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Efficient Garbage Monitoring System: An Aspect of Smart City

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ABSTRACT: With the increasing population, the scenario of cleanliness is degrading day by day. A smart city is incomplete without a smart waste management system. The idea is to propose a model of Garbage Management using Internet of Things for Smart Cities in organizing a garbage collection system of a residential or commercial areas. In this proposed system multiple dust bins are located in the city with unique ID and different types of sensors embedded on the bins which detect the level of garbage. When the bin is full, respective authority is informed. The respective authority is informed through internet. Alert is sent to the cleaners' mobile about the location of the bin from where garbage needs to be collected. Authority keeps check on the action taken by the cleaners and improves the efficiency of the system. This system helps in maintaining hygienic condition for the people staying in its vicinity.

KEYWORDS: Wireless Sensor Network, Internet of Things, ID3, Travelling Salesman Introduction

I. INTRODUCTION

Due to tremendous growth in the rate of population there is a necessity of economical urban development plans. By using advance technologies and vital approach, smart cities are developing all over the world. A smart city is incomplete without a smart garbage management system. Many times we see garbage bins overflowing and they are left as it is. This model provides a solution to the static waste management system and implements dynamic waste management system. Our motive is to design a system that keeps our city clean and maintains cleanliness in the surroundings. The idea is to propose a model of Garbage Management using Internet of Things for Smart Cities in organizing a garbage collection system of a residential or commercial areas. In this proposed system multiple dust bins are located in the city with unique ID and different types of sensors embedded on the bins which detect the level of garbage. When the bin is full, respective authority is informed. The respective authority is informed through internet. Alert is sent to the cleaners' mobile about the location of the bin from where garbage needs to be collected. Authority keeps check on the action taken by the cleaners and improves the efficiency of the system. This system helps in maintaining hygienic condition for the people staying in its vicinity.

II. RELATED WORK

Secure connection establishment between the sensor nodes. Authors show how wireless sensors were integrated with internet and whether the existing technology was able to fulfil the requirement. It takes care of end to end connections between the nodes and all possible approaches which could be used to connect a WSNs with internet. It takes care about the security of data being transferred. The work includes feature of connection establishment and security of data being transferred [1]. Machine to machine interaction is an important feature in IoT. In future as maximum things are going to be automated, machine to machine interaction must be accurate. Internet of things deals with M2M interaction continuously. This system implements the feature of M2M interaction as the sensing, processing, storing and sending alert in our system is done by M2M interactions [2]. All the aspects of WSN, i.e. its flexibility, range, requirements, protocols used, cost, life, design. WSN monitoring includes both indoor and outdoor applications. It shows the usage of WSN in long term environmental monitoring, its accuracy and the number of sensors used [3].

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The authors propose to give solution to the irregular waste disposal system. The design makes use of various kinds of sensors using for detecting the overflow of the waste in the bin. The sensors used are weight sensors, bio sensors and height sensors. Sensor data is fed to the microcontroller which with the help of GSM module send data to the authority. This makes authority aware of the status of the bin and respective action is taken to avoid the overflow of the waste and keeps the city clean. For operating the system, power is supplied by harnessing solar energy which is a renewable source but on the other hand it increases the cost of the system [4]. Vehicles are used for garbage collection hence authors proposed vehicle routing problem for plastic waste collection. It aims for re- designing the collection routes and compares the collection options of plastic waste using efficiency parameters as performance indicator. Certain drop- off points are fixed on a map for plastic waste management and the routes for collection are designed in such a way that only bins with plastic waste are visited instead of visiting each and every bin [5].Different kinds of trucks are required depending upon the amount of garbage generated, to focus on the size of trucks sent for the collection of waste i.e High Capacity Trucks (HCTs) and Low Capacity Trucks (LCTs) and it uses dynamic routing for waste collection.

This model gives the implementation of smart city, weight sensors are implanted in the garbage bin and on the basis of its weight trucks are sent for collection. If it crosses certain threshold value then High capacity trucks are sent as their storage capacity is more. The model also uses shortest path algorithm to reach the respective location which helps in improving the cost estimation as it saves fuel [6] .The proposed model gives the implementation of garbage management using Internet of things for Smart Cities. It proposes a highly stable model of waste management which includes sensors, microcontroller, Arduino board GSM unit, master unit and client side. It verifies correctness of the data sensed by the sensor and then informs the authority about the status, if detected value is incorrect then sensor will not send any value and keeps collecting further values. Detected values are displayed on screen in the control room and an alert message is sent to cleaners' mobile phone so that action is taken as early as possible [7].

