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# Waste Management Improvement in Cities using IoT

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**Abstract**—Garbage collection is one of the most critical problems faced by Municipal Corporation. While implementing the waste management in cities the biggest challenge is the management of waste in cost optimal way with high performance. The current process of collecting the waste, separating it and transporting the containers everyday which is a complicated process. This paper deals with the concept of waste management and the smart system for waste management with higher benefits to the society. The proposed system for waste management will use various sensors for sensing the type of waste and separate the waste in different categories and actuator to inform the management to collect the waste container. This system will save money and time compared to the already available process of waste management and also improves the society cleanliness.

**Keywords**— IoT, Segregation, Garbage Collection, Sensors, Waste Monitoring and Management.

## I. INTRODUCTION

Management and disposal of waste is a challenge in today's world. The dumping of garbage wastes at open landfill sites is the common method of disposal. The disposal method of dumping in open land sites has an adverse effect on the environment. Due to dumping of waste in such an open environment it affects the health of human beings and also life of plants & animals [1].

The method used to treat the disposal of waste into water leads to contamination of surface and groundwater. It gives rise to diseases which affect the living things in environment. Disposing waste in water spreads unhygienic conditions. This process breaks down the beauty of the environment.

In India waste collectors play a crucial role in recycling process in many cities. Many waste collectors have chances of getting prone to various diseases. The job of rag pickers (waste collectors) is a hectic task, also to eliminate the process of rag picking; it can be automated at the waste disposal zone by segregating at early stage. Until the waste is completely recycled its economic value is not realized. There are several advancements in

technology which has allowed reusing and recycle the waste. Generation of biogas for use of household works is possible due to waste management at small level.

To increase the potential of recovery and recycling, the waste can be separated into various types such as wet, dry, metallic waste, etc. Metal detectors can also be used for detection of metallic waste. The collected waste is the source of different useful gases and fertilizers [2].

The dry waste can be segregated further and can be reused and recycled. At present there are waste separation plants present on large scale, it is better to separate waste at collection level. By separating the waste during collection level, the quality of waste would be higher for recycling process. Hence the job of human waste collectors is reduced [3],[8]. Internet of Things (IoT) is among the technologies by means of which one can transfer data from one device to another using any type of network, at anytime and anywhere [4],[5].

Separation of waste is difficult task to do. It has to be cost efficient and easy to implement. This paper proposes a system which segregates urban household waste and manages it.

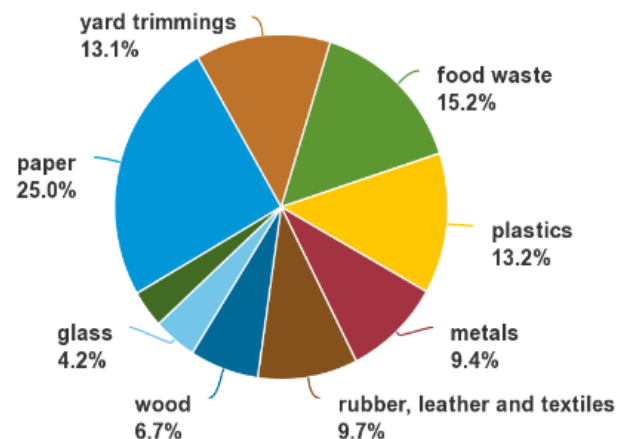


Fig.1: Statistics of Waste Source:Adapted [13]

## II. LITERATURE REVIEW

Need for managing large amount of garbage has led to lot of research. Largely there are two activities in managing waste. Those are segregation and garbage collection. Another paper studied which gave sufficient information intended for garbage in municipal areas that system consists of dustbin equipped with sensors and communication model for managing garbage collection schedule and garbage status. Smart dustbin has different specifications and most critical specification is segregation. Dustbin will have separate compartment for dry waste and wet waste. It will also have various sensors which are necessary for managing garbage collecting activities. Data collected from dustbin's sensors and garbage collecting vans will be stored on the cloud. This data can be analyzed from which corporation can predict the area in which garbage generated is in larger quantity compared to others. Using this information garbage collecting vans will be send to those locations frequently. This system has large scope. Municipal Corporation can use integrated system for managing waste. Integrated system will contain all the information about dust bins and garbage collecting vans in the city. When solving various problems integrated system can be useful [5].

