A New Smart Waste City Management

Dung D. Vu

Electrical Engineering Department,
École de Technologie Supérieure (ETS)
Montréal, Quebec, Canada.
Email: do-dung.vn.1@ens.etmstl.ca

Georges Kaddoum

Electrical Engineering Department,
École de Technologie Supérieure (ETS)
Montréal, Quebec, Canada.
Email: georges.kaddoum@etsmtl.ca

***Abstract*—This paper presents a new method of smart waste city management to provide a clean and hygienic environment to the city residents with a low cost. In this approach, the sensor model is used to read, collect, measure, and transmit waste volume data over the Internet. This data put into a spatio-temporal context and processed by regression, classification, and graph theory. Thenceforth optimization algorithm is used to dynamically and efficiently manage the waste collection. The new method proposed in this work predicts, classifies, and monitors the hazard and amount of waste, respectively. Then, it recommends the priority and optimization of the route to manage the garbage truck efficiently. Finally, to visualize the performance of this method, simulation results are proposed and estimated.**

1. Introduction

A smart city is an urban development vision to integrate information and communication technology (ICT) and Internet of things (IoT) technology which is the way of becoming the next technological revolution [1] in a secure fashion to manage a city's assets. IoT is a framework in which all things have a representation and a presence in the Internet. More specifically, the IoT aims at offering new applications and services bridging the physical and virtual worlds, in which Machine-to-Machine(M2M) communications represents the baseline communication that enables the interactions between things and applications in the cloud such as environment monitoring [2] [3], object tracking [4], traffic management [5], health care [6], and smart home technology [7] [8]. Organizations can use IoT to drive considerable cost savings by improving asset utilization, enhancing process efficiency and boosting productivity. IoT is driven by a combination of forces, including the exponential growth of smart devices, a confluence of low-cost technologies (sensors, wireless networks, big data, and computing power), pervasive connectivity and massive volumes of big data. IoT and big data basically are two sides of the same coin. An IoT device generates continuous streams of data in a scalable way and companies must handle the high volume of stream data and perform actions on that one. The actions can be event correlation, metric calculation, statistic preparation, and analytic. In a normal big data scenario, the data is not always stream data, and the actions are different. In the smart city, waste management is a crucial point for the living environment, and its quality is considered seriously. A possible Smart waste city management system requires a way to cluster the area of trash bin, detect the status of waste in each bin, and a way to process this data. The result of this work will be a valuable input data for the garbage truck management system which can be used to calculate the most optimal route to prevent the hazard of damage, pollution of waste, and resource consumptions.

To manage the waste of a smart city, a system incorporates a model for data sharing between truck drivers in the real time to perform garbage collection, and dynamic route optimization was proposed in [9]. A waste collection solution based on providing intelligence of trash cans including sensors and IoT prototype, which can read, collect, and transmit trash volume data via wireless network was proposed in [10] [11]. This data put into a spatio temporal context and processed by graph theory optimization algorithms that is used to dynamically and efficiently manage waste collection strategies. An adaptive large neighborhood search algorithm for finding optimal cost routes of garbage trucks such that all trash bins are emptied, and the waste is driven to disposal sites while respecting customer time windows is presented in [12]. An improved dynamic route planning is discussed in [13] where the authors enhanced a guided variable neighborhood threshold meta-heuristic adapted to the problem of waste collection. On the other hand, the most important part of a waste management system is the smart bin [14] [15] [16] which collect the data of waste by using sensor and send them over the internet to the server for monitoring the volume of waste. While the network of ultrasonic sensors enabled smart bins connected through the cellular network generates a large amount of data, which is further analyzed and visualized at real time to gain insights about the status of waste around the city [14], a Smart waste management with self-describing objects can detect the kind of waste based on its Radio-frequency identification (RFID) information [15]. However, they don't know the hazard of each bin such as explosion or flame from the bottle of perfume, chemistry, batteries, and electronic wastes. In [16], a hazard detection method was proposed to detect and prevent these issues. Hence, a waste city management process was conducted by an optimal routing garbage truck algorithm based on a given status of the smart bin. We observed that citizens in the city tend to throw their waste into the bins without a certain time of a day. Therefore, a method for predicting the status of each bins will help the city's waste management system to operate more efficiently.

Contributions: This paper presents a new method of smart waste city management to provide a clean and hygienic environment to the city resident. In this approach, each collected data from the recycle bin has been transferred over the Internet to the server which contains the location and status of each bin, respectively. The proposed method is a new smart waste city management which process data from N bins to improve the efficient of garbage truck route. The contributions of this paper are summarized as follows:

- The number of working clusters in each city are optimize and the location of recycle bins are classified automatically.
- A regression algorithm is applied to predict the situation of waste which can reduce the overload trash bin phenomenon while the garbage truck is coming.
- Finally, the priority weight of each bin is considered to improve the efficient of garbage truck routing algorithm.

This paper is organized as the followings: In section 2, a new method of smart waste city management (SWCM) is explained and the structure of the algorithm is investigated. Section 3 presents the SWCM simulation model and it's performance which are used to compare with other method to evaluate our approach. Finally, the related concluding remarks are discussed in section 4.

2. IoT-Based Smart waste city management model

2.1. Data acquisition

In this section, we describe how to collect waste meta data associated with their status and locations. We choose to evaluate our model with real big data in order to validate its output.

