

A Survey on Smart Garbage Management in Cities using IoT

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Abstract

As the population is increasing day by day, the environment should be clean and hygienic. In most of the cities the overflowed garbage bins are creating an unhygienic environment. This will further lead to the arise of different types of unnamed diseases. This will degrade the standard of living. To overcome these situations an efficient smart garbage management method has to be developed. As the scope of IoT is developing day by day effective methods can be found out easily. Various designs were proposed and have advantages as well as disadvantages. This paper is a survey based on Smart Garbage Management in Cities using IoT. This survey involves various smart garbage management ideas that can be easily implemented.

Keywords: -Sensors, Microcontroller, GSM, GUI, IoT, Internet.

commercial deployment. IoT can be used to provide a platform for smart garbage management.

1 Introduction

Due to rapid population growth, disorganization of city governments, a lack of public awareness and limited funding for programs, 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 survey paper shows some effective solutions.

Some of the commonly used methods are implemented using sensors and microcontrollers. The details of each bins are monitored by the authority with the help of GUI. Effective actions will be taken if the corresponding authority is not concerned regarding the cleaning of bins.

Internet and its applications have become an integral part of today's human lifestyle. It has become an essential tool in every aspect. Due to the tremendous demand and necessity, researchers went beyond connecting just computers into the web. These researches led to the birth of a sensational gizmo, Internet of Things (IoT). Communication over the internet has grown from user - user interaction to device – device interactions these days. The IoT concepts were proposed years back but still it's in the initial stage of

The implementation of smart garbage management system using sensors, microcontrollers and GSM module assures the cleaning of dustbins soon when the garbage level reaches its maximum. If the dustbin is not cleaned in specific time, then the record is sent to the higher authority who can take appropriate action against the concerned contractor. This system also helps to monitor the fake reports and hence can reduce the corruption in the overall management system. This reduce the total number of trips of garbage collection vehicle and hence reduce the overall expenditure associated with the garbage collection. It ultimate helps to keep cleanness in the society. Smart collection bin works with the sensors will show us the various levels of garbage in the dustbins and also the weight sensor gets activated to send its output ahead when its

threshold level is crossed. If dustbins are not cleaned in time, the details will be forwarded to higher authority. Different implementation methods are explained in the remaining parts.

The remaining part of the paper is organized as follows. In Section II survey of all methods will be described in detail. The paper concludes with a brief summary in section III.

2 Literature Survey

The garbage management in cities has to be effectively and efficiently implemented. The various proposals were put forward and some of them already implemented. But it cannot be considered 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.

The paper [1] Smart Garbage Management in Smart Cities using IoT proposed a method as follows. The level of garbage in the dustbins is detected with the help of ultrasonic sensors system, and communicated to the authorized control room through GSM system. Arduino microcontroller is used to interface the sensor system with GSM system. A GUI is also developed to monitor the desired information related to the garbage for different selected locations. This will help to manage the garbage collection efficiently. Level detector consists of IR sensors which is used to detect the level of the garbage in the dustbin. The output of level detector is given to microcontroller. Four IR sensors are used to indicate the different levels of the amount of the garbage collected in the dustbin which is placed in public area. When the dustbin is filled up to the highest level, the output of fourth IR receiver becomes active low. This output is given to microcontroller to send the message to the Control room via GSM module. At receiver, control room is present where all the activities are managing. At receiver, control room is present where all the activities are managing. This system assures the cleaning of dustbins soon when the garbage level reaches its maximum. If the dustbin is not cleaned in specific time, then the record is sent to the higher authority who can take appropriate action against the concerned contractor. This

system also helps to monitor the fake reports and hence can reduce the corruption in the overall management system. This reduce the total number of trips of garbage collection vehicle and hence reduce the overall expenditure associated with the garbage collection. It ultimate helps to keep cleanness in the society. Therefore, the smart garbage management system makes the garbage collection more efficient.

Another method for garbage management is introduced [2] as follows. A dustbin is interfaced with microcontroller based system having IR wireless systems along with central system showing current status of garbage, on mobile web browser with html page by Wi-Fi. Hence the status will be updated on to the html page. There by to reduce human resources and efforts along with the enhancement of a smart city vision. Considering the need of modern technology, the smart garbage bin can expensive but considering the amount of dustbin needed in India, there for they used based sensors to reduce its cost and also make it efficient in applications. And at the sender side they used only a Wi-Fi module to send and receive data. But because of the use of weight sensor for detection of amount of garbage in dustbin. It will only detect the weight of waste; not how much level it is of. The message can be sent directly to the cleaning vehicle instead of the contractor's office. Thus garbage bins are managed.

A Geographical Information System (GIS) transportation model for solid waste collection that elaborates plans for waste storage, collection and disposal has been proposed in [3] for the city of Asansol in India. An enhanced routing and scheduling waste collection model is proposed for the Eastern Finland, featuring the usage of a guided variable neighborhood thresholding metaheuristic. The aim of the research was to develop an optimal schedule for trucks on defined collection routes. The data from the bins are processed in the DSS and if it is correct it is sent to organizers of waste collection in this particular place and to the road police. The truck driver doesn't waste time for waiting, he/she goes to the next point and the route is dynamically recounted. When the problem is solved the

system recounts the route for one of the available trucks and the waste from unlocked bin is collected. It is combined with dynamic routing algorithms to maximize the efficiency of waste collection.

