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Efficient Trash Management System Using Smartbin

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Abstract – *Increase in population growth leads to increase in the amount of garbage generated on a daily basis. There is no proper waste management system to monitor and manage the waste disposals and waste collection. If the existing waste collecting garbage bins are not cleaned on proper intervals, the garbage overfills the garbage bins and hence making the surroundings unhygienic and polluted. Hence a system is required which monitors the status of garbage bins based on quantity of garbage, temperature and humidity variations and foul smell due to decomposition and alerts the concerned authorities, so that the required procedures can be done. A solution to this problem is to use a proposed 3 stage monitoring system: smart garbage bin, gateway, base monitoring station. The status of the bins are determined and is transmitted through the gateway which is monitored at the base monitoring station. Based on the status of the garbage bin the required steps to clear the garbage bin can be implemented.*

Key Words: Waste management system, Smart-bin, Gateway, Monitoring Base station.

1. INTRODUCTION

Every year there is increase in population in the country and lifestyle of the people is also changing at a faster rate. There is also increase in the no of industries and the municipal

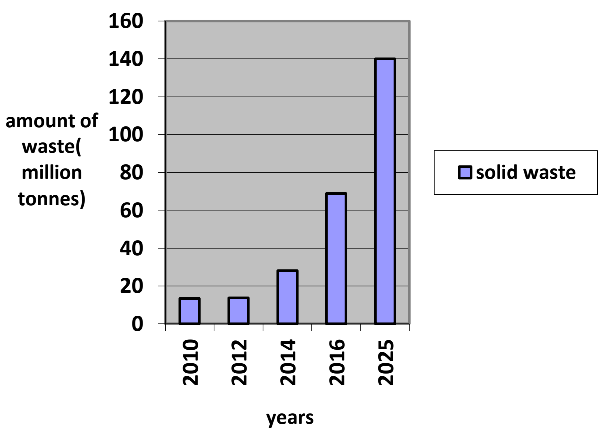


Figure 1: Survey of waste generated

Waste generated from these industries and the population collectively measures up-to 68 million tones every year. This is expected to be doubled by 2025[1].

Managing the solid waste collection effectively is a big challenge to the municipal department. If proper waste collection systems are not deployed then this municipal waste accumulates more and spreads around leading to dirty and unhealthy environment [1]. At present the traditional method of collecting waste is by sending the garbage collecting vehicles to all garbage dumpsite where the municipal waste is been dumped by the public as shown in Figure 2.

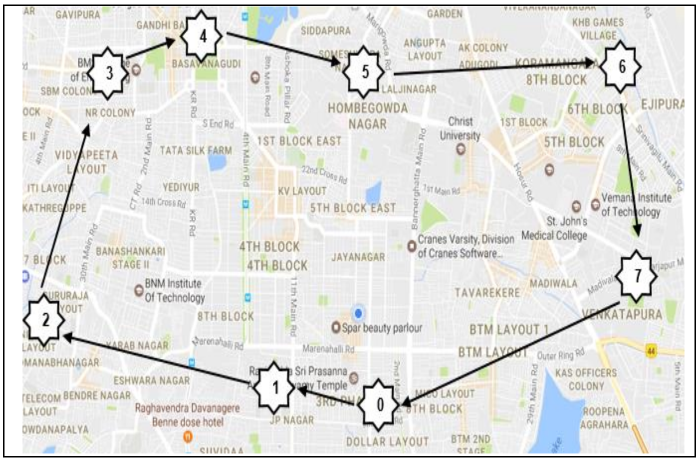


Figure 2: Traditional method of picking up garbage

Nodes 1 to 7 in figure 2 indicate the garbage collection points in a city , according to the traditional garbage collection practice the garbage trucks travel to all the garbage collection points in the city. This method of collecting the garbage is un-optimized as the garbage collecting trucks are sent to every point without any information of the spot being filled with garbage or empty. This leads to unnecessary consumption of fossil fuel by the trucks to travel to those collection points where there is no garbage to collect. The garbage spots are very soiled, often the employees of the municipal department hesitate to collect the waste by hand and make false statements that the garbage has been collected when enquired by the higher authority. Hence more garbage gets accumulated at the spot as shown in Figure 3[3].

