GARBAGE MONITORING AND COLLECTION WITH FUTURE PREDICTION OF WASTE MATERIAL BY USING IOT SMART SYSTEM

[1]TARIQ ALI, [2]ALWADIE, A, [3]MUHMMAD IRFAN

[1,2,3] College of Engineering, Electrical Engineering Department, Najran University KSA
E-mail: [1]tariqhsp@gmail.com, [2]alwadie@hotmail.com, [3]irfan16.uetian@gmail.com

Abstract - Now a days, Garbage collection management is very important issue for cleaning the environment. The garbage amount is increasing in major cities of the world due to population growth. This garbage contamination into an environment causes a large irreversible effect, absence of order and detriment/distress to the ecosystem. The developing countries and the most populated cities in the world are badly affected by the population growth. Improper garbage disposal causes various issues like health problems, hazards and environment pollution. Proper arrangement and prediction of garbage is necessary to make environment clean and for future counter measures. The garbage management and removal are performing a main role to improve the health of the people. The garbage collection management could be performed manually in traditional way as well as by using modern technologies. This paper presents a modern garbage management, prediction and collection system using Internet of Things (IoT). The proposed system would be based on smart dumpster that contains an ultrasonic ranging module for the garbage level detection, a infrared (IR) flame sensor to detect flame in the dumpster, Arduino UNO, SkyNav GPS Module for getting GPS coordinates and a GSM SIM 900D module to send the alert SMS to the concerned authorities. The weight sensor is used to measure the total garbage in the dumpster on daily basis to made prediction for future collection and planning. The system sends alert SMS when it detects any change along with the dumpster location coordinates with the help of GSM module.

Keywords - Ultrasonic Ranging Module; Detect Flame Sensor; SMS Alert; GSM Module; ARDUINO UNO.

I. INTRODUCTION

The rapid growth in garbage production is a big challenge for the more populated countries, especially in large cities. The huge amount of garbage has to be collected on daily basis. To deal and collect this huge amount of garbage manually is a challenging task and required high level management. A lot of resources are needed to deal with huge data to collect and dump. This is also very complicated to predict the future garbage collection trends. Therefore, a technological and smart system are needed to handle such kinds of issue in the large cities. This study presents the new system design which enable the way to check the filling level of dumpsters and monitoring efficiently through IoT devices. It also helps to predict the future collection of garbage in specific areas, which helps the management to make proper planning and decision. There are different communication and information technologies such as Radio Frequency Identification (RFID), Geographic Information System (GIS), Geographic position System (GPS) and various transportation model being applied for dumpster monitoring and as well as garbage collection [1]. The proposed garbage collection and monitoring level system in this paper demonstrates a prototype that can be integrated into the municipal waste management system. The Arduino UNO, GSM module with SIM 900D, GPS, Opt couplers, LCDs and different types of sensors are user in the proposed system for waste management. The garbage level in the dumpster is detected with help of ultrasonic sensor and weigh of garbage is measure by using weigh sensor. The system detects three different levels of garbage such as empty, half and full. The IR flame sensor is also placed in the dumpster to get an alert about the fire in the garbage.

Rest of the paper is organized as, section ii presents the related work, system design is collaborated in section iii, in section iv, garbage prediction model, comparison and conclusion are given in section v and vi respectively.

II. RELATED WORK

In [2][3], the authors proposed the system to monitoring the garbage bins remotely. The design systems were comprised and integrated with Zigbee, GSM and other communication modules. The different kind of sensors were used installed on the garbage bins located on different public places to monitor the bins. The used sensor sends an indication to the controller when bins reaches the set threshold of sensors. The controller is responsible to send an alert to the vehicle drivers which bins bis got filled. These alert messages send to truck drivers via using GSM technology. It is very important for the societal concerns to understand the increase rate of resource consumption and waste production. Therefore, the management officials and policy makers must

