Monitoring and Smart Planning of Urban Solid Waste Management based on IoT

Akshatha G
PG Student
BNMIT
Bangalore

Sneha K
Associate Prof.
BNMIT
Bangalore

Dr. B. G. Prasad
Professor
BMS
Bangalore

***Abstract*:- Solid waste generated is a ever growing problem at local regions or at global levels. There is proper disposal of solid wastes pollute all the components of the green environment (i.e., air, land and water) at regional and global levels. Since there is rapid increase in producing or consumptions, quantity of wastes generated by the urban society has increased. The problem is more faced in the developing countries than in developed countries, as the economic growth as well as urbanization is more rapid. The continuous flow of garbage in all places where public people move around creates the unhygienic situations. It may invoke several injurious diseases among the nearby people. To avoid such a situation and to improve the cleaning, 'smart waste management system' is proposed. In the proposed system, the completeness of waste in the dustbins is checked with the help of Sensors used in the system, and information is sent to the required control room through GSM/GPRS system. Renesas Microcontroller is used to communicate the sensor system with GSM system. An android application is been designed to monitor the information related to the waste for different selected locations. Through this the collection of garbage can be made efficiently.**

Keywords- Solid waste, micro controller, GSM, PIR sensor, ultra sonic sensor, force sensor

I. INTRODUCTION

Internet of Things (IoT) is the new emerging technology which has vast applications. In internet of things all the devices are made to talk to each other. Any data shared using the real world application can be viewed from any place at any time. This helps the user to make the decision in a suitable way.

Management of waste is a big challenging problem in urban areas for most of the countries throughout the world and is seen in most of the developing countries than in the developed countries. An efficient management of waste is a requirement for maintaining a clean and green environment as there is increase in all kinds of wastes thrown by many places like industrial, agricultural, home waste, etc. Waste collection and recycling is done through various technologies. Collection of information is big and cumbersome. The current growth in nation with large residential area and a demand for modernization in the city creates a challenging task for waste management people. The complexity of BBMP or municipal authorities is mainly on problems related to the collection the waste from different locations, transport ting them for degradation and processing of residential solid waste today the garbage collection is manual which takes a lot of efforts and is time consuming.

The organic waste from vegetables and fruits market is biodegradable quickly and releases bad odor. Rats, flies and other pests are attracted due to discharge of organic waste. These cause diseases such as typhoid and cholera, and can also cause diarrhea, eye problems,skin diseases etc. Due to improper disposal of waste in the environment many diseases are attracted due to the presence of many insects like flies, mosquitoes. Better SWM (Solid Waste Management) with improved waste collection, improves the health of all citizens. The solid waste management is very difficult in developing countries as there is no proper management system for collection of waste and recycling.

Internet of Things will help the cities to be improved by making the people use moder technologies for different kind of activities. With new hardware and software technologies all common "things" and infrastructures will be integrated. The sensors will be placed in the road and all streets to measure the temperature, noise, traffic etc., actually it means all things. Collected data from all the sensors will be transferred to other "sensors" and process them. To provide better services to people for monitoring the environment and react to the natural disasters quickly.

Huge amount of money is wasted every year for waste collecting from all cities, without the size or their location. According to the population, the quantity of bins to be located in the roads and no of vehicles required to throw the waste is calculated. Even though all this calculation is taken the count goes either too high or low. This is all done to reduce the cost and save fuel. The waste collection from the bins is based on the material in the bin like plastic, raw waste etc., the raw waste must be collected within two days without the regard of the state of the bin because the waste must be thrown before it starts smelling. "Stream of constant information on the quantity of waste daily is required to predict the best time to make the garbage collection and optimizing the number of vehicles and containers placed on the street becomes feasible".

Now as the technology develops the best way to check the fullness of the bins is through sensors, this helps in achieving an efficient system." Smart waste management "can be defined as the system that is appropriate to events itself. Therefore, in a smart city context, the important concept is that it allows users to interact and access anytime and from any device with information in the city.

In our scheme we introduce a method for waste collection by monitoring and smart planning. We adopt the SmartM3 platform that helps us to take some of its important characteristics such as "interoperability, uncoupled

communications, wide range of APIs and ease of implementation". The solution mainly has two parts: a monitoring phase where the waste bins fullness levels is measured constantly; second is the computation phase in which the collected data is elaborated for the trash collection.

