

# Smart Waste Management using Internet of Things

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**Abstract** – Waste disposal is one of the biggest challenges confronting the world, regardless of the situation in developed or emerging countries. The biggest problem of waste disposal is that the trash bin of public areas is being overflowed well in advance of the start of the next cleaning cycle. This, in effect, contributes to a number of risks, such as foul odour and ugliness, which may be the root cause of the spread of various diseases. This work is installed on a smart waste management system to prevent all these dangerous situations and to ensure public cleanliness and safety. The key focus of the research is the creation of a safe, intelligent garbage monitoring system for proper waste management. Cloud-based, linked, and data-driven IoT technology systems provide customers with a way of incorporating potentially challenging business use cases, such as predictive maintenance, pay-per-use, and analytics. Real-time data transforms into better efficiency of company assets and improved profitability [1] [2]. This paper suggests a smart waste disposal warning system by supplying an alarm signal to the municipal corporation for the urgent cleaning of the dustbin with adequate monitoring depending on the amount of the garbage filling. The sensor interface with Raspberry Pi helps with these processes in testing the amount of waste that is in a waste bin and if the waste is filled, sends an alert to the municipal corporation. The municipal authorities may control and track the actual status of how waste is collected with the aid of this system. Furthermore, the necessary corrections / alternatives could be adapted. An Android program is built and connected to a web server to intimate notifications from Raspberry Pi to the Municipal Corporation Office and to remotely track the cleaning operation conducted by staff, thereby minimizing the manual control and testing phase. The notifications are sent via internet to the Android app.

**Keywords**– IoT, Raspberry PI, Monitoring System, Waste Management

## I. INTRODUCTION

Waste is the one that grows with the growth of the world. Segregation of waste is important for the proper disposal of vast quantities of waste generated by modern society in an environmentally sustainable manner. A big Challenge in the urban cities is Solid waste management, not only in India but for most of the countries in the world [3]. People have been adapted to throw away things and never know the consequences of their actions. The growing method of disposal of industrial waste is by unregulated and unplanned dumping at river sites and open areas. This approach is extremely harmful to plants, human health and animal life.

Smart cities have been described as a promising potential development area for the Internet of Things, with a broad variety of potential services that can help both city administration and residents alike. Smart waste management is one service that can be provided in a smart city. Public garbage cans damage the natural atmosphere when they are filled over a long period of soft time. Such effects are more noticeable in urban areas with millions of citizens, the so called mega cities, which in the near future

will be more and more common [4]. The main concept behind a Smart City is the integration of the physical world with the virtual world [5].

The Internet of Things (IoT) is another point of view of communication expected as a general course of action in which physical objects and contraptions will interact with one another. It incorporates a course of action of physical articles, gadgets, machines, homes, etc., furnished with hardware, sensors, programming, and structural openness with fitting custom stacks that make them arranged to collect and exchange information among themselves. In IoT, a 'thing' can be any trademark or fake objects which can be extremely linked to numbers, names or addresses and fitted with the ability to share information over the network. IoT is rising amazing idea in two or three partnerships today and has been recognized as a leader among the most inspiring fields of future progress. For example, when related gadgets can cooperate and encourage with their frameworks and activities, veritable inspiration for undertakings is achievable. With the IoT accident, the contraptions were seen expanding and this latest IoT gadget time was called 'smart,' having the ability to properly discern, find, examine, and solidify the wrapping state. Shrewd contraptions are installed with

hardware deemed to be substantial swarming and heterogeneous in nature with respect to potential, asset constraints, and advancement degrees of correspondence. In fact, these sharp gadgets have projected that the measure of other commendable gadgets would be outflanked in getting to the Internet at the earliest opportunity. Specifically, it has estimated that by 2020, 26 billion amazing gadgets will be linked over the Internet. After a short time, the application conditions powered by IoT are typically reviewed, highly coordinated efforts, vehicle and marvellous versatility, astute centrality and clever structure, insightful urban structures and frameworks, helpful organizations, video vision, vigilant house, sharp waste association and amazing metering. Therefore, IoT quality lies in the high effects that it created in the well-ordered life and the immediate effects of the potential client.