encourage recycling and reuse the waste material to fulfill the raw demand and save the landfill [5], [6]. The authors proposed system in [7][9][10] which is an integrated system that consist Radio Frequency Identification (RFI), GPS, GIS and web camera. The claim the solution of solid waste management and collection. This system is eased to use and install as per the claim of the authors. The solid waste management and current system management activities are categories in [11][12] [13] [14] [15]. They have explained few suggestions for the authorities of municipal solid waste management (MSWM) to improve the system and work towards the future. This study also helpful to overcome the trouble municipality issues and provide the better services to the community. The proposed systems are described in [16][17][18], to detect the garbage level in the dustbins with the help of ultrasonic sensor. The microcontroller is used to interface the hardware components. The system detects the level of bins and communicated to the control room and concern authorities through GSM system. The authors also developed the graphical web interface to monitor the desire information from bins that are located on different places by using GUI environment and mobile application. It makes the system more efficient to manage the garbage collection and monitoring. A new concept of IoT based smart system and smart bins for large city to collect and dump the waste material was introduce in [19][20][22][23]. The cellular mobile and wireless networks are used to connect the smart bins to handle the large amount of generated garbage data. It also helps further to analyze and visualization of real time data of the connected bins and share this information on different remote places. This information is helpful to take proper and required action to save big losses. This paper also provides the future directions for the solid waste management and control system.

III. SYSTEM DESIGN

The design of proposed system which consists of the sensors such as ultrasonic level sensor, flame sensor and weight sensor along with microcontrollers, GSM module and GPS module has been shown in Figure 1. The system can detect the level of garbage, fire and garbage weight in the dumpster with the help of relevant equipped sensors system and communicated to the authorized person through GSM system and other communication devices. The Arduino is used as microcontroller to provide the interface between different sensors and modules like GPS and GSM. The mobile is used to receive the notification and different alerts about the dumpster status. The google maps is used as a web interface to view the position of the dumpsters and to find out the shortest efficient path for garbage collection. The goal is to monitor the smart dumpsters and timely collection of garbage and wastes in them.

