Embedded IoT Based Segregation and Monitoring of Waste for Smart Cities

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***Abstract*— In order to manage the waste collection a design for segregation and monitoring of waste using Embedded IoT is proposed. In India, One of the major problems is increase in waste generation. The waste that is generated is just recklessly dumped in most cases, some wastes are dumped on the streets and some wastes are dumped in landfills that are not properly managed and this ends up polluting the environment. So, in our proposed system we use embedded IoT system that will monitor the amount of waste deposited, for segregation and monitoring of waste. In segregation part, we make use of the sensor which separates the wastes into dry waste and wet waste and in monitoring part, the dustbins with dry waste and wet wastes are embedded with sensors so that the level of dustbin is transmitted via IoT. The IoT devices do most of the work without human intervention, although people can interact with the devices -- for instance, to set them up, give them instructions or access the data., it also introduces economical solution for massive data collection.**

Keywords*— ultrasonic sensor, moisture sensor, servo motor, Arduino uno*

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I. INTRODUCTION

Because of the quick increment of populace in India the waste is hugely created and isn't as expected arranged and oversaw which has brought about the flood of trash, awful smell and so forth that dirties the climate and prompts wellbeing unsafe. Metropolitan India produces 62 million tons of waste (MSW) every year, and it has been anticipated that this will arrive at 165 million tons in 2030. 43 million tons of civil strong waste is gathered yearly, out of which 31 million is unloaded in landfill destinations and simply 11.9 million is dealt with. There aren't an adequate number of public containers, and the accessible receptacles are not even covered and, by and large, squander floods out of those canisters and wind up going all around the roads. Many individuals will leave the losses on the streets and half of waste isn't as expected gathered from the houses, these wastages will be tossed outside and no one will clean those wastes which will contaminates the air totally. There are many sorts of squanders, for example, dry waste, wet waste, dangerous waste, metal waste, glass squander and so on each waste ought to be appropriately gathered and ought to be isolated by their characters. Since the headways in innovation have lead to many changes in our nation thus, we considered utilizing Internet of Things for isolation and checking of waste consequently without the utilization of labor. By utilizing Embedded IoT we can send the sensors to the dustbin that screens the dustbin and gives data about the containers continuously. This IoT conveyed sensors will send the actual information into computerized information and permit us to get to that information from anyplace whenever through the server. We utilize cloud server that stores and dissects the information which resembles a data set. The information put away in the cloud will assist the general specialists with knowing the situation with the dustbin so

they can deal with the containers by sending trash vans to gather the waste at whatever point it is full which helps in diminishing the flood of trash. By this way we can screen climate changes from a distance from any region of the planet by means of web.

II. RELATED WORK

A Prototype of Remote Smart waste segregation and garbage level monitoring system

Sanket Salvi and Shashank Shetty, (2020) introduce the SAF-Sutra, a prototype of a remote smart waste segregation system that can be used to monitor the status of the garbage and collect information about it. The system is easy to implement and can be assembled. The demonstration shows the system's interaction with the user through the mobile app and web platform. [1].

A cloud-based smart recycling bin for in-house waste classification

In 2020, a project by Nikolaos Baras and Dimitris Ziouzios aims to introduce a system for urban waste management that will allow people to recycle more efficiently and effectively. This method is very cost-effective and can help people reduce their waste consumption. The cloud-based system will allow people to easily identify and recycle their waste materials. A centralized Information System collects measurements in smart dustbins; the waste in each bin can be classified using Artificial Intelligence and also neural networks. And it is capable of classifying different types of waste with an accuracy of 93.4%. [2]

IoT based Waste Management for Smart Cities

Padmakshi Venkateshwara Rao, Pathan Mahammed Abdul Azeez, (2020) presents the "IoT based Waste Management for Smart Cities" to defeat the difficulties in the climate like lacking waste assortment, treatment, and removal. Because flooding of the dustbin causes unhygienic circumstances are made, the dustbin is set in the whole city; it is conveyed with least expense implanted technique to help with a following of the trash, accordingly, the "Blynk application" is utilized to get the prompt SMS as soon as trash canister arrives at its pinnacle level. Consequently, a moment move will be initiated by the frightened specialists once the situation with a container is told through the web. Ultrasonic sensor, node MCU, blynk application, and a servo engine is utilized to foster the proposed framework. [3]

