Waste Management System in Smart Cities using IoT: An Overview

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Abstract—*In developing countries due to Increasing population and rapid urbanization, waste generation has become a significant challenge. In India, due to Rapid industrialization and population explosion people migrate from village to the cities, which result in generation of ample amount of Solid Waste. Due to a huge amount of waste thrown everywhere the biggest challenge is the waste management. No proper mechanism for collection and disposal of waste which significantly leads to increase in waste material. Furthermore, various other problems also occurred because of the existing systems which are not only inefficient and inadequate but they also involved non-scientific procedures in the solid waste management. The lack of intelligent technology and the increase of peoples toward big cities used to support the waste management system. It is also seen that at different spots dustbins are set like in open places which are flooding, for example, Industries, healing centers, Instructive Institutes. This flooding of bins creates unhygienic condition which leads to spread of various diseases. In the last few decades, Urbanization has increased tremendously which leads to expansion in waste material and Waste management is a serious issue to be considered. In this paper, an IoT-based smart waste monitoring and solid waste management system is proposed. This system helps to solve the problems associated with management of waste material and the IoT-based waste collection for the smart city.*

Keywords: *Waste management; smart city; IoT; sensor Technologies*

INTRODUCTION

The Internet of Things (IoT) is an advanced technology in which every device is assigned a unique IP address and automatically allocates data over the network without human- computer or human- human interaction. It also provides connectivity of different type of equipment, application, numerous protocols and various services; moreover, IoT is characterized with the vision of heterogeneity [1]. For improving living conditions the important topic now-a-days is of smart city. GOI has taken initiative to set up 100 smart cities. The term smart city is diverse enough and equipped with different innovative technology which includes IT infrastructure, wireless devices, cameras, sensor network, fast network like 5G, and data centers to offer necessary services like water supply, electricity, transportation, sanitation, waste management and recycling etc. [2]. The main concern is the solid waste management in our environment which impacts our society's health and environment. The primary problem of the present era is the detection, management and monitoring of waste material. The traditional way of manually monitoring the wastes in waste bins requires huge time and cost and human effort, which can easily be avoided with our present technologies.

The Problem

In the recent decades, Urbanization has increased tremendously. There are number of house and apartments built in the rapid urbanization area due to high demands of housing raised as a result of which migration increased from villages to cities to find work and to accommodate in the urban area. In the meantime there is an expansion in waste creation and disposal of solid waste. The overflowing of garbage might cause diseases like cholera and dengue.

A smart city directly includes smart waste management system. The inorganic and organic waste produced from commercial or household activities and the major sources of waste material are collected from household and the only way to collect household waste is the dustbins or the garbage bins which are also placed in front of societies or public places which are sometimes overfull due to the increase in the waste material every day and no such proper management of waste material which leads to serious health hazards and various diseases and also surrounding environment is polluted [4]. To safeguard the environment we require a system that sends the prior alert information to the concerned authority about the filling of the dustbin so that the cleaning of the bin is done on time. Moreover, city consists of offices, market,

societies and institutions, small or large scale homes [3]. The society and city can be smart if it includes the following component like water saving, energy saving, waste management, and environment saving etc.

The rapid urbanization, population growth and the economic development and the rise in the standard of living in developing counties are major causes of generated waste [5]. The smart city major component is the smart waste management system in which the waste can be collected and organized through sensors and the dynamic and optimal routing for waste management is performed on the basis of bin fill level.

RELATED WORK

The author developed a monitoring system with GSM, which informs about the dustbin whether it is completely filled or not so that it can send SMS to the municipal authority to send the truck for the collection of garbage and also the ultrasonic sensor are used which are used to sense the level of garbage in the bin and the GSM module was used for messaging purpose which gives information about the status of the bin whether it was filled or cleaned. [Anwar, Md Aasim 2018] [6].

An Arduino UNO board with GSM module for the collection of waste and ultrasonic sensor are used which are used to sense the level of garbage in the bin was proposed and the author concluded the overall paper with the issues of smart dustbin like affordability, durability, maintenance. [Monika, K. A., et al. 2016] [7].

