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Intelligent Sensors based Waste Disposal system for Smart Cities

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Abstract: **Municipal solid waste administration has loomed to be a considerable threat faced by environment conservation departments in developing countries. In the present scenario, waste administration is outlined by feeble collection mechanism and deficient canopy of the compilation system. Imprudent management of ruins creates an unhygienic environment and leads to many health issues. An intelligent waste administration system is built to overcome these problems. The major purpose of the planned structure is to implement a smarter way of managing waste using an intelligent sensor. The sensor helps in identifying the quantity of garbage in the trash bin and real-time information collected from the various dustbins located at different places. This system can be implemented with the thought of smart cities in mind. The drivers would make use of an android application to find the shortest and fastest path to collect the garbage. Once the garbage is collected the information would be updated on the web page. The system would even ensure that there is no waste thrown around the trash bin. The intelligent sensor would make a beeping sound if any person negligibly throws it around the trash bin and not into the trash bin. This system ensures a clean and hygienic environment with optimum resources.**

Keywords: Intelligent Sensors; waste bins; GSM; GPRS; smart city; Google Map API;

I. INTRODUCTION

At the outline, the garbage or dust bin is filled at most of the public locations in the cities. It creates an unhygienic atmosphere and generates bad sniff in the ambiance, leading inconvenience for the people. Most of the time drivers drive a long distance to collect the garbage from an almost empty bin It results in a waste of petrol, labor, transportation resources which causes pollution and traffic jams. To avoid such a problem an intelligent waste disposal system is developed.

The main objective is to control pollution, diseases, wastage of resources, and irregular management of waste which disturbs society. It is even capable of auditing the waste administration through a web page, catering to a throb technology. The waste acquiring course is a captious facet for the service managers. The classic way of human monitoring the garbage in waste boxes is a sophisticated process and employs more manual effort, time, and money. Erratic management of waste causes health disorders and has ill effects on the hygiene of human beings. The idea of an intelligent waste management system aids in the management of solid waste without much manual effort to preserve hygiene surroundings. This system can be implemented with the thought of smart cities in mind. All cities, disregarding their size, geographical occupancy, and economic stability, consume huge capital annually for waste assembling. The bins located in the streets and the number of collection vehicles used to clear them are generally predicted based on the bulk of citizens in the area, but the prediction is sometimes erratic. The proposed system is mainly designed to avoid such wrong estimation as the sensors which act intelligently by sensing and updating the right information. And also to reduce manual time and labor which results in a healthful and sanitized environment leads to having a decrease in traffic jams and pollution.

II. RELATED WORK

In general, the prevailing system, local administration manages waste by setting up waste boxes in the city and employing multiple pickup vehicles for waste collection. However, the existing waste management approach causes many environmental problems.

Some of the disadvantages of the existing systems consume a lot of time and thus they are less

effective (Even though the dustbins aren't full the trunks go to empty them), cost-effective, create an unhygienic condition in the city, human beings may have to face many health-related problems and more consumption of fuel and more Traffic.

The need and motivation behind waste management is a critical issue that gives an overall idea of how increasing waste to be managed in developing countries [1]. The comparative study of the state of the art of urban waste management was carried out in [2]. The analysis gives the deficiency of the system. It focused on how to collect data based on regional differences. In [3], a review of different methods used for solid waste management in India. The work carried out in [4] [5], gives an overall idea of how IoT can enable smart waste management. The design of the smart bin was proposed in [6]. The basic idea here is to identify the status of the litter bin and transfer the collected information through a wireless mesh network. The motive here to reduce the work of the waste management team by providing appropriate information. The smart garbage bin which aids in the smart and wireless waste management is implemented in [7]. The idea here is to improve the cleanliness of the environment by informing waste management workers before the dustbin is filled up also separate the plastic waste by using NIR spectroscopy and generate biogas for energy purposes.

