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Smart Waste Management using Wireless Sensor Network

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ABSTRACT: In most of the places, the garbage bins are not cleaned at proper time intervals which results in overflowing of garbage resulting in hygiene problems, land pollution; also it creates ugliness to that place. This shows the need for a system that monitors the status of the garbage bin and provides information to the concerned authorities to manage the collection intervals for cleaning the bins. A solution to this problem is proposed in this paper in the form of a 3 tier waste management system: Intelligent bin, gateway, remote base station. The parameters of the bin monitored are transmitted through a gateway to remote base station to be stored in a database**.**

KEYWORDS: Solid waste, Intelligent bin, Zigbee, GPRS

I. INTRODUCTION

With the increase in population, change in living lifestyle and increased number of industries, the amount of Municipal Solid Waste (MSW) is increasing at a very high pace [1]. At present, the amount of solid waste produced in urban India is 68.8 million tons per year [2]. This amount is expected to be double by 2025 [1]. This shows the need for proper waste management solutions so that the harmful effects to the environment can be reduced.

The waste management cycle includes the generation of the waste from industries, houses, markets etc. from which the waste is thrown in the garbage bins. This waste is further picked up by the municipal corporations to finally dump it in dumping areas and landfills. But due to lack of resources, ineffective groundwork, some waste is not collected which poses serious health hazard to the surrounding environment.

Proper cleaning intervals may provide a solution to this problem. But keeping a track of the status of the bin manually is a very difficult job. An answer to this problem is proposed in this paper in the form of a framework employing a Wireless Sensor Network (WSN) that transmits information from the bin to the control station via a gateway to be stored in a database accessible by the user. The Related Work, Proposed System Framework, Results & Discussion and Conclusion & Future Work have been discussed in the next sections to give detailed information on the work done in this field.

II. RELATED WORK

A RFID and a load cell sensor based waste management system have been implemented in paper [3]. The parameter of the bin monitored in this system is the amount of waste being dumped in the bin. The collection interval is decided based on this parameter. The use of authentication password based on RFID technology helps to provide extra security in this system by identifying stolen bins.

Another framework based on the integration of RFID and communication technologies such as GSM, GPRS, and GIS has been proposed in paper [4]. Theoretical framework and algorithm have been developed in this paper for successful hardware implementation. The information retrieved is stored for monitoring and management activities. A Graphical User Interface is presented for user interaction.

Another framework based on RFID, GSM and GIS has been proposed in paper [5]. The proposed system monitors the waste collection and management process. This system provides the real time data of waste collection process, tracking of vehicle position is done with the help of GIS which helps to overcome difficulties like route optimization, safe environment, availability of a vehicle and low fuel.

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An application based on distributed sensor technology and geographic information system to be used in the monitoring of municipal solid waste has been proposed in paper [6]. A case study based in Pudong area is presented in this paper. The most important outcome of this paper is calculation of waste weight and volume to be further used for optimizing routes of garbage collection vehicles and material density evaluation.

A paper based on real time monitoring of bin is proposed [7]. This paper depicts a structure about the traceability innovation accessible in the streamlining of strong waste gathering, and presents an imaginative vehicle directing model coordinated with the constant traceability information, beginning the application in an Italian city of around 100,000 tenants. The model is tried and accepted utilizing recreation and a sparing attainability study is accounted for toward the end of the paper.

A solution for segregation of waste at the source level has been proposed in form of GREENBIN in paper [8]. The segregation is based on sensors such as moisture sensor, metal sensor, methane sensor and odour sensor and the type of waste considered is plastic waste, inert waste, metal waste, bio waste and food waste. At the end of the paper, an idea to use waste to generate electricity is presented.

A system based on ultrasonic sensor, load cell sensor and GSM is proposed to provide an overall solution starting from smart waste collection to waste disposal in paper [9]. The values from the sensors are transmitted through GSM communication to a server. A method to separate 5 types of plastic and generating electricity from biodegradable waste is presented at the end of the paper.

A new architecture based on sensor nodes which uses Data Transfer Nodes (DTN) to transmit information from the garbage bins to a remote server has been implemented by some researchers in paper [10]. In this framework, a single parameter is monitored and its value is stored in a remote server which provides a web server to interact with the user. The author uses Argos mote in this paper that covers 430m geographical area only.