## II. RELATED WORKS

S.V Kumar et al [6] in their work proposed an IoT-based unbelievable waste clean association structure where sensor frameworks are utilized to steadily checking the waste component of the garbage canisters. In this methodology, when the waste estimation over the dustbins is recognized, the framework along these lines cautions the embraced individual by strategies for GSM/GPRS. They structure works by utilizing microcontroller which gives interface between the sensor and the

GSM/GPRS framework. Also, an Android application is utilized to screen and join the important data identifying with the unmistakable component of waste found in various zones. With this framework, another client can basically choose on the structure and not simply the manager. Regardless, anybody can make a record and the framework likewise surrender access to clients not expected for. This framework can be improved by setting two holders to self-rulingly collect dry and wet squanders. For this situation, the wet waste can be moreover masterminded and be utilized for the period of biogas, made intense by making it insignificant and fiscally astute.

M.A.B. Abdullah et al [7] built up a sharp reject watching framework which is utilized in the estimation of deny level ceaselessly and cautions the fitting expert through SMS writings. The framework is wanted to screen the waste holder and send the messages as alerts when perceived to be full or in every way that really matters full to help its evacuation of the compartment on time. The centrality of the structure is to improve the ability of strong waste trade the executives dependably. In any case, the downside is that the notice of the storehouses' status avoids the zone of the holder or its orientation, making it badly arranged to find and amass the waste canisters in a brief moment.

Prajakta [8] proposed a garbage storing up framework that is adjusted having data gathering structure subject to the arranging of pictures taken and GSM module. To accomplish this point of confinement, the framework utilizes a camera which is set at each position where rubbish is amassed close to a stack cell sensor orchestrated at the base of the waste holder. For this situation, the camera will constantly take surveys of the reject holder while the stack cell sensor takes the weight to pick whether full or not. Besides, an edge level is set which is utilized to separate the result of the camera and weight sensor. Exactly when the edge is practiced, the controller transmits a message by strategies for the GSM module to the suitable master urging them that the junk holder is full and ought to be engineered. Reasonably, the waste archive total vehicle is dispatched to gather the deny utilizing a robot instrument. In any case, catch is that the camera takes pictures all through disregarding the manner in which that its purpose of constraintment is come to in any case just contemplates the latest to pick gathering. As requirements be, the use of camera is senseless or unessential.

Chaware et al [9] proposed a waste get-together structure considered imaginative to help with keeping urban domains clean. The structure works by watching rubbish stores and tell the experts and the waste collection vehicles about the part of garbage set away or contained in the reject holder through a web application. Regardless, the framework utilizes ultrasonic sensors in which their distinctive precision can be affected by changes in temperature. In addition, it utilizes Wi-Fi which is inherently a short-range alliance Instrument. From this time forward, these disadvantages sway the ideal execution of the structure.

## III. PROBLEM STATEMENT

Currently, urbanization is growing rapidly, which has led to an increase in the supply of goods and the disposal of waste. The excessive use of daily goods leads to waste disposal by-products that cause mosquitoes to grow and a major problem of street bins overflow that results in air being carried away causing problems.

To build an integrated device that can be conveniently connected to any dustbin that tracks the garbage levels to monitor the leakage of dustbins and chemical contamination rates that contribute to the proliferation of mosquitoes and insects and alerts the user with proper remote messaging.