One of the efficient solution that can be incorporated to solve this problem is by using a network of sensors and managing the waste collection methods by analyzing the real-time values obtained from the sensors. By making use of obtained real-time outputs from the sensors the status of the garbage spots can be known and then the shortest route to these spots can be taken and thereby utilizing the fossil fuel efficiently.

Figure 3: overfilled garbage collection spot

Apart from this a method to acknowledge, record the details and time of collection of the garbage by the municipal employee, RFID tagging can be used to prevent lethargic employees from making false claims of garbage been collected and keep a track of each employee and the work being done by them [2][4][5][6].

2. PROPOSED METHODOLOGY

An array of sensor networks and real-time data analyzing techniques to monitor the garbage level and condition of industry level municipal garbage bins deployed at different locations is used. Figure 4 shows the block diagram of the prototype implemented.

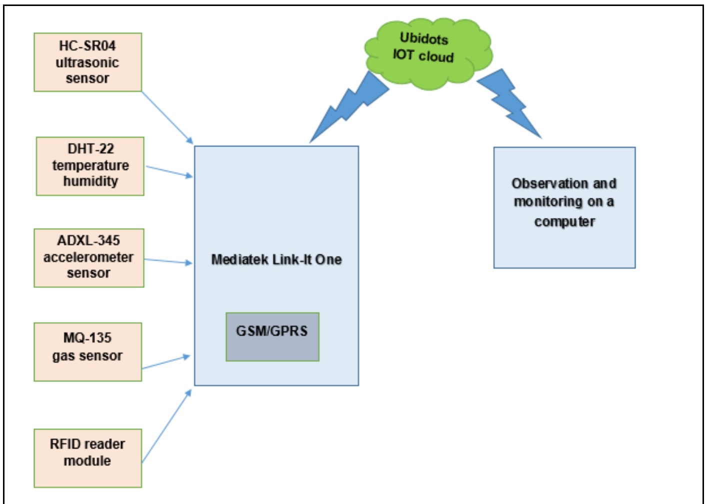


Figure 4: Block diagram of prototype

Then determine the shortest and the fastest route to be taken to collect the garbage from the garbage collections spots as shown in figure 5.

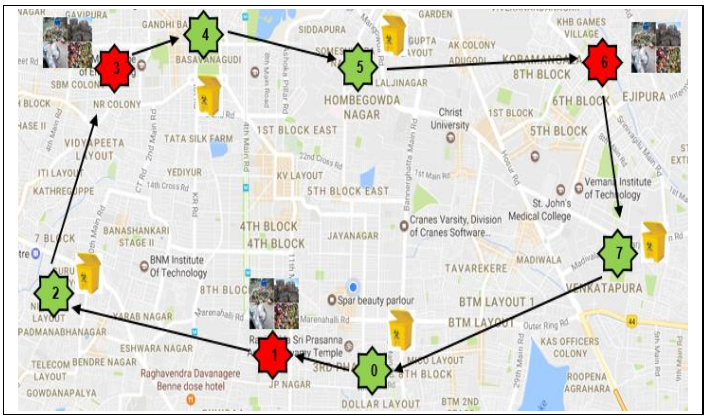


Figure 5: Shortest Route Selection between filled Garbage Bins

As shown in figure 5, the points indicated red represent the filled garbage spots and the points indicated green represent the empty garbage spots. By knowing the status of the garbage spots the shortest path to these spots can be decided and used therby utilizing less fossil fuel and hence reducing the overall transport costs.

Figure 6 shows the flow of implementaion of the efficient trash management system using smart bin.

