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# Automatic Waste Segregation and Monitoring system of Municipal Solid Waste

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**Abstract -** *Rapid increase in population has led to improper waste management in metro cities and urban areas which has resulted in spreading of diseases. It is estimated that 2.02 billion tons of municipal solid waste was generated universally in 2006. The segregation, transport, handling and disposal of waste must be managed properly to minimize the risks to the public, and the environment. An efficient method to dispose the waste has been designed in our project, "automatic waste segregator and monitoring system". This paper proposes an automatic waste segregator (AWS) which is a cheap, easy to use solution for a segregation system at households, so that the wastes can be sent directly for processing. Automatic waste segregator is designed to sort the waste into three main categories namely; metallic, organic and plastic, thereby making the waste management more effective. Ultrasonic sensors are added for monitoring waste collection process. The sensors would be placed in all the garbage bins. When the garbage reaches the level of the sensor, then the indication will be given to a microcontroller. The microcontroller will give indication to the driver of garbage collection truck by sending SMS using GSM technology.*

## 1.INTRODUCTION

Ten million ton of garbage is generated in metropolitan cities. The landfills of most of these cities are overflowing with no space for fresh garbage waste. The philosophy of "waste management hierarchy" has been adopted by most nations as the step for developing municipal solid waste (MSW) management strategies. So we decided to separate waste in the home itself with the help of using sensors. Here we are going to use ultrasonic sensor and inductive sensor. in this project we are separating the waste at our home itself with the use of sensors. By separating the waste at home itself we can reduce the work done by the our municipality. This helps our government to recycle our waste in very simple manner.

According to a sanitation survey called ministry of urban development under the mission, it was found that about 50% people in India face the problem of improper waste collection and management. According to center of science and environment, innovative disposal and recycling methods must be introduced instead of landfill sites.

Thus, we have proposed a cost effective Automatic waste segregator categorizes the waste as plastic, metallic or organic. The monitoring system helps to monitor the waste collection process. The common method of waste disposal is by unplanned and uncontrolled dumping at landfill areas. This method is hazardous to human health, plant and animal life. When the waste is segregated into basic streams such as plastic, metallic and organic, the waste has a higher potential of recovery, and then, recycled and reused. The organic waste is 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 metal waste could be reused or recycled.

Even if there are large scale industrial waste segregators present, it is always feasible to separate the waste at the source itself. The benefit of doing so is that the occupational hazard for waste workers is reduced. Also, the separated waste could be directly sent to the recycling and processing plant instead of sending it to the segregation plant then to the recycling plant..

### 1.1 OBJECTIVE

The proposed system would be able to automate the solid waste monitoring process and management of the overall collection process using IOT (Internet Of Things). The Proposed system consist of four main subsystems namely Smart Trash System(STS), Local Base Station(LBS), Vehicle System(VS) and Smart Monitoring and Controlling Hut(SMCH). In the proposed system, whenever the waste bin gets filled this is acknowledged by placing the waste bin, which transmits it to the receiver at the desired place in the area or spot. In the proposed system, the received signal indicates the waste bin status at the monitoring and controlling system.

To separate waste at the houses in the society into dry waste and wet waste using a relay circuit driven by a comparator circuit. This waste is collected at the container. The container has a sonar sensor used to detect the level of the garbage collected into it. When garbage reaches a particular level, an indication to the control unit is sent using RF module. Also, an area besides the roadside garbage containers is implemented. This zonal area uses the concept

of load sensor to indicate if any garbage spills out the container.

The process of making things automatic is being exploited in almost all the major fields of life. Making things automatic reduces burden on the humans. The cost and effort used in manually controlled products is much higher than the automated systems. Considering the fact, that the problem of efficient waste management is one of the major problems of the modern times, there is an utmost need to address this problem. The proper waste management system is must for the hygienic society in general and for world as a whole. Solid waste which is one of the sources and causes of environmental pollution has been defined under Resource Conservation and Recovery Act as any solid, semi-solid liquid or contained gaseous materials discarded from industrial, commercial, mining or agricultural operations and from community activities.

Solid waste also includes garbage, construction debris, commercial refuse, and sludge from water or waste treatment plants or air pollution, control facilities and other discarded materials. In order to protect human health and the environment from the potential hazards of delayed waste disposal and environmental pollution a systematically supervised and controlled handling of these wastes is must. The type of wastes which constitute environmental pollution and which this work emphasizes on is domestic refuse consisting of degradable food wastes, leaves, dead animals and non-degradable ones such as plastics, bottles, nylon, medical and hospital wastes, generated in households, hospitals, industries and commercial center.