Architecture for garbage monitoring systems using integrated technology

Chethan Kaushal, Anshu Singha, (2020) introduced the Architecture for garbage monitoring systems using integrated technology, proposed the novel architecture of waste management that utilizes the concept of IoT and digital image processing, the architecture acts as a surveillance system to monitor the over the flow of the garbage and delivers the message to the concerned authorities to take the necessary and instant action. [4]

III. EXISTING SYSTEM

- Manual systems in which humans have to clean the dumpsters periodically.
- There's no systematic way of approach towards the cleaning of dumpsters.
- Employers are unaware about the status of the dustbin and its particular location.
- Employees are not aware of the need for a particular location where the dustbin might overflow.
- It is very less effective in cleaning cities.

IV. PROPOSED SYSTEM

The smart dustbin is specially designed to solve the social issues of the waste disposal; the smart dustbin detects the kind of waste being thrown inside it and segregates it into dry or wet wastes. It allows sending messages to the user via internet by updating the status of the bin periodically.

The main objectives of the proposed system are:

- To study and analyze the segregation of wastes to smart cities
- To develop an automated system to check the level and types of wastes collected in the bin.
- To implement and test continuous monitoring of waste.

V. SYSTEMANALYSIS

The proposed system has been developed using the embedded hardware, software, and IoT components. The system block diagram is shown in fig. 1 which illustrates the architecture of the proposed system. This system consists of two parts:

1. **Segregation part**: In this part, waste is collected and the collected waste is separated into Dry waste and wet waste. If the waste contains moisture content then the moisture sensor will detect it and that waste is thrown into the wet bin or else it is thrown to dry bin via servo motor.
2. **Monitoring part:** In this part, the level of these wastes dustbins are sensed by ultrasonic sensor and when it reaches above the threshold level, the level of the waste is transmitted to cloud server through Wi-Fi module (ESP8266) where the data can be stored and retrieved anywhere at any time.

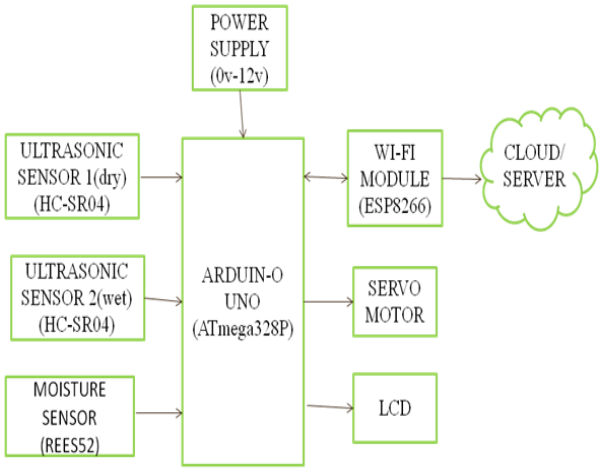

Fig 1: The block diagram of proposed system design

The above fig.1 is the block diagram of our proposed system. So, initially a power supply of 0-12 volts is given to the Arduino uno. We use three sensors i.e., moisture sensor to detect the moisture content in waste and two ultrasonic sensors for wet and dry wastes to calculate the level of the bin. These three sensors contain the analog data and are connected to Arduino uno.

So, whenever the sensor value reaches the threshold voltage, the sensed analog data is sent to Arduino uno. This Arduio uno will convert the analog data into digital data written in Embedded C using Arduino IDE. The digital data will be sent to the servo motor so that it can separate the wet and dry wastes.

And the status of the bin is shown in the LCD. This data will be sent to the cloud using Wi-Fi module where the relative authorities can view the data anywhere at any time and take necessary actions

VI. HARDWARE COMPONENTS

A. Arduino UNO:

The Arduino UNO is a popularly used open source microcontroller board that contains ATMEGA328P microcontroller. It runs on Arduino IDE and it contains a set of digital and analog I/O data pins that are used to interface the board with other electronic components.