A survey presented in [4] reviews the researches done on waste collection in developing countries from 2005 to 2011 and considers challenges for developing countries in waste collection sphere. The research focuses on determination the stakeholders actions/behavior and evaluation of influential factors defining their role in waste collection process. The models in the survey were tested on real data. Considering system approaches for solid waste collection in developing countries is presented. The research compares the history and the current practices, presented from 1960s to 2013. The output of the survey is drawing a conclusion that developing and implementing solid waste collection approaches in developing countries are of a great importance. The main issue is that waste collection does not include innovation that IoT can provide. Models do not use real time information of the waste collection, although some approaches use advanced scheduling and routing via exploiting modern ICT algorithms. Information about bins status was not considered as part of waste collection. All the reviewed surveys do not propose a model that will use IoT technology for Smart Cities, though they consider different approaches for waste collection.

The paper [5] proposed an advanced Decision Support System (DSS) for efficient waste collection in Smart Cities. The system incorporates a model for data sharing between truck drivers on real time in order to perform waste collection and dynamic route optimization. The system handles the case of ineffective waste collection in inaccessible areas within the Smart City. Surveillance cameras are incorporated for capturing the problematic areas and provide evidence to the authorities. The waste collection system aims to provide high quality of service to the citizens of a Smart City. System architecture aims to suit two main targets. First target is providing software as-a-service (SaaS) products for customers. Mainly, these customers are private companies that are involved in waste collection, owning

waste trucks, organize work of drivers, get contracts from municipalities and pass wastes to recycling organizations or city dumps. Second main target is developing a system, which makes possible mutually beneficial communication between all the stakeholders involved in the chain of supplying goods and utilizing solid waste in smart city. This paper presented a novel cloud-based system for waste collection in smart cities. The system aims to provide services for different kind of stakeholders involved in this area - from city administrations to citizens. Still, the design focuses mostly on providing SaaS services to commercial waste management companies.

In paper [6] Infrared sensor (IR sensor) is used which is a multipurpose sensor, which can detect the level of garbage. IR sensor emits the light, which is invisible to naked eye but the electronic components can detect it. It consists of IR transmitter and IR receiver. The output of IR sensor is acquired by The National Instruments myRIO-1900. It is an input output device which is portable and reconfigurable. USB acts as a connector between the NI myRIO-1900 and host computer. It has connectors A and B that acts as an expansion port and a connector C that act as a mini-system port, they carry the signals and these signals are distinguished by different connector names. Sensor senses level of the bin. The GUI gives the output of what level of garbage is filled. Sensor senses level of the bin. The graphical representation to access the output of the sensor is as shown below. It gives the output of what level of garbage is filled. When the level in a bin is reached the threshold, the LED placed at the location of the bin starts blinking. When the blinking LED is clicked, a display opens showing the location of the bin, status of the bin, data and time when the bin gets filled, mobile number and the text to send to the concerned person. But this system does not ensure whether garbage is cleaned or not and transportation cost is another issue.

KalsiwalMansai [7] proposed model of Garbage Management using Internet of Things for Smart Cities in organizing the garbage collection system of residential or commercial areas. In the proposed system, the level of waste

material in the garbage bin has been detected with the help of ultrasonic sensor and it will continuously communicate to the authorized control room through GSM module. Micro-controller is used to interface the sensor system with GSM system. A GUI is also developed to supervise the desired information related to the garbage for various selected locations. The main feature that differs from other systems is that MATLAB based GUI. In this system there is a requirement of master and slave units. Slave unit is placed in the garbage bin likely wise master unit is placed at the control room. Slave unit consists of Arduino Uno board which has Atmega328 IC, ultrasonic sensor and GSM module. The entire circuit is placed at top of the dustbin. In ultrasonic sensor, the trigger pulse is continuously sent in the dustbin and echo pulse reflects back to ultrasonic sensor. Ultrasonic sensor continuously checks the garbage level in dustbin. Once the level of garbage reaches to specified threshold values, ultrasonic sensor gives indication to Arduino Uno board and through GSM, SMS will be send to control room which will indicate that the "Please inform the cleaner of specific floor as the dustbin of that floor is full". In master unit when the SMS is received at control room, it will indicate on GUI the percentage of approximate garbage collection of that floor and it will automatically inform the cleaner of that floor.

The system proposed by Vishesh Kumar Kurrel [8] assures the cleaning of dustbins soon when the garbage level reaches its maximum. In this management system IOT as the working in the field for networked radio-frequency identification (RFID), tracking the collection vehicle, Dustbin monitoring and other emerging sensing technologies. The IR sensor is act as level detector. The assures a low budget by changing all light traffic servers into Raspberry Pi. The sensor senses the content of the dustbin and sends the signals or the data to the ARM microcontroller then the microcontroller reads the data from the sensor and process the data received from sensor, and the same data will send to Dashboard section and this section send mail/message to respective Municipal / Government authority person or collection vehicle. If the

dustbin is not cleaned in specific time, then the record is sent to the higher authority who can take appropriate action against the concerned contractor. This system also helps to monitor the fake reports and hence can reduce the corruption in the overall management system. This reduces the total number of trips of garbage collection vehicle and hence reduces the overall expenditure associated with the garbage collection.

