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IoT Based Garbage Management (Monitor and Acknowledgment) System: A Review

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Abstract- In India Now a days Solid waste management is one of the primary problems that is faced irrespective of the case of developed or under development states. It is seen that most of the garages across the roadside are overloaded because the waste is not collected periodically. It creates unhygienic condition for the people and creates bad odour around the surroundings. Due to this it gives birth to some deadly diseases and causes human illness. Most of the time wet and dry wastes are not separately collected so that proper processing like composting, recycling, incineration cannot be applied to different kinds of waste.

This system will help us in garbage management which will results in garbage processing .This systems consist of ultrasonic sensor, infrared sensor for detecting the level of waste, Arduino UNO, microcontroller, Raspberry Pi2 as controlling boards.

This system is comprised of ultrasonic sensors to sense the level of garbage in the bin, flame sensor to detect the fire and moisture sensor to separate out wet and dry garbage. By using global system for mobile (GSM) the concerned persons shall be informed through SMS. The status of waste bins can be monitored and this data is transmitted and processed by fast Raspberry Pi3

Keywords – Internet of Things, Garbage Management, Dry Garbage, Wet Garbage.

I. INTRODUCTION

The environment should be clean and hygienic for better life leads in India. In todays situation , it is seen that the garbage bins or dust bin which are placed at public places in the cities are overflowing due to increase in the waste every day. These overflowed garbage bins create an foul smell which is unhygienic for environment which leads to the rapid growth of bacteria and viruses which causes different types of diseases.
The proposed system shall overcome such problems by alerting the status of garbage bins as well as helps to keep dry and wet garbage separately so that different processes- composting, recycling, incineration shall be applied to different kinds of garbage. By intimating the notification of garbage filled, the number of trips of the garbage collecting vehicle shall be also reduced.

II. REVIEW

G . Shyam et al. have researched waste collection management solution based on providing intelligence to waste bins, using an IoT prototype with sensors. It can read, collect, and transmit huge volume of data over the Internet. Such data, when put into a spatiotemporal context and processed by intelligent and optimized algorithms, can be used to dynamically manage waste collection mechanism

[1]. S. Kanta et al. worked on efficient garbage collection systems with wireless sensor network and mores focus on IoT [2]. S. Kumar et al. worked on the system which checks the waste level over the dustbins by using Sensor systems. Once it detected immediately this system alerts to concern

authorized through GSM/GPRS [3]. A. Arber et al. have analyzed a distributed cross-layer commit protocol (CLCP) for data aggregations and its support for query based search for IoT application [4].

Singh et al. proposed a methodology with use of Infrared sensors to gather real time data from the waste bins and that of Raspberry Pi2Development Board to communicate this information to the waste managers [7]. F. Fulianto et al. presented a system that identifies fullness of litter bin. The system was designed to collect data and to deliver the data through wireless mesh network [8]. P. Shrivastava et al. have done a review and comparison on various GIS models suggested for solid waste management

Al Mamun et al. have proposed new framework that enables the remote monitoring of solid waste bin in real time, via Zig-Bee-PRO and GPRS, to assist the solid waste management process [10]. The system framework was based on a wireless sensor network, contained three levels: smart bin, gateway and control station that stored and analysed the data for further use.

W. Reshmi et al. developed a system with use of biosensor sensor, weight sensor and height sensor to detect overflow of the waste in the dust bin and the extent of pollution caused by unwanted toxic gases from the bin [11]. In this system sensors unit were used for sensing, microcontroller for controlling and for communication GSM module is used. V. Catania et al. proposed a system where waste collection is made by real-time monitoring the level of bin's fullness through sensors placed inside the containers [12]. S. Islam et al. introduced an integrated system combined with an integrated system of RFID, GPS, GPRS, GIS and web camera. The built-in RFID reader in collection trucks would automatically retrieve all sorts of customer information and bin information from RFID tag, mounted with each bin. GPS would give the location information of the collection truck [13].

S. Longhi et al. developed the system which is based on sensor nodes and makes use of Data Transfer Nodes (DTN) in order to provide to a remote server the retrieved data measurements from the garbage bins filling

M. Areber et al. developed the system using RFID associate with intelligent systems like GSM and geographical information system (GIS) for tracking vehicle position [15].

III. BASIC SYSTEM ARCHITECTURE

We propose a smart waste collection system on the basis of level of wastes present in the wastebins. The data obtained through sensors is transmitted over the Internet to a server for storage and processing mechanisms. It is used for monitoring the daily selection of wastebins, based on which the routes to pick several of the wastebins from different locations are decided. Every day, the workers receive the updated optimized routes in their navigational devices. The significant feature of this system is that it is designed to update from the previous experience and decide not only on the daily waste level status but also the predict future state with respect to factors like traffic congestion in an area where the wastebins are placed, cost-efficiency balance, and other factors that is difficult for humans to observe and analyze. Based on this historical data, the rate at which wastebins gets filled is easily analyzed. As a result, it can be predicted before the overflow of wastes occurs in the wastebins that are placed in a specific location. Depending on economic requirements specified at early stages, the optimized selection of wastebins to be collected is expected to improve collection efficiency.