## 2. EXISTING SYSTEM

Intelligent solid waste bin is essential to develop an efficient and dynamic waste management system. This research presents the implementation and execution of an integrated sensing system and algorithm for solid waste bin to automate the solid waste management process. Several sensing methods have been integrated and have combined their verdicts that offer the detection of bin condition and its parameter measurement. A number of test runs have been conducted to assess the functioning of the prototype system. The outcome showed that the sensing system with the algorithm is efficient and intelligent and can be simply used to automate any solid waste bin management process.

### 2.1.METHODS ADOPTED FOR SOLID WASTE SEPERATION

Trommel separators/drum screens, Eddy current separators, Inductor sorting, Near infrared sensors, X-ray technology and Manual sorting.

## 3. Proposed system

The whole system is controlled by an Arduino Uno board. All other parts like ultrasonic sensors, inductive proximity sensor, DC motors, blower and electromagnet are interfaced to the Arduino board. The system comprises of different parts and mechanism such as Open-Close Mechanism, Conveyor Belt, Inductive Proximity Sensor, Geared DC Motor, Blower, Robotic Arm, Electromagnet, Ultrasonic Sensor, GSM Module, Monitoring System, and working softwares.

## 4. Sample survey

Survey conducted in southern part of Tamilnadu Tirunelveli municipality- Palayamkottai, Thachanallur, Melapalayam, Tirunelveli

Usually all the waste are separated at the zones itself each zones have their own waste separating warehouse with it. Each zones have sanitary officers. Sanitary officers take responsibility of the whole work that takes place in his respective zones, Each zones have 120 municipal workers within it. Where that they have 80 sweepers and 10 vehicle drivers and some members to screen the vehicle whether their is loaded properly in the truck or lorry, All the zones waste are finally collected to the RAMAIYANPATTI, Here the waste are finally crushed in this area with crusher almost 100 tons crusher, Initially all the waste are separated at the respective zones itself. Hence there is no need of separating waste in ramaiyanpatti, In each zones, all the waste are separated at the zones itself and placed in the large container.

The waste are separated into four different form of waste. They are

- Plastic waste
- Metallic waste
- Organic waste
- Medical waste

The waste ratio is in the form of
Plastic:metallic:organic:medical:37:21:27:15

Finally all the waste are placed on to the area at ramaiyanpatti waste warehouse. This is the place where all the waste are collected from 4 different zones of tirunelveli municipality.

At ramaiyanpatti all the waste are crushed into a cubic structures with the help of large crushers. The crushed waste are then send to the respective places where there is the need of the cubic raw materials. These cubic structures are send to recycling process. Sweepers are used to sweep the waste from the road and road side. The need of sweepers arise due to indifference of people. Due to the only reason of indifference. Here comes the need of sweepers. If there is maintained a proper rules and regulations strictly. There won't be no need of sweeping work by the municipality. However municipality is doing there best to keep our city clean. Peoples are not showing their full support for keeping the city clean. So the city can be maintained clean and tidy

| Sl. No | Waste medium | Percentage of waste (%) | Gross weight of the waste (kg) |
|---|---|---|---|
| 1. | Plastic | 27.5 | 260 |
| 2. | Metallic | 21 | 200 |

| | | | |
|---|---|---|---|
| 3. | Organic | 37.2 | 288.5 |
| 4. | Medical | 14.3 | 140 |

**Table 1. percentage of waste and gross weight in zone 1 THACHANALLUR**

| Sl.no | Waste medium | Percentage of waste(%) | Gross weight of the waste(kg) |
|---|---|---|---|
| 1. | Plastic | 27.5 | 200 |
| 2. | Metallic | 21 | 307 |
| 3. | Organic | 37.2 | 230 |
| 4. | Medical | 14.3 | 141.5 |

**Table 2. percentage of waste and gross weight in zone 2 Melapalayam**

### 4.1. Composition of Plastic Waste

The mixed plastic wastes were selected to cover a wide spectrum in the relative proportions of high- and low-density polyethylene (HDPE and LDPE), polypropylene (PP), polystyrene (PS) and polyethylene terephthalate (PET). From the results it was deduced that the reduction in Gieseler fluidity in the coal blend is linked to the total amount of polyolefin in the waste. It was also found that these thermoplastics increase the pressure exerted against the wall in the course of the coking process and that coke quality is maintained or even improved. However, when the level of aromatic polymers such PS and PET are increased at the expense of polyolefin, the coking pressure decreases. Thus, the amount of aromatic polymers such as PS and PET in the waste is critical, not only for controlling Gieseler fluidity and coking pressure, but also for avoiding deterioration in coke quality (reactivity towards CO2CRIand mechanical strength of the partially-gasified coke CSR). An amount of polyolefin in the waste lower than 65 wt.% for a secure coking pressure is established.