A Zigbee Pro and GPRS based waste management system has been proposed in paper [11]. The system framework monitors amount of waste in weight, temperature and humidity inside the bin, and remaining power of the bin and updates the data to a control station. The final data stored in the form of a database is presented at the end of the paper.

III. PROPOSED SYSTEM FRAMEWORK

The proposed framework is a 3 tier system namely A) Intelligent Bin, B) Gateway and C) Remote Base station as shown in Fig. 1.

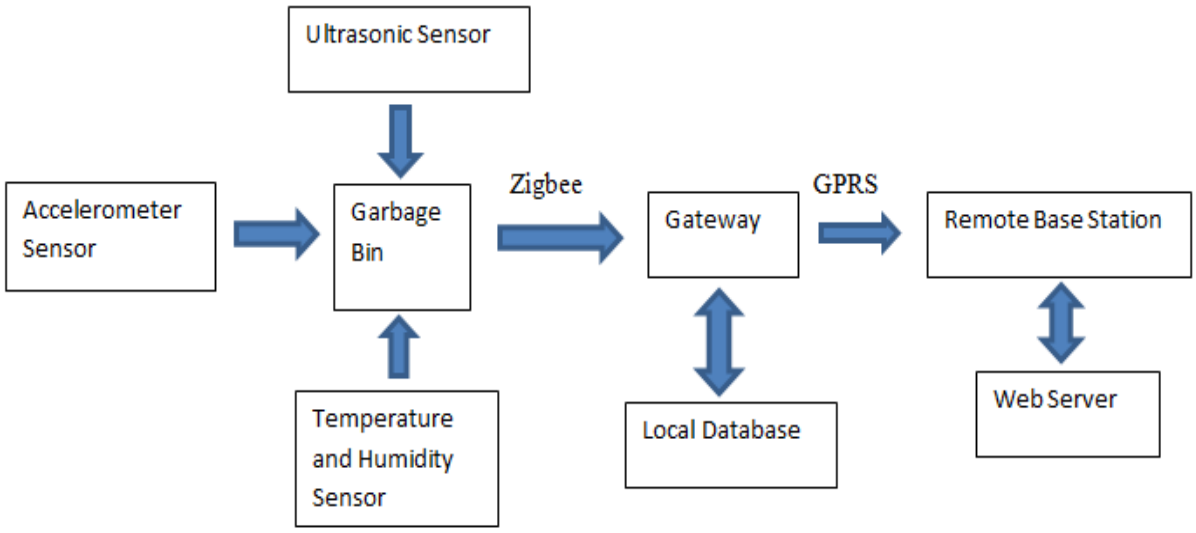

Fig.1:Block Diagram of the proposed Smart Waste Management System

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A. *Intelligent Bin:*
The sensor node attached to the bin helps in the collection and transmission of data. The sensor node is divided in 2 groups. The first group consists of accelerometer sensor, temperature and humidity sensor, ultrasonic sensor. The Accelerometer sensor checks the opening/ closing of the lid. The temperature and humidity sensor keeps track of the temperature and humidity inside the bin; two parameters that become important when storing organic waste. The ultrasonic sensor measures the filling of the bin. The second group consists of a Zigbee Pro that acts as a transmitter to send the collected data to the gateway. The importance of this bin is that it can be used to store any waste: Plastic waste, E-waste, Metal waste, Food waste, Organic waste as in all these types of waste, collection interval will depend on the filling of the bin except in food waste and organic waste where all these parameters decide the collection interval.
B. *Gateway:*
At the heart of the gateway is a Zigbee Pro that acts as a receiver to receive the transmitted data so that it could be stored in the local database. This data is further transmitted to the control station with the help of GPRS communication.
C. *Control Station:*
The central server that hosts the Data Base Management System (DBMS) and the database is present at the control station. A web based user interface is present for user interaction with the system. The data from here is fed to programs like data parsing programs, route optimization systems and scheduling applications.

IV. RESULTS AND DISCUSSION

The database containing the values of various parameters of the bin is discussed in this section. The data from the bin is collected for 5 consecutive days. The database is created online using an application named Caspio. The login page for the database is shown in Fig. 2. The name of the database is Smart Waste Management System. The date of creation and last date of modification is mentioned on the login page. The various options such as addition of tables, data pages, adding authentication to the data stored, changing the style of the database etc. are mentioned on the left hand side of the login page.