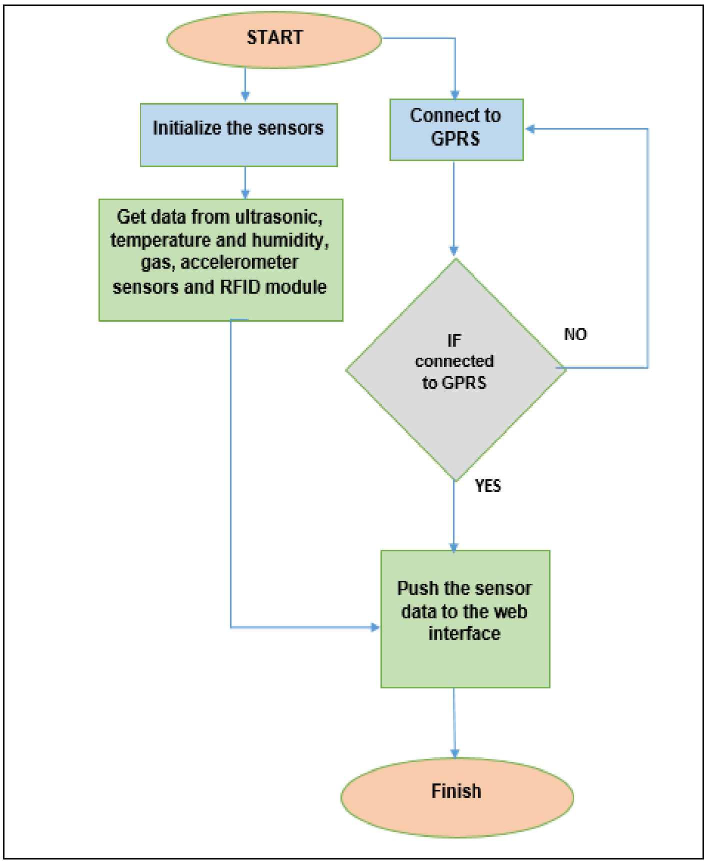


Figure 6: Flow diagram

Once the data is collected from all the sensors, a connection would be established between the client and the server using GPRS and all the collected data will be pushed onto the server thereby helping the department to choose the best route between the garbage collection points and navigate the garbage trucks to those points.

3. PROTOTYPE IMPLEMENTATION

For implementing the prototype, sensors and hardware used are

3.1 Ultrasonic Sensor- HC-SR04

This sensor is used to calculate the distance between the sensor and the garbage in the garbage bin. Based on the distance measurement the quantity of the garbage in the bin is calculated.

Figure 7 shows the implementation flow of the HC-SR04 ultrasonic sensor.

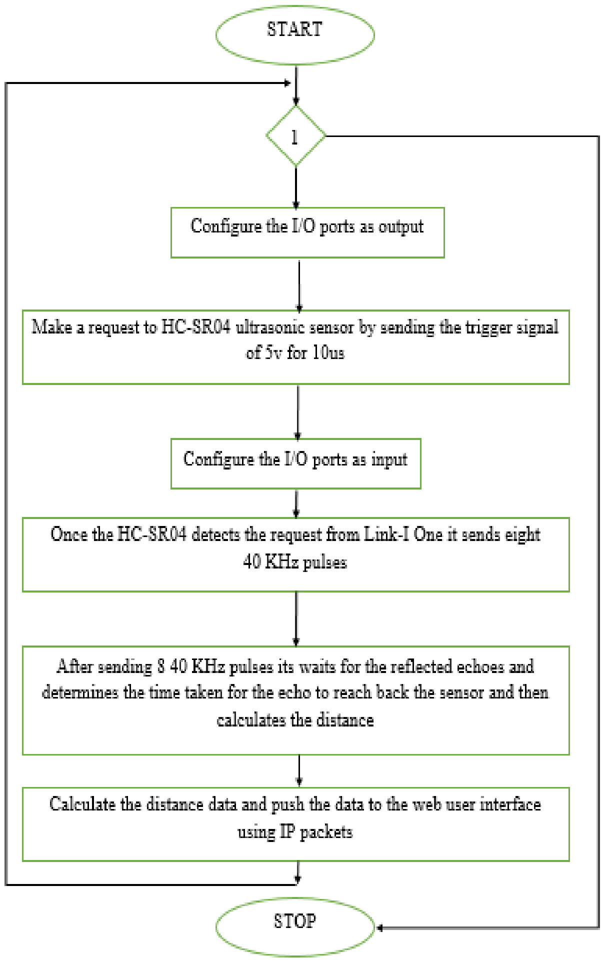


Figure 7: Ultrasonic sensor implementation flow diagram

The sensor is activated by sending a constant 5v signal for 10µs which will trigger the sensor to send 8 pulses at 40 khz from the module and a timer will be started till the 8 pulses are received by the module and then the distance is calculated by using the formula

$$Dx = \frac{Tx}{58} \text{--} (1)$$

Where,

Dx → Distance between sensor and garbage in cm

Tx → time duration between the sent and received signal

3.2 Temperature And Humidity Sensor DHT22

DHT22 sensor also known as the AM2302 sensor gives out calibrated digital signals. It makes use of digital-signal-collection-technique and humidity sensing technology which assures a reliable and accurate readings. Its sensing elements are connected with 8-bit single chip computer which outputs a *40-bit digital signal.*

The 40 bit digital signal composes of multiple 8 bit data as indicated below

← 40 bit digital data signal →

RH_L	RH_D	T_L	T_D	CS

Where

RH_L → 8-bit integral Relative Humidity (RH) data

RH_D → 8-bit decimal RH data

T_L → 8-bit integral (Temperature) T data

T_D → 8-bit decimal T data

CS → 8 bit check-sum data.