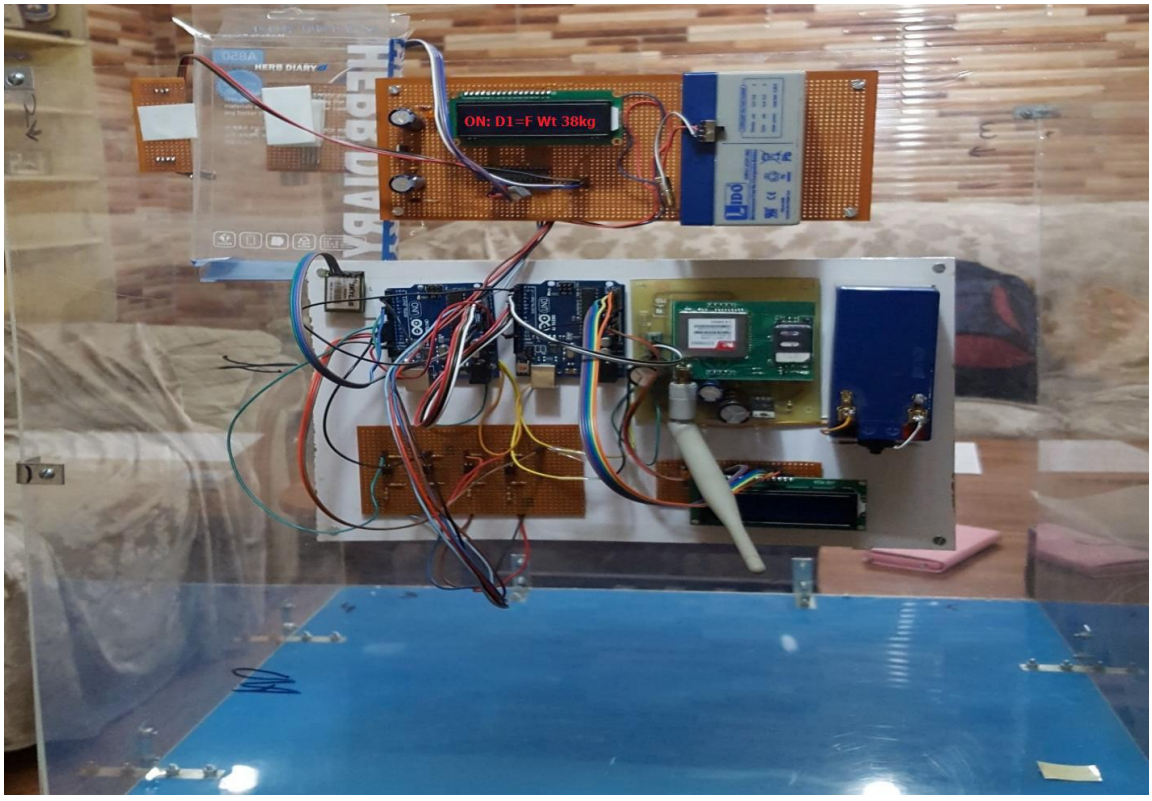


Figure 1: Prototype design

The Figure 2 presents the overall working of the proposed system. The system get initialization by using power battery and all modules becomes functional. The sensing status send as a notification through GPS and GSM modules. The Arduino receive signal of data when attached sensors start sensing as per their define conditions and parameters.

