



SMART WASTE COLLECTION USING IOT

V B K L Aruna¹, M Bindu Priya²,

^{1,2}Asst Professor, ECE Department, V R Siddhartha Engineering College, Vijayawada

Abstract

The Internet of Things (IoT) is the network of physical objects or things embedded with electronics, sensors, software and network connectivity which enables these objects to collect and exchange data. Cities in the world are becoming smarter by implementing the things around using IoT. One of the objectives of smart cities is keeping the environment clean and neat. Bin Management is one of the major applications of IoT for providing the environment neat and clean and also aims at exploiting the Waste collection system is based on providing intelligence to trashcans, by using an IoT prototype embedded with sensors, which can read, collect, and transmit trash volume data over the Internet. The module is linked with GPS module to specify the location and is also linked with GSM module to send locations of bins to be collected, to the drivers. By using route optimization algorithms, best route to be followed is calculated. Node MCU is used for this project as it is sufficient for collecting data from sensors and sending them to the Internet through a network interface with minimum power consumption and lower price.

Index Terms: IoT, Node MCU, GSM Module

I. INTRODUCTION

In a Smart City, waste collection is a vital point for environment and its quality should be considered seriously. Fundamental components of smart city are Smart Economy, Smart Environment, Smart People, Smart Living, Smart Mobility and Smart Governance. Smart Environment is the major fundamental component which is tightly connected to environmental pollution. In urban areas overflowing dust bins have been cause of concern for residents as there is an increase in the population and tremendously the unsanitary

conditions in locality are increasing. These overflowing bins also lead to spread of germs, air pollution and diseases which are easily spreadable. Traditionally, the municipal authorities check on weekly routes to pick up waste from bins regardless of whether they are full or not. The authorities should generate reports and should make control over the trucks so that time and money are not wasted, and at the same time quality of service should be good.

As it is seen from a couple of decades internet has been a constant state of evolution. The Internet of Things (IoT) provides us to use the technology comfort by improving our energy efficiency and by simplifying the tasks that consumes much time. The waste collection system using IoT is a very ingenious system which will help us to keep the cities clean. This system monitors the garbage bins and informs the level of garbage collected using ultrasonic sensors in the bins via a web page and also sends newly calculated routes to the drivers daily. This collection system is based on waste level data from trashcans in a metropolitan area. As it has been seen number of times that the dustbins are getting overflowed and the concerned department doesn't get the information with in time and due to which unsanitary conditions are formed in the surroundings. Internet of Things (IoT) is a major paradigm which is rapidly emerging in the present technologies.

II. INTERNET OF THINGS

IoT is a network of physical objects or things embedded with electronics, sensors, software and network connectivity which enables the objects to collect and exchange data. The Internet of things was introduced by Kevin Ashton in 1999 in the Auto-ID Centre at MIT. In the IoT things can be an objects like electronic devices, food, clothing, furniture etc., both living and non

living things like people, animals, plants, lights, air, wires, etc.

The major components of internet of things are sensors, connectivity, people and processes. Sensors can provide a digital nervous to the world by using microphones for ears, cameras for eyes, accelerometer for speed, GPS for location, gyroscope for movement, compass for direction and proximity for closeness. Connectivity can be provided by many technologies like Wi-Fi, Ethernet, WIMAX, ZIGBEE, LAN, WAN, MAN, Bluetooth, GSM etc. Processes are mobile devices, apps, control and automation etc.

III. SMART WASTE COLLECTION SYSTEM

As it has been seen number of times that the dustbins are getting overflowed and the concerned department doesn't get the information with in time and due to which unsanitary conditions are formed in the surroundings. The other problem identified is waste collection team doesn't get information of the waste level of dustbins and due to which they have to check in each dustbin located at different localities. These problems cause unsanitary conditions in the locality, air pollution and is time consuming to identify the dustbin which is filled.

The data collected by sensors is sent to a server where it is stored in a database and processed. The collected data is then used for monitoring and optimizing the daily selection of trashcans to be collected, calculating the routes accordingly. The rate at which trashcans are being filled can be analyzed and the optimized selection of trashcans reduces the costs, improves the collection efficiency or both, depending on the predefined economic requirements.

A. Architecture

In this waste collection system the waste level is measured by an ultrasonic sensor. From the top of the bin the sensor calculates the distance between the trash and its transmitter. This sensed data is sent to the Node MCU which has an Arduino like hardware and ESP8266 Wi-Fi module. Bins are equipped with GPS receivers to obtain the locations where they are placed. These obtained locations are sent to the Node MCU. By using optimized selection algorithm, daily best

routes are calculated and their locations are sent to the drivers using GSM modem Sim 900A which is connected to the Node MCU. The entire received bin data are also sent to the site called WWW.ALLTHINGSTALK.COM, where the bin level is observed and also the graphical approach can be noticed. The programming of Node MCU is done in Arduino IDE.

