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Smart Waste Management for Smart City using IOT

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Abstract: *As the population of the world is increasing every day, we should keep our environment clean, hygienic and fresh for our daily life routine. Waste management is one of the primary problem that we world faces disregarding of the case of developed or developing country. Due to lack of care and attention, the garbage bins in the city are mostly seem to be overflowing and spreading an obnoxious smell in surrounding area. This has to be taken into care by corresponding authorities and should think about methods to be followed to overcome. This huge unmanaged assemblage of garbage is polluting the environment, spoiling the beauty of the area and also leading to the health hazard. To overcome, many garbage collection systems are getting developed now a days based on IOT. In this paper, we provide a survey of an Internet of Things (IOT) Garbage Monitoring and Waste Management System to diminish the flood of waste component and suitably keeping nature clean.*

Key Word*: Waste Management, Smart City, Garbage, Sensors.*

I. INTRODUCTION

The human population keeps growing, so does their creation of increasingly large amounts of trash. Our municipal authorities of cities are trying to keep up with this, but it is very difficult to figure out when to empty the garbage bin or whether they are full or not at all.

Overflowing of waste garbage bins are primary breeding ground for bacteria, insects and vermin. Cause, they increase the risk of contracting with salmonella, which cause typhoid fever, gastroenteritis, enteric fever, and various other major illnesses. Another outcome of overflowing garbage is air pollution, which causes various respiratory diseases and adverse health effects as contaminants are absorbed from lungs into other parts of our body. In our everyday life we identify the polluted air normally through bad odors, which are usually caused by decomposing the waste items and liquid waste items. Garbage that end up inside water bodies changes the chemical composition of the water. For waste collection staffs the risk of picking up and handling garbage causes infections, chronic diseases and allergies. Direct contact with waste can result in skin and blood infections too through infected wounds. Aside from pollution, overflowing garbage is a public nuisance and eyesore. Obviously everyone wants to live and visit places that are fresh, clean, and healthy. A smelly city with poor sanitation and trash all over the place does not attract people or tourists, rather let alone investments.

The latest developments in the internet and smart technologies, communication systems, provides the possibility of connecting devices, software, and objects communicating among them without a human arbitration, thereby paying the way for a new paradigm called the Internet of things (IOT). One of the main definitions of IOT is that IOT is a dynamic and global network infrastructure, in which intelligent things, subsystems, physical, virtual entities are identifiable, autonomous, and auto-configurable. Several efforts and research works have been dedicated to IOT technologies, such as RFID known as Radio-Frequency Identification technologies, sensors and actuators, wireless mobile communication automation, embedded systems and cloud computing technologies. These advances allows IOT technologies to bridge the gap between network-based devices and technologies that monitor and collect information from physical world and provide new services and applications used to improve the living conditions of people in many areas and one of the example of these applications are smart cities.

Figure 1: Today bin condition in the city

II. LITERATURE SURVEY

[1] "Garbage Collection System Using IOT", Ashiya Malak, Pallavi Bhoyar, This paper provides the system of waste monitoring, In which there are multiple dustbins located throughout the city or the Campus, these dustbins are provided with low cost embedded device which helps in tracking the level of the garbage bins so that it is easy to identify which garbage bin is full. The embedded system sends the message or a signal if the waste level inside the bin reach its maximum limit. The collectors gets this information through GSM Module and hence according they collect the waste within proper amount of time.

[2] "Internets of Bins- Trash Management in India" , Keerthana Betal, This paper provides the designed system of bins for trash management in India. Here the designed system includes sensors, microcontrollers and corresponding system utilities that tracks the level of garbage inside of garbage bin. Here two threshold limits are set for the bins, the first one is normal and the another one is critical. An alert message is sent to the van (garbage collection vehicle) that collects the trash. The system accepts the trash, when it reaches the normal mode the acknowledgement is sent, till the system gets a response it accepts the trash. After getting response, the system locks the accepting waste process. When the threshold limit reaches its critical value the system automatically locks the waste acceptance, instead of waiting for the response and displays the message "Overloaded". The dustbin will be monitored for a specific time and when not cleared within certain time limit by the waste collector, then a message will be sent to the higher authority that takes appropriate action.