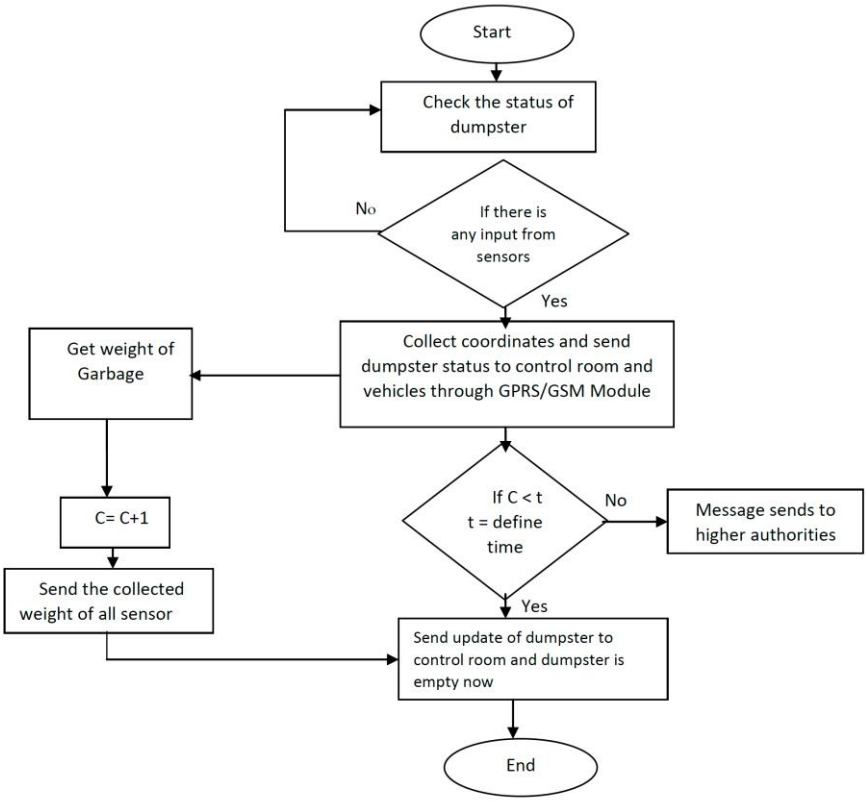


Figure 2: Flow Chart of system design

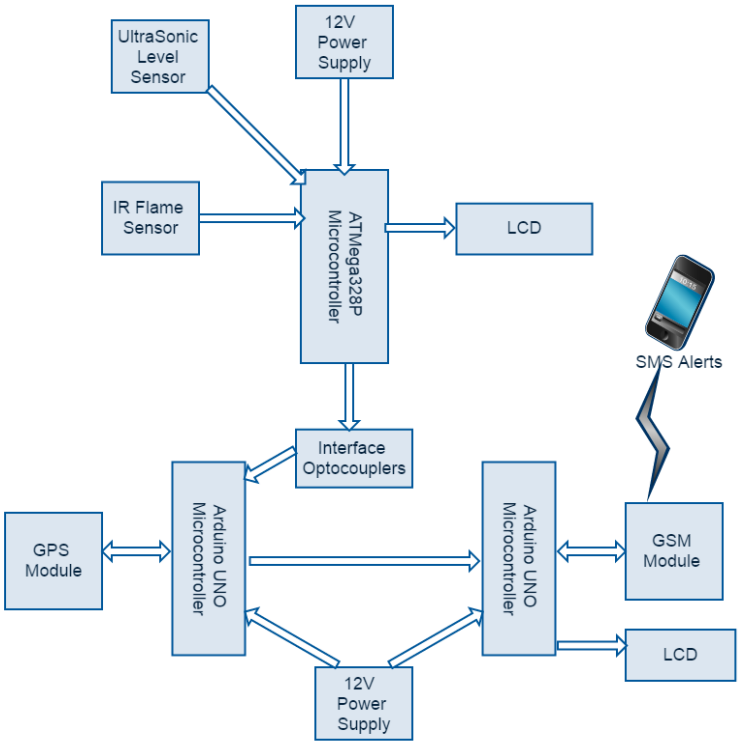


Figure 3: Block Diagram

IV. GARBAGE PREDICTION MODEL

The prediction model is designed to predict the total collection of garbage from the installed dumpsters. The dumpster can contain maximum forty kilograms weight. This model works statics and as well as in dynamic mode. In the statics mode we used the fixed weight of garbage for prediction as dumpster contains forty KG. In the dynamic mode, the weight sensor gets the actual weight of garbage from each dumpster and send it to the controller for further processing.

A. Static Model

The garbage weight collected from all dumpsters is calculated as in equation (1).

Total Garbage = wd*td*C (1)

wd= Garbage weight of one dumpster
td= Total number of dumpsters
C= attempt for garbage collection

We have predicted the total garbage collection in static mode by using collected data monthly and yearly. The volume of data varies as number of attempts are increasing to make the dumpster empty. We use two number of attempts daily to collect the garbage from each dumpster. We have used fix number of days in a month and two number of dumpsters are taken as a sample case for future prediction of garbage generation. Therefore, the collected garbage weight in a month can calculated as in equation (2)

Total Garbage = wd*td*2*30 (2)

