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Survey on Municipal Waste Collection Management in Smart City

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Abstract - *At present waste management is a major concern in the metropolitan cities of the developing and developed countries. As the population is growing, the garbage is also increasing day by day. Garbage management is becoming a global problem. Due to the lack of care and attention by the authorities the garbage bins are mostly seem to be overflowing. It has to be taken into care by corresponding authorities and should think what method can be followed to overcome this. This huge unmanaged accumulation of garbage is polluting the environment, spoiling the beauty of the area and also leading to the health hazard. To overcome this situation an efficient smart municipal waste management system has to be developed. In this era of Internet, Internet of Things (IOT) can be used effectively to manage this waste as many effective methods can be found out easily. This is the survey paper which involves the various ideas to solve this problem using some algorithms that can be easily implemented.*

***Key Words*: Internet of things (IOT), Smart Garbage collection.**

1. INTRODUCTION

Now-a- days smart cities represents hot topic in terms of improving living conditions. As one of the application of Smart City, Waste Management in a city is a formidable challenge faced by the public administrations. IoT is a network of sensors where data is exchanged, using different connectivity protocols, with systems. Waste is defined as any material in which something valuable is not being used or is not usable and represents no economic value to its owner, the waste generator. Depending on the physical state of the waste, they are categorized as solid waste and wet waste. With the proliferation of population, the scenario of cleanliness with respect to waste management has become crucial. Waste management includes planning, collection, transport, treatment, recycle and disposal of waste together with monitoring and regulation. The existing waste management system, where the garbage is collected from the streets, houses and other establishments on quotidian basis, is not able to effectively manage the waste generated. Our work focuses on the optimization algorithms for Smart City management and more specifically this paper deals with municipal waste collection procedure. Nowadays, the garbage-truck needs to pick-up all garbage cans even if they are empty. To avoid such challenges faced we are proposing a system where efficient routes are defined shortest route to collect the garbage filled bins.

2. Literature Survey

The garbage management in cities should be effectively and efficiently implemented. The various proposals were put forward and some of them are already implemented. But we cannot considered it as an effective one. So a survey was done among different proposals and this survey paper includes survey among different methods for smart garbage management in cities using IoT. This section discusses about the existing approaches in the field of smart waste management.

Insung Hong et.al [1] has suggested that replacing SGS(Smart Garbage Sensor) instead of RFID garbage collecting system helps to improve their energy efficiency up to 16% and can reduce the food waste reduction .Inside the SGS they have installed SGBs (Smart Garbage Bins) to control the energy efficiency of the system.

Dario Bonino et.al [2] has suggested that it provides end – to - end security and privacy that is built upon dynamic federation smart city platform. Its benefits is that it has good dependability and has resilience on failure of a system over a particular month. It focuses on the collection of wastages and accomplishment of ontology method.

A lvaro Lozano Murciegoet.al [3] has suggested that to collect the dustbins that are been filled using a truck. The main advantage is that it reduces the fuel cost of the trucks rather than travelling a long distance it makes the path simpler and easier to reach the dustbin using route optimization.

Theodoros Anagnostopoulos et.al [4] has suggested that it first starts with an assumption that the smart city must include the IoT base. It uses dynamic scheduling. It is based on the fact that the garbage will be collected only when it is fully filled or the maximum capacities of the dustbins are filled.

Rachael E. Marshall et.al [5] outlines that the smart waste management system in the high salaried countries and a developing countries.

Lilliana Abarca Guerrero et.al [6] outlines the fact that the developing countries undergo a prominent factor of affecting the waste management systems due to rising population levels and rapidly growing urbanization. The collaborator of the waste management are many such as household, industry sectors, educational and research intuitions etc.

produces huge number of wastages. Collecting, transferring, Transportation of the wastages and they are finally disposed in an open land.

Ala Al - Fuqaha et.al [7] proposed that sketch of the IoT with a stress on technology, application and protocol concern. It explains about the differences between IoT and developing technologies like cloud computing and data analytics.

Jose M. Gutierrez et.al [8] proposed the functional smart city and the use of an smart waste management .It uses IoT for sensing the wastage level in the dustbins, processes the data and sends it to the server for storing and process the data. The process is carried out by the Geographical Information system.

Vikrant Bhor et.al [9] has suggested that when the system ensures that the garbage bins are fully filled up to their maximum it must be cleaned using IR sensor, GSM mode and microcontroller. When it is not filled it must be reported to the higher authority of a particular contractor. It concludes that it has a clean environment and it decreases the total number of trips the garbage collector vehicle rounds.

