IoT based Smart Garbage and Waste Monitoring System using MQTT Protocol

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***Abstract*-As people are getting smarter so are the things. While the thought comes up for Smart cities there is a requirement for Smart waste management. The idea of Smart Dustbin is for the Smart buildings, Colleges, Hospitals and Bus stands. The Smart Dustbin thus thought is an improvement of normal dustbin by elevating it to be smart using sensors and logics. Smart dustbins is a new idea of implementation which makes a normal dustbin smart using sensors for garbage level detection and sending message to the user using MQTT protocol.**

I. INTRODUCTION

Internet and its applications have become an integral part of today's human lifestyle. It has become an essential tool in every aspect. Due to the tremendous demand and necessity, researchers went beyond connecting just computers into the web. These researches led to the birth of a sensational gizmo, Internet of Things (IoT). Communication over the internet has grown from user - user interaction to device – device interactions these days. The IoT concepts were proposed years back but still it's in the initial stage of commercial deployment. Home automation industry and transportation industries are seeing rapid growth with IoT. Yet not many articles have been published in this field of study. This paper aims in structuring a state of the art review on IoT. The technology, history and applications have been discussed briefly along with various statistics.

Since most of the process is done through the internet we must have an active high speed internet connection .The technology can be simply explained as a connection between human computers-things. All the equipment's we use in our day to day life can be controlled and monitored using the IoT. A majority of process is done with the help of sensors in IoT. Sensors are deployed everywhere and these sensors convert raw physical data into digital signals and transmits them to its control center. By this way we can monitor environment changes remotely from any part of the world via internet.

This systems architecture would be based on context of operations and processes in real-time scenarios. Smart collection bin works in the similar manner with the combination of sensors namely weight sensor and ultrasonic sensor that indicates its weight and different levels respectively. The ultrasonic sensors will show us the various levels of garbage in the dustbins and also the weight sensor gets activated to send its output ahead when its threshold level is crossed. DTH sensor which measures the temperature and humidity of the dustbin. GPS is used to track the location of the dustbin placed. This details are further given of the microcontroller (Atmega328p) and the controller gives the details to the transmitter module (Wi-Fi module). At the receiver section a mobile handset is needed to be connected to the Wi-Fi router so the details of the garbage bin is displayed onto the HTML page in web browser of our mobile handset.

MQTT (Messange queuing telemetry transport) is a client server publish/subscribe messaging transport protocol. It is light weight, open, simple and designed so as to be easy to implement. These characteristics make it ideal for using many situations, including constrained environments such as for communication in machine to machine and internet of things contexts were a small code footprint is required and/or network bandwidth is at a premium.

The protocol runs over TCP/IP, or over other network protocols that provide ordered, lossless, bidirectional connections. Its features include:

• Use of the publish/subscribe message pattern which provides one to many message distribution and decoupling of applications.

• A messaging transport that is agnostic to the content of the payload.

• A small transport over head and protocol exchanges minimized to reduce network traffic.

• A mechanism to notify interested parties when an abnormal disconnection occurs.

It can access the multi number of resources needed in a blink, utilize and pay only for it. To access server, data base by direct link can be done using distributed computing and provides wide arrangements of Internet administrations.

ESP32 is a Wi-Fi and Bluetooth combo chip designee, which is used as a Wi-Fi module in this project.

It is a highly integrated chip which sends the data or a messages to the broker and further to client uses some of the standard frequency and baud rate ranges.

Proposed system: Smart dustbins is a new idea of implementation which makes a normal dustbin smart using sensors for garbage level detection and sending message to the user updating the status of the bin.

II. SYSTEM ANALYSIS

System analysis is the act, process or profession of studying an activity typically by mathematically means in order to

define its goals or purposes and to discover operation and procedures for accomplishing them most efficiently.

III. HARDWARE REQUIREMENTS

The hardware requirements for the system are as follows.

3.1 Ultrasonic Sensors: Knowing the distance you are away from an object is very important in robotics or even for tasks just as simple as driving.