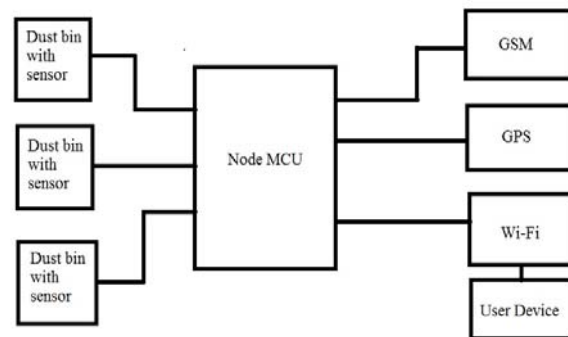


FIG 1: Smart Waste Collection System Architecture

Sensor: An Ultra Sonic Ranging sensor (HC-SR04) is used for detecting the waste level which provides 2cm-400cm non-contact measurement function, the ranging accuracy can reach to 3mm. Initially the trigger of the sensor should be made low and high level signal for atleast 10us. Then the module sends eight 40 kHz sonic burst and then detects if there is any pulse signal back. When the signal is back through high level, the time of high Echo signal duration is the time from sending ultrasonic from transmitter and returning to the receiver.

Microcontroller: Micro controller used is Node MCU. It has Arduino like hardware and ESP8266 Wi-Fi module. This microcontroller is used because it has combined features of Wi-Fi access point and microcontroller and is also less cost system on board for IoT projects. It uses LUA based programming language. It consists of 4MB storage and 128kb memory.

GSM Modem: It is a specialized type of modem which can accept a SIM card and it also operates like a mobile phone. The modulation used in this is Gaussian Minimum Phase Shift Keying (GMSK). It is a kind of continuous phase frequency shift keying. The transmission rate of a time slot is 22.8Kbps. The uplink frequency

band is 933-960MHz and the downlink frequency band is 890- 915MHz. Its default baud rate is 9600. The sms to the drivers is sent by using AT commands of GSM in the Arduino IDE.

GPS Receiver: Global Positioning system(GPS) helps us to track the locations of objects and even individuals which have a GPS receiver. It has 3 segments namely, Space segment, User segment, Control segment. It consists of an on board led, when led is ON then it indicates that a valid signal is obtained. And when the LED is flashing then it indicates that the device is powered on but signal is not acquired. It has an antenna and it should be placed where it can visualize whole sky. It transmits data in serial TTL format. GPS transmits information in the NMEA (National Marine Electronics Association) format, in which each sentence begins with a \$ symbol. There are different NMEA formats. \$GPGGA is the basic format of NMEA.

User Device: Drivers receive messages to their mobiles and the officials or the municipal authorities can observe the bin levels and the graphical output on ALLTHINGSTALK site using any device like mobile, laptop, tablet, PC etc.

Arduino IDE: Arduino Integrated Development Environment (IDE) is a programming platform for Arduino microcontrollers. Arduino IDE also supports Node MCU. “ESP8266 Core for the Arduino” is the developed Arduino core for ESP8266 Wi-Fi Soc. ESP8266 modules must be installed in to the Arduino library. The code written in the Arduino IDE is compiled and dumped in to the Node MCU using an USB cable.

B. Algorithm

Initially each bin is checked and the range can be calculated through the time interval between the sending trigger and receiving echo signal. The formula used to convert the time interval in to centimetres and inches is as follows.

$$\text{Centimetres}=\text{time interval}/58$$

$$\text{Inches}=\text{time interval}/148$$

This data is modified such that the percentage of level left in bin is obtained. Optimization algorithm based on the waste level is used for selection of bins. When the trash in bin crosses

50% then optimization algorithm is called and is compared with the remaining bins which cross 50%. Based on the percentage level, the Bins are selected and the locations of the bins are tracked using GPS and these locations are sent to the drivers using GSM modem.

IV WEB SERVICES APPROACH FOR IOT SMART WASTE COLLECTION SYSTEM

For implementing the IoT platform in ALLTHINGSTALK.COM, ATT_IOT library should be installed in to the Arduino IDE. A node should be created in the site and its deviceID[], clientID[],clientKey[] should be called in to the program. ATT site uses HTTP and MQTT servers. Where HTTP API is server host and MQTT is the server address. The device should be connected to the IoT platform and we should make certain that we can receive messages from the IoT platform for an active MQTT. By creating the assets for the device, data is sent to site from the Arduino. A call back fuction is used which handles the messages that were sent from the IoT platform to the device. The site will then show the bin results. For every bin a asset should be created.

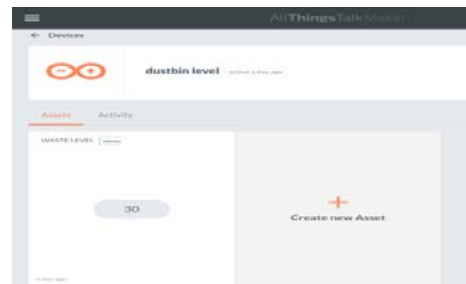


FIG 2: Bin Level indication

V EXPERIMENTAL STUDY

All the bin data received by the site stores it in a database. First open the device in the All Things Talk site and in the assets the every single current bin data can be observed and in the activity all the stored data is displayed in the form of graphical output. Each bin is represented with a separate colour and the results can be observed 24 hours (1 minute average), 1 month (24 hrs average) etc. At the same time drivers are provided with locations. All the data can be downloaded in the form of excel sheet.