## III. PROPOSED SYSTEM

The system intends to examine the already available waste management system and collect the data to create more optimised waste management system. The system not only notifies the trash level but also alerts the person working on it. It will help the Municipal corporations, Government organisations also individuals who till date use manual ways for collecting garbage from dustbins. It also aims at minimizing the process time and the interference of humans in the processes [6],[14]. It may also be used to file complaint on application if the garbage is not collected. In today's growing world continuously managing the rapidly increasing waste is a difficult job. In many cities where numerous of dustbins are placed, keeping watch on all dustbins is difficult task. Human interrogation is not that efficient to manage huge number of dustbins. A proper framework using IoT is needed for that purpose. Efficiency of the waste management is not up to mark. If dustbin gets filled before time, it will be very hard to know the dustbin location. So, proper infrastructure is required to know location and collecting waste from dustbin which is developed as follows [7].

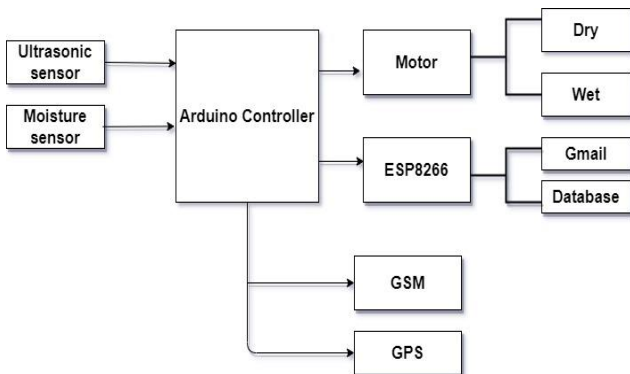


Fig.2: Component Diagram of Proposed System

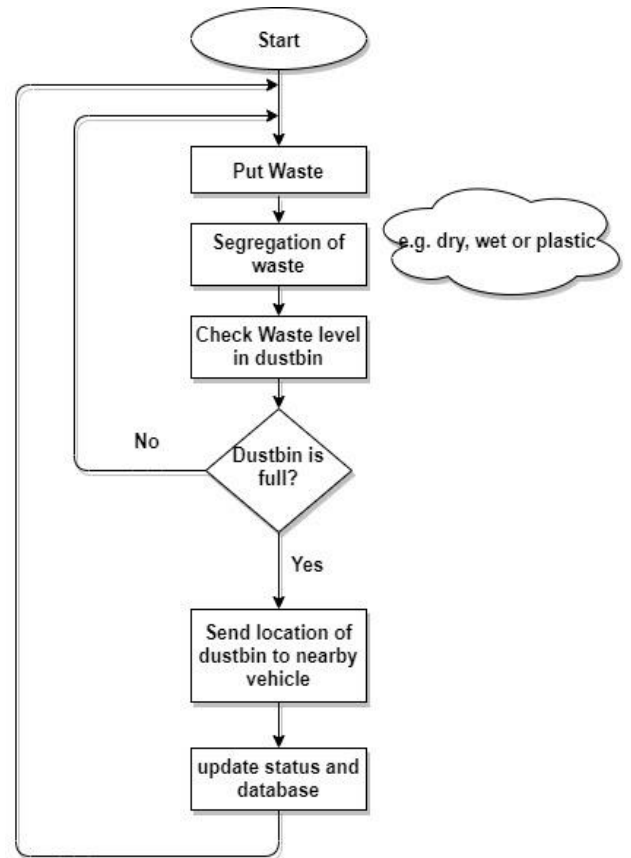


Fig.3: Flow Diagram of the Proposed System

## IV. ARCHITECTURE

Placement of different dustbins in specific areas with location IDs. Each Dustbin contains one ultrasonic sensor and segregator using moisture sensor with motor. These all dustbins located on a server for data collection. After distance measurement from ultrasonic sensor cross specific limit, it will show Dustbin is full with a mail sent to nearby vehicle with location. This will carried out using path optimisation method which is used Cab services. Updation of dustbin empty will be automatically updated on server [8],[14].

Fig.2 specifies the components of proposed system. Following are the details of the components used in the Fig.2.

- **Ultrasonic Sensor:** Measurement of level of waste in dustbin is estimated using ultrasonic sensor which is placed at the top of dustbin.
- **Moisture Sensor:** Dustbin will have various types of waste. Hence to detect the kind of waste moisture sensor is used.
- **Arduino:** The Arduino IDE is background framework for sensors in the system. It will connect different sensors which are working together to form the system.
- **DC Motor:** The separation of waste is carried out in different compartments in dustbin. So DC motor is used to separate waste in dustbin.
- **ESP8266:** ESP8266 is a Wi-Fi module. It is used for hosting the application [9].