Figure 8 shows the implementation flow of DHT22 sensor

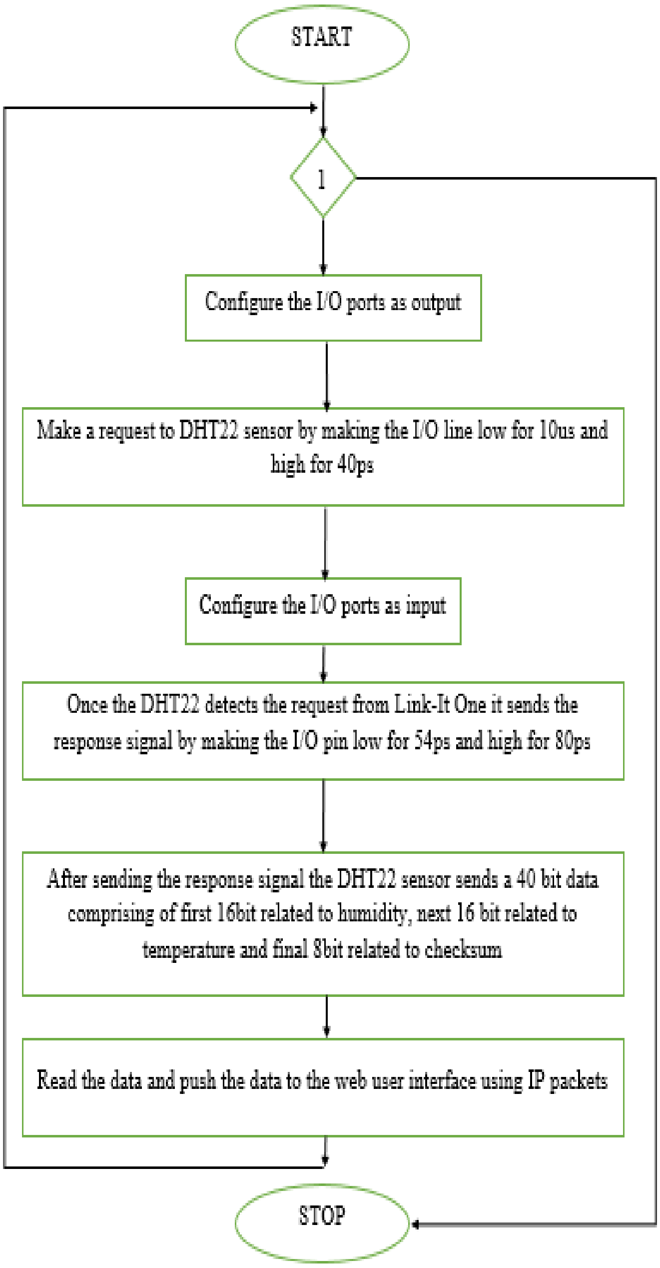


Figure 8: Temperature and Relative humidity sensor implementation flow diagram

3.3 Gas sensor MQ135

MQ135 gas sensor is a low power gas sensor which is sensitive to various gasses such as CO_2, Benzene, NH3, Alcohol, LPG, Methane and Smoke. MQ135 sensor makes use of stannic oxide also known as tin dioxide as the conductive medium which has lower conductivity in clean air and conductivity increases with increase in concentration when the target gas exists.

This gas sensor requires a preheat time of 20s and after this preheat time we get the accurate analog signals. The flow of implementation of MQ135 gas sensor is shown in Figure 9.