II. RELATED WORK

S. V. Srikanth [1] tells about the problem due to the rapid increase in the population and as our country is stepping towards developed country, people have improved their life style. Hence there is increase in the number of vehicles in the country. Therefore its becoming difficult in places like restaurants, malls, public places etc. There is a need for effective smart management of the parking in all these places above mentioned. Parking problems are becoming ubiquitous and ever growing at a rate in every major city. All over the world a lot of research and development is being done to implement well-defined and parking mechanisms. Use of wireless technologies is widespread with the new schemas in wireless applications for parking, so that digital data could be the key to solve upcoming parking problems. Wireless Sensor Network (WSN) schema has wide applications in various fields hence it gained increased attention. The paper proposes a Parking Smart (SPARK) System Management based on sensor wireless network which provides advanced facilities like remote monitoring of parking, automatic guidance, and parking reservation mechim. The SPARK overall system architecture from hardware to softwe implement has been explained. Our preliminary test results tells that the performance of the WSN based system can effectively satisfy requirements of existing parking problems therefore reducing the time taken to find vacant parking lot, real-time information gathering, and smart reservation techqunies. With this SPARK system it helps the public people to reserve for their vehicle parking in different locations like mall, hospital, public places etc. It also provides the location of the parked vehicle in huge parking lot places. The parking problem is very big problem faced by the public people in various situations and various places.

P. Zhou [2] discuss about the agricultural area in China is leading in the world. Modern technology information of in agriculture with various applications. This helps us to solve some number of questions related to collection of information in large area efficiently with reliability. Information transmission, intelligent system integrating for different needs and environment. The transforming from the traditional farming method to modern farming technique happens. It provides for inventing new mechanisms and services in IOT for farming to help farmers. An IOT based intelligent monitored framework platform and system structure for agriculture ecosystem has been told. The solution is divided into four function layers based on the information exchange and logical handling, i.e the sensor layer is responsible for numerical sensing of physical values required for farming.

L. Liu [3] discusses about a violation approach for the monitoring of regional/urban solid waste management systems under uncertainty, based on a special technique called "interval-parameter fuzzy integer programming" (IPFIP) model. In this approach, given levels of violation system constraints permitted are more tolerable. The decision space of the model is explained using the critical constants called the violation variables. Violation analysing scheme does not satisfy all the models original constraints. This method gives reasonable solutions through this planning. Within the management system a small information regarding expansion of facility and waste flow decision were made generated. The results of modelling generates a series of decisions under system conditioning, allows for more in-depth analysing of tradeoffs between environment and economic things as well as those between system reliability and optimality. This whole model depends on the different decisions taken by the user with the each step in the project. This plays a major role in the system progress.

G.J. Manderson [4] discuss about the amount of solid waste produced from industries in developing countries that can no longer be ignored. The safe disposal that is urgently required as the quantity is increasing day by day. Reducing the volume of solid waste produced in the cities and towns is the first step of measure. However volume reduction is only one measure to the problem. We need to convert of solid waste to non-harmful waste that is not harmful to environment. Different methods of decomposing both the agricultural and industrial waste have been discussed. One of them is the cleaner technology where the production of waste in industries can be minimized. Cleaner technology includes five steps namely planning and organization, pre-assessment, assessment, feasibility study and implementation. Re-cycling of waste is the key activity of cleaner technology. The waste collection is required to be done on a daily basis as the dirt cannot be left without treatment in open space [5].

III. PROPOSED SYSTEM

All the embedded systems have equally different designs according to their functions and uses. In the project explained here the design is a structured design concept is inherited and the system is mainly contains of microcontroller, Ultrasonic sensor, force sensor, GPS, GPRS, LCD, Amazon cloud web server and Android application.

There is no proper system followed for the collection of waste and disposal in India. The waste is collected and dumped in various areas of the cities. The collected waste is not taken for disposal and left in same place for many days and becomes rotten in that place and cause bad smell, spreading diseases.

Hence a "smart solid waste management method" is introduced in the paper discussed. Here in this project various dustbins are placed in the different locations of the area. The dustbin is placed with various sensors called ultrasonic sensor and force sensor. The ultrasonic sensor is used to check the level of the dustbin and force sensor is used to check the weight of the bins. When the value exceeds the threshold value, this information with the GPS location where the dustbin is located will be sent to server through GSM/GPRS system. The android mobile will fetch the information from the server in which area the dustbin is located by comparing the coordinates.

Since now almost all common people use the smart phones it becomes easy for us to provide the product which will be helpful for us to keep the city clean. Any common man can download the application and use the application for the waste displacement. By using this procedure we can keep our city clean and people away from any type of diseases.

A. System Architecture

The Fig 3.2 refers to the hardware architecture of the system. It tells about all the hardware devices used in the waste management system.