Another method [9] is that, Once the garbage reaches the threshold level ultrasonic sensor will trigger the GSM modem which will continuously alert the required authority until the garbage in the dustbin is squashed. Once the dustbin is squashed, people can reuse the dustbin. At regular intervals dustbin will be squashed. In this method, GSM 900A modem is used to send the messages. It consists of a GSM/GPRS modem with standard communication interfaces like RS-232 (Serial Port), USB, so that it can be easily connected to the other devices. The ultrasonic sensor is used to find the height of garbage filled at different intervals of time. They use three 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 achieve the same results, only one sensor is placed at surface level. This system has various features such as durability, affordability, prevention against damage and maintenance issues. But they require a more amount of machines and labors.

Another solution was proposed in [10], 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 and a unique ID will be provided for every dustbin in the city so that it is easy to identify which garbage bin is full. The project module is divided into two parts Transmitter section and receiver section. Here in the transmitter section we are using 8051 microcontrollers, RF Transmitter and sensors these are attached to the dustbin. Where sensor is used to detect the level in the dustbin whether the dustbin is full or empty. The sensor senses the content of the dustbin and sends the signals or the data to the 8051 microcontroller, Power Supply +9V Battery power supply is given to the 8051

microcontroller to drive the system and the 8051 microcontroller reads the data from the sensor and process the data received from sensor, and the same data wirelessly transmitted to the Central system (Intel Galileo microcontroller) using RF Transmitted. RF Transmitter is to transmit the signal from 8051 microcontroller to the Intel Galileo microcontroller. Here RF Receiver is used to receive the data sent by RF transmitter to the Intel Galileo microcontroller. The Intel Galileo Gen2 Microcontroller is used to receive the data sent by the multiple transmitters and process the data and the same data transmitted to the Client i.e., Web Browser. But comparatively the number of components used is more such as 8051 microcontrollers, IR sensors that make an excessive cost and complex codes.

3 Conclusion

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. As the level of garbage in the bins crossed the threshold, it will be informed to the corresponding authority, if it was found ignored then the details will be forwarded to the higher authority to take necessary actions. Thus a hygiene and clean environment can be provided. This survey helps in identifying all possible smart garbage management methods that can be implemented to make city clean.

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References

[1]. Vikrant Bhor, Pankaj Morajkar, Maheshwar Gurav, Dishant Pandya, "Smart Garbage Management System", March 2015.

[2]. S.S. Navghane, M.S. Killedar, Dr.V.M. Rohokale," IoT Based Garbage and Waste Collection Bin", May 2016.

[3]. Ghose, M.K., Dikshit, A.K., Sharma, S.K. "A GIS based transportation model for solid waste disposal – A case study on Asansol municipality. Journal of Waste Management".

[4]. Guerrero, L.A., Maas, G., Hogland, "W.: Solid waste management challenges for cities in developing countries. Journal of Waste Management".

[5]. Alexey Medvedev, Petr Fedchenkov, Arkady Zaslavsky, Theodoros, Anagnostopoulos Sergey Khoruzhnikov,"Waste Management as an IoT-Enabled Service in Smart Cities".

[6]. Meghana K C, Dr. K R Nataraj," IOT Based Intelligent Bin for Smart Cities".

[7]. Kasliwal Manasi H., Suryawanshi Smitkumar B, "A Novel Approach to Garbage Management Using Internet of Things for Smart Cities".

[8]. Vishesh Kumar Kurrel," Smart Garbage Collection Bin Overflows Indicator using Internet of Things".

[9]. Monika K A, Nikitha Rao, Prapulla S B, Shobha G, "Smart Dustbin-An Efficient Garbage Monitoring System".

[10]. Parkash, Prabu," IoT Based Waste Management for Smart City".

[11]. Basic Feature, "Solid waste Management Project by MCGM".

[12]. Microtronics Technologies, "GSM based garbage and waste collectionbins overflow indicator", September 2013.

Professor at Sree Buddha College of Engineering, Kerala University, India.

[13]. S. Thakker and R. Narayanamoorthi, "Smart and wireless waste management," Innovations in Information, Embedded and Communication Systems (ICIIECS), 2015 International Conference on, Coimbatore, 2015.

[14]. Riondaet al., "UrVAMM — A full service for environmental-urban and driving monitoring of professional fleets," new Concepts in Smart Cities: Fostering Public and Private Alliances (Smart MILE), 2013 International Conference on, Gijon, 2013.

[15]. Narayan Sharma, Nirman Singha, Tanmoy Dutta, "Smart Bin Implementation for Smart Cities", International Journal of Scientific & Engineering Research, vol 6, Issue 9, 2015, pp-787-789.

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