Plastic pollution is the accumulation of plastic objects (e.g.: plastic bottles and much more) in the Earth's environment that adversely affects wildlife, wildlife habitat, and humans. Plastics that act as pollutants are categorized into micro-, or macro debris, based on size. Plastics are inexpensive and durable, and as a result levels of plastic production by humans are high. However, the chemical structure of most plastics renders them resistant to many natural processes of degradation and as a result they are slow to degrade. Together, these two factors have led to a high prominence of plastic pollution in the environment.

Plastic pollution can afflict land, waterways and oceans. It is estimated that 1.1 to 8.8 million metric tons (MT) of plastic waste enters the ocean from costal communities each year. Living organisms, particularly marine animals, can be harmed either by mechanical effects, such as entanglement in plastic objects or problems related to ingestion of plastic waste, or through exposure to chemicals within plastics that interfere with their physiology. Humans are also affected by plastic pollution, such as through disruption of various hormonal mechanism. Plastics themselves contribute to approximately 10% of discarded waste. Many kinds of plastics exist depending on their precursors and the method for their polymerization. Depending on their chemical composition, plastics and resins have varying properties related to contaminant absorption and adsorption. Polymer degradation takes much longer as a result of saline environments and the cooling effect of the sea. These factors contribute to the persistence of plastic debris in certain environments. Recent studies have shown that plastics in the ocean decompose faster than was once thought, due to exposure to sun, rain, and other environmental conditions, resulting in the release of toxic chemicals such as bi sphenol A. However, due to the increased volume of plastics in the ocean, decomposition has slowed down. The Marine Conservancy has predicted the decomposition rates of several plastic products. It is estimated that a foam plastic cup will take 50 years, a plastic beverage holder will take 400 years, a disposable nappy will take 450 years, and fishing line will take 600 years to degrade.

### 4.2. Composition Metallic Waste

If the magnet sticks, you have a ferrous metal. Common metals like steel and iron fall under this category. And since they‘re easily available, ferrous metals won’t amount to much. Nevertheless, scrap yards still accept them for recycling and will pay you for them. If the magnet does not stick, you have a nonferrous metal. Copper and aluminum are nonferrous, and they’re worth more than the ferrous variety for a number of reasons. They have greater resistance against corrosion, have higher conductivity, and weigh less. one ton of recycled paper saves approximately 17 trees, 2.5 barrels of oil, 4100 kWh of electricity, 4 cum of landfill and 31,780 liters of water over production of virgin paper from wood. Recycling of one ton of steel scrap saves 1.2 tons of iron ore, 0.7 tons of coal, 0.5 tons of limestone, 287 liters of fuel oil, 2.3 cubic meters of landfill, and is achieved through 40 per cent less water and with 58 per cent avoided CO2 emissions. According to a study ,recycled steel reduces 97 per cent mining waste produced through manufacture of virgin resources, saves 75 per cent of energy, cuts back 86 per cent of air pollution and 76 per cent on water pollution. Similarly, recycling of an aluminium can or producing a glass container saves 95 per cent and 70 per cent, respectively, of the energy required for producing a similar container from virgin material.

Scrap consists of recyclable materials left over from product manufacturing and consumption, such as parts of vehicles, building supplies, and surplus materials. Unlike waste, scrap has monetary value, especially recovered metals, and non-metallic materials are also recovered for recycling.

Metals which contain iron in them are known as ferrous where metals without iron are non-ferrous.

•Common non-ferrous metals are copper, brass, aluminum, zinc, magnesium, tin, nickel, and lead. Non-ferrous metals also include precious and exotic metals.

•Precious metals are metals with a high market value in any form, such as gold, silver, and platinum group metals.
•Exotic metals contain rare elements such as cobalt, mercury, titanium, tungsten, arsenic, beryllium, bismuth, cerium, cadmium, niobium, indium, gallium, germanium, lithium, selenium, tantalum, tellurium, vanadium, and zirconium. Some types of metals are radioactive. These may be "naturally occurring" or may be formed as by-products of nuclear reactions. Metals that have been exposed to radioactive sources may also become radioactive in settings such as medical environments, research laboratories, or nuclear power plants.

