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Smart Dustbin

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Abstract: **Rapid increase in volume and types of solid andhazardous waste as a result of continuous economic growth, urbanization and industrialization, is becoming a burgeoning problem for national and local governments to ensure effective and sustainable management of waste. It is estimated that in 2006 the total amount of municipal solid waste generated globally reached 2.02 billion tones, representing a 7% annual increase since 2003 (Global Waste Management Market Report 2007). The segregation, handling, transport and disposal of waste are to be properly managed so as to minimize the risks to the health and safety of patients, the public, and the environment. The economic value of waste is best realized when it is segregated. This paper proposes a Smart Dustbin which is a cheap, easy to use solution for a segregation system at Public Places such as Railway stations, Shopping malls, Historical places etc. so that it can be sent directly for processing. It is designed to sort the refuse into metallic waste, wet waste and dry waste. The Smart Dustbin employs Inductive Proximity sensor to identify metallic items, and capacitive sensors to distinguish between wet and dry waste. Experimental results show that the segregation of waste into metallic, wet and dry waste has been successfully implemented using the Smart Dustbin.**

***Keywords*—Automation, waste segregation, metal detection, capacitive sensing.**

I. INTRODUCTION

In recent times, garbage disposal has become a huge cause for concern in the world. A voluminous amount of waste that is generated is disposed by means which have an adverse effect on the environment.

The common method of disposal of the waste is by unplanned and uncontrolled open dumping at the landfill sites. This method is injurious to human health, plant and animal life.This harmful method of waste disposal can generate liquid leachate which contaminate surface and ground waters; can harbor disease vectors which spread harmful diseases and candegrade aesthetic value of the natural environment and it is an unavailing use of land resources.

In India, rag pickers play an important role in the recycling of urban solid waste. Rag pickers and conservancy staff have higher morbidity due to infections of skin, respiratory, gastrointestinal tract and multisystem allergic disorders, in addition to a high prevalence of bites of rodents, dogs and other vermin. Dependency on the rag-pickers can be diminished if segregation takes place at the source of municipal waste generation.

The economic value of the waste generated is not realized unless it is recycled completely. Several advancements in technology has also allowed the refuse to be processed into useful entities such as Waste to Energy, where the waste can be used to generate synthetic gas (syngas) made up of carbon monoxide and hydrogen. The gas is then burnt to produce electricity and steam; Waste to Fuel, where the waste can be utilized to generate bio fuels.

When the waste is segregated into basic streams such as wet, dry and metallic, the waste has a higher potential of recovery, and consequently, recycled and reused. The wet waste fraction is often converted either into compost or methane-gas or both. Compost can replace demand for chemical fertilizers, and biogas can be used as a source of energy. The metallic waste could be reused or recycled.

Even though there are large scale industrial waste segregators present, it is always much better to segregate the waste at the source itself. The benefits of doing so are that a higher quality of the material is retained for recycling which means that more value could be recovered from the waste. The occupational hazard for waste workers is reduced. Also, the segregated waste could be directly sent to the recycling and processing plant instead of sending it to the segregation plant then to the recycling plant.

Currently there is no system of segregation of dry, wet and metallic wastes at a initial level. J.S. Bajaj has recommended that a least cost, most appropriate technological option for safe management should be developed. The purpose of this project is the realization of a compact, low cost and user friendly segregation system for public places to streamline the waste management process.

A. Technical Background

The mixed waste is sorted based on the following methods at the industrial level. Larger items are removed by manual sorting. Then the refuse is sorted based on its size by using large rotating drums which is perforated with holes of a certain size. Materials smaller than the diameter of the holes will be able to drop through, but larger particles will remain in the drum.

For metallic objects electromagnets or eddy current based separators can be used. Near infrared scanners are used to differentiate between various types of plastics based on the ability of the material to reflect light. X-rays can also be used to segregate materials based on their density.

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The methodology adopted in this paper to resolve the issue of waste segregation is by making the entire process automated and to the reduce cost such that it could be adapted in a initial level.

B. Proposed Solution

Waste is entered into the proposed system. An IR proximity sensor detects this and starts the entire system. Waste then falls on the metal detection system. This system is used to detect metallic waste. After this the object falls into the capacitive sensing module. This module distinguishes between wet and dry waste. After the identification of waste, a circular base which holds containers for dry, wet and metallic waste is rotated. The collapsible flap is lowered once the container corresponding to the type of garbage is positioned under it. The waste falls into the container and the flap is raised. The waste in the containers now can be collected separately and sent for further processing.

C. Organization of the Paper

The paper is organized as follows: Section II encompasses the design methodology of the Smart Dustbin, which has a detailed description of the implementation of each block. Section III contains the Applications. Section IV contains the Advantages. Section V includes the Conclusion. Section VI includes the Future Work.