## IV. PROPOSED ARCHITECTURE

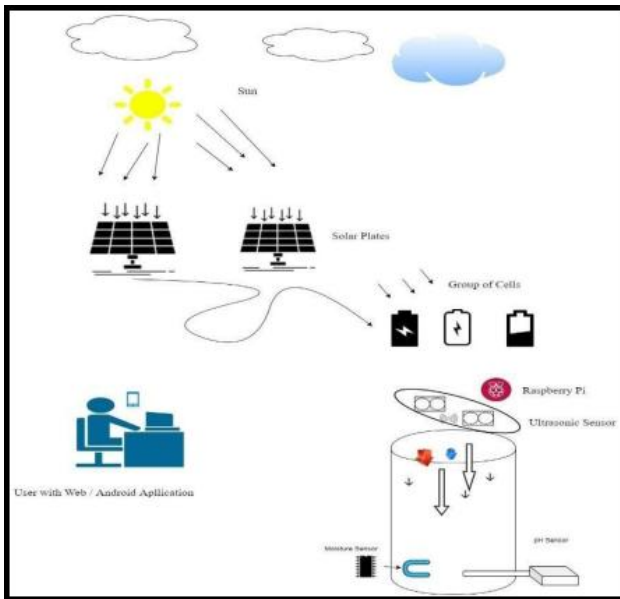


Fig.1.Architecture Diagram

System architecture consists of several ultrasonic sensors, the Raspberry Pi, Moisture sensor and pH sensor. Ultrasonic sensors placed on the top head of the dustbin and are used to measure the amount of garbage in each container, moisture and pH sensor, which helps to detect the presence of moisture in the container, if present it calculates the pH value of the liquid and then sends this information to the Raspberry Pi, which functions as a device controller. As soon as Raspberry Pi updates the data to the database, end users can access the latest data in their Android application.

#### Block Diagram

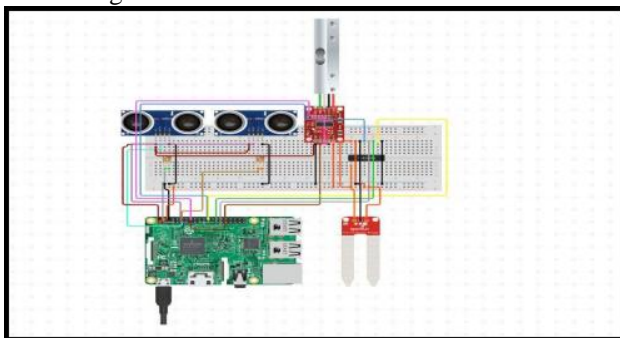


Fig.2.Block Diagram.

The block diagram gives the pictorial representation of how breadboard and wires are used to connect the sensors to Raspberry Pi.

#### 1.Database Design

Firebase is a Backend as A Service or BAAS, meaning it is a NoSQL data store that is in the cloud that your clients can access directly in real time. Now this means Firebase has its own Real time Database, Cloud Storage, Authentication, Hosting and many other services.

The Firebase Realtime Database is a NoSQL Database which has a lot of optimizations and features compared with most of relational databases. It includes a flexible

rule to define how the data should be structured to provide security and flexibility.

Firebase is a Database stored as JSON objects, which is easier to use than some SQL databases for the way to handle the data like a tree. When you start adding data to your database it automatically creates a node in the existing JSON structure with an associated key.

#### 2.Flowchart

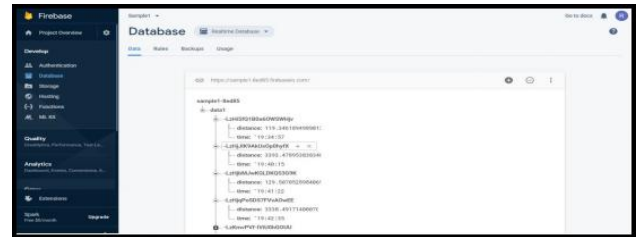


Fig.3. Database Overview.

The project flow diagram is shown in fig. It provides the concept of this project in general. The flow of the smart Waste Management System project begins with choice start. Ultrasonic sensors are installed that detects the amount of trash in the bins, and when they reach the threshold point, a message is sent to the authority concerned through GSM so that the authority concerned can clean the dustbin as quickly as possible. In the case of a liquid being detected in a waste container, pH and humidity sensors may provide pH-value alongside ultrasonic sensors. The cycle will be repeated again and again until the dustbin is cleaned.

