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Disposal and Monitoring Of Bins Using Smart Network

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Abstract: The Internet of Things (IoT) is constantly evolving and is giving unique solutions to the everyday problems faced by man. "Smart City" is one such implementation aimed at improving the lifestyle of human beings. One of the major hurdles in most cities is its solid waste management, and effective management of the solid waste produced becomes an integral part of a smart city. This paper aims at providing an IoT based architectural solution to tackle the problems faced by the present solid waste management system. By providing a complete IoT based system, the process of tracking, collecting, and monitoring the solid waste can be easily automated and monitored efficiently. In India, we have come up with the overall system architecture and protocol stack to give a IoT based solution to improve the reliability and efficiency of the system. By making use of sensors, we collect data from the garbage bins and send them to a gateway using LoRa technology. The data from various garbage bins are collected by the gateway and sent to the cloud over the Internet using the MQTT (Message Queue Telemetry Transport) protocol. The main advantage of the proposed system is the use of LoRa technology for data communication which enables long distance data transmission along with low power consumption as compared to Wi-Fi, Bluetooth or Zigbee.

Keywords: - IoT, Smart Waste Management, Smart City, Real Time Monitoring, Lora Module

I. INTRODUCTION

Households generate degradable (food) and non-degradable (plastics, glass etc.) at a massive scale on a daily basis. Degradable waste can be readily made into compost with simple tools while non-degradable waste could be collected and deposited at the regional centres who recycle the material. An on-demand service would be helpful for the public to manage their plastic waste conveniently. This reduces landfills to major extent and also helps to better utilize the resources of the waste management companies. The main aim behind this system is to improve the resource management in domestic waste collection. The system so fabricated must comply with some necessary features such as to control overflowing of the bins, real time Monitoring of the sensor data with respect to specific polling interval and maintaining the database, to send signal to the user with proper GUI with the help of App Development. The main aim of the proposed solution is to optimize the resources that the municipal corporations use in waste collection process. The proposed solution aims at providing an economic, robust, efficient and viable way for optimization of resources used in waste collection process. These resources include labour, vehicles, heavy duty machinery, time etc. An efficient use of these resources can be achieved by utilizing the internet of things platform. The various features like real time monitoring of waste bins, route optimization etc. will help in better utilization of the resources and also improve the efficiency of waste collection process.

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Urban society rejects and generates solid material regularly due to rapid increase in production and consumption. The problem is more acute in developing nations than in developed nations, as their economic growth as well as urbanization is more rapid.

This necessitates management of solid waste at generation, storage, collection, transfer and transport, processing, and disposal stages in an environmentally sound manner in accordance with the best principles of public health, economics, engineering, conservation, aesthetics and environmental considerations. An on-demand service would be helpful for the public to manage their plastic waste conveniently. This reduces landfills to major extent and also helps to better utilize the resources of the waste management companies.

In this era Internet of Things (IoT) had been proven a lot more helpful and smart in various applications and still continues to be useful. The most promising application of IoT is in the field of Resource management and in communication.

II. LITERATURE SURVEY

Shraddha Zavare and Rashmi Parashare have planned a "Smart and wireless waste management system" [8] that uses the GSM system to send messages to the server whenever a bin is full. This method is impractical to use on a town wide level as distribution GSM modules and SIM cards to every garbage bin isn't attainable.

Manjusha Amritkar proposes a technique of sorting of the waste by selecting RFID technology[9]. Every waste is detected by data properties keep in a very RFID tag associated with it. At every step wherever wastes are to be processed the RFID tags are scan in order to offer the relevant data. This method improves the sorting quality of useful product. We have a tendency to assume organic wastes product are not recycled and thence RFID tags aren't connected with it.

Keeping in mind the shortcomings of the above systems, we tend to propose a system "IoT based solid waste management system" with an discipline answer giving an entire summary of the system level design, block level design, and a protocol stack, which may be enforced and scaled on a town wide level while not abundant hurdles.

III. SYSTEM DESIGN

A. SEMTECH LoRa RA-02 Module

Ra-02 can be used for ultra-long distance spread spectrum communication, and compatible FSK remote modulation and demodulation quickly, to solve the traditional wireless design cannot take into account the distance, anti-interference and power consumption. Ra-02 is available in SMD package and can be used for rapid production by standard SMT equipment. It provides customers with high reliability connection mode. LoRa ™ uses spread spectrum modulation technology It has Receive sensitivity as low as -141 dB . Programmable bit rate up to 300Kbps .IT supports FSK, GFSK, MSK, GMSK, LoRa ™ and OOK modulation modes. It has packets with CRC, up to 256 byte.

Fig 1: LoRa Module

B. Raspberry Pi-4

The Raspberry Pi 4 is the latest product in the Raspberry Pi range, boasting an updated 64-bit quad core processor running at 1.4GHz with built-in metal heatsink, USB 3 ports, dual-band 2.4GHz and 5GHz wireless LAN, faster (300 Mbps) Ethernet, and PoE capability via a separate PoE HAT. Sporting two micro-HDMI ports means can drive two displays up to 4K in resolution from a single Raspberry Pi 4 device, the handling of which comes courtesy of an improved Video-Core VI GPU. The Raspberry Pi 4 is able to make use of the Mesa "V3D" driver to deliver OpenGL accelerated web browsing and desktop compositing.

