Smart Waste Management System

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ABSTRACT

Internet of Things (IoT) plays an important role to make the cities greener, safer, and more efficient. Waste collection management solution based on providing intelligence to wastebins, using an IoT prototype with sensors is been presented in this paper. Planning the waste management for all of the garbage produced in the country is an enormous task which involves both logistical planning and scientific knowledge in order to balance the impact on the environment and the people. With speedy increase in population, the issues related to sanitation with respect to waste operation are demeaning immensely. It creates unhealthy conditions for the citizens in the near surroundings, leading to the spread of contagious conditions and illness. In the proposed system, embedded device helps in real time monitoring of checking the status of the waste in waste dustbins. The data regarding the waste level will be used to deliver optimized route for waste collecting vans, which will reduce cost associated with fuels. The load sensor will increase effectiveness of data related to waste status and moistness sensor will be used to give data of waste segregation in a dust bins.

***Keywords*:** Internet-of-Things, smart waste management, Arduino, Wi-Fi, Internet.

I. INTRODUCTION

IoT applications in smart waste management help in segregating and managing the waste materials more sustainable. In this paper, an attempt is made to segregate and optimize garbage collection routes based on the collection of wastes per individual units and characterize fill levels. The Internet of Things (IoT) shall be suitable to incorporate transparently and seamlessly a large number of different and miscellaneous end systems, while delivering open access to selected subsets of data for the development of a plethora of digital services. constructing a general framework for the IoT is hence a truly complex task, substantially because of the extremely large variety of device, link level technologies, and services that may be involved in such a system. One of the main concerns with our surroundings has been solid waste management which in addition to disturbing the balance of the surroundings also has adverse effect on the health of the society. The spotting, monitoring and management of wastes is one of the primary problems of the present period. The traditional way of manually looking after the wastes in waste dustbins is a complex, clumsy process and utilizes more human effort, time and cost which isn't compatible with the present-day technologies in any way [1]. This an advanced system in which waste operation is automated. This system IoT Garbage Monitoring system is a truly innovative system which will help to keep the municipalities clean. This system monitors the waste dustbins and informs about the status of waste collected in the waste dustbins via a web pages.

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II. LITERATURE SURVEY

There are many existing systems where the sensors present in the bin checked whether bin is filled till the lid. If the bin is found to be filled a message will be sent to the server system with the help of Arduino SIM module. At the same point when the message reaches the server, it would be passed onto the workers and the worker who are free would accept the work and reach the place from where message was originated and complete the work assigned.

Other System used Smart dustbins where level of the dustbins ware kept on check and all the available smart dustbins in a locality were under supervision through the system server and the fill level of the dustbin could be accessed at any place and the dustbins can be prioritized in accordance with their fill level. High prioritized dustbin could be collected before other dustbins. As we know traffic congestion is common in metropolitan cities so prioritising the dustbin would help to reduce the traffic and even garbage collection vehicles could reduce visiting the same places now and then. The exact status of the fill level in dustbin would be known beforehand so garbage collection vehicle reaching the same place every time could be avoided and maximum time could be saved and utilised for other tasks.

The other system utilised microcontroller, infrared sensor and the wi-fi module and this system ensured the waste is disposed once the level of dustbin reaches maximum level. If the disposal does not take place in specified time, then it should be brought into the notice of superiors in the management and superior should make sure the waste is disposed on time and proper measures should be taken so that the delay in time does not repeat. The management should ensure health and hygiene in the society [2].

The Infrared sensor detected the waste when it was thrown in the bin and it made sure to send signals to the microcontroller. The existing microcontroller would detect the received signals and send it to the available router. The function of the router is to verify the received signal and to generate codes which could be random and send these codes to the microcontroller. This microcontroller's work is to scan the random code which it received and send it to the lcd and lcd displays it. The user could enter the code which was generated on the interface which was currently hosted on the server. In response to the request the server displays the wifi password so that user could get connected to the internet and this wifi gets disconnected exactly after 10 minutes. Fachmin folianto, Yong Sheng Low and Wai Leong Yeow (2015) suggested a system which had three -tier structure. The ultra sound IOT based sensor detects the fill level of the dustbin and put forth the sensor readings. This sensor reading is been transferred to the nod in the gateway which is present along with the sensor. The nod in turn sends the information to the server. The server makes sure to analyse the information which is gathered and processes the sensor readings and compare the values with already existing rules and give rise to appropriate action when the value reach beyond the given level. The collected and analysed necessary information is been forwarded to the particular workstation and this information is displayed to the user making the usage of graphs.

