Smart Waste Management System For Metropolitan Cities

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Abstract: Indiscriminate disposal of solid waste is a major issue in urban centers of most developing countries and it poses a serious threat to healthy living of the citizens. Access to reliable data on the state of solid waste at different locations within the city will help both the local authorities and the citizens to effectively manage the menace. In this paper, an intelligent solid waste monitoring system is developed using Internet of Things (IOT) and cloud computing technologies. The fill level of solid waste in each of the containers, which are strategically situated across the communities, is detected using ultrasonic sensors. A Wireless Fidelity (Wi-Fi) communication link is used to transmit the sensor data to an IOT cloud platform known as Thing Speak. Depending on the fill level, the system sends appropriate notification message (in form of tweet) to alert relevant authorities and concerned citizen(s) for necessary action. Also, the fill level is monitored on Thing Speak in real-time. The system performance shows that the proposed solution may be found useful for efficient waste management in smart and connected communities.

INTRODUCTION

Now a day Solid waste management (SWM) is the process of collecting, handling, and disposing of no longer in use solid objects that are discarded. In today's world, typical solid waste management includes large outdoor waste bins, waste pickup trucks, and scheduled pickup routine by the related party. Manaf et al. Explain that solid waste is categorized into three categories, each is handled by different authorities. Table 1 shows the categories of solid waste and the related party that's responsible for handling the waste. In a SSWMS, the smart waste bins are integrated with several sensors (e.g., proximity sensor, weight sensor, temperature sensor, etc.). Example of working smart waste bin is produced by ZAN Compute Inc. called Smart Garbage Bin, as patented by Shahabdeen. These sensors then collect related real-time data regarding the solid waste inside the bin before the microcontroller embedded on each bin transfer the data to Cloud servers. Next, the Cloud servers communicate with specially developed mobile-based and/or web-based applications for monitoring and management purposes.This SSWMS is important as its efficiency is proven to be better than the traditional waste management procedures. The aim of this system is to assist the waste management team to carry out their work more efficient in terms of (but not limited to) monitoring, scheduling and cutting operational cost. For example, the implementation of Bigbelly Solar Waste &Recycling System (BSWRS) in smart cities such as Hamburg and New York City has managed to help these cities reducing their number of waste pickups up to 80% while also reducing the waste collection costs around 75%.There is no universal solution on how SSWMS should be planned and implemented as it is a complex task. Therefore, several factors and aspects need to be considered and analyzed. The main purpose of this paper is to gather more relatable information about SSWMS. Next, Section II elaborates related works regarding SSWMS while Section III explains the review process. Result and discussion are reported in Section IV. Finally, Section V concludes the study and states its future work.

OBJECTIVE

The overall objectives of the waste management assessment are (i) to assess the activities involved for the proposed and determine the type, nature and estimated volumes of waste to be generated; (ii) to identify any potential environmental impacts from the generation of waste at the site; (iii) to recommend appropriate waste handling and disposal measures / routings in accordance with the current legislative and administrative requirements; and (iv) to categorise waste material where practicable (inert material / waste fractions) for disposal considerations i.e. public filling areas / landfill.

LITERATURE SURVEY

We did a survey over the possible sources that we could access. In our exploration, we did find the authors.

Authors: M. Mijac, D. Androcec, and R. Picek, “Smart City Services Driven By Iot. The results of this SLR are based on the major indexing databases that are ACM Digital Library, IEEE Xplore Digital Library, Google Scholar, Springer Link Journal and Web of Science. Around 100 literature are found that are related to SSWMS, however, only 25 met the selection. The search process flow of related studies is shown in Figure 3. The trends of articles related to SSWMS from the year 2013 until 2018. The highest number of published related literature found is in the year 2017 with a total of nine papers while the least number of papers published is in the year 2013.

Authors: T. V. Anagnostopoulos and A. Zaslavsky , V. Catania and D. Ventura, M. Lamichhane. Anagnostopoulos &Zaslavsky proposed an effective shortest path selection with the shortest path semi-static and dynamic routing. The effective solid waste collection is proposed to be achieved by both routing models introduced, as they are complemented with sensing abilities through objects connected to the Internet. Semi-static routing is proposed to be implemented when there is no network segment disruption, in contrast, if the disruption of a network segment happens, the dynamic routing model is proposed. Both models are evaluated by the effective threshold, which is time spent, distance covered, fuel consumption and solid waste capacity.A smart waste management system using IoT and blockchain technology called “Thrift and Green” (TAG) is proposed by Lamichhane. The blockchain technology is proposed to be used as a payment channel using custom cryptocurrency due to its nature of high-security measures and lowering massive overhead cost of traditional payment method. Author present the idea of the client paying waste collection service based on the amount of waste disposes instead of paying a fixed price assigned by the service provider. On the other hand, Mware[29] took another approach by proposing a smartbin prototype, specialized for in-house waste management.