In our project, the RPi is present at host and is acting as a host device and also act as gateway device which is been connected to LoRa IC module. It receives all the information and processed it simultaneously.

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Fig 2: Raspberry Pi-4

C. Ultrasonic Sensor HC SR-04

An optical sensor has a transmitter and receiver, whereas an ultrasonic level sensor uses a single ultrasonic element for both emission and reception. In a reflective model ultrasonic/level sensor, a single oscillator emits and receives ultrasonic waves alternately. This enables miniaturization of the sensor head.

Fig 3: HC SR-04 Ultrasonic Sensor

D. Arduino board and ATmega 328p IC

Fig 4: Arduino Uno Board

The high-performance Microchip Pico Power 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed. By using ATmega 328P, we can boot load and flash the program imbibes in it.

Fig 5: Atmega 328P IC

IV. METHODOLOGY

This is the block diagram of the model we have proposed and the following diagram elaborates in a quick way of how things are done.

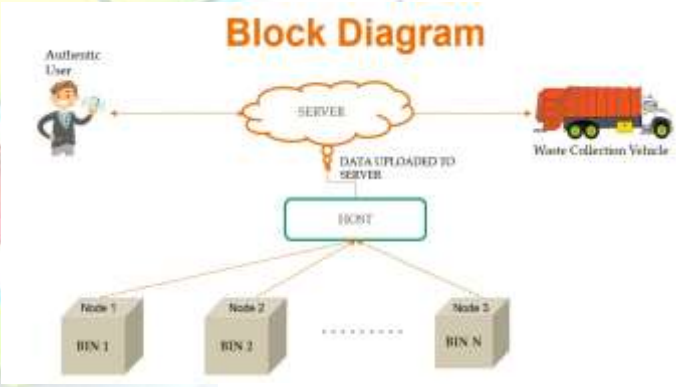

Fig 6: Block Diagram

We have divided our project in to two main parts:

A. Hardware Development

Bin Level Arrangement consists of the waste bin fitted with the embedded hardware. We are using three waste bins. Each garbage bin will have their GPS co-ordinates soft coded and are fitted with a **ultrasonic sensor** to detect bin level, a microcontroller IC to collect all the sensor data, and a LoRa Module for sending the data to a host device. In our System, Each node i.e. individual bin is being fitted with the Arduino microcontroller IC which is being connected to the

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LoRa module IC which will be communicating serially. The transmission is being based upon LoRa Module. The host is RPi which is being fitted with **LoRa Ra-02 IC** for receiving data simultaneously.

Fig 7: Interfacing of LoRa with Arduino

B. Software Development

In our model, city is being divided into 'n' clusters, within each cluster local host continuously polls the data from bin at fix polling interval. The communication between the host and the node done by SEMTECH LoRa Module. The communication between the Local host and server is been done over using Wi-Fi, data is being wrapped into JSON format over MQTT protocol. The data is being extracted from MQTT server into MY SQL database (for data logs, frequency of received data and timings). This all been done for optimization of waste collection resources.

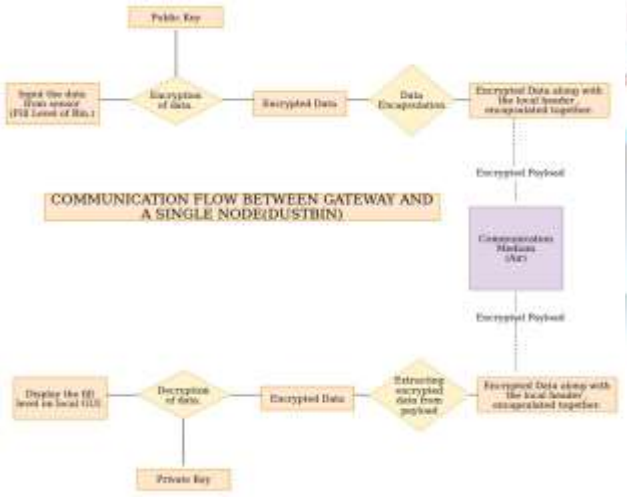

Fig 8: Communication Flow

V. RESULTS

The following graphic is demonstration carried out by us on a bin which shows the real time monitoring of the data from the sensor of the bin received on the IoT platform.

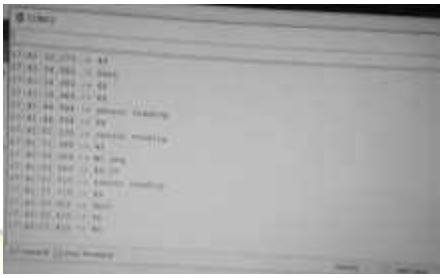

Fig 9: Level data sent from bin displayed locally

Fig 10: Result obtained on the IoT Platform (ThingsBoard)

Tkinter is the standard GUI library for Python. Python when combined with Tkinter provides a fast and easy way to create GUI applications. The extracted output from MQTT server is being displayed on our local GUI based on TKinter is displayed below.

Fig 11: Output values displayed on Local GUI

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VI. CONCLUSION

All in all, we are here with our system which was already tested in a friendly environment with the optimal hardware and software working properly. So, this hardware can be readily used for real time monitoring the bins which will help in better utilization of the resources and also improve the efficiency of waste collection process. The proposed solution aims at providing an economic, robust, efficient and viable way for optimization of resources used in waste collection process. These resources include labour, heavy duty machinery, time etc. An efficient use of these resources can be achieved by utilizing the internet of things platform.

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