[3] "IOT based Garbage and Waste Collection Bin", S.S. Navghane, M.S. Killedar, V.M. Rohokale, This paper provides the dustbin interfaced with microcontroller based system having IR wireless system, Here the current status of the garbage is made available on mobile web browser. At sender side they used only Wifi module technology for sending and receiving the data. In this system the sensor based modern technology is used for monitoring the waste.
The system calculates the weight of the waste collected inside of the dustbin on a waste collection plate and the information is made available in html format on the mobile web module . Hence a proper monitoring is made on the waste weight entity. The collector gets the information by the wifi modules and performs the further emptying part of the dustbin.

[4] "Cloud-based Smart Waste Management for Smart Cities", Mohammad Aazam, Marc St-Hilaire, Chung-Hong Lung, Lonnis Lambadaris , This paper provides the sensors-based waste bin, that notifies the level status of waste inside the garbage bin. Here they have used the cloud computing paradigm for management mechanism. This whole waste management system is linked with different stakeholders, which includes recycles, importers and exporters.

Here they have used different bins for each category of waste, namely; organic plastic/paper/bottles, and metal. So each type of waste is already separated and through the status it is known that how much of is collected and of which type. And that's how the available stored data in the cloud can be useful for different entities and stakeholders in effective ways. Analysis and planning starts as soon as waste starts gathering and up to when recycling and import/export related matters are available. The stakeholders will be able to see through the cloud and analyze type of waste and its quantity . So they can do better arrangements and efficient ways of recycling in a dynamic way.
Resource management by Cloud SWAM is based on the waste generation around a particular city or area, In this way, not only waste material can be minimized, but also their operations can be managed. Various stakeholders can take benefit from the gathered data and foresee about their production system.

[5] "Waste Management as an IOT-Enabled Service in smart Cities", Alexey Medvedev, Petr Fedchenkov, ArkadyZaslavsky, This paper provides the advanced decision system for the efficient waste collection in smart cities. In this they have used the route optimization technique for dynamic waste collection. The system uses the data model for sharing of data between the truck drivers as a real time in order to perform the waste collection. The system has aim to provide high quality of service, the surveillance cameras are assimilated for capturing the problematic areas and provide evidence to the corresponding authorities. The design of the system focuses on providing software-as-a-service to commercial waste management companies.

III. LITERATURE SURVEY ANALYSIS

Table No. 1 : Literature Analysis

Sr. No.	Title	Advantages	Disadvantages
1.	Garbage Collection System using IOT	Timely Waste Collection, Route Optimization	Informs only if the bin is full.
2.	Internet of Bins-Trash Management in India	As two levels are set increase system efficiency, Improve Security, Lock-based system with acknowledgement, Higher authority is taken into consideration	Complex design of dustbin Improper attention by collectors reduce system performance
3.	IOT based Garbage and Waste Collection Bin	Sensors-based modern technology, Less expensive	Low power consumption sensor should be used due to its limited power Fault or Error in Wifi module affects entire system
4.	Cloud-based Smart Waste Management for smart City	Involvement of various stakeholders, Increase waste recycling process	System requires number of waste bins and thus increase the cost, Complexity and low data speed
5.	Waste Management as an IOT-Enabled Service in Smart Cities	Involvement of traffic camera framework, Centralized-based architecture	System is costy

IV. TAXONOMY OF WASTE MANAGEMENT

Table No. 2: Taxonomy of waste management

Categories	**Component/Hardware**
Physical Infrastructure	Bins Line of trucks Depots Dumps
IOT Technology	RFIDs Sensors Wireless Sensor Networks Actuators Cameras

	GPS Near Field Communication
Software Analytics	DSS GIS Dynamic Scheduling Dynamic Routing

V. CHALLENGES

Waste management in the cities is the most expensive part in the investment because of the involvement of both collection of waste and transportation . The implement of the such process system seems easy enough but creates various problems -

Motivation - Lack of motivation among the people for waste management and its impact on the environment.

Resources - Need sufficient bins and related system software to handle the waste appropriately.

Policy - Need government policy for segregation at source.

Recycling - Only having a smart technology is not sufficient for waste management the disposal responsibility and recyclable waste should properly sorted.

Improper knowledge of the operations of smart sensors –Sensors are actually very affordable, easy to use , durable save cost. But because of new and emerging technology, the improper knowledge about sensors working, lot of people believe that it is a complicated in terms of operation there are steps that need to be taken in installation.

