



International Journal of Emerging Technologies in Computational and Applied Sciences (IJETCAS)

(Open Access, Double Blind Peer-reviewed, Refereed and Indexed Journal)

www.iasir.net

Smart Waste Management: An innovative approach to waste disposal and waste collection

Tarandeep Singh¹, Navreetinder Kaur²
P.G. student, Dept. of Electronics and Communication
PEC University of Technology
Sector 12, Chandigarh, India

Abstract: In a large portion of the spots, the garbage are not cleaned at appropriate time interims which results in flooding of waste bringing about cleanliness issues, land contamination; additionally it makes a bad impact to the look of that place. This demonstrates the requirement for a framework that screens the status of the garbage bin and gives data to the concerned people to deal with the collection interims for cleaning the waste. A solution to this problem is proposed in this paper in the form of a 3 tier waste management system: Garbage bin, remote gateway and monitoring station. A method to differentiate 5 types of non-biodegradable plastic resins and using rest of the biodegradable waste to produce biogas makes this solution a more promising one.

Keywords: Solid waste, X-Bee Pro, NIR spectroscopy, Biogas

I. Introduction

With the expansion in populace, change in living way of life and expanded number of businesses, the measure of Municipal Solid Waste (MSW) is expanding at a high pace [1]. At present, the measure of solid waste created in urban India is 188,500 tons per day [2]. This sum is relied upon to be twofold by 2025 [1]. This demonstrates the requirement for appropriate waste administration arrangements so that the harmful impacts to nature can be diminished.

The waste administration cycle incorporates the era of the waste from commercial ventures, houses, markets and so on from which the waste is tossed in the garbage bins. This waste is further collected by municipal authorities to at long last dump it in dumping zones and landfills. In any case, because of absence of assets, inadequate foundation, some waste is not gathered which poses serious health hazards to the surrounding environment.

Legitimate cleaning interims may give an answer for this issue. Yet, monitoring the status of the bin physically is an extremely troublesome employment.

II. Related Work

A system based on the integration of RFID and communication technologies like GSM, GIS, and GPRS is proposed in paper [3] [4]. Theoretical algorithms have been proposed for successful hardware implementation. A graphical user interface is displayed for client communication.

A RFID based system has been implemented in paper [6] that uses the weight of the waste collected as a measure for the collection interval and uses RFID technology for identifying the bins that got stolen from their respective places [5].

A WSN based single parameter monitoring system has been proposed by a group of authors. The system is based on Argos mote covering a geographical area of 430 m.

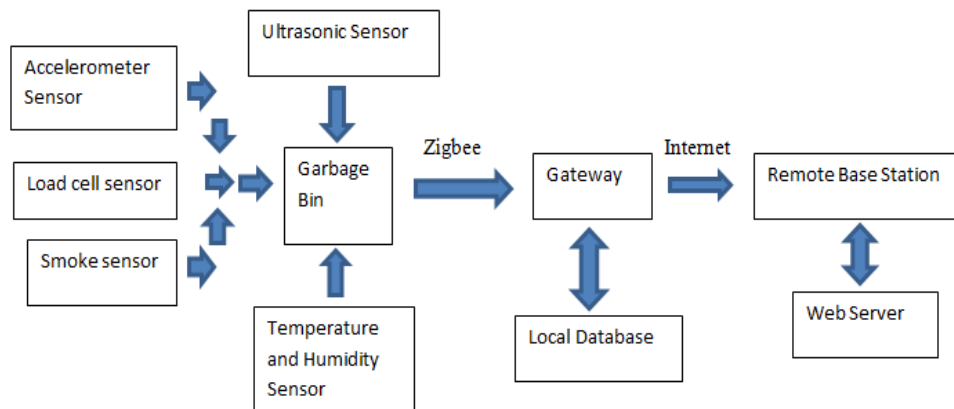
Although technologies like Global System for Mobile Communication (GSM), Geographic Information System (GIS), Radio Frequency Identification Device (RFID) have already been proposed but the cost of data to be transmitted from the garbage bin to one station and then to a remote base station increases the cost in these solutions.

A cost effective framework employing a Wireless Sensor Network (WSN) is proposed in this paper for the transmission of information from the garbage bin to the remote gateway and then to a monitoring station thereby reducing the cost as the data transmission to the remote gateway is free. From this bin, separating plastic resins paves way for biogas generation so that the waste collected can be effectively used.

III. Smart Waste Collection System

The proposed framework is a 3 tier system namely A) Garbage Bin, B) Remote Gateway and C) Monitoring station as shown in Fig. 1.

Fig. 1 Block Diagram of the proposed Smart Waste Management System



Garbage Bin

The sensor node attached to the bin helps in the collection and transmission of data. The sensor node is divided in 2 groups. The first group consists of

- Load cell sensor- measures the weight of waste inside the bin
- Smoke sensor- activates an alert if due to any reason, a fire mishappening occurs inside the bin
- Accelerometer sensor- checks the opening/ closing of the lid
- Temperature and Humidity sensor- keeps track of the temperature and humidity inside the bin; two parameters that become important when storing biodegradable waste.
- Ultrasonic sensor- measures the filling of the bin

The second group consists of an X-Bee Pro that acts as a transmitter to send the collected data to the remote gateway.