Authors: S. Lokuliyana, J. A. D. C. A. Jayakody, L. Rupasinghe, and S. Kandawala. The smart-bin prototype proposed takes gas emission levels and waste current level inside the smart-bin as the parameters over a period. These data are then used to notify users the right time to attend the waste bin besides reporting the average of waste disposal of a household.Next, Catania & Ventura simulated the real-time waste collection

By using an open-source platform called Smart M-3. The Smart M-3 platform has the features to virtualizea real environment, therefore the authors used this platform to simulate the real-time waste collection by implementing weight and proximity sensors, Raspberry PI and Xbee module using the Python language into the platform. Alternative simulation platform, Netlogo, is used by Likotiko et to propose a multi-agent based IoT smart waste monitoring and collection architecture. Netlogo is a multi-agent programmable modeling environment, or in other word, a platform for simulating processes that use a multi-agent model. In the authors' proposed solution, the waste current level in waste bins and waste pickup process by trucks are abstracted to a multi-agent model. The citizens are involved by paying the waste collection services, while a decision algorithm is used to determine the pickup truck optimal route for waste collection using waste data level collected. An IOT framework for waste collection optimization is introduced by Lokuliyana et. The name given in the framework is the IGOE IoT framework, whereas IGOE stands for input, guidance, output and enables which are the outcome of the proposed framework. The framework is divided into three layers which are Data Gathering Layer (DGL), Data Processing Layer (DPL) and Optimization Layer (OL). Furthermore, this framework's scope takes into consideration solid waste disposed at authorized and unauthorized disposal areas, which, for the unauthorized disposal areas, it depends on inputs from the local community. Another proposed solution is given by Giacobbe et. That is called The Big Bucket. In the authors' proposed solution, IoT and cloud technologies are implemented for smart waste management in the smart cities.

Authors: M. Cerchecci, F. Luti, A. Mecocci, S. Parrino, G. Peruzzi, and A. Pozzebon, T. Bakhshi and M.Ahmed, Authors emphasized on implementing the smart waste bin, named as "The Big Bucket" using economical sensors and convenient, open source hardware, software, and tools. The open source IOT platform proposed is Stack4Things platform, an OpenStack extension which it features include managing sensing and actuation resources, controlling nodes remotely while virtualizing their tasks and generating network overlays among them. A similar solution is proposed by Hassan by proposing a smart city service for monitoring and waste collection using low-cost and open source technologies. The proposed system is further divided into five subsystems which are Smart Waste System, Local Station, Smart Monitoring and Controlling, Smart Truck System and Smart Monitoring and Controlling Interface. Omar et al. Also proposed a smart waste management system by utilizing IOT. This system brings together local citizen, waste pickup contractor and local authorities into one system. This system pilot case study has been conducted in Sepang and Kuala Langat, Malaysia in collaboration with local municipal authorities. In their proposed solution, the GSM module is used for communication between smart bins and the system. Furthermore, Mustafa and Ku Azir proposed garbage monitoring system whereas each type of bins (paper, glass, plastic, and waste) are embedded with ultrasonic sensors respectively. These sensors will communicate with ThingSpeak platform in real-time for data storage and analysis. Cerchecci et al proposed an IOT-based Waste Management System architecture using low-powered sensors as its nodes. This architecture design uses LoRa LPWAN (Low Power Wide Area Network) technology in order to reduce energy consumption thus extending the nodes' battery lifespan. The low power architecture is achieved by implementing no electrical grid connection in the smart bin side, instead, the nodes are expected to be running on batteries or energy storing cells such as solar panels. The effectiveness of this proposed architecture is proven in a laboratory environment. However, it is not yet validated in the real-life scenario as the implementation will be dependent on local authorities' and local waste management companies' policies. Finally, Bakhshi and Ahmed introduced a back-end data analytics algorithm to be integrated with the off-the-shelf smart waste management system.