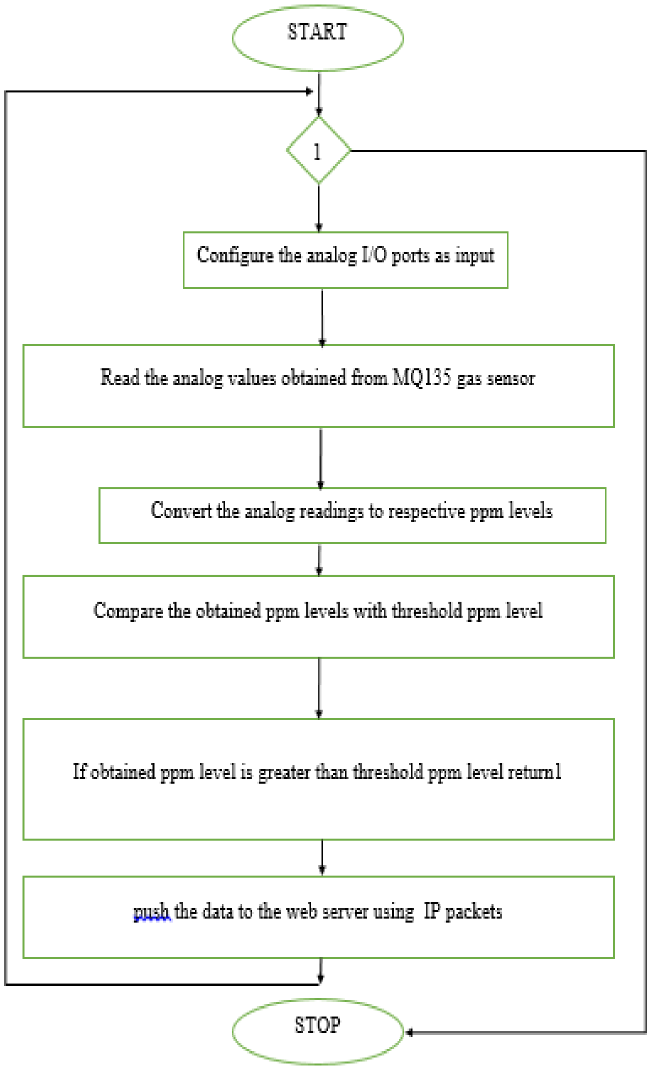


Figure9: Gas Sensor implementation flow diagram

3.4 3 Axis accelerometer ADXL345

ADXl345 is a 3 axis electromechanical device which measures the acceleration forces in x, y and z axis. These forces can be static such as constant gravitational force pulling down towards the earth or dynamic which is caused by moving or vibrating the accelerometer. ADXL345 is a capacitive type digital accelerometer whose internal capacitance changes proportionally with the variation in the acceleration forces in all the 3 directions. The flow of implementation of the 3 axis digital accelerometer is as shown in figure 10.