A survey of smart waste management using IOT was carried out in [8]. It lists out merits and demerits of each algorithm compared here. This gives input for the collection of data and analysis of data. This also gives an overall idea for efficient collection and management of waste. The waste bin is a solar-powered compact bin [9]. It can hold 10 times of normal dustbin. The data transferred wirelessly to a cloud server. Users can view the status by logging to the server. The power supply to the bin is intelligently managed. The low cost, power waste management system is explained in [10]. Whenever the bins are full the motor will rotate and close the bins and information is passed using the GSM module to collect information. The information about whether trash is filled or decomposed will be passed to the concerned authority. The work proposed in [11], describes how solid waste management can be accomplished efficiently with the help of sensors. Here waste management techniques are integrated with the use of different sensors like Ultrasonic Sensor to determine the level of waste, Moisture Sensor to separate wet and moist waste, GPS, RFD to accumulate waste efficiently, and Motion Detection Sensor to automate the opening and closing of the bin. A smart bin was designed to monitor the level of the bin also automatically disposes of the trash and detect the overflow of the bin by rainwater that can be avoided [12]. The IR sensor, gas sensor, rain sensor is used for the same purpose.

There is a lot of work carried out in the direction of solid waste management. The study motivates to develop an efficient waste management system by using minimal resources. There is a need to develop a system that deals with real-time information, and based on this necessary information the action must be taken.

III. PROPOSED SYSTEM

In the proposed system is designed to keep smart cities in mind. The various bins in the city are equipped with intelligent sensors (Ultrasonic sensors). These sensors are employed to sense the waste level in the bins and to check if any wastes are outside the waste boxes. This ensures the cleanliness of the environment. It improves the environment ambiance by reducing the bad sniff and health issues due to an unhygienic environment. The dustbins can be deployed based on actual use and not on assumptions and hence effectively use all the dustbins. It reduces the cost by optimizing the use of resources. The real-time information is received by the driver and the webpage (using GSM and GPRS). The details on the webpage can be accessed by authenticated users. The collection of garbage can be easily monitored through the webpage. It reduces the excessive usage of petrol by providing the shortest and fastest path (by using Google Map API) to the drivers through the android application and by collecting the garbage only after the threshold level is reached.

The proposed intelligent waste management system has the following advantages such as reliability, mobility, service continuity, and user convenience.

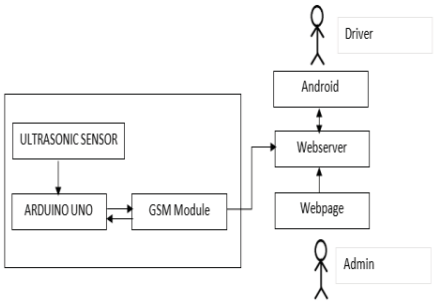

Fig.1. Architecture of the proposed system

Fig.1 gives the overall functionality of the proposed system. The intelligent collection bin employs two sensors such as weight sensor and InfraRed (IR) sensors to indicate the weight and levels of waste in the bins respectively. The IR sensors help in getting information regarding the levels of waste in the bins. The weight sensor activates and sends information to the concerned once the waste in the bin reaches the threshold level. This information is passed on to the microcontroller Arduino UNO and further to the transmitter module (Wi-Fi module). The processed information regarding the waste bins is displayed onto the HTML page in the web browser of the mobile handset.

IV. METHODOLOGY

This module outlines the requirements of the proposed and describes what the proposed system should do.

A. Scope and boundary

The proposed structure will meet the requirements of the user by equipping the following features:

1. Clean the trash bin before it overflows.
2. Reduce pollution and traffic by controlling the excessive movement of garbage trucks.
3. Ensures the cleanliness around the bin by making a buzzer sound if garbage is thrown outside the bin.
4. Provide the shortest and fastest path for the drivers through an android application installed on phone.
5. Provides tabular representation of the status of the dustbin on the webpage.
6. Provides the position of the dustbin located at the various places on the google map API.
7. Provides real-time information regarding the status of the trash bin.
8. Effective usage of the dustbin.
9. Intelligent management of services.

B. Inputs and outputs

In the case of sensing the data, the input is the garbage that is dumped inside or outside the bin. The buzzer sound is the output for garbage thrown outside the bin. The message sent to the driver and data sent to the webpage is the output for the garbage thrown inside the trash bin if it crosses 75% of the garbage level. In the case of analyzing the data from the web, page input is the username and password, the resulting Google map API and tabular representation of the data is the output. The driver's current location is the input to the android application. The shortest and fastest path found is output.

1. Assumptions and dependencies

- Dustbins located at various locations are marked on the map. The roles and tasks are predefined. Android mobile application is installed on driver's cell phone.

2. General constraints

The general constraints of the methodology are the availability of the internet, GUI, login, and password are used for the identification of the admin and the authenticated users, mobile with Android OS, and driver's phone should be installed with Android Application.

C. Interface Requirements

Table 1 presents the hardware and software requirements.