Fig.3 specifies the flow diagram in which as soon as the waste is thrown into the dustbin the waste is segregated into dry, wet, plastic. After the process of segregation of waste the level of waste in the dustbin is checked. If the dustbin is not full, more waste can be put in the dustbin. On the other hand, if the dustbin is full, the location of the dustbin is send to the nearby vehicle by using path optimization method and the status of the dustbin is updated in the database. This process is repeated for all the dustbins [10].

## V. PROPOSED WORKING

This proposed system works with the help of Ultrasonic sensors, Moisture sensor. The ultrasonic sensor will sense the waste level in the bin as soon as the bin will start filling with waste, the ultrasonic sensor will measure the depth. The ultrasonic sensor is placed at the top of the dustbin and as soon as the dustbin starts filling it will emit sound waves. The transmitter will measure the level of garbage in the bin and emit a sound wave and the receiver will listen to the sound wave. In this way the distance between the ultrasonic sensor and garbage in the dustbin is calculated.

This collected data is then stored at the backend in the database. After storing the data in database the system will notify the user and will send a message to the nearby waste collector van through cell phone using GSM technology. Upon receiving the message, the operator will go and collect the waste in the van. To know the location of dustbin, Global Positioning System (GPS) is used. GPS will show location in form of latitude and longitude to user which will help to reach at dustbin in mean time. The dustbin will consist of two plates at a certain inclination. As soon as waste is kept on the area where the two plates meet, the moisture sensor will sense the waste using the principle of the specific moisture level which is separating dry and wet things. The specific moisture level in this case is a function of water content. The sensor creates a voltage which is proportional to the specific moisture level and hence the water content in the waste is calculated and separated. The moisture level of a wet waste material will be more as compared to dry waste. Hence, like this the moisture sensor will segregate the waste as dry or wet [11].

When moisture level is calculated, then the waste on the two plates will be deposited according to moisture level in respective compartment. For this DC motor will open the plate in which the waste is to be placed. If any or both of the chambers get full it will send notification to the nearby garbage collector operator and the operator will come and empty the bin. This process is repeated for all the smart dustbins.

## VI. PROPOSED DESIGN

The basic concept of smart waste management system in cities is to handle the waste from initial to the disposal. The design is as follows:

### A. General System:

As the bin gets full it will be detected by the ultrasonic sensor, then a message will be sent to a nearby garbage collector operator, then the operator will come and collect the garbage in the garbage collector van. Also, the waste

is separated in the bin itself by using moisture sensor, which will separate the waste in two compartments i.e. dry and wet [12].

### B. Ultrasonic Sensor:

It calculates the distance from the waste to itself i.e. sensor by sending sound waves and calculating the time required the wave to travel from transmitting till it bounces back.

### C. Moisture Sensor:

It measures the moisture in the waste collected and separate it on the basis of moisture level in it.

### D. GSM Module:

GSM is used to provide message service to enable communication. Using GSM module the concerned person will receive message regarding the dustbin location through SMS.

Using Optimization, we reducing fuel consumption and time of operation. Proper database of waste collected can be updated on server which will be developed on a system.

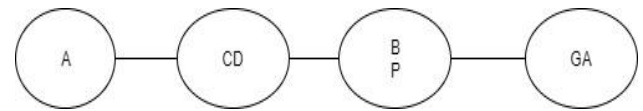


Fig.4: The Mathematical Model

A = input data of sensor

CD = classify the data

B = according to classified data match with the predefined message.

P = predicted result

GA = give alert

### Failures and Success conditions:

#### A. Success Conditions:

1. Searching the information required for building the system from the datasets available.
2. Getting the result effectively as required.

#### B. Failure Conditions:

1. Time consumption can be more due to large dataset available.
2. Failure of hardware.
3. Failure of software.

#### C. Input:

1. Sensor (PIR) data
2. Garbage amount(dataset)

#### D. Output:

1. Message to garbage collector van
2. Allocate van to the location
3. Collect garbage and further processing

## VII. CONCLUSION AND FUTURE WORK

The paper contains details about how to establish a Waste Management System using IoT and its applications. With proper use of integrity of software and hardware, this idea can develop a better waste control in over populated cities

and towns. The curriculum of this paper is just to focus on existing systems and solutions to improve the existing system.

Future work will include the path optimization technique to reduce fuel consumptions and provide better transition system in metropolitan cities. Also segregation of different types of wastes such as e-waste, plastic, metal, etc. can be included in our system. Peripheral work of project is based upon development of smart cities and overall development of our country in terms of hygiene issues.

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