III. PROPOSED ALGORITHM

A. *Design Considerations:*

- **Sensors** - Here we are using ultrasonic sensors and load sensors are embedded in the garbage bin to continuously monitor the condition of the dustbin like checking the height and weight of the waste in the dustbin.
- **Arduino Uno Board** - This unit is used to receive data from the sensors and the received data is processed and the relative information will be sent to the respective authority where the server is present.
- **GSM Module** - GSM module is used to send and receive the information about the status of the waste in the dustbin over the distance.
- **Mobile Application** - It will contain cleaners' information in that particular area and this application will contain the sub module to send and receive alert.Nearest cleaner will be informed so that its avoids overflow of garbage.
- **Master Unit** - Master unit contains server which controls the data transmission and retrieval and a GSM unit. It's is responsible for status reporting.
- **Slave Unit** - Slave unit is the garbage bin which consist of sensors and Arduino Uno board and GSM unit embedded.
- **Database** - It is used to save the data received from the garbage unit and if required data can be retrieved.

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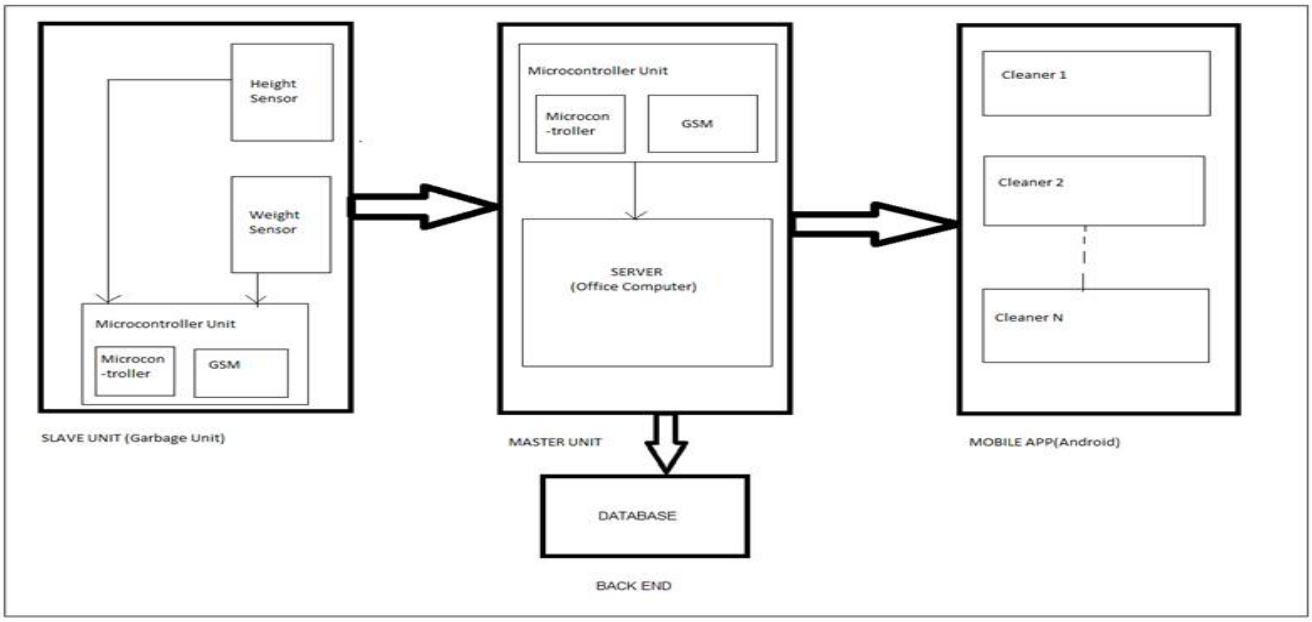

B. *Description of the Proposed Algorithm:*

ID3 (Iterative Dichotomiser 3) : ID3 builds a decision tree from a fixed set of examples. The resulting tree is used to classify future samples. The leaf nodes of the decision tree contain the class name whereas a non-leaf node is a decision node. The decision node is an attribute test with each branch (to another decision tree) being a possible value of the attribute. ID3 uses information gain to help it decide which attribute goes into a decision node.

The travelling salesman problem (TSP): It asks the following question: Given a list of cities and the distances between each pair of cities, what is the shortest possible route that visits each city exactly once and returns to the origin city? It is an NP-hard problem in combinatorial optimization, important in operations research and theoretical computer science.