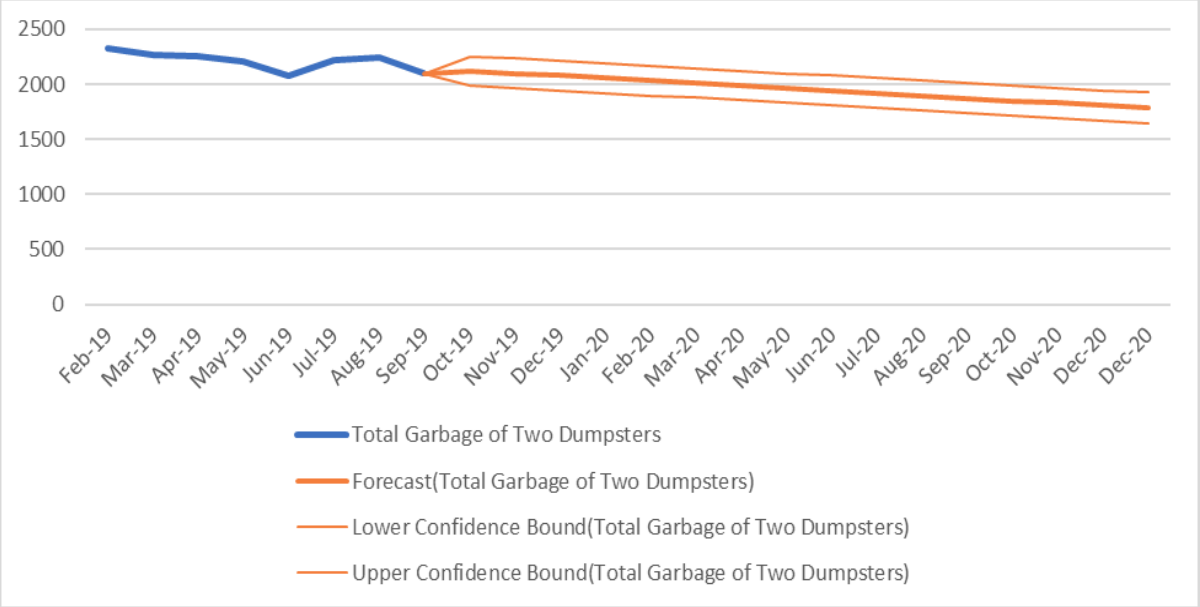


Figure 5 : Garbage collection of two dumpsters till december 2020

Figure 5 presents the trend of garbage generation and collection from two dumpsters. It shows that garbage collection increase as number of attempts to make the dumpster empty increases.

B. Dynamic Model

Number In the dynamic mode the weight sensors received the sense data from the dumpsters and send it to the controller for further processing. The prediction for future garbage collection is made on the received data from the sensors and number of attempts to make the dumpsters empty. We consider n=2 for the data collections and future prediction. Equation 3 presents the prediction detail used in dynamic model.

Dn = total number of dumpsters
di= Received garbage data from all sensors.
C= total number of attempts for garbage collection

Dn= d1+d2+d3……..dn
Rd = di+ Dn*C (3)

Total Garbage in dynamic mode = dn*di*2*30 (4)

The data set is prepared based on the equation (4), that is used for data prediction.

Figure 6 presents the trend of garbage collection from the two dumpsters in specific area. For the first few months of 2019, we used estimated data and after that the real data is used that received from the dumpsters. It shows monthly trend of data collection per year.

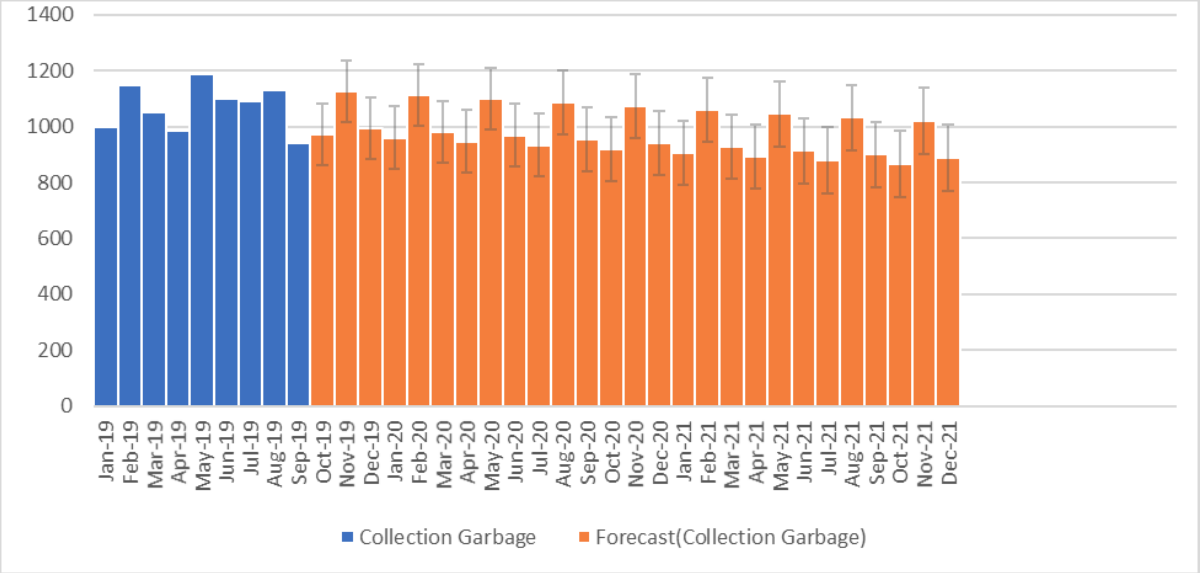


Figure 6: collection garbage forecast for future in dynamic mode

V. COMPARISON

The designed system is compared with other latest well know IoT based garbage management and monitoring system. The comparison is performed based on major hardware used and some performance measures like cloud data storage, Future data prediction and fire detection. Further, this comparison can provide the help to new researchers and academia research projects. Table 3 shows the comparison of designed system and components used to integrate these systems and their facilities.