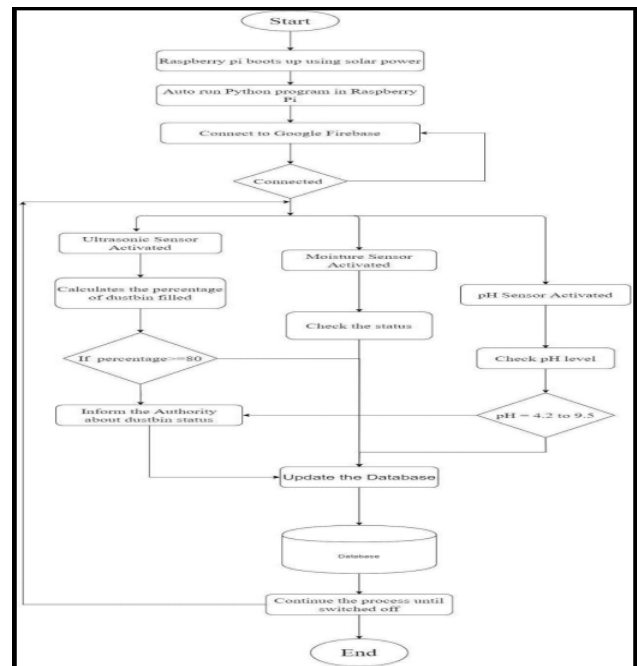


Fig.4.Flow chart.

### III. HARDWARE REQUIREMENTS

Key Requirements: Raspberry Pi 3 B Model, Jumper Wires, Bread Board, Ultra-Sonic Sensor, Soldering Kit, pH Sensor, Resistor, Moisture Sensor

#### Raspberry Pi 3 B Model

The Raspberry Pi is a series of small single-board computers developed by the Raspberry Pi Foundation in the United Kingdom to facilitate basic computer science teaching in schools and developing nations. The

original model became far more popular than expected, selling for uses such as robotics outside of its target market.

#### Jumper Wires



Fig.5.Raspberry Pi B Model.

A jump wire (also known as jumper wire, or jumper) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.



Fig.6.Jumper Wires.

#### Bread Board

A breadboard is the building foundation for electronic

prototyping. The term originally referred to a simple bread board, a polished piece of wood that was used to slice bread. The solderless breadboard (a.k.a. plug board, a terminal array board) became available in the 1970s and these are commonly referred to by the name "breadboard" nowadays.

#### Ultra-Sonic Sensor

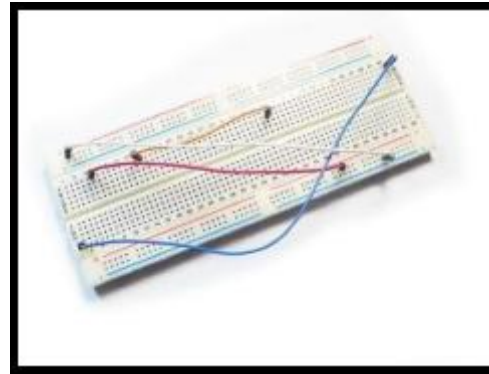


Fig.7.Breadboard

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. High-frequency sound waves reflect from boundaries to produce distinct echo patterns.

Ultrasonic sensors work by emitting sound waves at a frequency too high for humans to hear. They then wait for the sound to be reflected back, calculating distance based on the time required. This is similar to how radar measures the time it takes a radio wave to return after hitting an object.

#### Soldering Kit



Fig.8.Ultra-sonic Sensor HC-SR04

Soldering is a process in which two or more items are joined together by melting and putting a filler metal (solder) into the joint, the filler metal having a lower

melting point than the adjoining metal. Unlike welding, soldering does not involve melting the work pieces. In brazing, the work piece metal also does not melt, but the filler metal is one that melts at a higher temperature than in soldering. Soldering kit is used to solder the metal to join the two ends.

pH Sensor



Fig.9. Soldering Kit.

pH sensor tests how acidic or alkaline the water is? It is defined as the concentration of the negative log of hydrogen ions. The pH scale is logarithmic and goes between 0 and 14. The expression pH describes the values of concentration of hydrogen ions. It is low for acidic solutions, and high for alkaline. A natural source of pH for water is about seven. The concentration of hydrogen ions decreases tenfold for each rise in pH level, and water becomes less acidic. A pH sensor has electrode calculation and reference electrode. A battery-positive terminal attached to the reference electrode by the measuring electrode and negative terminal by it.

Resistor



Fig.10. pH Sensor.

A resistor is an electrical component that restricts the flow of electrical current. One or more resistors may be used to deliver the appropriate amount of current to various components within an electronic system.