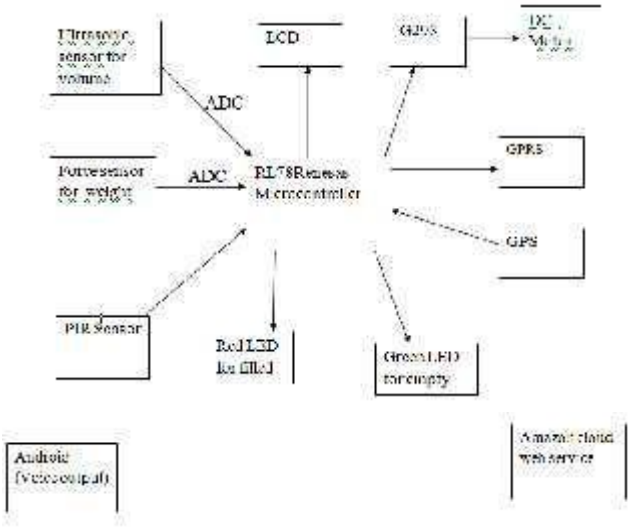

Figure3.2: Architecture of solid waste management system

The microcontroller placed at the center of the block diagram forms the control unit of the entire project. The microcontroller is embedded with a program that helps the microcontroller to take action based on the inputs provided by the output/actions of the sensors.

Here we have used Ultrasonic sensor and force sensor to monitoring the waste in the dustbin. Amount of waste in the dustbins is detected with the help of Ultrasonic sensing system. Force sensor is used to check the weight of the dust bin. Red and Green LEDs are used to indicate filled and empty level of dustbin respectively. When the measured value of sensors exceeds a certain threshold value, this information with GPS location where the dustbin is located will be updated directly to Amazon cloud web server through GPRS (IoT). Android device is used to fetch data from server, and can be viewed on Google map. Android device will detect in which area dustbin is located, by comparing coordinates and updates the location and inform the respective vehicle to collect the waste. Microcontroller is used as branch between the sensor system with GSM system. This will help to manage the garbage collection efficiently.

In an android application a GUI is developed like when user logs to smart phone the menu will be provided, which holds the commands to hold data and view data. This helps in viewing the system by a single application by just logging into the application you can view the status of the bin and get location to any of the bins [6].

B. Advantages of proposed system

- Waste management can be done in a faster and in a smart manner.
- Collection of waste becomes simple.
- Waste is collected then and there from the place which has been filled, and saves fuel of the vehicle.

IV. IMPLEMENTATION

The implementation of this is done by considering three parts: the embedded part, android part and the web server part.

The embedded part consists of various devices like microcontroller, LCD, force sensor, ultrasonic sensor, PIR sensor, GPRS and GPS.Each device has its significance in the project. The micro controller is the heart of the system to which all other devices will be connected or they will communicate with it to support the project. Here in this project the controller used is RL78, Renesas micro controller. The LCD is used to display the status of the dustbin near the bin to the users who can view it near the bins. The force sensor and the ultrasonic sensors are used in the dustbin to detect there fullness of the bin and record the weight of the bin regularly. PIR sensor is used to detect the human motion near the dustbin and to open the dustbin lid automatically if the bin is empty or partially filled [9]. But if it is completely filled the lid will not be opened. The GPRS and GPS are used for communication and to provide location. The GPRS is used for communicating with the micro controller and web server. GPS is used to provide the location of the dustbin to the different users.

Figure 4.1: Renesas RL78 microcontroller with LCD display

The above figure 4.1 shows the Renesas RL78 microcontroller with the LCD display. The micro controller is used to program all the sensors used for the project. The sensors are coded and the code is dumped into the microcontroller using the Renesas flash programmer. The status of the bin is going to displayed on the LCD monitor [7].

The android part consists of an application through which the users can view the status of the bins stored in the web server and get the direction to the dustbin. The user just needs to login to the application and use the features of the application [8].

The web server part is just the amazon cloud server where the status of the bin keeps updating from the information collected by the waste management system.

Finally the overall system functions as follows: first the user need to download the waste management application, then he need to provide the user credentials for login. Once he has logged in then the user will be provided with the web server credentials where he can login to the web server to view the status of the bins. When the user knows the status he can select any of the bins which are not empty and ask the waste management application to provide the direction to the selected dustbin. As soon as he goes near the bin, the lid open for the user to through the waste. As soon as the waste is thrown in the bin the data again gets updated in the webserver.

The below figure 4.2 shows the model setup of the dustbins with all the sensors fitted in it and ready for working. It has two LED lights for the indication of the fullness of the bins. Red is used to indicate the fullness and green for empty. The PIR sensor is used to detect the presence of human and open the lid automatically when the bin is empty only. Ultra-sonic sensor to detect the fullness and sends it to the waste management system and this system updates the information to the web server, where the status can be viewed any time.

Figure 4.2: Model of the dustbins with all the sensors fitted

V. CONCLUSION

The Smart waste management system provides the best way to help the public people to maintain the city clean by using the developed application to locate the different dustbins places in the different locations of the area. The application also provides the status of the different dustbins, if they are semi full, empty or completely full. This saves the time and helps people to throw the waste only in the dustbin and not elsewhere in the city.

The future enhancement of this project is to monitor different types of waste in the bins: which means there must be minimum of 2 dustbins placed in each off the roads, one for dry waste such as plastic, paper, bottles etc and the other for wet waste. We need to take measures so that the wet bins are cleared for at least two days once even if they are not completely filled, since it starts smelling if it is kept for long.

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