II. IMPLEMENTATION

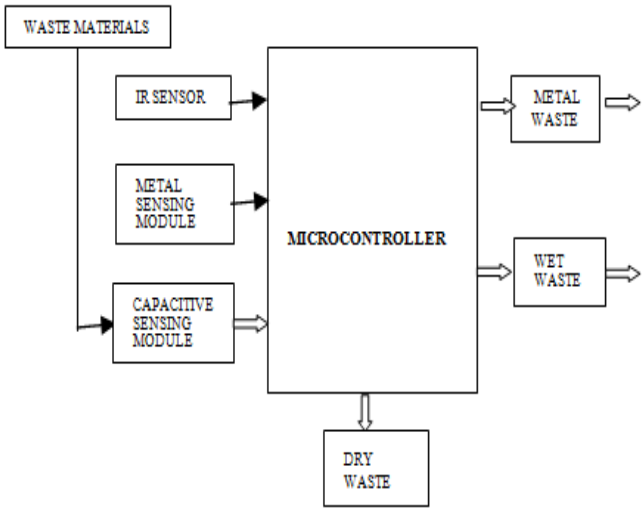

Figure 1: Block Diagram of Smart Dustbin

Figure 1 shows a Block diagram of the Smart Dustbin. When the Waste is dumped into the Smart Dustbin, the IR sensor detects the waste and activates the microcontroller. The object falls on the conveyor belt where different sensors are connected to identify the type of waste. The first sensor is metal sensor which is used to sense any metal object. The object continues and drops into the capacitive sensing module. Here, a decision is made if the waste is wet or dry based on its relative permittivity. Two DC geared motors are used to perform the final segregation based on the identification. Stepper motor moves a circular base to get the corresponding container under the collapsible base. This collapsible base is controlled by the DC Servo motor. The individual modules are explained here as follows.

A. Entry System and Initialization

The waste is dumped into the Smart Dustbin. Object comes in the proximity of the IR proximity sensor which marks the entry of the waste. The sensor sends an interrupt to the microcontroller which comes out of the low power mode. It then initializes the sensor modules. The initialization of all modules ensures that any dynamic changes in the environment do not affect the sensing. When the object is dumped into the dustbin, it falls on the conveyor belt where different sensors are connected to identify the type of waste.

B. Metal Detection System

The object moves over the Conveyor belt where different sensors are connected. The first Sensor is metal sensor which transmits electromagnetic field. Any metal object within the electromagnetic field will become energized and retransmits an electromagnetic radiation of their own. The sensor's coil receives retransmitted field and alerts the user by producing a target response. Microcontroller continuously checks the status of the proximity sensor. If sensor is detecting metal then program is written to select the particular bin using stepper motor. If the object is nonmetallic then object continues over the conveyor belt. The sensor provides excellent results even with difficult-to-detect objects, e.g. small or thin parts, wires or bright metals. A variety of types cover a wide range of individual requirements and installation situations. Thus, devices are available with N.C. or N.O. functions, with NPN or PNP switching outputs, and cable or plug connection. The enclosure rating is IP66.

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C. Capacitive sensing module

A pair of copper plates are placed along the walls of the structure which are inclined to each other at an angle of 45°. This arrangement is made to ensure that waste of all sizes can be sensed. The area of pair of plates increases as it moves away from the apex of the structure. The sensitivity of the plate decreases with its increase in area, hence smaller plates would accurately sense objects of smaller size. Alternating Voltage of 30V is applied to the plates and output voltage is measured without inserting any object and that voltage is taken as reference voltage. When the dry object is inserted then output voltage is nearly equivalent to the reference voltage. When the wet waste is inserted then the output is very much higher than the reference voltage. Based on the values obtained for both wet and dry waste we will fix a threshold voltage.

The property used for segregation of waste is the relative dielectric constant. Once a dielectric is introduced between the plates of the capacitor the capacitance increases. Wet waste has a higher relative dielectric constant than that of dry waste because of the moisture, oil and fat, content present in kitchen waste. If the output of capacitive sensing module is greater than threshold then the type of garbage is inferred as wet waste else it is dry waste. Thus, the type of waste is identified as either wet or dry and the actuators are activated.

D. Segregation Module

Three bins are placed in circular fashion with 120 degree spacing between them. Based on the waste detected microcontroller activates stepper motor and the program is written for the stepper motor to rotate in clockwise and anti-clockwise direction to select a particular bin.

Once the required container is positioned under the flap, a DC Servo motor moves the collapsible flap by rotating the motor by 90° it then waits to ensure that the waste falls down and finally rotates the flap back to the initial position by rotating the motor in reverse direction by 90°. Thus the segregation is complete. After this the microcontroller is put to low power mode until the entry of the next waste material into the system.

III. APPLICATIONS

- *Shopping malls:*

Smart dustbin will be useful to those shopping Centre employees who might be involved with planning and implementing recycling and waste prevention programs at malls and shopping centers. Because waste management services at most shopping centers are controlled by property management rather than by retail tenants.