The Branch and Bound strategy divides a problem to be solved into a number of sub-problems. It is a system for solving a sequence of sub-problems each of which may have multiple possible solutions and where the solution chosen for one sub-problem may affect the possible solutions of later sub-problems. Suppose it is required to minimize an objective function. Suppose that we have a method for getting a lower bound on the cost of any solution among those in the set of solutions represented by some subset. If the best solution found so far costs less than the lower bound for this subset, we need not explore this subset at all.

- Let S be some subset of solutions.
- L(S) = a lower bound on the cost of any solution belonging to S.
- Let C=cost of the best solution found so far.
- If C<=L(S), there is no need to explore S because it does not contain any better solution.
- If C>L(S), then we need to explore S because it may contain a better solution.

IV. ALGORITHM

ID3:

1. Establish Classification Attribute.
2. Compute Classification Entropy.
3. For each attribute in R, calculate Information Gain using classification attribute.

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4. Select Attribute with the highest gain to be the next node in the tree (Starting from the root node).
5. Remove Node Attribute, creating reduced table RS.
6. Repeat steps 3-5 until all attributes have been used, or the same classification value remains for all rows in the reduced table.

Entropy:

$$H(X) = -\sum_{i=1}^{n} p(x_i) \log_b p(x_i)$$

TSP:

1. Mark all the nodes to be visited.
2. Mark the starting point.
3. Check the distance between each node.
4. Calculate the distance between adjacent nodes.
5. Select the node with minimum distance
6. Travel all the nodes such that total cost of travelling is minimum
7. Return to the starting point after visiting all the nodes.

V. RESULTS

Fig 1 Shows the hardware kit which consist of Arduino Uno board, GSM module, Ultrasonic sensor, Load sensor, Gas sensor and LCD screen. LCD displays the values sensed by the sensors and with the help of GSM module this information is sent to the cleaners mobile in the form of SMS show in Fig 2.

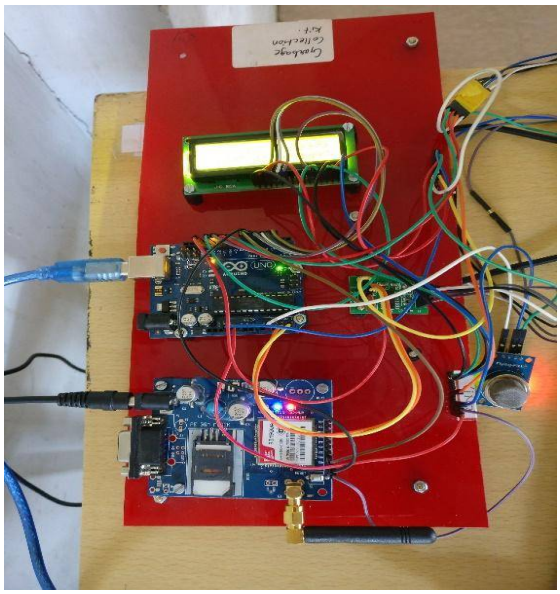

Fig.1. Hardware kit

Fig. 2. SMS received on Mobile phone

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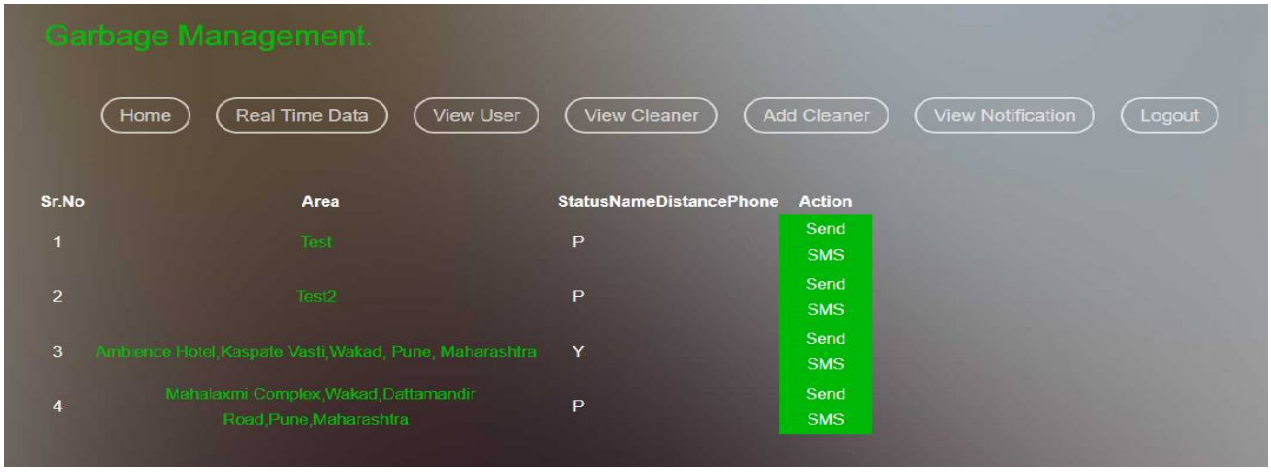

