Smart Waste Bin Monitoring in Municipal Based on IOT for Clean City

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***Abstract* — Rapid increasing urbanization and increasing population all over the world, there is a dynamic increase in the amount of waste disposal has become a matter of concern, and diseases like malaria, dengue, and cholera are caused due to overflow of garbage which contains rotten things which form foul smell and burning things that cause air pollution to the environment. As a result of this we human beings are sufferers, So, we need to maintain this worst scenario and we need to keep a track of the garbage bin so that it will be cleaned in the proper interval of time. So, we are implementing this project which will identify the waste by checking its humidity and temperature and will also check the level of the garbage bin so that it doesn't overflow and pollute the environment. In this project the garbage level in each bin is monitored using ultrasonic sensors present in every bin, rotten and burning elements or any such abnormal situation that arises will be identified by the Gas sensor and DHT11 sensor. The Gas, ultrasonic sensor, and Humidity sensor will read the data and will send it to the Cloud server and then the Municipal Control room will be able to monitor the information from the Cloud server through a GUI interface. When more than 70 percent of the garbage bin is filled, or any situation mentioned above arises the buzzer will give the indication. The system is driven by a microcontroller- ESP-32 which is working as the brain of the operation, and it is programmed using Embedded C. All the devices and Cloud Server plays a key role to implement the project.**

Keywords- Waste Bin, IoT Sensors and devices, Cloud Server.

I. INTRODUCTION

One of the famous technologies in this world is the Internet of Things (IoT). The term IoT was first used by Ashton in 1999. IoT works with devices like bulbs, cameras, sensors, relays, and some internet-connected microcontrollers among other things. Various applications of IoT are smart health, smart city, environment monitoring, smart home automation, traffic management, smart education system, smart farming, and many others. In the modern world, people are adapted to tossing out waste without knowing its adverse effect on the environment. The generation and disposal of waste in large amounts have created great concern over time for the world, adversely affecting human lives and the environment. The waste can spread various life-threatening diseases that in turn harm the lives of a whole city and country as well. Our generation's main problems are the prevention, tracking, and treatment of these wastes . The current waste disposal schemes are not effective enough to dispose of the huge amount of waste generated from cities, leading to the spread of diseases, and prevention of harmful situations. So, we propose an alternative waste disposal strategy, consisting of a smart waste bin with three sensors for real-time monitoring of the garbage bin.

Different sensors are used for checking the temperature and humidity with level detection. In this innovative system, smart bins are installed in urban areas at different places that store garbage. The labour work, time, and cost will be less required than the traditional garbage collection system. Municipalities and corporations struggle to keep up with the outdoor bins to determine when to clean them or whether they are completely filled or not, that is why the level of the garbage or any harmful situation that arises in the bins is monitored continuously and is emptied timely.

The advantages of this technique are as follows:

i) The above dustbin also sends a mobile notification when the dustbin is almost filled.

ii) In this process, various electronic components are used to make this dustbin smart.

As per the report published by World Bank, approximately 1.3 billion tons of municipal waste is generated every year and it is expected to rise to approximately 2.2 billion tons per year by 2025. Due to a lack of proper cleaning of waste, a large amount of untreated waste is dumped into landfills. Implementing our project at the regional level will reduce the expenditure on waste disposal, and make people aware that how much cleaning is important for us and for the environment too.