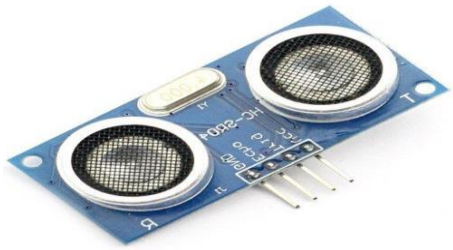

Fig1: Ultrasonic sensor

As shown in the Fig 1. Ultrasonic distance sensors use a sound transmitter and a receiver. An ultrasonic distance sensor creates an ultrasonic pulse, often called a "ping", and then listens for reflections (echo) of the pulse. This pulse of sound is generally created electronically using a
Sonar projector consisting of a signal generator, power amplifier and electro-acoustic transducer/array.
A beam former is usually employed to concentrate the acoustic power into a beam.
To measure the distance to an object, the time from transmission of a pulse to reception is measured and converted into a range by knowing the speed of sound. This signal together with noise is then passed through various forms of signal processing, which for simple sensors may be just energy measurement. It is then presented to some form of decision device that calls the output either the required signal or noise. This decision device may be an operator with headphones or a display, or in some systems this function may be carried out by software.
Further processes may be carried out to classify the target and localize it, as well as measuring its velocity. Some ultrasonic sensors have multiple beams to provide all round cover while others only cover a narrow arc, although the beam may be rotated, relatively slowly, by mechanical scanning.

3.2 Arduino Board:
As shown in Fig 2, the Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/ output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4UARTs (hardware serial ports), a 16 MHz crystal oscillator, 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 an AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove Or diecimila.

Fig 2: Arduino board

Table 1, briefs the summary of this microcontroller board

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input voltage (limit)	6-20V
Digital I/O pins	54 (of which 15 provide PWM output)
Analog Inputs	16

Table 2, Features of Arduino board

Pins	
DC Current per I/O Pin	20mA
DC Current for 3.3V Pin	50mA
Flash Memory	256KB of which 8KB used by boot loader
SRAM	8 KB
EEPROM	4 KB
Clock speed	16 MHz
Length	101.52 mm
Width	53.3 mm
Weight	37 g

3.3 WI-FI MODULE ESP32

ESP32 is a single2.4GHz Wi-Fi and Bluetooth combo chip designed with TMSC ultra-low-power 40nm technology.

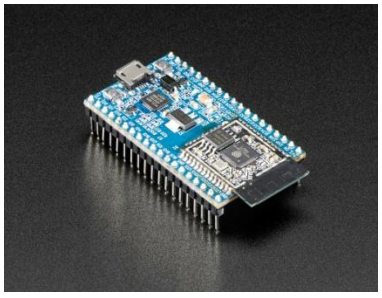

Fig3: Wi-Fi module (ESP32)

It is designed to achieve the best power and RF performance, showing robustness, versatility and reliability in a wide variety of application and different power profile. ESP32 is designed for mobile, wearable electronics, and Internet-of-Things (IoT) applications as shown in the figure3. It features all the state-of-the-art characteristics of low-power chips,

including fine-grained clock gating, multiple power modes, and dynamic power scaling. For instance, in a low-power IoT sensor hub application scenario, ESP32 is woken up periodically and only when a specified condition is detected. Low duty cycle is used to minimize the amount of energy that the chip expends. The output of the power amplifier is also adjustable, thus contributing to an optimal trade-off between communication range, data rate and power consumption.

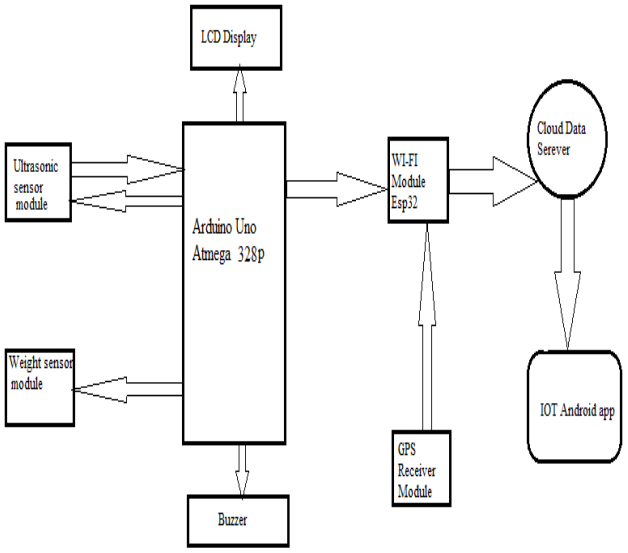

Fig.4:System Architecture

3.4 WEIGHT SENSOR MODULE

A weight sensor is a load cell used as a force sensing module. It is a metal structure, with small elements called strain gauges mounted in precise location on the structure. Load cell are IoT based smart garbage and waste management using MQTT protocol designed to measure a specific force, and ignores and other force being applied. The electric signal output by the load cell is very small and requires specialized amplification. Fortunately, the 1046 Phidget Bridge will perform all the amplification and measurement of the electrical output. Load cell are designed to measure in one direction. They will often measure force in other directions, but sensor sensitivity will be different, since part of the load cell are operating under compression are now in tension, and vice versa.