### 4.3 Composition of medical waste

The estimated daily waste generation rate was 4,600 kg/day, which consisted of 4,100 kg/day noninfectious refuse, 340 kg/day infectious waste, 70 kg/day kitchen waste, 50 kg/day pathological waste, and 40 kg/day plastic syringes. The waste consisted of 99.02% combustible wastes and 0.97% noncombustible wastes by mass. The combustible wastes constituted paper (16.17%), textiles (9.77%), cardboard, wood, and leaves (1.12%), food waste (21.51%), and plastics (50.45%). The noncombustible waste included 0.40% metal and 0.57% glass. Furthermore, the analysis indicated that the wastes contained 38% moisture, 4% ashes, and 58% solid with an average heat value of 3,400 kcal/kg. From the elemental analysis, the dominant elements were found to be carbon (34%) and oxygen (15%). Biomedical waste is any kind of waste containing infectious (or potentially infectious) materials. It may also include waste associated with the generation of biomedical waste that visually appears to be of medical or laboratory origin (e.g., packaging, unused bandages, infusion kits, etc.), as well research laboratory waste containing bio molecules or organisms that are many restricted from environmental release. As detailed below, discarded sharps are considered biomedical waste whether they are contaminated or not, due to the possibility of being contaminated with blood and their propensity to cause injury when not properly contained and disposed of. Biomedical waste is a type of bio waste. Biomedical waste may be solid or liquid. Examples of infectious waste include discarded blood, sharps, unwanted microbiological cultures and stocks, identifiable body parts (including those as a result of amputation), other human or animal tissue, used bandages and dressings, discarded gloves, other medical supplies that may have been in contact with blood and body fluids, and laboratory waste that exhibits the characteristics described above. Waste sharps include potentially contaminated used (and unused discarded) needles, scalpels, lancets and other devices capable of penetrating skin. Biomedical waste is generated from biological and medical sources and activities, such as the diagnosis, prevention, or treatment of diseases. Common generators (or producers) of biomedical waste include hospitals, health clinics, nursing homes, emergency medical services, medical research laboratories, offices of physicians, dentists, and veterinarians, home health care, and morgues or funeral homes. In healthcare facilities (i.e., hospitals, clinics, doctor's offices, veterinary hospitals and clinical laboratories), waste with these characteristics may alternatively be called medical or clinical waste.
Storage refers to keeping the waste until it is treated on-site or transported off-site for treatment or disposal. There are many options and containers for storage. Regulatory agencies may limit the time for which waste can remain in storage. Handling is the act of moving biomedical waste between the point of generation, accumulation areas, storage locations and on-site treatment facilities. Workers who handle biomedical waste must observe standard precautions.

### 4.4 Composition of Organic Waste

Biodegradable waste includes any organic matter in waste which can be broken down into carbon dioxide, water, methane or simple organic molecules by micro-organisms and other living things by composting, aerobic digestion, anaerobic digestion or similar processes. In waste management, it also includes some inorganic materials which can be decomposed by bacteria. Such materials include gypsum and its products such as plasterboard and other simple organic sulfates which can decompose to yield hydrogen in anaerobic land-fill conditions. In domestic waste collection, the scope of biodegradable waste may be narrowed to include only those degradable wastes capable of being handled in the local waste handling facilities.

#### 4.4.1 Liquid Waste

Liquid waste is commonly found both in households as well as in industries. This waste includes dirty water, organic liquids, wash water, waste detergents and even rainwater. You should also know that liquid waste can be classified into point and non-point source waste. All manufactured liquid waste is classified as point source waste. On the other hand, natural liquid waste is classified as non-point source waste. It is best get in touch with waste removal experts, such as 4 Waste Removals, to dispose of liquid waste properly. Liquid waste can be defined as such Liquids as wastewater, fats, oils or grease (FOG), used oil, liquids, solids, gases, or sludge and hazardous household liquids. These liquids that are hazardous or potentially harmful to human health or the environment. They can also be discarded commercial products classified as "Liquid Industrial Waste" such as cleaning fluids or pesticides, or the by-products of manufacturing processes. There are general regulatory requirements relating to waste, additional regulations apply to generating, storing, transporting, treating and disposing of hazardous and liquid wastes.