Remote Gateway

At the gateway is an X-Bee Pro that acts as a receiver to receive the transmitted data so that it could be stored in the local database. This data is further transmitted to the control station with the help of internet.

Monitoring Station

The central server that hosts the Data Base Management System (DBMS) and the database is present at the control station. A web based user interface is present for user interaction with the system. The data from here is fed to programs like data parsing programs, route optimization systems and scheduling applications.

IV. Smart Waste Disposal System

The Waste Disposal System should be such that it generates something useful from the waste collected. An effective use of waste is in generating biogas which can only be produced from biodegradable waste. This requires the separation of other non-biodegradable waste from the collected waste. As plastic is one the major constituents of waste which cannot be decomposed but can be recycled, a method is discussed in this section to separate plastic from the collected waste and thereby producing electricity from the rest of the waste.

A. Separation of Plastic Resins

Once the waste collection process is over, the separation of plastic from the biodegradable waste becomes an important aspect. Recycling and segregation of plastic resins has remained a complex job for all the governments across the world [7].

The major 5 plastic resins include polypropylene (PP), high density polyethylene (HDPE), polyethylene terephthalate (PET), polystyrene (PS) and polyvinyl chloride (PVC) On the basis of density, manual sorting techniques include hydrocyclone (referred as cyclone in short) and float/sink tank [8]. On account of the color [9, 10] and type [11, 12], optical spectroscopy can be used. Also electrostatic sorting can be used to differentiate different types of polymers [13]. X-rays can be used for automatic sorting but there are safety issues [14].

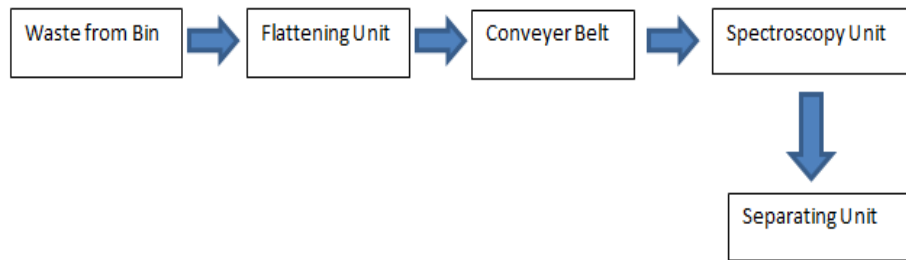
The NIR spectroscopy technique classifies plastics into 5 major types. The samples are flattened before feeding to the NIR which reduces rolling and other movements on the conveyer belt [15].

The block diagram shown in Fig. 2 gives a view on the separation process of plastic using NIR spectroscopy.

The NIR spectroscopy covers a range of 700 to 2500nm [14]. There are few limitations associated with this technique:

- This technique is not applicable for black color plastic surface.
- The detection whether the bottles have plastic cover or cap is not possible with this technique.

Fig. 2 Separation of Plastic using NIR Spectroscopy



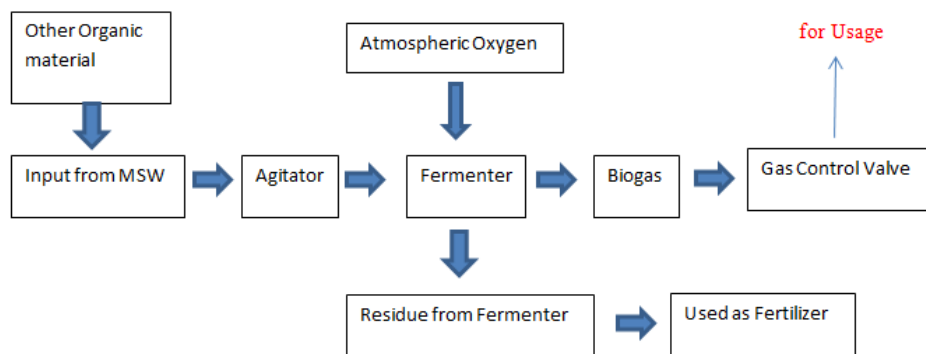
B. Biogas Generation System

The renewable raw materials and other organic waste are a source of Biogas. This gas can be stored and continuously produced and can be used to produce electricity and heat.