Table 1: Hardware and Software requirements

Hardware Requirements	• Arduino UNO • Ultrasonic sensors • GSM module • Dustbin
Software Requirements	• Operating System: Microsoft Windows Vista/XP/7/8/ 10. • Browser: IE, Google Chrome, Mozilla Firefox.

D. Functional requirements

The functional requirements for a system describe the functionality or services that the system is expected to provide. These define the services to be provided by the system, reactions of the system to inputs, and the behavior of the system for various reactions.

1. *Role of admin*
2. The various operations of the admin are to approve and remove users to access the application, add new services or features on the web page, analyze the data on the web page, monitor the punctuality of Drivers, controls the overall system, and mark dustbin locations on Google map for newly placed bins.*Role of driver*

3. The driver receives a message if the garbage is almost full. Make use of the application to find the shortest and fastest path to reach the bin. And also drive towards the bin to collect the garbage from the bin.*Non-Functional requirements*

a) Eco-friendly: It ensures a clean and healthy environment by not allowing the trash bins to overflow. It also indirectly reduces pollution as the drivers only drive when the dustbins are full.
b) Availability: The software should be available when required.
c) Security: Data is highly confidential as only authenticated users can access the data.
d) Portability: Data can be accessed throughout the world on any platform.
e) Reliability: Data can be highly reliable as real-time information is stored.
f) Scalability: Handles many trash bins.
g) Maintainability: It is easy to maintain the operation as it can be easily monitored through the web page. The admin is responsible for the overall maintenance of the system.
h) Usability: It is easy to use for both the drivers and admin. Since most of the drivers are not flexible with modern technology, hence it is made easy for them.
i) Extensibility: The future work is taken into consideration. Extra features can be added to the web page and the sensing quality

V. IMPLEMENTATION

Implementation is the process of putting a decision or plan into execution. Implementation is the carrying out, execution, or practice of a plan, a method, or any design, idea, model, specification, standard, or policy for a system.

The ultrasonic sensor given in Fig.2 is fixed on the lid of the dustbin and the distance between garbage and the top of the dustbin is measured. As the garbage level increases the distance between the garbage and sensors decreases and finally when it is less than the threshold value the sensors would indicate that the dustbin is full and a message (dustbin is full) would be sent to the drivers mobile as well as the status of the bin would be updated on the webserver. Here threshold value is fixed to 10cms.

Fig.2. Ultrasonic sensors

GPRS & GSM module allows the users to interact with the GSM using AT commands. The details of the GSM module are given inFig.3. It allows the communication between the modem and the server. In the proposed work the GSM900A module is utilized for GSM and GPRS communication. It performs operations such as connecting to the remote server, sending the message to the driver's mobile, sending the data to the remote server, etc.

Fig.3. GSM module

The web page provides the authenticated users (Admin) with real-time information. It enables the admin to check the status of each dustbin that is

placed at different locations. It consists of a Google map API which highlights the different locations of the dustbin. It also gives a tabular representation of the status of the various dustbins. As soon as the dustbin status has changed the web page would be updated with real-time information. The web page is created using PHP and bootstrap.

Android application is mainly programmed for the drivers who are responsible for collecting the garbage and this android application should be installed on the driver's mobile phone. This application enables the user to find the shortest and fastest route to collect the garbage from the full trash bin.

VI. RESULTS

A webpage was designed as a part of the implemented system. The website is managed for the concerned authority of the waste management system; they must frequently check and update the status of waste collection and other information. The sample screenshot of the webpage for the implemented system is given inFig.4 and the login page is given inFig. 5. The web page provides the authenticated users (Admin) with real-time information. It enables the admin to check the status of every dustbin that is placed at different locations.

Fig .4. webpage of the implemented system

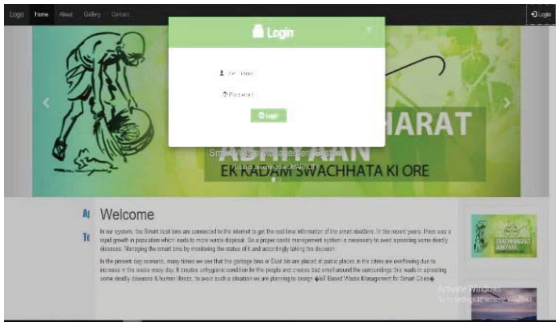

Fig .5. Login page of the website

The implemented system consists of a Google map API given inFig.6 highlights the different locations of the dustbin. It also gives a tabular representation of the status of the various dustbins. As soon as the dustbin status has changed the web page would be updated with real-time information. The web page is created using PHP and bootstrap.