Project name	H/W components	S/W and languages	Cloud data storage	Local data storage	Future Data Prediction	Fire Detection
Proposed System in this paper	Sensors, Arduino Microcontroller, GSM/GPS/GPRS module, IoT devices, Wi-Fi	Lab view, Java and C++, and other relevant software	Yes	yes	Yes	Yes
Solid waste management in smart cities using IoT [4]	Ultrasonic Sensor, Arduino, GSM Kit, Etc.	Java, C++ and other relevant lab test software	Yes	No	No	No
Automation of Smart waste management using IoT to support [21]	Ultrasonic Sensor, Arduino, GSM Kit,	Java, C++ and other relevant lab test software	No	Yes	Yes	No
iot based waste management for smart city [8]	Ultrasonic Sensor, Arduino, GSM Kit,	Java, C++ and other relevant lab test software	Yes	Yes	No	No

Table 3: Comparison between proposed system and other existing well know system

VI. CONCLUSION

The real time smart dumpster monitoring and garbage collection system is proposed in this paper. The level sensor is used to check the filling level of smart dumpster whether it is full or not. This system can provide the information from anywhere. The authorized person can access this information and can take on time decision to accordingly. This system helps to reduce traffic and helpful to make the city clean and healthy.

It also helps to the management to take counter measure for future production of garbage in specific area based on prediction of collection data. The

municipal vehicles visit the city to collect the garbage multiple time depend on the population of the city. Sometime these vehicles visit the dumpster places unnecessarily without have information either dumpster is full or empty. This is wastage of time and fuel and as well as the create rush on the road. The proposed system will inform the status of dumpsters to the concern persons in real time and pinpoint the area of dumpsters which is full by using GPS coordinates. The system can also provide the shortest and precise route toward the filled dumpsters. Based on this information the vehicle can visit only those places where dumpsters are full. In this way the management can save the maximum time, fuel and as well as reduce the traffic on the roads.

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REFERENCES

[1] Kanchanmahajan, "waste bin monitoring system usingintegrated technologies", international journal of innovative research in science,engineering and technology, issue 3 ,issue 7 , july 2014.

[2] M. Al-maaded, n. K. Madi, ramazan kahraman, a. Hodzic, n. G. Ozerkan , an overview of solid waste management and plasticrecycling in qatar, springer journal of polymers and the environment, march 2012, volume 20, issue 1, pp 186-194.

[3] Raghumani singh, c. Dey, m. Solid waste management of thoubal municipality, manipur- a case study green technology andenvironmental conservation (gtec 2011), 2011 international conference chennai 21 – 24

[4] Vikrant bhor, "smart garbage management system" international journal of engineering research & technology (ijert),vol. 4 issue 03, march-2015.

[5] Narayan sharma,, "smart bin implemented for smart city",international journal of scientific & engineering research, volume 6, issue 9, september-2015

[6] Jose m. Gutierrez, michael jensen, morten henius and tahir riaz, "smart waste collection system based on location intelligence",complex adaptive systems, publication 5 cihan h. Dagli, editor in chief conference organized by missouri university of science and technology 2015-san jose, ca

[7] Parkash, prabu v,"iot based waste management for smart city", international journal of innovative research in computer and communication engineering (an iso 3297: 2007 certified organization) vol. 4, issue 2, February- 2016.

[8] Kansara, K., Zaveri, V., Shah, S., Delwadkar, S., & Jani, K. Sensor based automated irrigation system with IOT: a technical review. International Journal of Computer Science and Information Technologies, 6(6), 2015, pp 5331-5333.