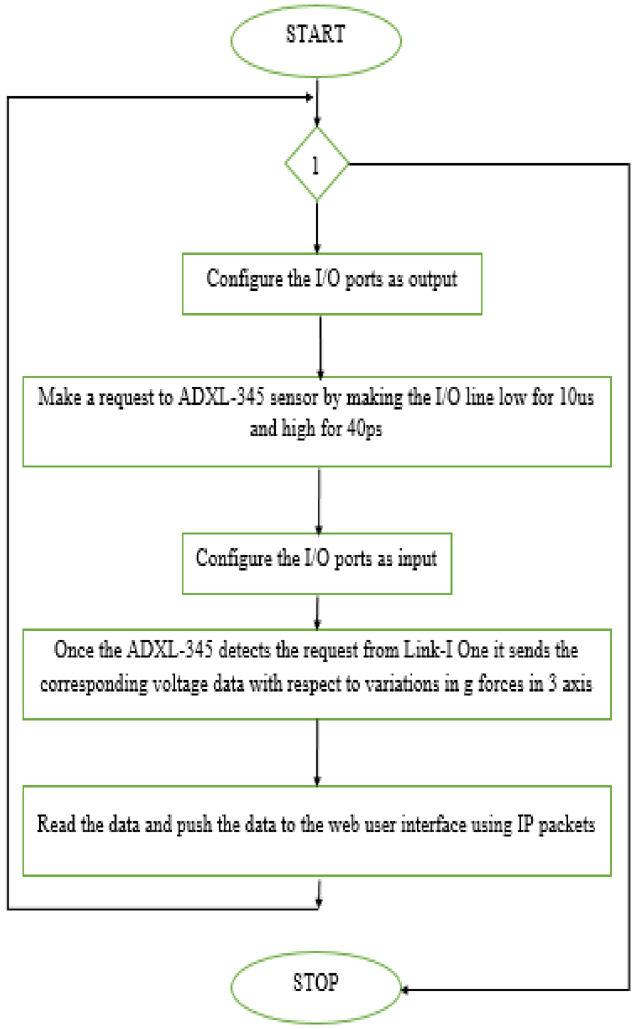


Figure10: Accelerometer implementation flow diagram

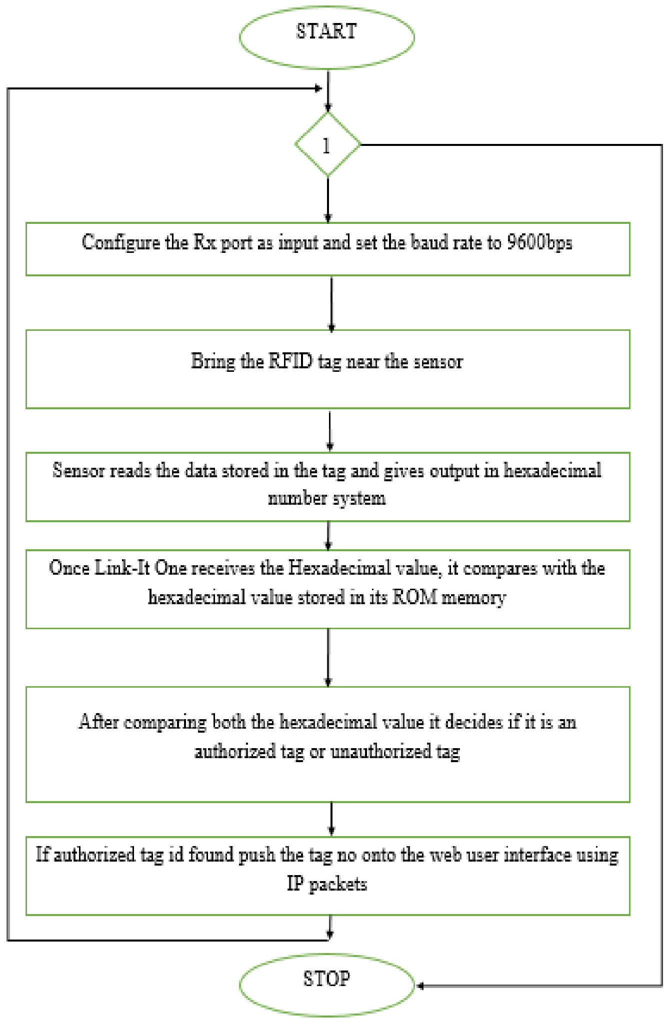


Figure 11: RFID module implementation flow diagram

3.5 RFID reader module EM-18

RFID makes use of electromagnetic fields to read and store data in magnetic sensitive chips or cards. RFID cards are characterized into two types – passive and active. Passive cards make use of energy from the nearby RFID reader modules interrogating waves whereas active RFID cards have their own power source such as batteries.

EM-18 RFID reader module is a low cost reader module capable of detecting data stored in RFID cards which work at 125 KHz frequency.

Figure 11 shows the flow of implementation of EM18 RFID module.

The EM-18 module reads the data from the RFID tag and outputs the stored data in two formats (i,e)weigand26 format and RS232 format (TTL format). The weigand26 format consists of 26 bits in which the 0^{th} and the 25^{th} bit are the parity bits and the 1^{st} to 24^{th} bits are the data bits. In RS232 format the output data is of 12 bits of which the 1^{st} 10 bits is card no is ASCII format and the last 2 bits are the XOR result of the 1^{st} 10 bits in ASCII format.

3.6 Link It-One Development Platform

All the above mentioned sensors namely HC-SR04 ultrasonic sensor, DHT22 relative temperature and humidity sensor, MQ135 gas sensor, ADXL345 3 axis digital accelerometer and the EM-18 RFID reader module are interfaced to a Mediatek Aster(MT2502) based development platform which also includes hi-performance Wi-Fi (MT5931) chipset and a on board hi-performance

GPS (MT3332) chipset along with Bluetooth and GSM connectivity.