Chung-Horng Lung, Ioannis Lambadaris (2016) have provided the idea of IOT sensor related dustbins which is the idea of sensors-based waste bin efficient enough to notify the filling level of the dustbin. This system makes use of cloud computing model so as to increase the robustness and effectiveness of the system. They had put forward cloud swam where each dustbin would be provided with different sensors so as to inform about the filling level. There would be separate dustbins for every classification of waste which include dry waste, wet waste, organic waste, metallic waste and plastic. With the help of this method waste is been segregated accordingly. The required information (type of waste amount of waste and so on) is stored in the cloud and which would be used by the management when required. This even provides an appropriate method to gather the waste so as to improve the health and hygiene of the locality. This also make use of machine learning based shortest way which combats traffic congestion and reduces fuel consumption. The management authorities would be in the position to study the classification of waste and the amount of waste being deposited. Information collected could be efficiently analysed as the data is easily accessed through the cloud server.

Keerthana (2017) proposed a system of dustbins based on internet of things for collection and segregation of waste. This smart waste management system which makes use of various sensors, embedded controller and various other modules which make sure the disposal of waste when the level of waste in the bin reaches the threshold value. There were two threshold values and at the time of second threshold value the message overloaded is displayed which alerts the management and they have to ensure the waste is collected on time. The bin will be under supervision for some

stipulated time, even then if the waste is not collected a notification would be sent to the administration personnel to take necessary step.
Kang (2020), put forth the system which consists of collection bins which consists of ultrasonic Sensor, Arduino microcontroller and wifi module. Using these elements, we can find out the filling level of various bins and this information is been sent to the database in the cloud server.

Commonly the collection bin is in the inactivated stated and it would be activated by reading the QR code and at that particular time the electronic waste should be thrown in the bin. The bin will be in the activated state only for five minutes. At the time when the QR code is read the bin receives signal from the server and the ultrasonic sensor has the task of checking the filling level of the bin every 3 minutes and sends the data to the cloud server. When this model was analysed, total cost of all the elements was nearly $ 38.60 and the total energy cost of the 1 collection bin was nearly $ 0.7 per month [3].

The survey related to the effective implementation of garbage management system in the metropolitan cities. The numerous proposals were put forth and some of them were already in practice but they were not considered effective. The level of waste in the bins will be detected with the assistance of ultrasonic sensors and communicated to the authorized person through the help of the GSM system. Arduino board is used to interface the sensor system along with the GSM system. A Graphical user interface is also developed to keep in check the required data which is in accordance with the waste from various desired area. The fill level detector includes IR sensors which will be used to find the level of waste. The result of fill level detector is passed onto the microcontroller. Four IR sensors were used to detect the various levels of the amount of the waste gathered in the bin present in the various locality. The output from the fourth Infrared sensor is been sent to the microcontroller to forward the required information to the Control room through GSM. At the point of receiver, control room is present where all the necessary actions are managed [4]. The system makes sure the clearing of bins as soon as the waste reaches its threshold level. If the bin is not cleared in stipulated amount of time, the higher administration authority would be notified and asked to take necessary action and clear the waste. It ultimately helps to maintain the health, hygiene and cleanness in the surrounding.

III. PROPOSED SYSTEM

The IOT Garbage Monitoring system could be a truly innovative system which is suitable to help maintain the megalopolises clean. this system monitors dust lockers and informs about the volume of waste collected within the trash boxes. We propose intelligent waste collection system on the idea of status of wastes present within the wastebins. the information captured through sensor detectors is transmitted over the internet to a garçon for storage and processing mechanisms. it's used for covering the day- to- day selection of wastebins, rested on which the routes collect several of the wastebins from different points are decided. Through navigational devices, workers obtain the updated optimized routes every day.
In a state, around 27000 tonnes garbage is collected per day. This garbage consists of the different types of the wastes like organic waste, dry waste, consisting plastic & paper, Metallic waste, Hospital waste, electronic waste and industrial waste. Segregating these different types of the wastes is the huge challenge faced by the waste management department. This paper proposes a robust and fully automated system which can be implemented in the dustbins to segregate the wastes into three categories which are, dry wastes, Organic wastes, metallic wastes. Dry wastes can be paper, plastic materials which have almost negligible moisture content and methane levels. Organic wastes can generally the household wastes, leaves and other organic products which contain moisture content around 60-90%. The main characteristics of all sorts of organic wastes are that they contain the methane gas concentrations.
The ESP8266 Wi- Fi Module is self- contained System on Chip. It is integrated with TCP/ IP protocol heap that can give any microcontroller access to any Wi- Fi network. The ESP8266 is able of either hosting an operation or unpacking all Wi- Fi networking functions from another operation processor. Each ESP8266 module is preprogramed with an AT command set firmware [5].