Moisture Sensor



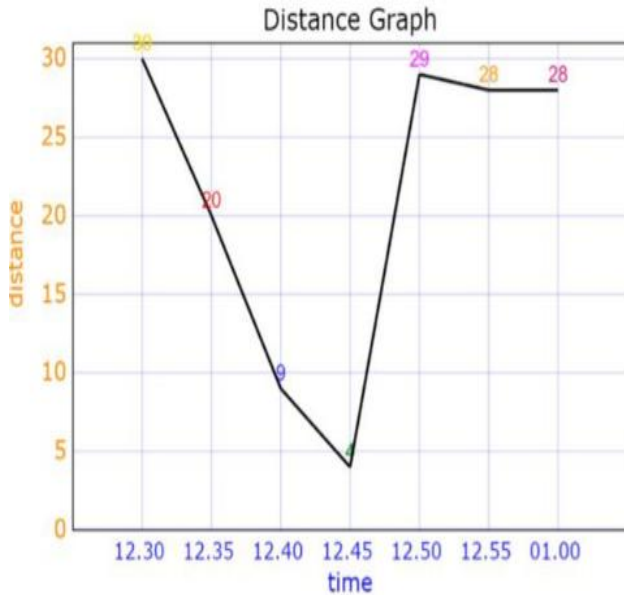
Fig. 11. Resistors

The soil moisture sensor consists of two probes which are used to measure the volumetric content of water. The two probes allow the current to pass through the soil and then it gets the resistance value to measure the moisture value. When there is more water, the soil will conduct more electricity which means that there will be less resistance. Therefore, the moisture level will be higher. Dry soil conducts electricity poorly, so when there will be less water, then the soil will conduct less electricity which means that there will be more resistance. Therefore, the moisture level will be lower.



Fig.12. Moisture Sensor.

## V. RESULTS ANALYSIS



This Graph illustrates the height of garbage level ( Y-axis ) in dustbin with respect to time ( X-axis ).

24\*7 Monitoring- The system introduced was therefore able to implement a real-time surveillance framework aimed at creating a clean and hygienic atmosphere in the local region. The user can remotely view the trash bin status from all over the world.

**1. Clean Surroundings-** As indicated, it generates a notification of the status of the trash bin completion to the municipal authority, thereby allowing the human-led forces to clean the trash bin and maintain a cleaner, more liveable atmosphere.

**2. Mosquito Prevention-** Here, the breeding of mosquitoes is tackled with the aid of this system, as the system is continuously in place to test the liquid is present or not and, if present, measures the pH level, if the pH level matches the pH range of mosquito breeding, the authority is informed to take the required steps.

**3. Alert System-** The device provides a local warning in the android app and an SMS showing the real-time state of the dustbin (if it is loaded  $\geq 80$ ) with the time stamp attached to it. The SMS includes details such as percentage of filled trash bin, moisture and pH level (if found) with a time stamp.

### 4. Android Application

The Android app was developed to display the actual state of the trash bin. The program consists of three operations which are related to one another. The android app retrieves data from the database and, in turn, produces data that is user-friendly, showing the percentage of trash filled in trash bin, whether moisture is present or not, and

pH showing the pH level of the liquid contained within the trash bin (if present).