This development platform provides a similar pinout as that of Arduino Uno making it compatible with other Arduino based shields and interfacing sensors which are compatible with Arduino based boards. Figure 12 shows the top level interfacing diagram of the setup and figure 13 shows the setup structure.

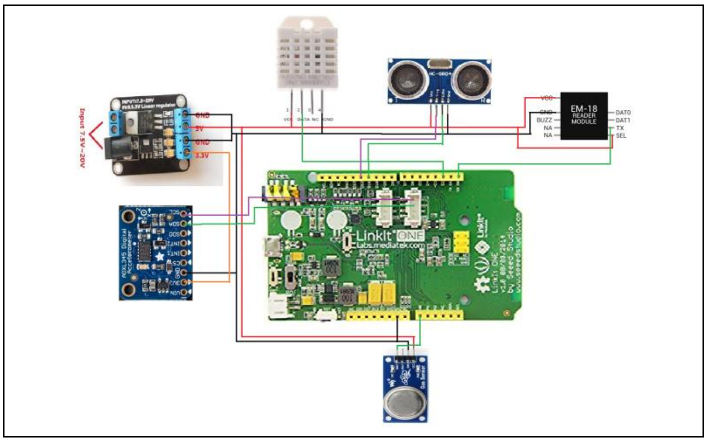


Figure 12: Top Level interfacing Diagram

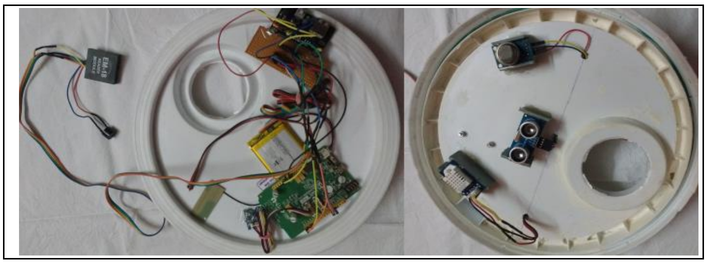


Figure13: Sensors mounted on downside and on the top of dustbin cap

3.7 Arduino IDE

LinkIt-One has the pinout layout same as Arduino Uno and sensors and other interfacing shields compatible with Arduino are also compatible with LinkIt-One. Hence the board support for LinkIt-One can be added into Arduino boards list and the entire project can be coded with Arduino IDE.

4. OBTAINED RESULTS

Figure 14 shows the web interface with gauge representation of different sensors.

- First gauge represents garbage quantity in dustbin at the garbage site.
- Second and third gauge represents the relative temperature and humidity level in the dust bin in the garbage site.
- The last gauge indicates the battery level as the development platform is powered by using li-ion battery

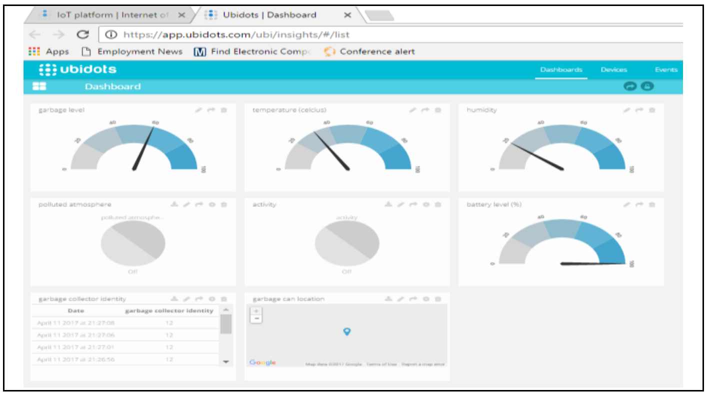


Figure 14: web interface showing output of HC-SR04, DHT22 sensors

Figure 15 and Figure 16 shows the web interface with the atmosphere polluted representation by the first indicator highlighted in green and activity representation by second indicator highlighted in green.