As shopping malls produce large amount of waste every day, it is better to use smart dustbin and understand the social responsibility.

- ***Public Places:***

Usually at public places such as Railway stations, Bus stations etc... Different dustbins are placed for different kind of waste. Unfortunately this step is not successful completely due to the simple reason that people love to break rules but, that is not only reason. We all know that India tops in adult illiteracy and hence many of us don't understand particular dustbin for a specific waste. Also, kids will have a problem in identifying correct/ suitable dustbin for a particular waste. The above said complex problem can be avoided by using a simple Smart Dustbin which automatically separates the waste.

- ***Offices***

We know that companies infrastructure is usually calm and clean. Cleanliness is just not achieved simply. They do take measures to achieve cleanliness. Let us consider example of TCS. At TCS, they are committed to reducing the environmental impact of their operation through appropriate ongoing material management.

This calls for conscious effort across TCS in the following areas:

1. Reduction of waste at source.
2. Reuse of material wherever possible.
3. Recycling
4. Purchasing products with recycled content.

Usually, waste from almost all offices/companies will be dry, wet or metallic waste. Our Smart dustbin best suits this application.

IV. ADVANTAGES

- *Agriculture:*

The wet waste is used for agricultural purpose as fertilizers. Most people are familiar with making compost from food wastes that can be done at the backyard. Rotten

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vegetables, fruits, grass and leaves are common ingredients of compost which is then used for home gardening purpose. They are mixed together with certain moisture level and turned regularly for airflow to the heap. It can take several weeks or months before they are considered suitable to be used as fertilizer or soil amendments. This is the kind of method we know that has long been practiced since centuries ago.

Biomax technologies from Singapore uses a similar concept but its patented technology converts organic waste into organic fertilizer in just one day. What's more, the quality of fertilizer is at a completely different level from traditional compost because of rich nutrient and organic matter content. The essential ingredient to this technology is the use of enzymes which break down the wastes at an accelerated rate. However, the use of enzymes alone is not enough to make this process possible. A properly controlled space is required for wastes to be decomposed. That is where Biomax's digestor comes in and provides temperature, aeration and mixing capabilities for wastes and enzymes. In a simple way, thedigestor and enzymes work together to produce fertilizer from waste.

- ***Bio-gas generation:***

Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. It is renewable energy source and in many cases exerts a very small carbon footprint. Biogas can be produced by anaerobic digestion with anaerobic bacteria, which digest material inside a closed system, or fermentation of biodegradable materials. Biogas is primarily methane and carbon dioxide and may have small amounts of hydrogen sulphide, moisture and soilxanes. Wet waste from smart dustbin can be directly used for this purpose.

- ***Making money out of waste:***

The economic value of waste can be understood only if it is separated. The waste which we separate can get us some amount of money but saves huge amount of money by providing us good health and health is wealth.

- ***One of the step for Swachh Bharat:***

Swachh Bharat campaign was officially launched on 2 October 2014 at Rajghat, New Delhi, where Prime Minister Narendra Modi himself cleaned the road. It is India's biggest ever cleanliness drive and 3 million government employees and school and college students of India participated in this event. The mission was started by Prime Minister Modi, who nominated nine famous personalities for the campaign, and they took up the challenge and nominated nine more people and so on. It has been carried forward since then with people from all walks of life joining it. Smart dustbin can be one of the method to implement Swachh Bharat. It is better to reduce and recycle waste at source root, which our smart dustbin does.

V. CONCLUSION

Automated Waste Segregator has been successfully implemented for the segregation of waste into metallic, dry and wet waste at a domestic level. However, it cannot segregate ceramic into dry waste because of its higher relative dielectric constant when compared to other dry wastes. Noise can be eliminated in the sensing module to increase accuracy and overall efficiency. The system can segregate only one type of waste at a time with an assigned priority for metal, wet and dry waste. Thus, improvements can be made to segregate mixed type of waste by the use of buffer spaces. Since, the time for sensing metal objects is low the entire sensing module can be placed along a single platform where the object is stable to ensure better result.

VI. FUTURE SCOPE

Smart dustbin can segregate only three types of wastes. In future improvement can be done to segregate more number of wastes like plastic, glass, toxic waste, separation of different metals. This can be improved to segregate mix waste dumped at atime usingdifferent high accurate sensors and other technologies and segregation of mix waste can also be achieved by using a servo motor to give jerks to conveyor belt so that mix waste gets separated. Size of smart dustbin can be made compact using different technologies and different methodologies. Some additional feature can be added like generating power or biogas generation at root source itself.

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APPENDIX

Capacitive Sensing Module Results

Type of Waste	Initial voltage	Final voltage
Paper box	0v	0.1v
Lemon	0v	30.1v
Onion	0v	30v
Rubber	0v	0.1v
Plastic	0v	0.13v
Carrot	0v	24v
Glass	0v	0.2v