The Waste to Biogas Generation System discussed in this section is shown in Fig. 3 [16]. The waste materials after separation of non-biodegradable waste can be kept in a closed area. Other agricultural and organic waste can be mixed to it. Since the municipal solid waste may contain byproducts of food waste, the processing of this waste before feeding to fermenter becomes important. To kill the bacteria in MSW, the waste is heated up to 1 hour using a heat exchanger. With the help of conveyer belt, the waste can be added to the fermenter. Also slurry can be formed from this waste by adding liquid waste to it. A homogeneous mixture is formed by mixing the materials in an agitator. This process can be performed every hour. After the formation of a uniform mixture, the materials are pumped to fermenter with the help of a macerator which is required so that any impurity might not enter the fermenter. The process that takes place inside the fermenter is a closed atmospheric process where no oxygen can enter by itself. Biogas is produced with the help of bacteria that help in the breakdown of the materials in to individual enzymes and other components. The average fermentation process takes about 60-70 days and the temperature required for fermentation is about 308.5 to 311.5 kelvin. The low expenditure and high level of efficiency makes this process an advantageous one.

The leftover material in the fermenter can be used as high quality fertilizer. The biogas can be accumulated and stored through a gas valve where the gas is constantly dehydrated and cooled. The flow of the gas can also be controlled through this valve.

Fig. 3 Biogas Generation System [16]



V. Conclusion

Through this paper, a conceptual approach to a smart waste management system beginning from smart solid waste collection system to solid waste disposal system is proposed. The status of the bin is continuously monitored at the control station and this collected data from the bin helps in the optimization of routes for the collection trucks so that the efficient use of resources can take place in the waste management system proposed. The NIR spectroscopy technique helps to solve the plastic separation problem and provides biodegradable material in the production of biogas. This complete system can help in the Waste Management problem we are facing and also help produce a renewable energy source.

References

- [1] Hoornweg, D., & Bhada-Tata, P., The World Bank: What a Waste- A Global Review of Solid Waste Management, Urban Development & Local Government Unit, World Bank , 1818 H Street, NW , Washington, DC 20433 USA, 2012.
- [2] The Kachhra Project <http://thekachraproject.in/infographic-municipal-solid-waste-msw-in-india/> accessed on 2-Mar-2016.

- [3] Arebey, M., Hannan, M. A., Basri, H., & Abdullah, H., "Solid Waste Monitoring and Management using RFID, GIS and GSM", in Research and Development (SCORED), IEEE Student Conference, pp. 37-40, 16 Nov 2009.
- [4] Hannan, M. A., Arebey, M., Begum, R. A., & Basri, H., "Radio Frequency Identification (RFID) and Communication Technologies for Solid Waste bin and Truck Monitoring System", in Waste management, 31(12), pp. 2406-2413, 31 Dec 2011
- [5] Chowdhury, B., & Chowdhury, M. U. "RFID-based Real-Time Smart Waste Management System" in Telecommunication Networks and Applications Conference (ATNAC), IEEE, pp. 175-180, 2 Dec 2007
- [6] Longhi, S., Marzioni, D., Alidori, E., Buò, G. D., Prist, M., Grisostomi, M., & Pirro, M. "Solid waste management architecture using wireless sensor network technology" in New Technologies, Mobility and Security (NTMS), 5th International Conference, IEEE, pp. 1-5, 7 May 2012
- [7] Zhuang, Y., Wu, S. W., Wang, Y. L., Wu, W. X., & Chen, Y. X., "Source Separation of Household Waste: a Case Study in China", in Waste Management, 28(10), pp. 2022-2030, 31 Dec 2008
- [8] Enick, R., "The Microsortation of Post-Consumer Thermoplastics using Near Critical Liquids" proc. Globec 96, Davos, Switzerland, pp. 18-25, 1996
- [9] Safavi, S. M., Masoumi, H., Mirian, S. S., & Tabrizchi, M., "Sorting of Polypropylene Resins by Color in MSW using Visible Reflectance Spectroscopy", in Waste management, 30(11), pp. 2216-2222, 30 Nov 2010
- [10] Tachwali, Y., Al-Assaf, Y., & Al-Ali, A. R., "Automatic Multistage Classification System for Plastic Bottles Recycling", in Resources, Conservation and Recycling, 52(2), pp. 266-285, 31 Dec 2007
- [11] Scott, D. M., "A Two-Colour Near-Infrared Sensor for Sorting Recycled Plastic Waste", in Measurement Science and Technology, 6(2), p. 156, 6 Feb 1995
- [12] Sommer, E. J. J., "Methods and Technologies for Post-Consumer Plastic Identification and Sorting", in Proceedings of the Technology the Spark in Recycling, Society of Plastics Engineers (SPE) Annual Recycling Conference, pp. 7-8, Nov 1996
- [13] Inculet, I., "Electrostatic Separation of Mixed Plastic Waste", Proc. Davos 92 Recycle, 1992
- [14] American Plastic Council. "Best Practices in PET Recycling, Automated Sorting System" NAPCOR, 1997.
- [15] Masoumi, H., Safavi, S. M., & Khani, Z., "Identification and Classification of Plastic Resins using Near Infrared Reflectance Spectroscopy", World Academy of Science, Engineering and Technology, International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering, 6(5), pp. 877-884, 22 May 2012
- [16] Thakker, S., & Narayanamoorthi, R., "Smart and Wireless Waste Management", in Innovations in Information, Embedded and Communication Systems (ICIIECS), pp. 1-4, 19 Mar 2015