To obtain a set of waste data, we use an open source database, [1] which has a significant amount of geo-location information and status of each bin at the largest city in the Commonwealth of Pennsylvania in the United Stated named Philadelphia. We removed the content that was automatically created by stream type service. For data analysis, we adopt the following five essential fields from this meta data:

- *sn*: Serial number of each bin
- *timestamp*: Milestone of recording data
- *level*: The amount of waset in each bin at the given timestamp
- *lat*: The latitude of each bin
- *lon* The longitude of each bin

1. https://www.opendataphilly.org/dataset

We observed that the original system has three levels of bin such as RED, YELLOW, and GREEN. So we tend to assume that the levels of bin should be HIGH, MEDIUM, and LOW, respectively.

2.2. System description

2.2.1. Subsubsection Heading Here. Subsubsection text here.

3. Conclusion

The conclusion goes here.

Acknowledgments

The authors would like to thank...

References

[1] F. C. Delicato, P. F. Pires, T. Batista, E. Cavalcante, B. Costa, and T. Barros, *Towards an IoT eco-system*, In the Proceedings of the 1st ACM International Workshop on Software Engineering for Systems-of-Systems, SESoS13, 2013, pp. 25–28.

[2] M. T. Lazarescu, *Design of a WSN platform for long-term environmental monitoring for IoT application*, IEEE Journal on Emerging and Selected Topics in Circuits and Systems, Volume 3, Number 1 (2013): 45–54.

[3] S. D. T. Kelly, N. K. Suryadevara, and S. C. Mukhopadhyay, *Towards the implementation of IoT for environmental condition monitoring in homes*, IEEE Sensors Journal, Volume 13, Number 10 (2013): 3846–3853.

[4] K. Gama, L. Touseau, and D. Donsez, *Combining heterogeneous service technologies for building an internet of things middle-ware*, Computer Communications, Volume 35, Number 4 (2012): 405–417.

[5] L. Foschini, T, Taleb, A. Corradi, and D. Bottazzi, *M2M-based metropolitan platform for IMS-enabled road traffic management in IoT*, IEEE Communications Magazine, Volume 49, Number 11 (2011): 50–57.

[6] A. J. Jara, A. Zamora, and A. F. G. Skarmeta, *An internet of things-based personal device for diabetes therapy management in ambient assited living (AAL)*, Personal and Ubiquitous Computing, Volume 15, Number 4 (2011): 431–440.

[7] S. Tozlu, M. Senel, W. Mao, and A. Keshavarzian, *Wi-Fi enabled sensors for internet of things: A pratical approach*, IEEE Communications Magazine, Volume 50, Number 6 (2012): 134–143.

[8] X. Li, R. Lu, X. Liang, X. Shen, J. Chen, and X. Lin, *Smart community: An internet of things appilication*, IEEE Communications Magazine, Volume 49, Number 11 (2011): 68–75.

[9] A. Medvedev, P. Fedchenkov, A. Zaslavsky, T. Anagnostopoulos, and S. Khoruzhnikov, *Waste management as an IoT enabled service in smart cites*, 15th ed, St. Petersburg, Russia: Internet of Things, Smart Spaces, and Next Generation Networks and Systems, 2015, pp 104–115.

[10] J. M. Gutierreza, M. Jensenb, M. Heniusa, and T. Riaze, *Smart waste collection system based on location intelligence*, Procedia Computer Science 61 (2015): 120–127.

[11] J. Hong, S. Park, B. Lee, J. Lee, D. Jeong, and S. Park, *IoT-based smart garbage system for efficient food waste management*, The Scientific World Journal (2014).

[12] K. Buhrkala, A. Larsena, and S. Ropkea, *The waste collection vehicle routing problem with time windows in a city logistics context*, Procedia Social and Behavioral Sciences 39 (2012): 241–254.

[13] T. Nuortio, J. Kytöjoki, H. Niska, and O. Bräysy, *Improved route planning and scheduling of waste collection and transport*, Expert Systems with Applications, Volume 30, Issue 2 (2006): 223–232.

[14] N. Sharma, N. Singha, and T. Dutta, *Smart bin implementation for smart cities*, International Journal of Scientific & Engineering Research (2015), Volume 6, Issue 9: 787–791.

[15] Y. Glouche and P. Couderc, *A smart waste management with self-describing objects*, The second International Conference on Smart Systems, Devices, and Technologies, 2013, pp 63–70.

[16] A. Sinhan and P. Couderc, *Smart bin for imcompatible waste items*, The ninth International Conference on Autonomic and Autonomous Systems, 2013, pp 40–45.

[17] C.-W. Hsu, C.-C. Chang, and C.-J. Lin, *A pratical guide to support vector classification*, Department of Computer Science and Information Engineering, National Taiwan University, 2003.

[18] P. M. Spira and A. P. On, *Finding and updating spanning trees and shortest paths*, SIAM Journal on Computing 1975 4:3, 375–380.

[19] J. M. Gutierrez, M. Imine, and O. B. Madsen, *Network planning using GA for regular topologies*, Proceedings of IEEE International Conference on Communications, 2008, pp: 5258–5262.

[20] M. B. Ferraro, R. Coppi, G. González, Rodríguez, and A. Colubi, *A linear regression model for imprecise response*, International Journal of Approximate Reasoning Volume 51, Number 7 (2010): 759–770.