A. BLOCK DIAGRAM

The gist of the IoT based model is explained via the help of the block diagram. It explains the use of microcontroller as well as culmination of the sensors used for monitoring as well as waste segregation.

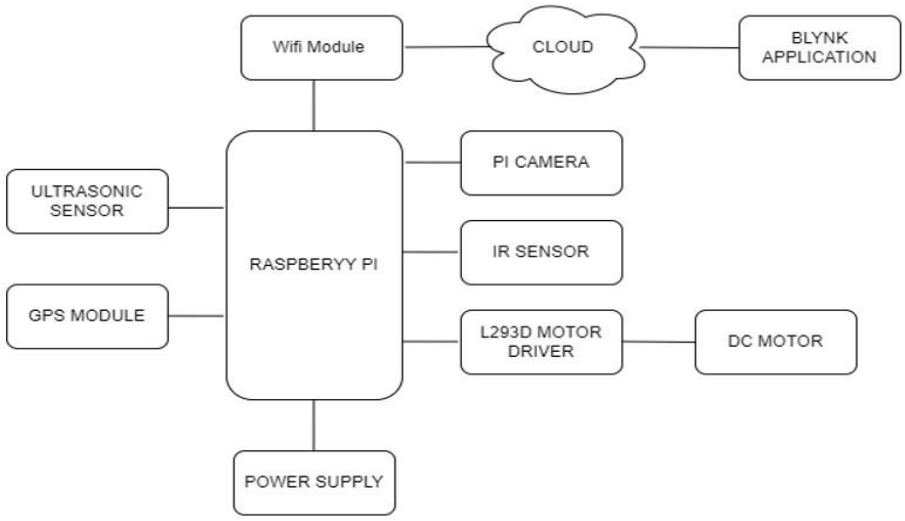

Fig 1. Block diagram of proposed system.

The smart bin is controlled via an Arduino which will drive the motor using the motor driver L298N. A ESP8266 module is the cheapest module for connecting the Arduino to the internet. The output is displayed on the node red dashboard for the users to help with waste management [6].

B. COMPONENTS USED

- Dc motor: A DC motor is defined as a class of electrical motors that convert direct current electrical energy into mechanical energy.
- Raspberry pi: The Raspberry Pi is a single-board, low-cost, high-performance computer that enables endless possibilities for physical computing and exploring the Internet of Things (IoT). It is equipped with various input and output ports (HDMI, USB, Ethernet, etc.) to connect a display, mouse, and keyboard to use as a traditional PC [7].
- GPS Module: The Global Positioning System (GPS) is the most widely used satellite navigation system around the world. It is one of the Global Navigation Satellite Systems (GNSS) that provides geolocation, time, and velocity information. GPS is operational since 1978 and globally available since 1994. The latest GPS receivers provide geolocation with an accuracy of 30 centimeters.
- Ultrasonic sensor: The Ultrasonic Sensor sends out a high-frequency sound pulse and then times how long it takes for the echo of the sound to reflect back. The sensor has 2 openings on its front. One opening transmits ultrasonic waves, (like a tiny speaker), the other receives them, (like a tiny microphone). The speed of sound is approximately 341 meters (1100 feet) per second in air. The ultrasonic sensor uses this information along with the time difference between sending and receiving the sound pulse to determine the distance to an object.
- Arduino: Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online [8].
- IR sensor: IR sensor is an electronic device, that emits the light in order to sense some object of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, but infrared sensor can detect these radiations.

- Wifi module (Node MCU): NodeMCU is an open source IoT platform. Which includes firmware which runs on the ESP8266 Wi-Fi Module from Espressif systems, and hardware which is based on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the dev kits. NodeMCU firmware was developed so that AT commands can be replaced with Lua scripting making the life of developers easier. So, it would be redundant to use AT commands again in NodeMCU.

