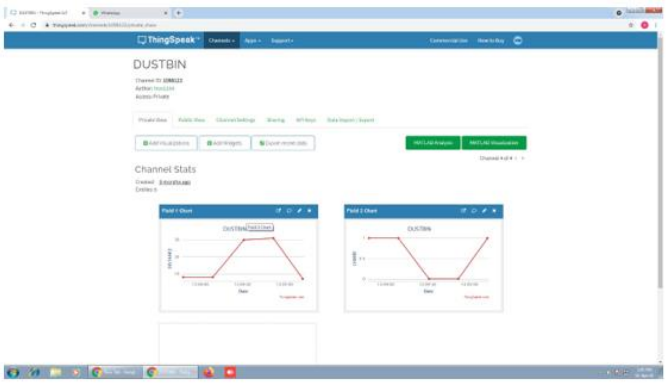


**Figure 5.2.2:** Result Analysis for Full bin using ThingSpeak

- Figure 6.2.1 shows the result analysis for full bin in this figure the LCD shows the distance i.e. the distance is 7cm in this we can conclude that if the distance is less then the bin is full and its gives trigger or alert signal to the municipal corporation office.

- In figure 6.2.2 in this the ThingSpeak reading is calculated for solid as well as liquid level here for solid state the distance is 8m and if we add some garbage on it then its level is increases and it gives alert signal. In the same way for

liquid garbage monitoring if the distance is '1' the bin is full then at that it gives alert signal to the controller and then process is continuing.

## 5. CONCLUSIONS

This system which is developed provides better database for garbage collection time and quantity of garbage collection at every place. After implementation of this project, we can avoid over flowing of garbage from the container in the residential area which was earlier done manually. Also, the system will reduce the risk of overfilled garbage bins and unhygienic conditions that are caused due to low awareness that is present in the current collection system. Importantly this system is directed at a city with a high or growing population. The official authorities can use this system to keep a watch on the levels of use of harmful materials developed and use already mentioned ways to reduce these levels.

## 6. Future Scope

The spread of internet is happening at a fast pace in every part of the world, which can digitized many aspects of day to day life. The scope from the project is that by providing knowledge of internet and its uses from people we can make village smart by providing these features like smart garbage management, digital water supply and intensity controlled street light, etc. The garbage which is collected can be converted into compost using the traditional methods and new techniques.

The proposed design of the smart garbage alert system is very flexible and can be easily installed at more crowded regions like airports, railway station, bus-stands, shopping malls, offices, etc. The government can setup recycling stations and the profit to be gained can be calculated.

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