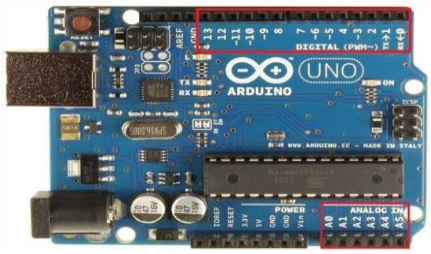

Fig 2: Arduino board

B. Ultrasonic sensor(HC-SR04):

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

Fig 3: Ultrasonic sensor

As shown in the Fig 3. 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.

C. Moisture sensor(REES52):

The moisture content is above threshold level, and then it is a wet waste. The moisture content is measured using two probes. These two probes allow passage of current to object and find it resistance value and from that moisture content is measured.

Fig 4: Moisture sensor

D. .Servo motor:

Servomotor is a linear actuator (that creates motion in straight) or rotary actuator (that produces rotary motion or torque) which controls angular or linear position, acceleration and velocity. Actuators are responsible for moving and controlling mechanisms. It consists of three parts: they are, output sensor, controlled device and feedback system. Even though servo motors are not specific class of motor it is referred as motor suitable for use in closed-loop control system. At the point when the wet waste is recognized by the moisture sensor, servo motor rotates 90 degree. The entryway associated with servomotor will stop the section of waste and toss it into the wet bin. In the event that it is a dry waste the motor stays in the first position.

Fig 5: servo motor

E. Wi-Fi module (ESP8266):

Esp8266 is a microcontroller unit i.e., system on a chip consisting of Wi-Fi module called ESP8266. Like Arduino, serial communication protocols like UART, SPI are supported by esp8266. The application can be developed on esp8266 using Arduino IDE. On-board Micro USB connector used to supply power to esp8266 there are 17 GP. IO pins, RST and FLASH are on the development board. ESP8266 module is low cost standalone wireless transceiver that can be used for end-point IoT developments. To communicate with the ESP8266 module, microcontroller needs to use set of AT commands. Microcontroller communicates with

ESP8266-01 module using UART having specified Baud rate.

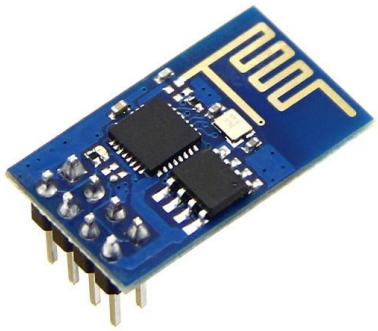

Fig 6: Wi-Fi module

F. LCD:

LCDS are available to display arbitrary images or fixed images with low information context. It can display messages in two lines with 16 characters each. It displays all the alphabets, Greek letters, punctuation marks, mathematical symbols etc.

Fig 7: LCD display

Implementation is one of the most significant responsibilities in a project, and it is the phase in which one must exercise caution because all of the project's efforts will be wasted be quite interactive The most important step is to put the plan into action stage in establishing a successful system and disseminating it users' trust in the new system's functionality effective. Each initiative is evaluated on an individual basis at the time of development based on the sample data, and it has been confirmed that these programmers interact in the manner described in the program's requirements the computer system as well as its components the user's pleasure is tested in the environment.

G. 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. PaaS 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.

Fig 8: Cloud server

VII. IMPLEMENTATION AND WORKING:

The below figure 9 depicts the flow of our project where we initially initialize the library functions, declaration of the pin has to be done, we have assigned the pre-set values to sensors. We have to check if the button is pressed if yes it proceeds to the next step, else it will halt the process.

The system will check for moisture content of waste then it will segregate waste into dry or wet waste based on previously set values. If the

bin is filled then the message will be sent to the department for collection of garbage, then the bin will be emptied. Else the above process repeats.