II. LITERATURE SURVEY

Aniqa Bano,1 Ikram Ud Din, and Asma A. Al-Huqail. Presented "A IoT-Based Smart Bin for Real-Time Monitoring and Management of Solid Waste" in which they aim to keep the environment green and clean, monitoring and disposing of the waste is very important these days. Improper disposal and poor monitoring of collected waste and waste bins can cause serious damage to human lives. Therefore, a waste management mechanism is proposed for smart cities, named SBM (smart bin mechanism) in order to sanitize and clean the environment intelligently.[1] V R Ravi1*, M Hema2 , S SreePrashanthini3 and V Sruthi4. Designed an IoT-integrated smart bin for Smarter Waste Disposal System is devised. In the proposed work an alternative efficient and economical waste disposal strategy is developed. A newer waste bin is designed in the proposed work and is attached with four sensors for effective real-time monitoring of the smart bin conditions. Whenever the garbage level in the smart bin reaches a programmed threshold level, an alert message is sent to the cleaning authority to empty the smart bin. Thus, the proposed waste disposal scheme using smart bins can effectively assist as a benchmark for waste disposal schemes used in smart cities [2] S. Vishnu , S. R. Jino Ramson* , Samson Senith, Theodoros Anagnostopoulos, Adnan M. Abu-Mahfouz , Xiaozhe Fan, S. Srinivasan and A. Alfred Kirubaraj proposed "IoT-Enabled Solid Waste Management in Smart Cities" in which they say as most homes are equipped with a wireless internet connection, it is inferred that the Wi-Fi-based solution is well suited for monitoring the household bins. This will minimize the additional infrastructure expense. Therefore, this work proposes an IoT-based solid waste management system for smart cities. The main contributions of this work in contrast to the existing solutions are as follows –

i) Hybrid Network Architecture to monitor the household and public trash bins.

ii) Solar energy harvesting facility to extend the lifetime of the end nodes.

iii) A GPS module is embedded to evaluate the Geo-location of the trash bins.

iv) An intelligent GUI is employed to view the status of every trash bin [3]. Tariq Ali Muhammad Irfan1, Abdullah Saeed Alwadie1 & Adam Glowacz "IoT-Based Smart Waste Bin Monitoring and Municipal Solid Waste Management System for Smart Cities" where Numerous IoT-based smart technologies have been developed to deal with different issues associated with trash management systems in smart cities. From the literature, it is recognized that the most significant issue is solid waste management for the smart city. Scholars have used a variety of strategies and procedures to overcome these challenges. In this system, sensors sense the level of waste in the bins and send alerts to the controller. A microcontroller encodes these alerts and forwards them to the main central processing unit [4]. B.Balaji Naik, T.Sai Kiran, B.K.N.Harish, J.Hermes Sujit ,D.Sai & Kiran written "IOT Based Waste Monitoring System for Smart Cities." where they describe The Internet of

Things (IoT) technology is transforming society in a variety of fields, including healthcare, industrial automation, transportation, and smart cities, in the age of interconnected devices. In this study, we present an internet of things (IoT)-based smart waste monitoring system that enables waste management authorities to continually monitor the status of trash cans located at various places and, as per the status, take suitable actions to collect it quickly and effectively.[5]Himadri Nath Saha, Supratim Auddy, Subrata Pal, Shubham Kumar, Shivesh Pandey, Rakhee Singh, Amrendra Kumar Singh, Swarnadeep Banerjee, Debmalya Ghosh, Sanhita Saha, "Waste Management using Internet of Things (IoT)", IEEE 2017.in which The trash can is battery- or solar-powered and functions as a Wi-Fi hotspot. It measures the volume of waste present inside the compartment and wirelessly sends information about the fill level to a cloud server. Time is used more effectively as a result, and the roads are cleaner. So, in this paper, we have proposed a system that can be deployed in general-purpose dust bins placed in public places. This system allows us to monitor its status remotely over the internet for efficient waste management.[6] A Vanitha proposed that the present day it has been seen that the dustbin is overflown with garbage, so the proposed system will help to avoid the overflow of dustbin. This system will give the real time information about the status of the dustbin [7]. S Vinod Kumar proposed that, with the help of Ultrasonic sensor, the level of waste in the dustbins is detected. To measure the weight of the dust bin force sensor is used [8].

III.METHODOLOGY

A. Working Algorithm of Smart Waste Bin:

STEP 1: Start (Initialize the process).

STEP 2: Gather all the information on the waste by reading the sensors.

STEP 3: Temperature, the humidity will check through the DHT-11 sensor and level detection will check through the ultrasonic sensor.

STEP 4: Now it will check whether the bin is full or not.

STEP 5: If it is above the limit, then a message will be sent to the cloud server.