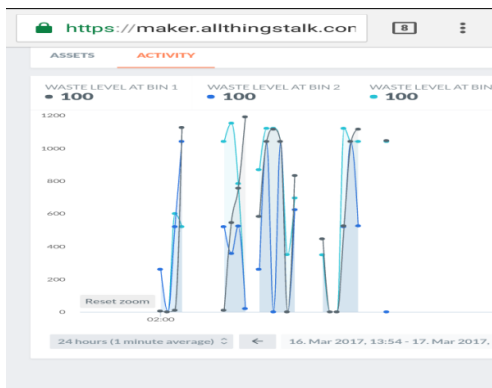


FIG 3: Graphical Output

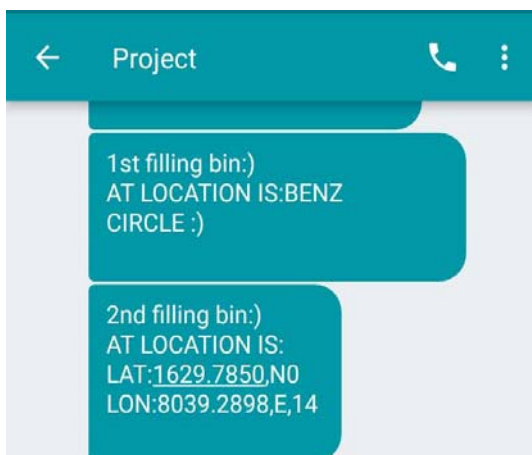


FIG 4: Message Output

Date/Time	WASTE LEVEL AT BIN 3	WASTE LEVEL AT BIN 1	WASTE LEVEL AT BIN 2
2017-03-08T05:50:00Z	297.3265386	297.4208343	262.747947
2017-03-08T05:50:00Z	199.1260334	207.3791902	14.29421952
2017-03-08T05:50:00Z	75	51.33333333	14.66666667
2017-03-16T05:30:00Z	721.4014109	651.6867377	301.7486312
2017-03-17T05:30:00Z	304.4166667	74.47643098	359.9520202

FIG 5: Excel Output

VI CONCLUSION

The presented waste collection solution provides the real time information level of the trashcans, by using an IoT prototype embedded with sensors, which can read, collect, and transmit trash volume data over the Internet. It reduces the cost and optimizes the resources. It also improves the environment quality and cleanliness of the cities. IoT has the potential to add a new dimension to this process by enabling

communication between smart objects. For the project IoT based smart waste collection system, waste level of the trashcan is calculated by using ultrasonic distance sensor. The result of the ultrasonic distance sensor is observed over the serial monitor of Arduino Software (IDE) and Node MCU board interfaced with ESP8266 Wi-Fi to provide network connectivity and store the collected data in a website so that the drivers can visualize the trash can information from anywhere. The visualized information is used for selecting the trash cans.

REFERENCES

[1] Klaus R. Kunzmann, “Smart Cities: A New Paradigm of Urban Development,” Crios, 7/2014

[2] Piro G., Cianci I., Grieco L., Boggia G., and Camarda P, “Information centric services in smart cities”, Journal of Systems and Software, vol.88, 2014.

[3] Luigi Atzori, Antonio Iera , Giacomo Morabito, “The Internet of Things: A survey,” L. Atzori et al. / Computer Networks 54 (2010).

[4] Nuortio T., Kytöjoki J, Niska H., Bräysy O., Improved route planning and scheduling of waste collection and transport, Expert Systems with Applications, Volume 30, Issue 2, February 2006.

[5] Alexey Medvedev1, Petr Fedchenkov, Arkady Zaslavsky, Theodoros Anagnostopoulos, Sergey Khoruzhnikov, “Waste management as an IoT enabled service in Smart Cities,” Conference Paper, August 2015.

[6] Byung-In Kima, Seongbae Kimb, Surya Sahoob, “Waste collection vehicle routing problem with time windows,” B.-I. Kim et al. / Computers & Operations Research 33 (2006) 3624–3642.

[7] Vikrant Bhor, Pankaj Morajkar,” Smart Garbage Management System,” International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, vol. 4 Issue 03, March 2015

[8] Z embedded, “GSM modem interfacing with 8051 for SMS” August2012.

[9] Narayan Sharma,, “Smart Bin Implemented for Smart City”,International Journal of Scientific & Engineering Research, Volume 6, Issue 9, September-2015

[10] Narendra Kumar G., Chandrika Swamy, and K. N. Nagadarshini “Efficient Garbage Disposal Management in Metropolitan Cities Using VANETs,” Journal of Clean Energy Technologies, Vol. 2, No. 3, July 2014

[11] J Parthasarathy,” Positioning And Navigation System Using Gps,” International Archives of the Photogrammetric, Remote Sensing and Spatial Information Science, Volume XXXVI, Part 6, Japan 2006

[12] Hindustan Embedded System, “City Garbage collection indicator using RF and GSM technology”.

[13] Microtronics Technologies, “GSM based garbage and waste collection bins overflow indicator”, September 2013.