The ESP8266 will send the data to the client server. The IP adders of the client are pre defined in the program using that readings of sensor values are sent. Client will receive all the data from the host, displayed on the ThingSpeak server anywhere at any time.

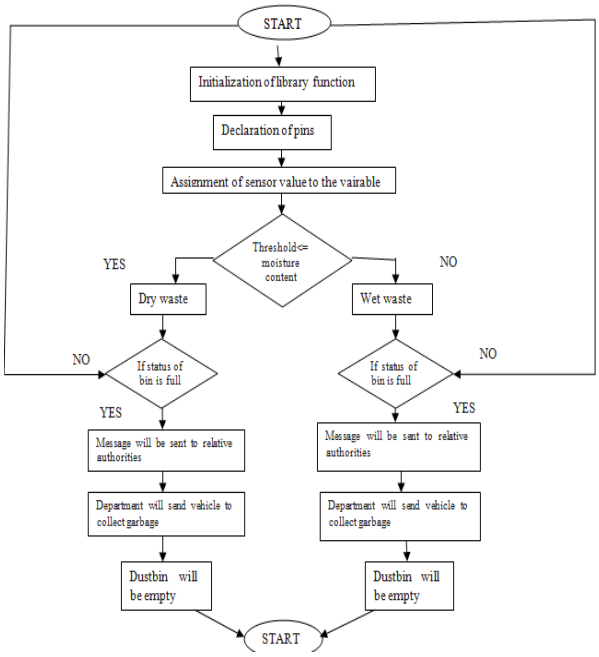

Figure9: Flowchart

VIII. RESULT

We have simulated the practical situations in which the smart bin is to be operated. The results show the functioning of the bin undergoing the segregation process. The below fig 10 is the hardware module of our proposed system.

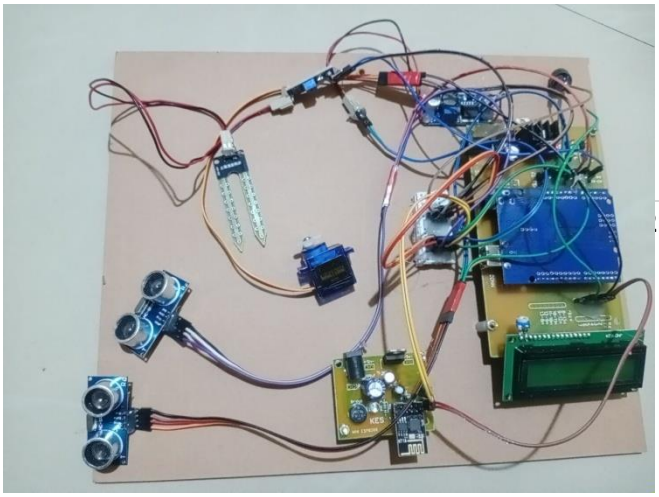

Fig10: Hardware kit

Whenever the ultrasonic sensor detects the level of the dustbin, the data will be displayed on the LCD that says “WET: FULL” or “WET: NOR” and “DRY: FULL” or “DRY: NOR” as shown in the below fig 11 and fig 12.

Fig 11: Message displayed that waste generated is Dry waste and wet dustbin is full

Fig 12: Message displayed that wet dustbin is full

And when the moisture sensor detects any moisture content in the waste the message will be displayed on the LCD which says "MOI: WET" or "MOI: DRY" as shown in the below fig 13.