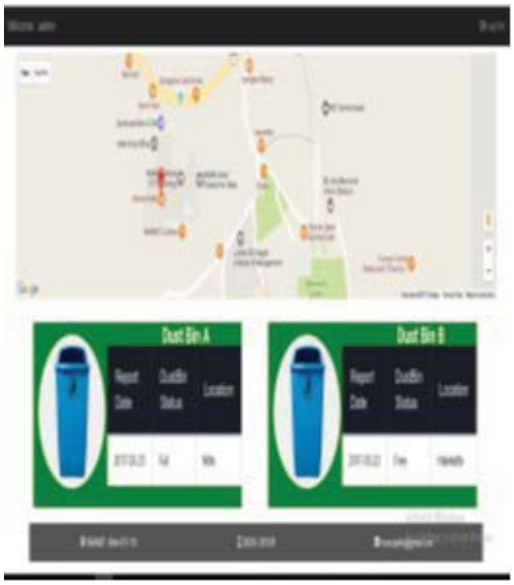

Fig.6. Google map API and logout page.

The android application is mainly programmed for the drivers who are responsible for collecting the garbage and this android application should be installed on the driver's mobile phone. This application enables the user to find the shortest and fastest route to collect the garbage from the full trash bin. The login page and Google map API for the developed application is given inFig.7,Fig.8 respectively. It is clearly given in fig.8 the app uses Google Map API to find the fastest route.

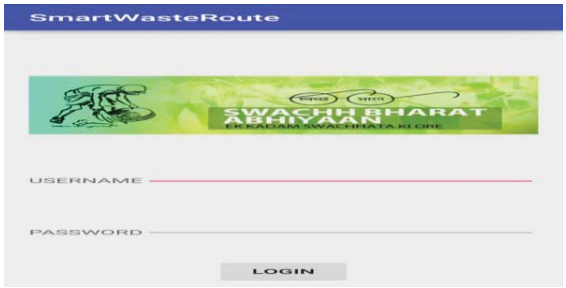

Fig. 7. Login page of the android application

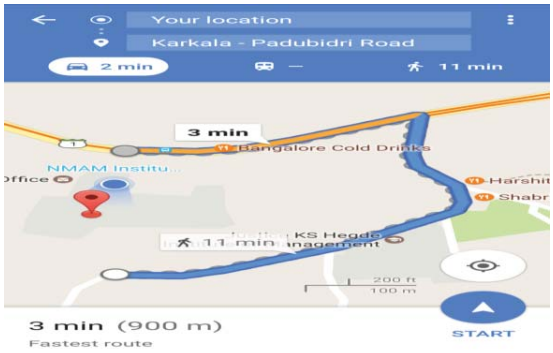

Fig.8. Google map API.

The webpage implemented also displays the application and the latest news has given inFig.9, and Fig.10.

Fig.9.Application page

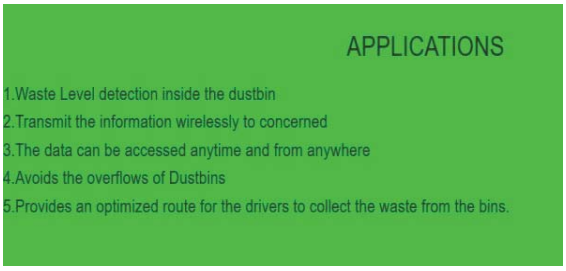

Fig.10.Technology page

VII. CONCLUSION AND FUTURE SCOPE

The proposed smart solution enhances waste collection efficiently and effectively. It also helps the user in accurately disposing of the waste. The sensors in the dustbin will identify the waste level and report it to the web page and driver, so that overflow of the garbage is controlled within a stipulated period. The intelligent dustbins help us to reduce pollution and bad smell. It helps society to maintain a clean and healthy environment. Authenticated users can monitor the waste management system.

In future enhancements, more models are added to the applications and additional functionalities. The functionalities are as follows, should only detect the waste around the trash bin and not human beings or animals, the web page should be able to provide search options, the map should be able to change the color of the marker according to the garbage level of the bin (yellow for below 50% of garbage, green for 50%-75% and red for above 75%).

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