STEP 6: After receiving the message, a garbage vehicle will be sent for the waste collection.

STEP 7: After collection, it will show the current status of the dustbin.

STEP 8: Otherwise, the scanning process of the garbage will repeat in a loop.

STEP 9: Stop (Process Terminated).

B. Flowchart:

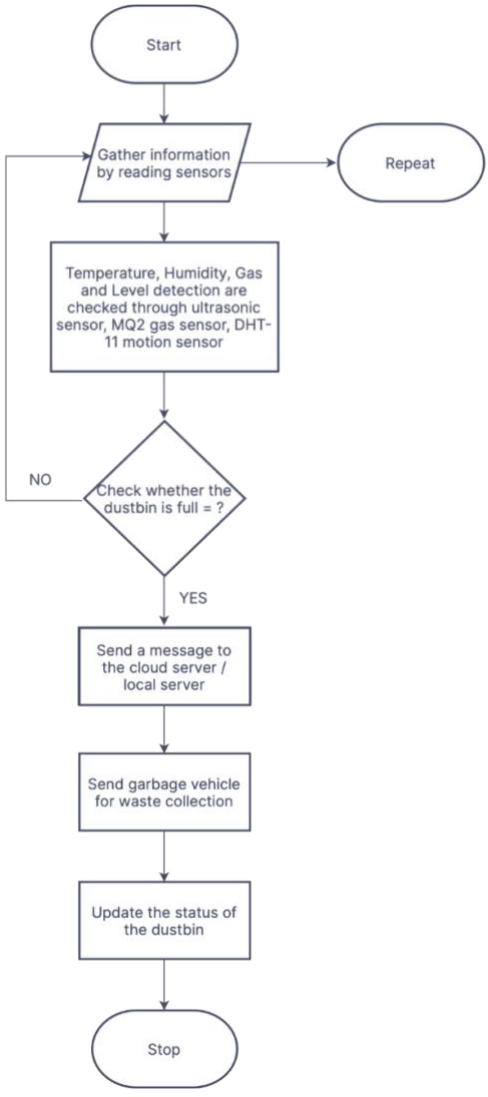

Fig. 1: Process flow diagram of proposed methodology

C. Proposed Model

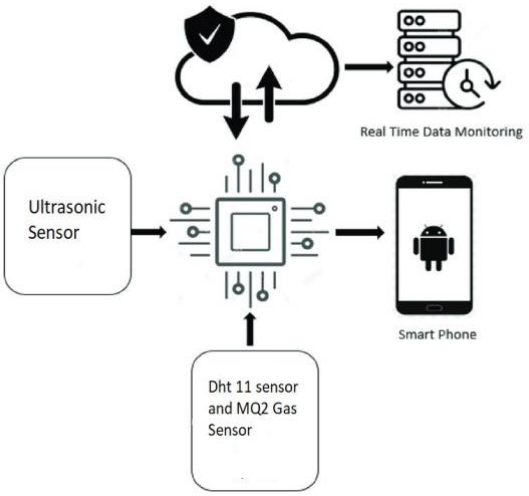

Fig. 2: Block Diagram of Proposed Model

The Smart Waste Bin system is driven by the Microcontroller ESP 32. All the components that are connected to ESP 32 are programmed in C++ language and it reads the input/output pins of the components. The temperature and humidity are monitored by using the DHT11 sensor and it will be displayed on the dashboard. Whenever the DHT11 sensor detects unusual temperatures in the bin which can hamper the system, a notification will be sent to the clearing authorities to remove it. The measure of the dustbin level is calculated by the Ultrasonic sensor connected at the edge of the dustbin. When the dustbin is full, the message- "BIN IS FULL" is sent to the cleaning authorities. The message is sent using the WI-FI that provides communication between the bin and the authority. The sensor sends the data to the Microcontroller which is connected to the Cloud and then it will be displayed on the dashboard. As the location of the bins is already mentioned in the code, when the bins are overloaded, they will be displayed on the dashboard with their location.