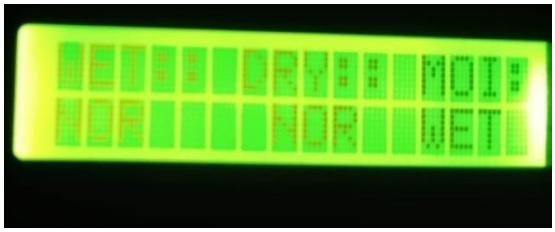

Fig 13: Message displayed that the waste generated is in wet condition

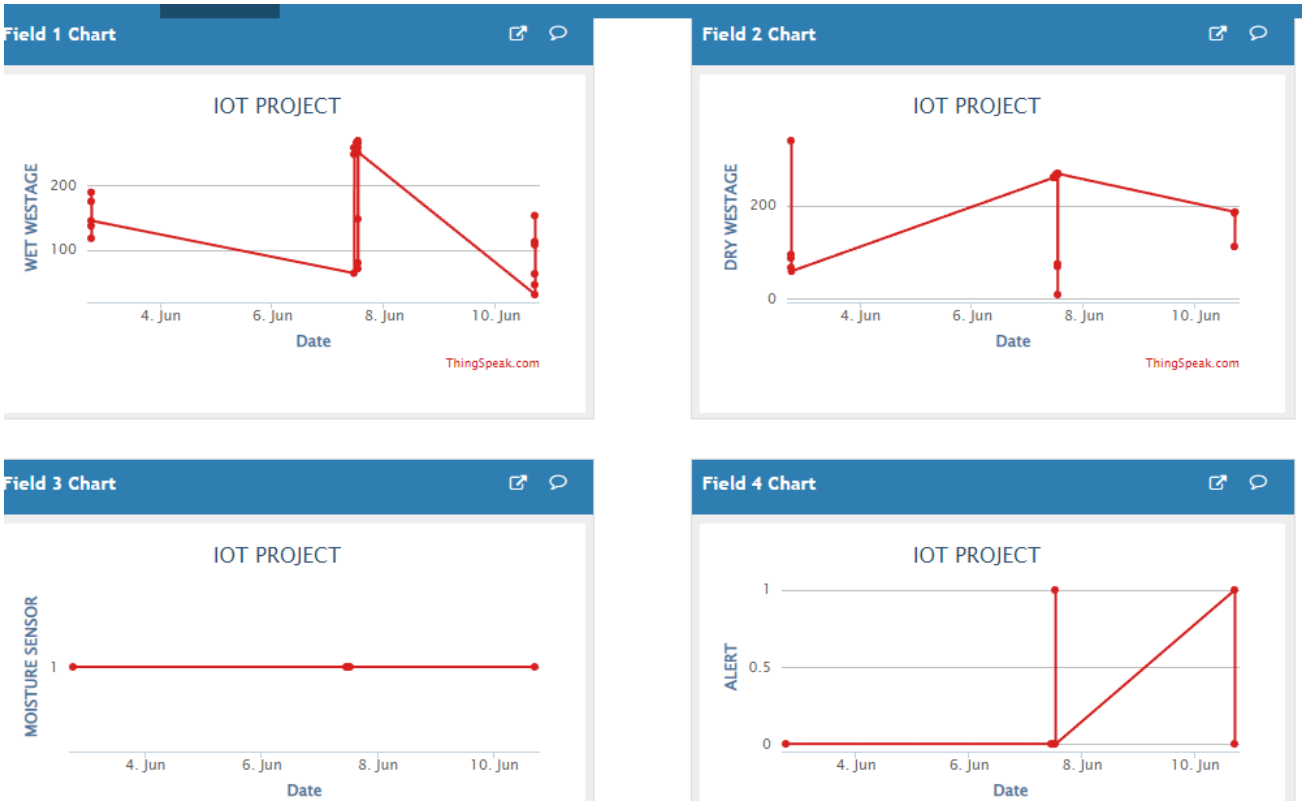

Fig 14: Output at server site

Through this ThingSpeak server anyone can view the data anytime from anywhere; it will allow us to view the time-time monitoring of waste through graphical form where we get to see the level of the dustbins and what type of waste is deposited as shown in the above fig 14.

IX. CONCLUSION

This proposed system helps in hygiene of the smart cities by the practical application of "Embedded IoT based segregation and monitoring of waste in smart cities' with metropolis and with the increasing populace, dumping of waste is the major concern. This proposed system is an effective waste segregation and monitoring system that has no human interference to segregate and monitor the dry and wet waste. It provides the timely collection of waste and disposal. The proposed system can be deployed on a domestic scale in household or a large scale in public places.

X.REFERENCES

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