C. WASTE COLLECTION AND MANAGEMENT

This process is the most important part of the waste disposal. In a smart city infrastructure, the multiple bins located in a cluster are monitored as group so as to determine the optimized collection time and routes via a notification provided to the municipal collection authority as well as the users in the nearby are to reduce the chance of bin overflow.

The smart bins collect the individual sensor values and pass through a function node so as to assess the garbage content via a ultrasonic level sensor. The values are projected for individual bins on the section of smart bin. The status of each bin is visually explained via gauges. If the content is greater than 70%, it shall change the colour and indicate in red. Another function node is used to see if 60% of bins in the cluster are filled more than 70%. it sends an email to the municipal board using an E-mail node and also the residents living nearby, if the conditions are met. A message in the form of an alert and notification is also flashed on the dashboard and the message dialog box states the information of the truck deployed for the collection of waste. ii. Optimized route for waste collecting Trucks

For a smart city to function efficiently, the collection routes at every stop shall be optimized. This research work can be further extended to identify waste collection routes whichever may be the shortest used by garbage trucks which slowdown the respective process. Once the email is issued to the respective personnel, trucks in the vicinity of the location can be deployed for collection via adding the GPS location. A truck deployed will send an alert regarding the time and vehicle type and UIN (unique identification number) to the users nearby so as to reduce congestion on small roads.

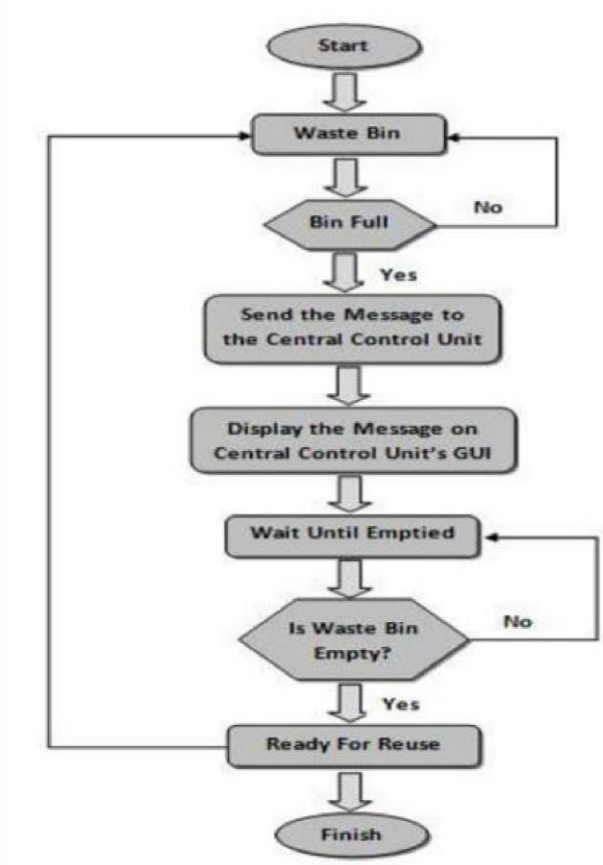

Fig 2: Flow chart of the proposed work

IV. RESULTS

The Smart Waste Management system paves a way in collection of waste in a clean, neat, resource optimal and environment friendly way. The proposed system uses a raspberry pi board which is in turn connected with a Pi camera that captures the pictures or images of the waste dumped in the smart bin and it is also connected with the IOT sensors namely the Ultrasonic sensors and the IR sensors which detects the level of waste in the bin(i.e, full or empty) and the type of waste (i.e, dry waste or e waste) respectively ,upon detection of the waste the DC motor opens the respective waste compartments such the it is dumped in the exact bin. Once the level of waste in the smart bin is full, it sends a notification to the concerned authorities to empty the dustbin with help of the GPS module attached to it and also gives the location of the filled dustbin, its latitude, longitude positions of the Blynk application with the help of the WIFI module. In this way the smart bin system helps the officials to not collect the waste manually and helps them from being safe and not being prone to diseases.

CONCLUSION

The proposed system uses the principles of IOT technology which helps in eradicating the manual or the oldest way of waste collection and brings in a complete new technical system of waste collection. The proposed technical system segregates the dumped waste into different compartments with the help of the sensors applied to it and checks the level of waste and sends a message to the concerned authorities to pick the waste. With the help of this system, it helps the rag pickers and the workers prevent themselves from being prone to diseases. This is an effective and a developed way of waste collection, being resource optimal, compatible and keeps the environment clean.

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