Fachmin Folianto et.al [10] has suggested that it uses mesh network. It is used to produce data and deliver it to the mesh network. Whenever the bins are filled they need to be cleaned. The bin collector gives the route to collect the bins. In [11-14], the routing protocols and the failure detection in sensor nodes are discussed.

2.1 RECENT RESEARCH IN MUNICIPAL WASTE COLLECTION OPTIMIZATION

The steady development of populace urban regions brings expanding city strong waste age with financial and ecological effect. City strong waste administration - source division, storage, gathering, exchange and transportation, preparing and recuperation, and to wrap things up, transfer, are today present city challenges. The mathematical programming and processes have been already used for optimizing the municipal waste management and transfer system. The waste collection and garbage-truck allocation problem could be solved by traditional mathematical methods such a linear methods. However, the linear methods show insufficient efficiency in some more difficult cases of waste collection. The large amount of variables was the reason for large computation time. The recent research works use mostly the heuristic solutions and methods dealing with the municipal waste collection as with a Travelling Salesman Problem (TSP). Dealing with problem formulation, the effectiveness of optimization and computation is based on input parameters and specific problem implementation. Only few works tried to use evolutionary algorithm to deal with implementation and optimization of waste collection problem as the TSP defines. These works utilize Ant Colony calculation. In any case, the hereditary calculation was additionally demonstrated as an extremely viable instrument to manage TSP of different executions, however not in the particular usage of waste gathering [4].

2.2 CHALLENGES

2.2.1 Challenges faced while working with wireless sensor networks (WSN)

1. Energy – Sensors require control for different operations. Vitality is expended in information accumulation, information strategy, and information correspondence. Batteries providing power need to be changed or recharged once they have been consumed. Sometimes it becomes powerful to recharge or change the batteries as a result of demographic conditions. The most critical research challenge for the WSN analysts is to design, develop and implement energy adequate hardware and software protocols for WSNs.

2. Self-management – Once when WSN are deployed it should be capable of working without help of human intervention.

3. Security – Confidentiality is required while data transmission otherwise there is possibility of eavesdropping attack.

4. Quality of Service - Quality of service is the level of service provided by the sensor networks to its users. WSN are being used in various real time applications, so it is mandatory for the network providers to offer sensible QoS.

5. Fault Tolerance - Sensor network should be able to work even if any node fails whereas the Network is operational. Network should be in a position to adapt by changing its property in case of any difficulty.

6. Limited Memory and Storage Space - A sensor is a small device with low quantity of memory and storage space for the code. In order to make an effective security mechanism, it is necessary to limit the code size of the security algorithm.

2.2.2 ISSUES

The given below are the list of issues that were represented in the previous papers.

- Requires a lot of maintenance price.
- Excess discharge of garbage within the public areas creates a fragile condition for the folks of close to by areas.
- It accomplishes completely different technologies like Java, relational database...etc.
- The bins are clean only if it's totally stuffed.
- During special days the bins are quickly stuffed and that we ought to increase the gathering time periods.

• It is employed to browse, collect, transfer information over the net.

• While not web it's impractical. High fuel price once it involves the quantity of the gap lined by the bin collector.

• It includes differing kinds of stake holders with completely different concentration on their interest.

2.2.3 SOLUTIONS

• **Data Freshness** – There should be fresh message even if confidentiality is assured. Informally, knowledge freshness suggests that the data is recent, new and it ensures that no old messages have been replayed. To solve this problem another time - related counter, can be other into the packet to make sure knowledge freshness.

• **Secure Localization** - Often, the utility of a device network can trust on its ability to accurately mechanically find every sensor within the network. A sensor network designed to find fault scan would like correct location data in order to purpose the placement of a fault.

• **Privacy -** The sensor networks have conjointly force privacy issues. Initially the sensing element networks area unit deployed for legitimate purpose may later on be used in out of the blue ways that. Providing awareness of the presence of sensor nodes and knowledge acquisition is notably vital.

• **Secure routing -** Routing and data forwarding is a crucial service for facultative communication in device networks.

• **Data Availability -** Availability resolves whether or not a node has the capacity to use the resources. However, failure of the base station or cluster leader's availability can eventually threaten the complete sensing element network. Thus availableness is of primary importance for maintaining associate degree operational network.