D. Components Requirement:

(a) Software Requirement :

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. It connects to the Arduino hardware to upload programs and communicate with them.

2. **Arduino IOT Cloud:** Arduino IoT Cloud is an application that helps makers build connected objects quickly, easily, and securely. You can connect multiple devices and allow them to exchange real-time data. You can also monitor them from anywhere using a simple user interface.

(b) Hardware Requirement :

1. **ESP-32:** ESP-32 is a series of low-cost, low-power systems on a chip microcontroller with integrated Wi-Fi and dual-mode Bluetooth. The ESP32 series employs either a Ten silica Extensa LX6 microprocessor in both dual-core and single-core variations, an Extensa LX7 dual-core microprocessor, or a single RISC V-core. RISC- microprocessor and includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. ESP32 is created and developed by Express if Systems, a Shanghai-based Chinese company, and is manufactured by TSMC using their 40 nm process. It is a successor to the ESP8266 microcontroller.

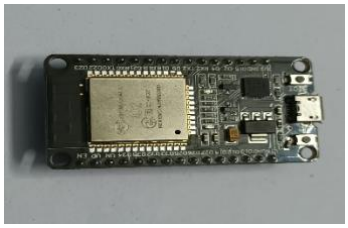

Fig. 3(a): Microcontroller ESP-32

2. **Power Supply:** A power supply is an electrical device that supplies electric power to an electrical load. The main purpose of a power supply is to convert electric current from a source to the correct voltage, current, and frequency to power

the load. As a result, power supplies are sometimes referred to as electric power converters. Some power supplies are separate standalone pieces of equipment, while others are built into the load appliances that they power. Examples of the latter include power supplies found in desktop computers and consumer electronics devices. Other functions that power supplies may perform include limiting the current drawn by the load to safe levels, shutting off the current in the event of an electrical fault, power conditioning to prevent electronic noise or voltage surges on the input from reaching the load, power-factor correction, and storing energy so it can continue to power the load in the event of a temporary interruption in the source power (uninterruptible power supply).

3. **DHT-11 Sensor:** The digital temperature and humidity sensor DHT11 is a composite sensor that contains a calibrated digital signal output of temperature and humidity. The technology of a dedicated digital modules collection and the temperature and humidity sensing technology are applied to ensure that the product has high reliability and excellent long-term stability. The sensor includes a resistive sense of wet components and an NTC temperature measurement device and is connected to a high-performance 8-bit microcontroller.

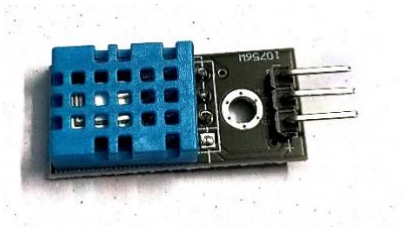

Fig. 3(b): DHT-11 Sensor

4. **Ultrasonic Sensor:** Ultrasonic transducers and ultrasonic sensors are devices that generate or sense ultrasound energy. They can be divided into three broad categories: transmitters, receivers, and transceivers. Transmitters convert electrical signals into ultrasound, receivers convert ultrasound into electrical signals, and transceivers can both transmit and receive ultrasound.

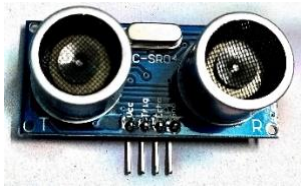

Fig. 3(c): Ultrasonic Sensor

5. **Breadboard:** A breadboard, solderless breadboard, or protoboard is a construction base used to build semi-permanent prototypes of electronic circuits. Unlike a perf board or stripboard, breadboards do not require soldering or destruction of tracks and are hence reusable. For this reason, breadboards are also popular with students and in technological education.

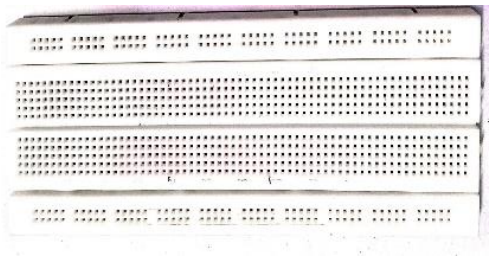

Fig. 3(d): Breadboard

6. **Jumper Wires:** A jump wire is an electrical wire, or group of them in a cable, with a connector or pins at each end, 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.