3.5 LCD DISPLAY

Interfacing a character LCD to an Arduino UNO adds a nice element of readability to your project. Many of the best Arduino projects around the world sport LCD displays. These LCDs can be used to display information from the Arduino or any sensor connected to it. For example, you can create a temperature monitoring system which displays the temperature on your Arduino. You can make your own speedometer that displays your speed on the LCD. Depending on what you want to build, an LCD is a highly useful output device for your Arduino.

3.6 GPS RECIEVER MODULE

The GP-20U7 is a compact GPS receiver with a built-in high performances all-in-one GPS chipset. The GP-20U7 accurately provides position, velocity, and time readings as well possessing high sensitivity and tracking capabilities. Thanks to the low power consumption this receiving GP-20U7 is deal for portable applications such as tablet PCs, smart phones, and other devices requiring positioning capability.

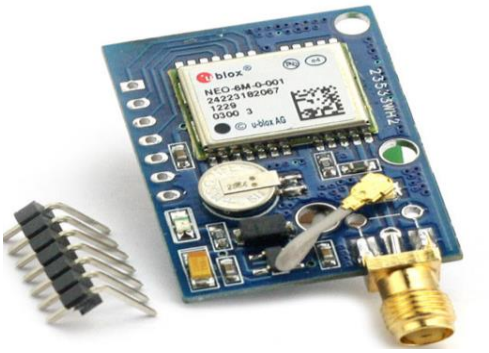

Fig5: GPS receiver

3.7 Cloud Storage

Cloud computing is the practice of using remote servers on the internet to manage, store and process data instead of using a personal computer.
Cloud computing is a general term that is better divided into three categories: Infrastructure-as-a- Service, Platform-as-a-Service, and Software-as-a- Service. IaaS (or utility computing) follows a traditional utilities model, providing servers and storage on demand with the consumer paying accordingly. PasS allows for the construction of applications within a provider's framework, like Google's App Engine. SaaS enables customers to use an application on demand via a browser. A common example of cloud computing is Gmail, where you can access your stored data from any computer with internet access. M2M (Machine to Machine) devices, comprises that are directly connected to the cellular network, such as cars that can report their location (in case of an accident or theft), or vending machines that can call in when their stocks are running low.

IV. SOFTWARE REQUIREMENTS

1. Arduino IDE
2. Arduino Language
3. Blynk app

4.1 Arduino IDE:
The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing

code, a message area, a text console, a toolbar with buttons for common functions and a series of menus as shown in **fig** It connects to the Arduino and Genuine hardware to upload programs and communicate with them.

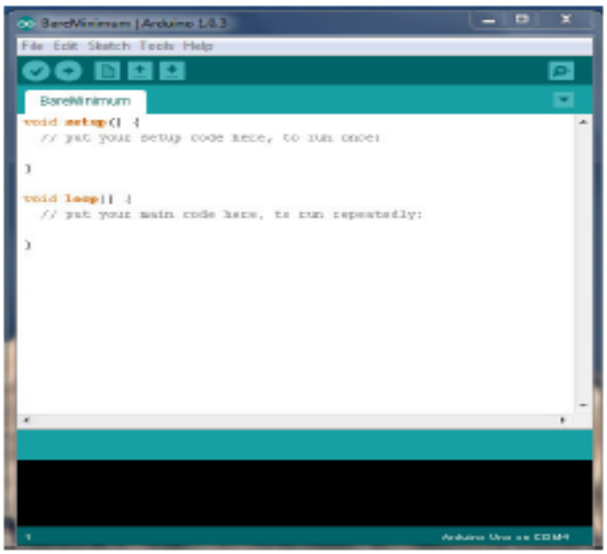

Fig6: Arduino IDE

Writing Sketches: Programs written using Arduino Software (IDE) are called **sketches**.
These sketches are written in the text editor and are saved with the file extension in. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

4.2 Arduino Language:
Arduino Language is used for programming in Arduino IDE. The Arduino language is merely a set of C/C++ functions that can be called from your code. Your sketch undergoes minor changes (e.g. automatic generation of function prototypes) and then is passed directly to a C/C++ compiler (aver-g++).