2.2.4 PATH OPTIMIZATION TECHNIQUES

The route planning and optimization is a well-researched area and hundreds of intelligent transport systems have been developed already. There are many projects aiming to provide an effective system for waste collection purposes. In [7] an advanced routing and scheduling waste collection model is proposed in eastern Finland, in which they use the guided variable neighbourhood thresholding Meta heuristic. A geographical information system transportation model for the solid waste collection and disposal is another technique. A truck scheduling model for the solid waste collection has been proposed by the city of Porto Alegre in Brazil. The aim of the research was to develop an optimal schedule for the trucks on defined collection routes. In [8] a novel cloud based approach is being employed. On board surveillance cameras for problem reporting with a cloud DSS system and dynamic routing models are used and this significantly increases the cost effectiveness, which is one of the important criteria of the mart cities. A method is proposed to use the operations research techniques to optimize the routes of waste collection vehicles servicing dumpster or skip type container. Here the waste collection problem is reduced to classic TSP then to Concorde solve the problem. The system aims to minimize the distance travelled and thereby helps in the reduction of vehicle wear. A new method for optimizing the waste collection routes is developed based on OSGeo software tools.

Table -1: Path Optimization Techniques

Path optimization Techniques	
1. ArcGIS Network Analyst and Ant Colony	Based on Geo referential spatial Database. Facilitate modelling of realistic traffic condition and different scenarios.
2. MapInfo	It is GIS software used for finding shortest path
3. OS Geo software tool	Route planning and optimization software.

3. DIFFERENT APPROACHES AND ALGORITHMS

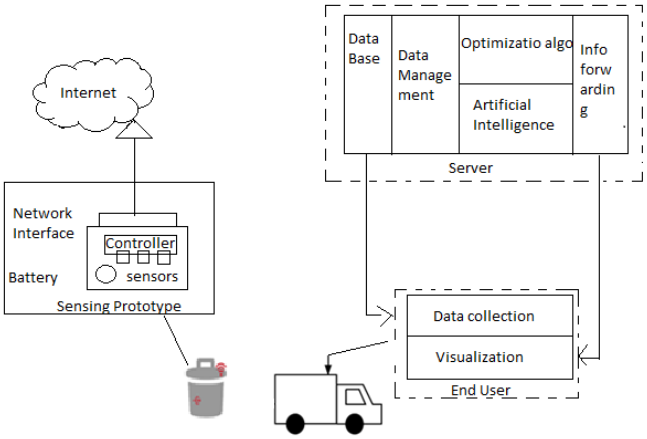

Fig -1: System Overview

There are some different approaches in paper [9] the proposed system was based on waste data level of garbage bins in metropolitan areas. The data was sent over the internet for analyzing and processing. Everyday new data was collected and on that basis the rate of waste level was calculated so as to predict the overflow of bins before. Fig 1. Gives the overview of this approach.

Another approach paper [12] was the bins were kept overall anywhere in the city or areas, a low cost device was inserted in the bin and a unique ID was assign to every garbage bin to check which bin is full. There were 2 parts Transmitter and receiver sections, sensors, 8051 microcontroller in which data from sensor was processed and send to central system by RF Transmitter

Another method [13] was when the garbage reaches a threshold level ultrasonic sensor will trigger GSM module to give alert till the trash can is empty. In this GSM 900 A modem was used to send the messages The ultrasonic sensor also calculated the height of the trash can at regular interval. There 3 sensors at various heights like h/3, 2h/3 and h, where h is the height of the bin but to make it affordable and to get the results.

Algorithms used in previous papers for research work was done.

3.1.1 XML Parsing used for graph processing –

The XML parsing is used for the graph (SVG) processing. After XML parsing.

3.1.2 Floyd- Warshall algorithm

The Floyd- Warshall algorithm is applied to distance recalculation. This algorithm was chosen due to the fact that we are using metric system and there the negative values of edges are not used. The algorithm (Floyd-Warshall) also computes straight the vertices distance, which is less time consuming than i.e. Dijkstra Algorithm (which computes distances always for each vertex).

4. PROPOSED APPLICATIONS

1. Waste Level detection inside the garbage bins. Transmission of the information wirelessly to concerned officials.

2. System can be accessed anytime and from anywhere.

3. Real-time data transmission and access.

4. Avoids the overflows of garbage bins.

5. This project can only be used by municipal authorities or other private firms to tackle the current problem of urban waste collection.

6. This system has no individual use, but can be used by a city, state or a country.

7. Using this system, waste collection would become efficient and also reduction in transportation costs can be witnessed.

5. CONCLUSIONS

This survey has been performed for collecting the details of smart garbage management methods and to find out effective methods which are useful for providing hygiene environment in cities. Our solution is based on the idea of IoT infrastructure, which should provide enough information to handle this Smart City issue more efficiently.

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