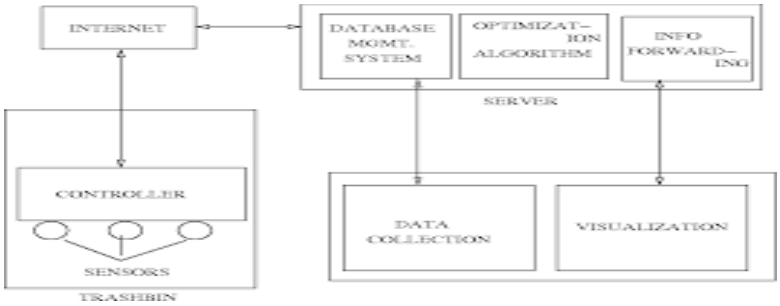

Fig. 1: System Architecture

- Sensors: We can determine the waste level by measuring the distance from the top of the trashbin to the waste by sonar. The sonar that can be used in this prototype should provide measurement from 2cm to 400cm with 3mm accuracy, which is adequate for typical wastebins, e.g., Ultrasonic Ranging Module (HC-SR04). It is essential to optimize the battery usage for achieving bigger lifespan of the devices. Sensing and data forwarding rates, and wireless technology used have a strong influence on energy consumption. Collection and forwarding of data can be done once or twice in a day.
- Access Network Interface: The data collected is sent to a remote server via a wireless link. For our work, WiFi is considered as a network access technology.
- Database: MySql is used for storage of all data collected by the sensors and the trucks.
- Artificial Intelligence (AI): The forecast of waste levels for the future and learning how to select the daily wastebins is based on historical data through artificial intelligence algorithm.
- Optimization algorithms: Once the identification of wastebins have been done, shortest path for collection of same is done. In this work, algorithm 2 is followed for optimization.
- Information adaptation and forwarding: The destination path must be sent to the collectors in understandable format.

IV. HARDWARE USED

Microcontroller: Microcontroller receives information from sensors and processes on it. Here we are using Arduino ATmega2560. It operates on maximum +5 Volt. Input voltage range is (6-20) V. It has a number of facilities for communicating with a computer, another arduino or other microcontrollers. This microcontroller board provides four hardware UARTs for TTL(5V) serial communication. An ATmega8U2 on the board channels one of these over USB and provides a virtual com port to software on the computer. The regulated power supply 5V is used to power the microcontroller and other components on the board. This can come either from VIN (the input voltage to the arduino board when it's using an external power source) via an on-board regulator, or be supplied by USB or another regulated 5V supply **[2].** This arduino board has 50 mA D.C for 3.3 V pin. It has 8KB SRAM and 4KB EEPROM as shown in *Fig. 2.*

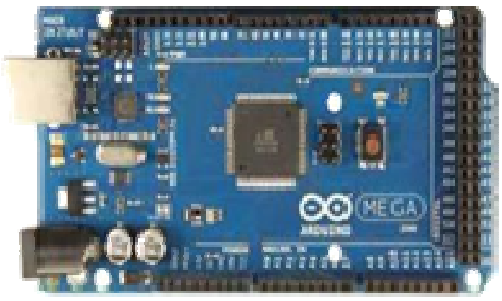

Fig. 2

Wi-Fi Modem: The arduino uno Wi-Fi module can be used as Wi-Fi modem. The Wi-Fi module is based on ATmega328P(datasheet) with an ESP8266 Wi-Fi module integrated. It has 14 digital I/O pins, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a Reset button. The ESP8266 Wi-Fi module is a self contained SoC with integrated TCP/IP protocol that can give access to the Wi-Fi network **[3]** as shown in *Fig. 3* and *Fig. 4.*

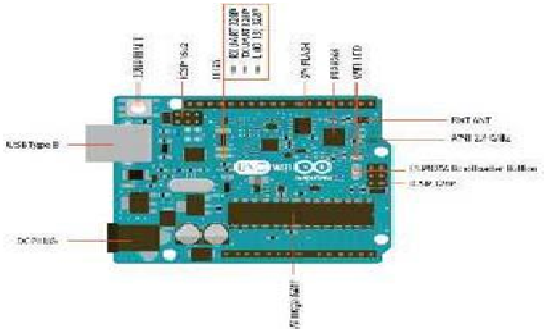

Fig. 3

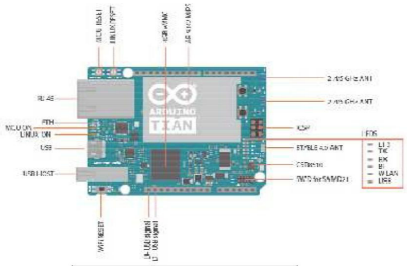

Fig. 4

Ultrasonic Sensors: An ultrasonic sensor transmits ultrasonic waves into the air and detects reflected waves from an object. It has two openings. One transmits ultrasonic waves and another receives them. The speed of sound is about 340 metres per second in air. The ultrasonic sensor uses this information along with the time difference between sending and receiving the sound pulse to determine the distance to an object **[2]** as shown in *Fig. 5.*

Fig. 5

Chemical Sensors: A chemical sensors are devices that convert chemical information, into an analytically useful signal. In this project the chemical information originates from chemical reactions rather reactivity of wastes with nitrogen and its oxides belonging into soil and other chemical compounds which detect the biodegradability of a waste. Chemical sensors contain two basic functional units that is a receptor part and a transducer part. In this sensor it has a separator which separates the biodegradable and non -biodegradable wastes. Here biochemical process is the source of the analytical signal as shown in *Fig. 6, Fig. 7* and *Fig. 8.*

Fig. 6

Fig. 7

Fig. 8

The above Bio Sensor is used in this project.