Fig. 3.Web application(Real time data)

The value are then stored in the database and values are displayed on the web application and mobile application. Fig 3 shows the exact location where the garbage bin is present and the status i.e. P represents pending and Y represents Yes which means garbage is collected. The location is stored in the form of latitude and longitude values. When user manually selects the point to report then it takes the value in the form of latitude and longitude. It contains detailed information about the time and location i.e every time message is sent about the status it's value could be seen on the web application.

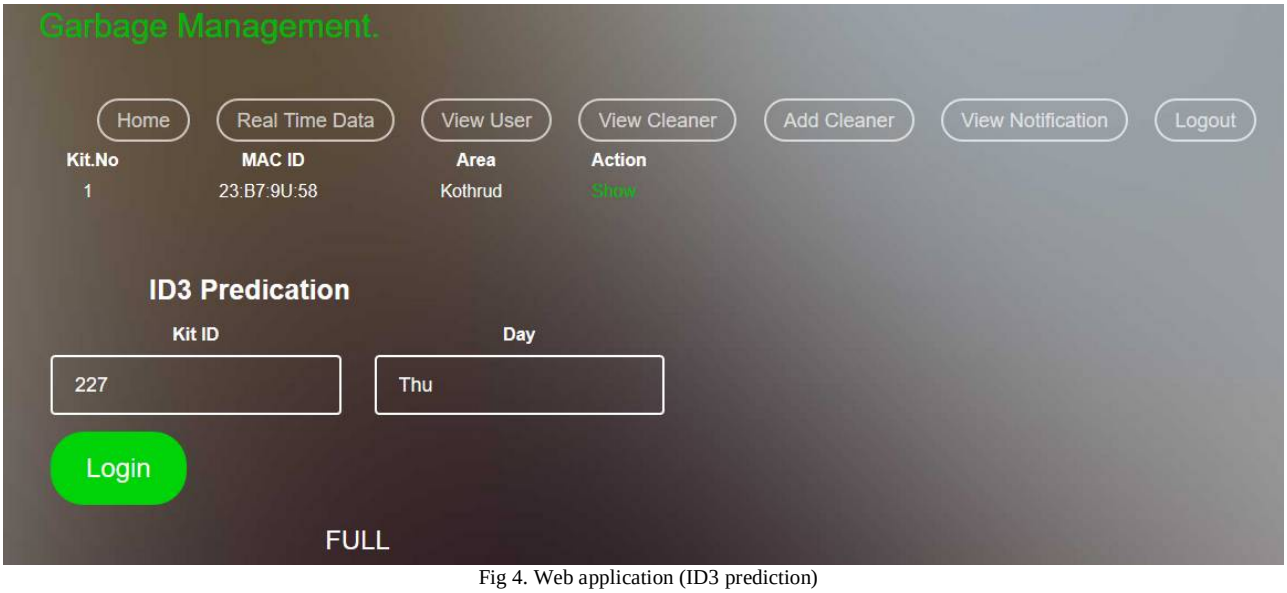

Fig 4. Web application (ID3 prediction)

Fig 4 shows the ID3 prediction i.e it can be used to extract the information like in the figure it shows on Thursday dustbin was full. It predicts whether the dustbin would be full, empty or partially full on the basis of previously collected data. TSP is used in finding the shortest route for garbage collection which would cover all the nodes but with minimal cost of travelling.

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VI. CONCLUSION AND FUTURE WORK

Maintaining hygienic condition is of utmost importance as a smart city is incomplete without a smart waste management system. Government has launched various schemes like "Swachh Bharat Abhiyan" for creating awareness about cleanliness among people. Improper waste disposal and improper maintenance leads to environmental pollution and health problems among people living in the vicinity. Thus we have proposed a system which gives practical solution for this problem. The system is completely based on sensors for overflow detection and reporting the status to the garbage collection centre so that appropriate steps can be taken. The administrator then assigns cleaners to collect the garbage from the respective area. The mobile application developed makes it easy for the citizens to get in contact with the Cleaning committee. This method will help in keeping the city clean and healthy. In future when the concept of smart cities would flourish then this model will be the most efficient way of Garbage management.

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