In the inaccessible areas of the city the waste management deals with the collection of garbage by using camera. Machine learning plays powerful and important role in making decisions and take actions based on data, identifying the specific pattern and also in analyzing the vast amount of data from the sensors used in various IoT devices, wearable gadgets and smart technologies. [Jetendra et. al. 2016] [8].

For smart city waste management not only collection of waste and disposal of waste important but also proper reduce, reuse, and recycle and collection and segregation, of waste material are equally important. Household products must be managed appropriately because they also release toxic gases into the air due to no proper disposal of paints, car oil, batteries, pesticides, etc. and the food waste also leads to production of hazardous gas like methane. Therefore, household waste management is still a problem of concern. [Ankidawa, Buba 2013] [9].

The author proposed a system for waste management based on multi agent whose data is collected from various villages and cities. Using the wireless sensors technology the system also measures the volume of the containers based at a low cost. In this research a system for optimized route and a mobile application for trucks are also proposed. They also proposed a case study which identifies the limitations of the system. [Murciego et. al. 2015] [10].

The author proposed the advanced Decision Support System for efficient waste management in smart cities. It also manages the optimization of routes and data sharing between truck drivers and also has access to the waste material from inaccessible areas. [Medvedev et. al. 2015] [11].

In this paper the concept of smart bin is discussed which identifies the level of garbage bin when bin are filled. Due to the use of duty cycle technique in this paper the power consumption is reduced and the operation time is maximized. The research is tested in the outdoor environment and the test depicts the utilization of dust bins and provides such information through better decision making and which increases performance and productivity. [Folianto et. al. 2015] [12].

METHODOLOGY

Waste management is one among the primary problem that the world faces irrespective of the developed or developing countries. The waste management key issue is that the garbage bin at public places overflows well in advance before the commencement of the next cleaning process which leads to various hazards such as bad odor and ugliness to that place which may cause spread of various diseases. The spillover of waste due to increase in population leads to tremendous degradation of hygiene in waste management system. So we need smartness based waste management system for eliminating the garbage and to maintain the cleanness.

The strategies which are used for waste minimization are: Minimize the use of packed material, promote the refill containers and development of eco-industrial plants, promotion for customers to return the packed materials, encourage the environmental friendly design of products [13]. Awareness should be created among the locals and they should be educated and encouraged towards segregation of wastes at the source point. Separately storing the waste helps in optimized waste processing which leads to increase in waste proportion in reusing and recycling. In the stage of up gradation the world faces garbage stinking problem were we see the pictures of garbage bins in our daily life overfull and the garbage spills out which leads to various hazardous diseases as large number of insects breed on it [14]. Not only in India but in most of the countries in the world biggest

challenge in the urban cities is solid waste management. Hence, such a system has to be build which can eradicate the problem or at least reduce it to the minimum level.

Figure 1: Steps involved in waste management

Recycling - Recycling is the process of converting waste materials into new materials and objects. The recycling Materials are picked from the bins which are then gathered, sorted, cleaned, handled and processed again into new materials for manufacturing the new products. Advantages of recycling the waste material are: reduction in environmental effects and waste collection cost and disposal, transportation, reduction in import of raw material and Landfill sites increases. The materials used for recycling are glass items, cardboard, paper, metal and plastic, tires and batteries.

Composting - Composting is a method of organically decomposing the waste material which can be further be used for recycling organic material. It is not a waste disposal mechanism but a naturally waste reusing component. For fertilizing the soil naturally composting is used and compost is a good fertilizer for plants. Good compost is rich in plant nutrients and beneficial organisms. To relieve the effect of uncontrolled deterioration of organic solid waste composting is used.
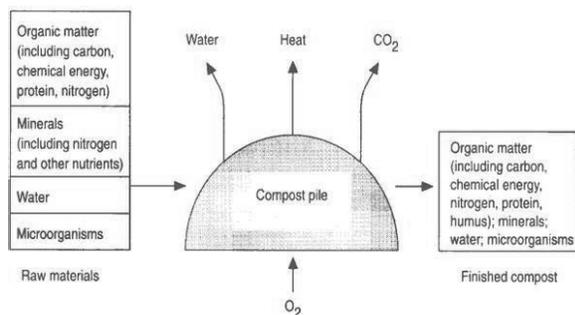
Figure 2: Composting

Incineration – Incineration is a process used for waste treatment that involves the combustion of organic substances which are contained in waste materials. For waste incineration Industrial plants are referred as waste-to-energy or the most common method followed for waste to energy production is incineration and the other high temperature waste treatment are described as "thermal treatment". To produce energy from waste material in the form of heat or electricity that process is referred as Waste to Energy. The efficient technologies for waste to energy can be seen if proper segregation and management of waste are followed and usually this treatment of waste to energy are bit expensive and require high technologies with skilled man power.