GSM Module: GSM Module is used to send SMS to the work station or garbage depot if the garbage exceeds set threshold level. GSM is Global System for Mobile Communication. GSM is connected to ATmega2560 via MAX232 serial adder circuit as shown in *Fig. 9.* GSM is controlled through ATmega commands.

Fig. 9

V. ALGORITHMS

Algorithm 1: Smart Waste Management Algorithm
Inputs:
Amount of Wastes generated ;
Number of Wastebins embedded with IoT devices; Capacity of Wastebins;
Nearest-neighbor shortest path algorithm for finding the opti-mized routes;
Output: Optimized routes to visit and empty identified Waste-bins;
Description:
[1].install several wastebins at multiple locations in the city;
[2].embed each of wastebins with IoT devices;
[3].define threshold value for wastes for each of the wastebins;
[4].collect the wastes in the wastebins;
[5].send the collected data (using algorithm 3) over the Internet to the servers;

[6].store and process the information in the server;
[7].calculate and send the optimized routes to send the vehi-cles for waste collection using algorithm 2;
[8].empty the wastes from the identified wastebins;
[9].use the collected data for monitoring daily selection of wastebins;
[10]. predict future traffic in specific location as per algorithm 4;
[11]. update the optimized routes in navigational devices;

Visualization for end-user: The path is sent to the end users via devices such as mobile phones, possibly em-bedded with cameras. This is to facilitate the driver to easily follow the path.

1 Data collection: Data such as GPS locations could help to learn and make better selection of routes.

Cases considered: The cases considered are discussed as follows.

- Case 1: In this case, the servers receive messgage from sensors (embedded within wastebins) from all locations, for waste collection. In this case, vehicle is sent to all the location through the shortest path possible covering all the locations.

- Case 2: In this case, the servers receive messgage from the wastebins, where the wastelevel is more than 70%. In this case, vehicle is sent only to those identified loca-tions from where the messages are received, through the shortest path possible covering all the identified locations.

- Case 3: In this case, the servers receive messgage from the wastebins, where the wastebins are filling at faster rate. In this case, vehicle is sent only to those identified locations from where the messages are received, through the shortest path possible covering all the identified locations.

Algorithm 2: Shortest path spanning tree algorithm (SPST) used by server
Inputs:
Distance from wastebins to worker stations ;
Output: Optimized routes between two points where the wastebin needs to be collected ;
Description:
1: consider street network as a graph;
2: consider street segments as edges and joining points as vertices;
3: calculate an accurate shortest travelling distance between two locations;
4: calculate the distance from one-to-all wastebins to speed up the route optimization process;

Algorithm 3: algorithm in wastebins sensors
Inputs:
Waste for each day of the week/weekends; Output: level of wastes in wastebins ;
Description:
1: sense the level of wastes in wastebins every 2 hour during the weekday ;
2: sense the level of wastes in wastebins every 1 hour during the weekend ;
3: compute the rate at which wastebins is getting field ;
4: if the rate is high every 1 or 2 hr, then send message to sever for sending the vehicle for waste collection;
5: if the wastebins level is more than 70% then send the message to the server to send the vehicle for waste collection;
6: if the wastebins level is below 50% then send the message to the server, not to send the vehicle for waste collection;

Algorithm 4: Analysis algorithm used by the servers
Inputs:
Waste level data for each day of the week/weekends; Output: Predicted waste level data for the coming days ;
Description:
1: get waste level for every day of the week from all wastebins ;
2: observe the changes in the waste levels during the week/weekends;
3: note down the drastic changes during the specific days(s);
4: when wastebins are getting filled faster, send alert to charge/change the batteries (area of research)
5: calculate the distance to wastebins which have significant rise in waste levels;
6: speed up the route optimization process for those days;
7: if the rate fill of wastebins in given area is very high, send alert to municipality to increase vehicles & wastebins;

VI. CONCLUSION

The proposed system 'IoT based Garbage Management (monitor and acknowledgement) System' shall provide the smart solution regarding overflowing of garbage bins. This system shall be beneficial in keeping dry and wet garbage separately so that different processes-composting, recycling, incineration shall be applied to different kinds of garbage. By intimating the notification of garbage filled, the use of the garbage collecting vehicle shall be optimized. By keeping the environment clean, contribution shall be given to the society for 'Clean India Concept'.

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