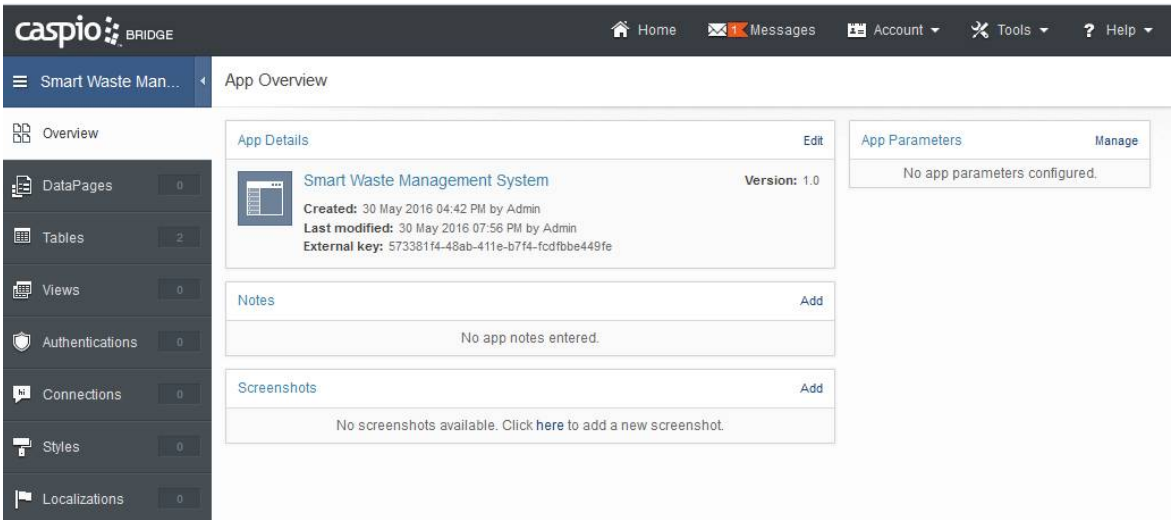

Fig.2: Login page of Database

The parameters whose information is collected is shown in Fig. 3 which include Bin ID, location of the bin, date, time, filling of bin in %, temperature in degree Celsius, humidity in %. The length of the data and the type of the data is selected under the Data Type tab. The data type has been selected as text with a data length of 255. Any tab can be

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removed from database by just selecting it from the list. With the help of Caspio tool, graphs can also be prepared from the data and authentication can be added to the database. The connections tab shows the no. of active users.