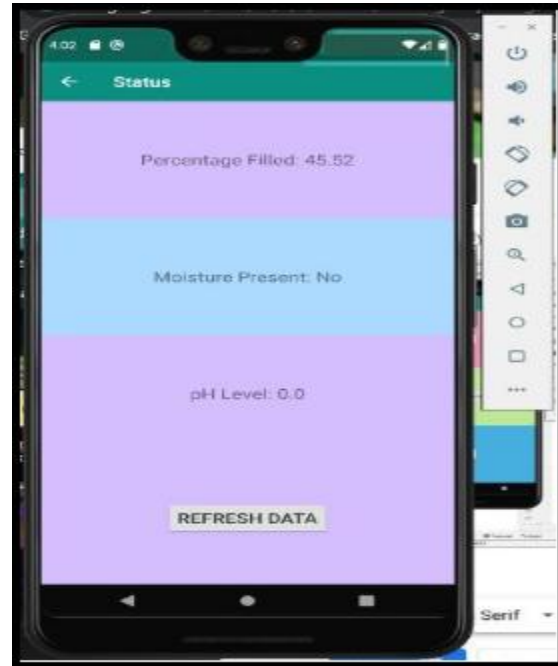


Fig.13. Android App Displaying Real time status of trash bin

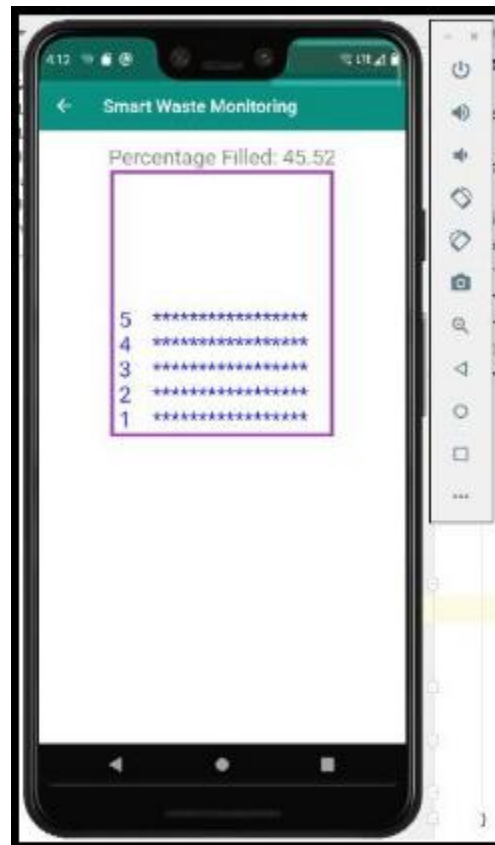


Fig.14. Android App Depicts pictorial representation of trash bin



Fig.15. Android App Displaying the graph (Recent Status)

## VI. CONCLUSION

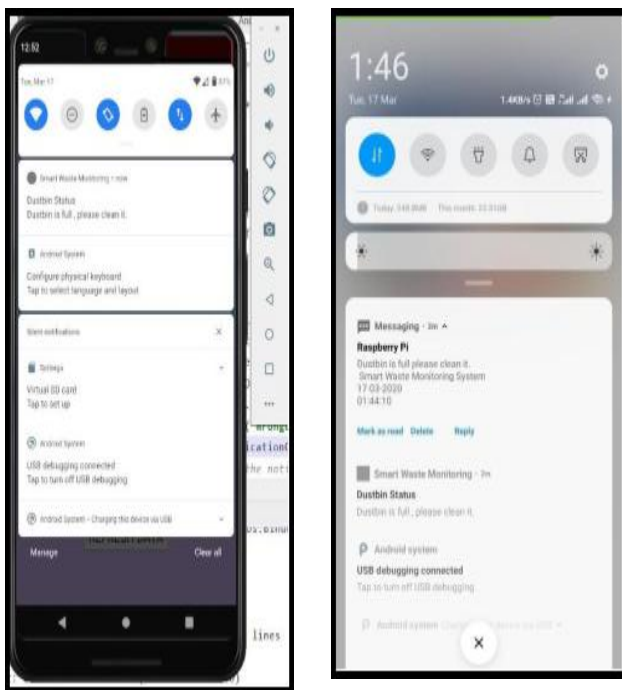


Fig.16. Android App SMS and Local notification.

The goal of the project is to access information on the dustbin in real time. This waste management system, using IOT, has incorporated waste management in real time using a smart dustbin to check the level of dustbin filling in order to test whether it is complete or not. The system will therefore provide accurate reports, increasing the performance of the system. Real-time tracking of the amount of waste, with the aid of sensors. IoT and its infrastructure are part of our daily life, working practices and industry. A lot of work is being done on designing critical building blocks and models for the next-generation Internet infrastructure assisted by a variety of connected things. The future scale of the work can be made 24\*7 linked to the internet with the aid of the gsm module, which integrates the sim card inside. The additional advantage of the gsm module is greater

coverage area. The other step towards renewable sources can be taken with the use of solar energy to provide the system with power. Solar energy is applied to the benefit as it reduces the power bill.

## VII. ACKNOWLEDGEMENT

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