[9] Tapashetti, A., Vegiraju, D., & Ogunfunmi, T. IoT-enabled air quality monitoring device: A low cost smart health solution. In 2016 IEEE Global Humanitarian Technology Conference (GHTC), 2016, (pp. 682-685). IEEE.

[10] Kelly, S. D. T., Suryadevara, N. K., & Mukhopadhyay, S. C. Towards the implementation of IoT for environmental condition monitoring in homes. IEEE sensors journal, 13(10), 2013, 3846-3853.

[11] Kim, K. J. Interacting socially with the Internet of Things (IoT): effects of source attribution and specialization in human–IoT interaction. Journal of Computer-Mediated Communication, 21(6), 2016, 420-435.

[12] Pavithra, D., & Balakrishnan, R. IoT based monitoring and control system for home automation. In 2015 global conference on communication technologies (GCCT)(pp. 169-173). IEEE.

[13] Mitton N., Papavassiliou S., Puliafito A., Trivedi K. S., Combining Cloud and sensors in a smart city environment, EURASIP Journal on Wireless Communications and Networking, 2012:247, 2012

[14] Insung Hong, Sunghoi Park, Beomseok Lee, Jaekeun Lee, Daebeom Jeong, and Sehyun Park, "IoT-Based Smart Garbage System for Efficient Food Waste Management," The Scientific World Journal, vol. 2014, Article ID 646953, 13 pages, 2014

[15] M. A. Hannan, Md. Abdulla Al Mamun, Aini Hussain, Hassan Basri, and R. A. Begum, "A review on technologies and their usage in solid waste monitoring and management systems: Issues and challenges," Waste Management, vol. 43, pp. 509–523, 2015

[16] Hu, L., & Ni, Q. IoT-driven automated object detection algorithm for urban surveillance systems in smart cities. IEEE Internet of Things Journal, 5(2), 2017, 747-754.

[17] Ms. Ankita Khedikar, Ms. Monika Khobragade, Ms. Neha Sawarkar. "GARBAGE MANAGEMENT OF SMART CITY USING IOT" International Journal of Research In Science & Engineering e-ISSN: 2394-8299 Volume: 3 Issue:2 March-April 2017.

[18] P Surapaneni, L Maguluri, P, M Syamala" Solid waste management in smart cities using IoT" International Journal of pure and applied mathematics, volume 118, issue 7, p. 635 – 640, 2018

[19] Bharadwaj B, M. Kumudha, Gowri Chandra N and Chaithra G, "Automation of Smart waste management using IoT to support "Swachh Bharat Abhiyan" - a practical approach," 2017 2nd International Conference on Computing and Communications Technologies (ICCCT), Chennai, 2017, pp. 318-320.

[20] Prof. S.A. Mahajan, Akshay Kokane, Apoorva Shewale, Mrunaya Shinde , Shivani Ingale, "Smart Waste Management System using IoT" International Journal of Advanced Engineering Research and Science (IJAERS) [Vol-4, Issue-4, Apr- 2017].

[21] Kasliwal Manasi H, Suryawanshi Smitkumar, "A Novel Approach to Garbage Management Using Internet of Things for Smart Cities" International Journal of Current Trends in Engineering & Research (IJCTER) e-ISSN 2455–1392 Volume 2 Issue 5, May 2016 pp. 348 – 353.

[22] Gope, P., Amin, R., Islam, S. H., Kumar, N., & Bhalla, V. K. Lightweight and privacy-preserving RFID authentication scheme for distributed IoT infrastructure with secure localization services for smart city environment. Future Generation Computer Systems, 83, 2018, 629-637.

[23] Subramaniyaswamy, V., Manogaran, G., Logesh, R., Vijayakumar, V., Chilamkurti, N., Malathi, D., & Senthilselvan, N. An ontology-driven personalized food recommendation in IoT-based healthcare system. The Journal of Supercomputing, 75(6), 2019, 3184-3216.

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