Non-optimized truck routes – The truck routes that are not optimized uses excessive fuel. Also the traffic part is to be taken into consideration.

Manual Collection- Civic bodies give waste collection contracts to the private contractors, but due to inefficient monitoring system, results in uneven attendance which impacts garbage collection.

Figure 2: Challenges in India for waste management

VI. ISSUES

- Improper planning for the waste collection
- Lack of awareness among the population about increase in waste productivity
- Lack of landfills for disposing purpose and also for recycling process
- Lack of awareness among people about smart waste management system

VII. BENEFITS OF SMART MANAGEMENT SYSTEM

- Efficient waste collection method
- Harmful gases can be detected easily
- Monitoring of garbage bins, reduce unnecessary visiting of every bin

- Reduces actual handling of waste
- Smart reporting direct to the corresponding agency or authority
- Improve street sanitation

VIII. SOLUTIONS

- **Data Availability** - Availability is of primary importance for maintaining the degree of operational network in waste management system. Failure of base station or clusters cannot affect the entire system .The data can be made easily available so that can easily managed.
- **Smart Fetch -** Get all the detailed information like the number of empty and full garbage bins. Easily fetch the location of the garbage bin and increase system quality.
- **Privacy** – The sensor-based networking, RFID tags gives high level privacy in waste management system
- **Secure Localization** - The time to time emptying garbage bins maintains healthy condition around the garbage bins.
- **Secure Routing** - Routing and data forwarding is a pivotal part in the system framework

IX. PATH OPTIMIZATION TECHNIQUES

Many cities around the world are trying becoming smart cities, making use of information and communication technologies to tackle waste generation problem. Waste collection is one of the targets on smart cities and has been gaining attention now a days. Waste collection is the daily task that requires planning , taking into account the environment and economic factors. The routes should be planned to avoid traffic, to minimize the fuel cost and the co2 emission. In the ideal scenario the truck routes should not be static, but dynamic. The algorithm offers

- ✓ City layout given by GIS
- ✓ Geographical Information System database which includes the information about the roads
- ✓ The number of trucks available and the truck capacity
- ✓ Fill level threshold, which fixes the set of containers that to be emptied.

Using such information the algorithm calculates the optimal number of tricks to use and provides the path to be followed. Helps to maintain the ecofriendly environment.

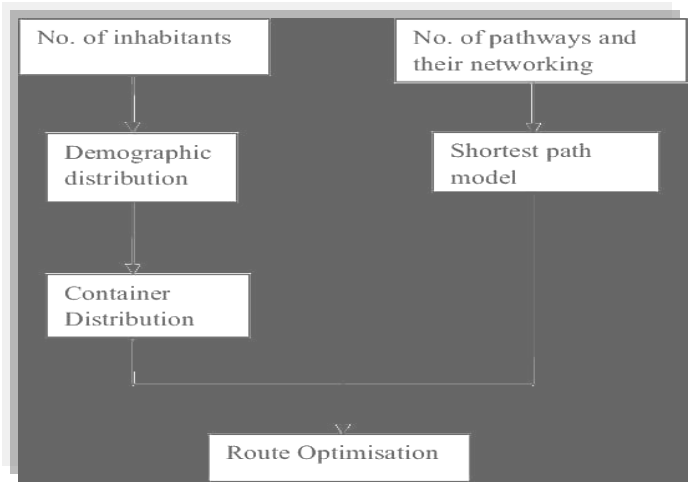

Figure 3: Path Optimization

PATH OPTIMIZATION ALGORITHMS-

Table No. 3: Path Optimization Algorithm

Approach	Strength	Weakness

Mathematical Programming	- Different types of VRPs are solved - Used for improvement in procedure - Ensures operational efficiency - Used as decision support tools	Unable to fully handle road network
GIS based	- Advanced road network modeling - Improve waste collection efficiency	Not ideal for route optimization for large cluster of points

X. CONCLUSION

This survey has been performed for collecting the details of smart garbage management methods and to find out effective ways which are useful for providing hygiene environment in cities. The proposed survey demonstrates that the waste management system in IOT empowers the cleaning operators to detect cleaning issue in real time. This survey helps in identifying all possible smart waste management systems that can be implemented to make city clean.

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