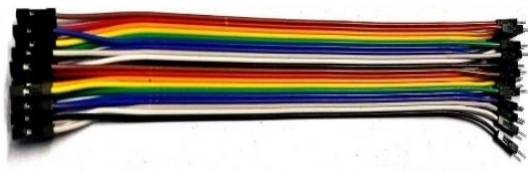

Fig. 3(e): Jumper Wires

7. **Gas Sensor:** Gas sensors are devices that can detect the presence and concentration of various hazardous gases and vapors, such as

toxic or explosive gases, volatile organic compounds (VOCs), humidity, and odours.

Fig. 3(f): Gas Sensor

8. **Buzzer:** An audio signalling's device like a beeper or buzzer may be electromechanics or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarms, music, bell & siren.

Fig. 3(g): Buzzer

IV. RESULT & DISCUSSIONS

As we do not have any proper waste management system to date, the hazardous impact of this unrestrained condition is continuously affecting the environment. So, we need to take the initiative to maintain the deteriorating condition we live in to make our city smart and clean. In order to make this happen we have used IoT technology, by using which we have made this Smart Waste Bin. Here we have used the Microcontroller ESP-32, DHT-11 Sensor, Gas Sensor, and other components mentioned above.

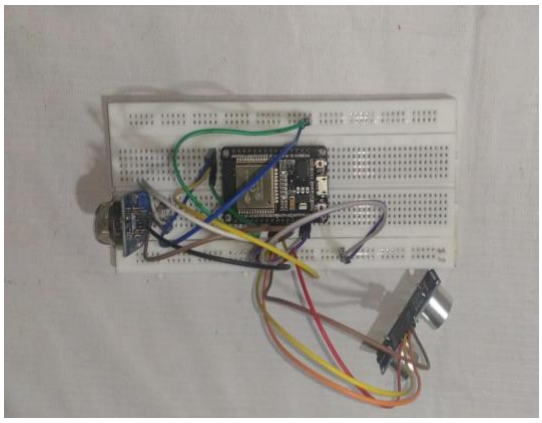

Fig. 4: Circuit Design of proposed model

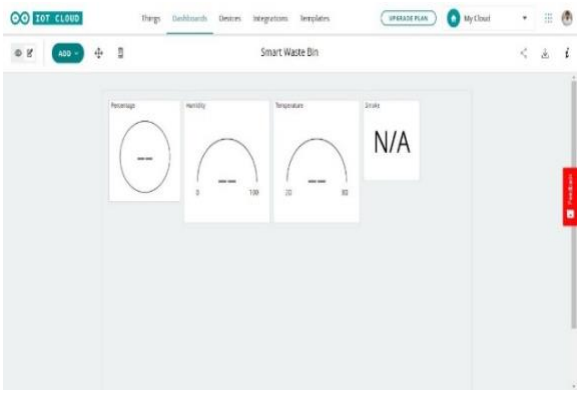

Fig. 5: Dashboard Image to display real time data.

V. CONCLUSION

Due to the rise in urbanization, waste is increasing very fast. Therefore, waste management is an important need to protect the environment. Any discarded object that has been passed to a party, a crowded room, a social structure, a school, or an apartment is considered to be waste This method of implementation saves time in level detection by humans and affordability in domestic applications. This Smart Dustbin prototype will contribute a lot to society to provide a clean and hygienic environment. The project focuses on "IoT technology" and how it can be used in "Smart City applications" (IoT). The initiative will aim to minimize the use of trash cans in the future. The main purpose is to clean the dustbin and better clean the environment.

By continuously using this system to find the maximum height of rubbish in a dustbin that is placed in it. If a dustbin is nearly 70 percent, a mail notification can be sent immediately. This would decrease the stray trash on the streets.

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