Land Fill - A landfill site also known as garbage dump, or dumping ground, is a site used for the disposal of waste materials. Landfill is the oldest and most common form of waste disposal. It should be limited to waste which cannot be recycled or used for energy conversion and the landfill sites should be away from Parks, water body's, habitation and places which are used for cultural and historical importance [13].
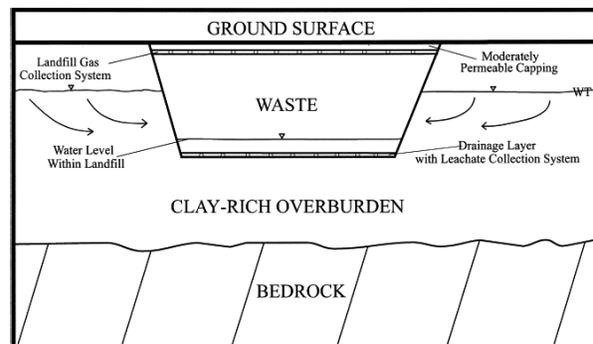
Figure 3: Land filling Phases

Waste collection involves investment costs large expenditures and includes operational costs and environmental costs problems. There are Modern traceability devices to obtain data in real time, like Radio Frequency Identification systems, volumetric sensors, GPRS (General Packet Radio Service) and GPS (Global Positioning System) technology. The integration of following sensors and recent technologies into existing waste management makes it smarter and highly efficient.

Ultrasonic Sensor - An ultrasonic sensor detects the waste level of the bin which is attached to each bin that measures the level of the waste in the bin by sending a sound wave and listen the reflected sound wave that is bounced back. It thus measures the distance at which obstacle is present by calculating the time taken by the wave for traveling and reflecting back. Therefore the

implementation of the ultrasonic sensor in the waste bins prevents the overflow of waste and also an alert message is sent to collecting authority.

Moisture Sensor - By integrating moisture sensor the basic segregation of waste into dry waste and wet waste can be achieved. This sensor detects the moisture content of the waste which is disposed into the bin and depending on the moisture content of waste, segregates the waste and then the waste is stored separately. By this segregation of the waste using moisture sensor the further processing of waste can be done more efficiently.

Motion Detection Sensor - A motion detection sensor is placed outside the waste bin for automatic opening and closing of the lid. This sensor detects person near to the bin for disposing the waste material and the lid is opened automatically for throwing the waste. If waste is exposed to external weather conditions then the waste get decomposed and results in bad odor so the automatic opening and closing of lid is required.

CONCLUSION

Around the world, Urbanization is at its rapid growth as people desires to stay in the city with more opportunities for success and growth. The population increases and people prefer modern lifestyles and the growing heights of urbanization have resulted in huge waste generation. Cities are expanding like never before to accommodate this growth and so the concept of smart cities came into action. The topic of concern in these smart cities is cleanliness and hygiene and necessary action should be taken for reducing the waste either by disposing it or recycling periodically. The objective of the paper is based on waste Management System using Internet of Things to check the fill level of dustbin whether it is full or not. And various technologies such as sensors, IoT etc., are applied to the present waste disposal schemes to make it highly suitable for smart city. For successful operation of waste management facilities, segregation is equally important. The other way is to conduct awareness programme among the citizens regarding the waste generation and its effect on human health and sustainability. It is imperative to have a strong method for dealing with the waste, so that not just the process becomes efficient but at the same time the disposal of waste is also done beneficially. The data can be used further for garbage collection and to reduce the overflowing of bins and to have a better public sanitation.

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