4.3 Blynk app
Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, vizualize it and do many other cool things.

V. IMPLEMENTATION AND WORKING

5.1 Flow chart

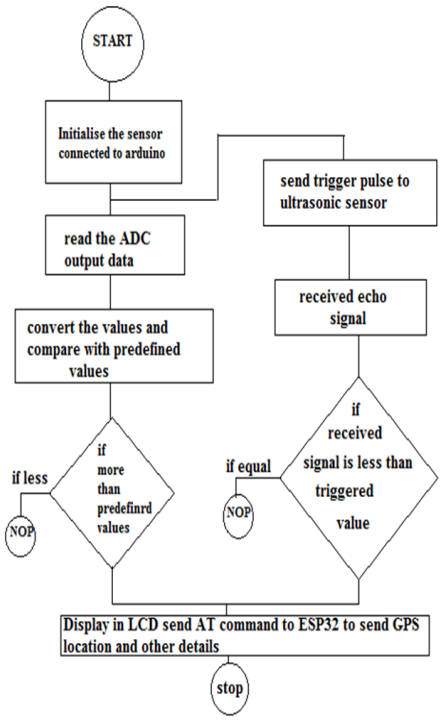

Fig7: flow chart

5.2 Working

Module 1:

- 5 Volt power supply is enough to power up the circuit.
- All the sensors will act as a transducer.
- GPS location value is calculated.
- Physical data are collected by Arduino and send to ESP32 Wi-Fi module as digital data.

Module 2:

- ESP32 will send the data to the client server.
- IP adders of the client is pre defined in the program using that readings of sensor values are sent.
- Client will receive all the data from the host, displayed on dash board of Blynk app.

VI. RESULTS AND CONCLUSION:

Here the result obtained is, Text message sent to the server to client using IOT and it's also displayed on the LCD display.
Successfully reduce risks of non-compliance by tracking regulations applicable to every waste profile.
Fastly and easily generate RCRA hazardous waste report in a user friendly way.

Fig8: output displaying on LCD board, dustbin reached maximum height and maximum weight.

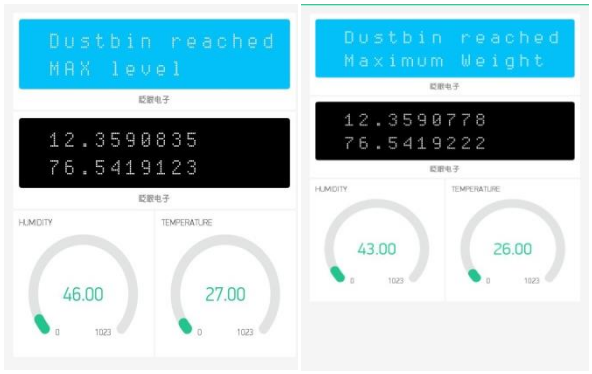

Fig9: Message displaying on Blynk app. GPS location value, temperature and humidity of the dustbin, maximum height and weight of dustbin at the receiver side.

VII. FUTURE ENHANCEMENT:

Smart dustbin helps us to reduce the pollution. M any times garbage dustbin is over flow and many animals like dog or rat enters inside or near the dustbin. This creates bad seen. This project can avoid such situation and message can be send directly to cleaning vehicle instead of contractor office.

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REFERENCES

[1] P.Suresh1J. Vijay Daniel2, Dr.V.Parthasarathy4" A state of the art review on the Internet of Things (Iota)" International Conference on Science, Engineering and Management Research (ICSEMR 2014)
[2] ArkadyZaslavsky, DimitriosGeorgakopoulos" Internet of Things: Challenges and State-of-the-art solutions in Internet-scale Sensor Information Management and Mobile Analytics" 2015 16th IEEE International Conference on Mobile Data Management
[3] Theodoros.Anagnostopoulos1,Arkady.Zaslavsky ,1, Alexey Medvedev1, Sergei Khoruzhnicov1" Top–k Query based Dynamic Scheduling for IoTenabled Smart City Waste Collection" 2015 16th IEEE International Conference on Mobile Data Management
[4] Manoj and Kannan E.P, "Data Acquaisition and Basic Feature, "Solid waste Management Project by MCGM.
[5] "City Garbage collection indicator using RF (Zigbee) and GSM technology"
[6] Vikrant Bhor, PankajMorajkar, MaheshwarGurav, Dishant Pandya4 "Smart Garbage Management System" International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 IJERTV4IS031175 Vol. 4 Issue 03, March-2015.
[7] Insung Hong, Sunghoi Park, Beomseok Lee, Jaekeun Lee, DaebeomJeong, and Sehyun Park, "IoT-Based Smart Garbage System for Efficient Food Waste Management". The Scientific World Journal Volume 2014 (2014), Article ID 646953.
[8] Marian Look, "Trash Plant: India", earth911B
[9] Ms. Puja K Dhotre and Ms. A L Borker "A review on smart garbage monitoring system using internet of things (IOTs).
[10] M. A. A. Mamun, M. A. Hannan, A. Hussain and H. Basri" Real Time Bin Status Monitoring For Solid Waste Collection Route Optimization"
[11] Dr. Sandeep M Chaware et al "Presents garbage monitoring system, monitors the garbage bins and informs about the level of garbage collected".