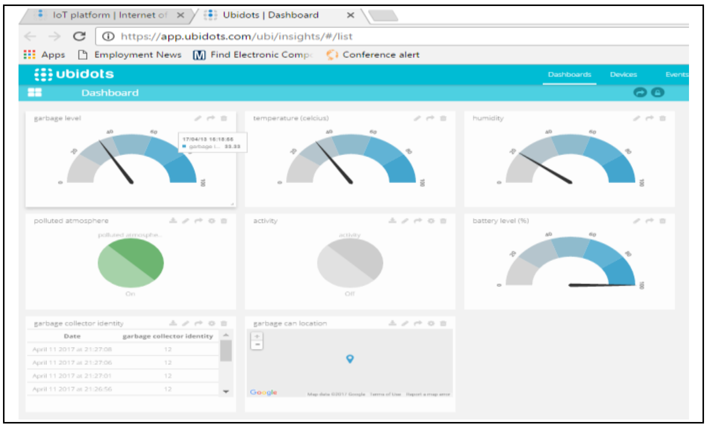


Figure 15: Web interface showing output of MQ135 gas sensor

The other outputs shown in Figure 14 to Figure 16 represent the table with the RFID tag ID read by the RFID reader module and the last output represent the location of the dustbin at the municipal garbage dump site within the city on a map layout.

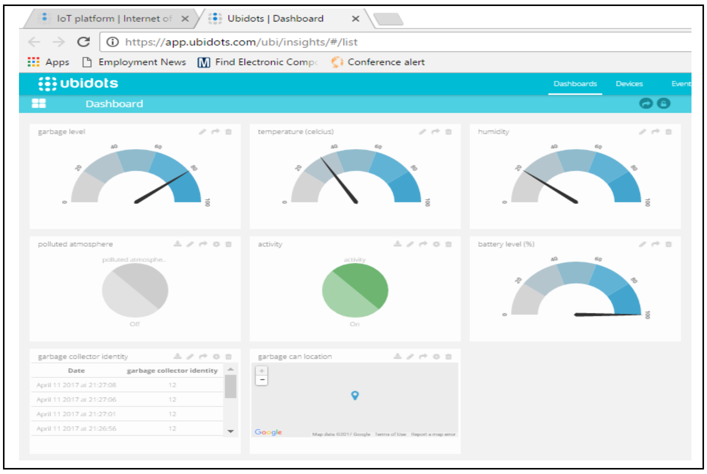
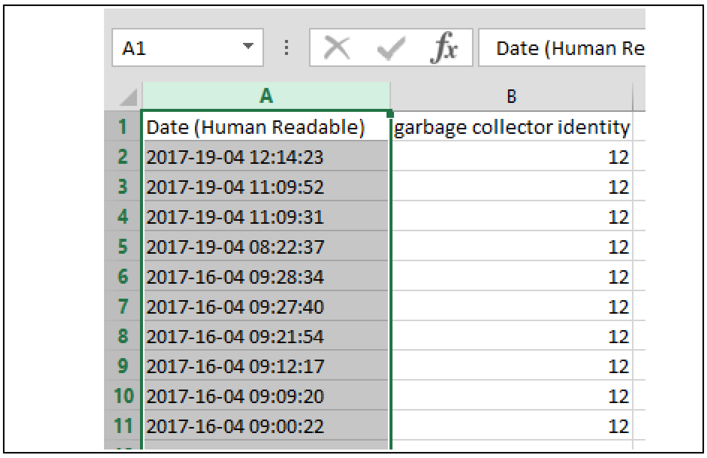


Figure 16: Web interface showing output of ADXL345 sensor

Figure 17 shows the graph representation of the ultrasonic sensor indicating the continuous variation in the garbage levels and figure 18 shows the log file of the RFID tags recorded showing the time, date and the employee number who collected the garbage.

Figure 17: graph showing garbage levels in garbage bins



	A	B
1	Date (Human Readable)	garbage collector identity
2	2017-19-04 12:14:23	12
3	2017-19-04 11:09:52	12
4	2017-19-04 11:09:31	12
5	2017-19-04 08:22:37	12
6	2017-16-04 09:28:34	12
7	2017-16-04 09:27:40	12
8	2017-16-04 09:21:54	12
9	2017-16-04 09:12:17	12
10	2017-16-04 09:09:20	12
11	2017-16-04 09:00:22	12

Figure 18: log file containing the date, time and the employee ID no read by the RFID reader

5. CONCLUSION AND FUTURE SCOPE:

This proposed system can be made fully automatic by integrating automatic garbage type segregation based on color and the material of the garbage such as plastics, metals and organic materials before the garbage drops into the garbage bin.

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