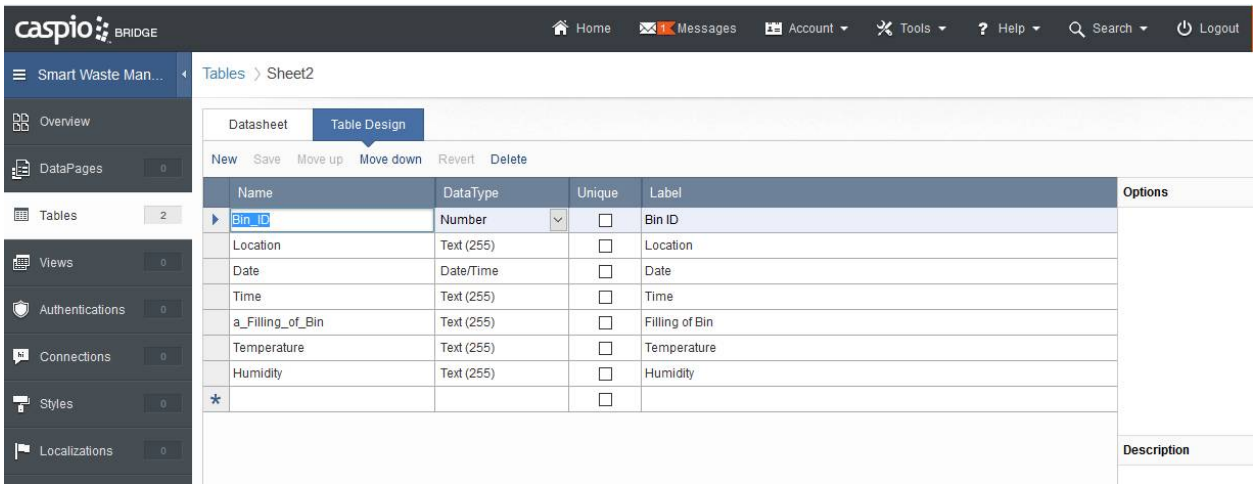

Fig.3: Bin parameters in the database

Fig. 4 shows the values of these parameters as stored in the database. The Bin ID of the bin whose data is being collected is set as 52 and its location is Aravali Hostel in PEC University of Technology, Chandigarh which is used as a testing location. This data can be further used for route optimization and to reduce Greenhouse gas emissions. The refresh button helps to refresh the data in the database. The data is updated at fixed time intervals to reduce power consumption in the waste management system proposed.

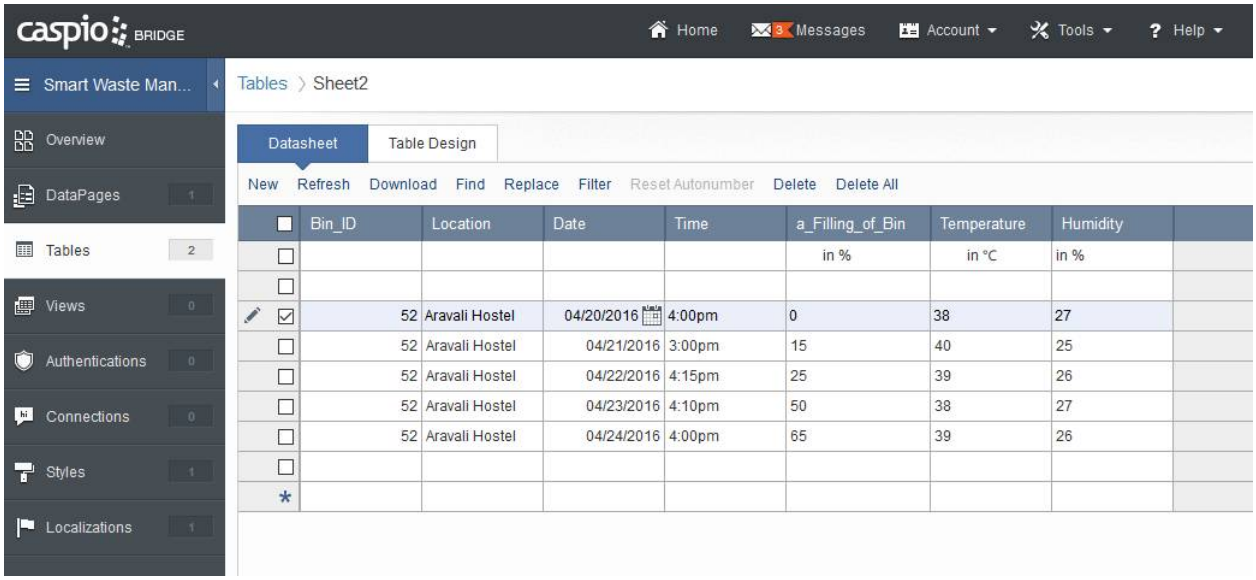

Fig.4: Bin parameters information in the database

The data collected in the bin shows that the bin gets filled to 65% in 5 days. From the data, it can be seen that if filling of the bin is to be chosen as an only parameter for waste collection, then the bin is to be emptied roughly every week if the data remains constant throughout the time period the bin is installed. This data helps in deciding when the cleaner has to come to clean the bin rather than on any random day. This helps to optimize the resources in waste management

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system. Other parameters: Temperature and humidity can also decide the collection interval depending on the type of the waste stored in the bin.

V. CONCLUSION AND FUTURE WORK

Through this paper, a smart waste management system is proposed which focuses on the waste collection process. The status of the bin is continuously monitored at the control station and is presented in a Graphical User Interface to provide a user interaction with the system. The values stored in the database helps a user to have the updated data of the bin as well as the previous values of the parameters of the bin. This collected data from the bin can be used in the optimization of routes for the collection trucks for efficient use of resources in the waste management system proposed.

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