#### 4.4.2 Solid Rubbish

Municipal solid waste (MSW), commonly known as trash or garbage in the United States and rubbish in Britain, is a waste type consisting of everyday items that are discarded by the public. "Garbage" can also refer specifically to food waste, as in a garbage disposal; the two are sometimes collected separately. In the European Union, the semantic definition is 'mixed municipal waste,' given waste code 20 03 01 in the European Waste Catalog. Although the waste may originate from a number of sources that has nothing to do with a municipality, the traditional role of municipalities in

collecting and managing these kinds of waste have produced the particular etymology 'municipal.'

Solid rubbish can include a variety of items found in your household along with commercial and industrial locations. Solid rubbish is commonly broken down into the following types: Plastic waste – This consists of bags, containers, jars, bottles and many other products that can be found in your household. Plastic is not biodegradable, but many types of plastic can be recycled. Plastic should not be mix in with your regular waste, it should be sorted and placed in your recycling bin. Paper/card waste – This includes packaging materials, newspapers, cardboards and other products. Paper can easily be recycled and reused so make sure to place them in your recycling bin or take them to your closest Brisbane recycling depot. Tins and metals – This can be found in various forms throughout your home. Most metals can be recycled. Consider taking these items to a scrap yard or your closest Brisbane recycling depot to dispose of this waste type properly. Ceramics and glass – These items can easily be recycled. Look for special glass recycling bins and bottle banks to dispose them correctly. If you still cannot grasp the concept of recycling, then an incredibly easy and efficient way to dispose solid rubbish is by hiring a Brisbane waste removal company, like 4 Waste Removals, to take care of your recycling for you. We will removal all of your rubbish and ensure it is disposed of properly. Organic waste is another common household. All food waste, garden waste, manure and rotten meat are classified as organic waste. Over time, organic waste is turned into manure by microorganisms. However, this does not mean that you can dispose them anywhere.

Organic waste in landfills causes the production of methane, so it must never be simply discarded with general waste. Instead, look to get a green bin from the Brisbane council, or hire a green skin bin or garden bag for proper waste disposal.

### 4.4.3 Recyclable Rubbish

Recyclable rubbish includes all waste items that can be converted into products that can be used again. Solid items such as paper, metals, furniture and organic waste can all be recycled. Instead of throwing these items in with regular waste, which then ends up in landfills, place them in your yellow recycling bin or take them to your local Brisbane recycling depot. If you're unsure whether an item is recyclable or not, look at the packaging or the diagrams on the lid of your yellow recycling bin. Most products will explicitly state whether they are recyclable or not.

### 4.4.4 Hazardous Waste

Hazardous waste is waste that has substantial or potential threats to public health or the environment. Household Hazardous Waste (HHW), also referred to as domestic hazardous waste or home generated special materials, is a waste that is generated from residential households. HHW only applies to waste coming from the use of materials that are labeled for and sold for "home use". Waste generated by a company or at an industrial setting is not HHW. The following list includes categories often applied to HHW. It is important to note that many of these categories overlap and that many household wastes can fall into multiple categories:

- Paints and solvents
- Automotive wastes (used motor oil, antifreeze, etc.)
- Pesticides (insecticides, herbicides, fungicides, etc.)
- Mercury-containing wastes (thermometers, switches, fluorescent lighting, etc.)
- Electronics (computers, televisions, cell phones)
- Aerosols / Propane cylinders
- Caustics / Cleaning agents
- Refrigerant-containing appliances
- Some specialty batteries (e.g. lithium, nickel cadmium, or button cell batteries)
- Ammunition
- Radioactive wastes

Hazardous waste includes all types of rubbish that are flammable, toxic, corrosive and reactive. These items can harm you as well as the environment and must be disposed of correctly. Therefore, I recommend you make use of a waste removal company for proper disposal of all hazardous waste

## RESULTS AND DISCUSSION

The proposed system "automatic waste segregator and monitoring system" sorts wastes into three different categories, namely metal, plastic and the wet (organic) waste. Wet waste refers to organic waste such as vegetable peels, left-over food etc. Separating our waste is essential as the amount of waste being generated today causes immense problem. Here, we have tested the household wastes which are generated in every home today and we have come up with the following result.

Tables 1–3 show the tested results of the waste when exposed to our automatic waste segregator and monitoring system. The proposed system would be able to monitor the solid waste collection process and management of the overall collection process. It would provide in time solid waste collection. The technologies which are used in the proposed system are good enough to ensure the practical and perfect for solid waste collection process monitoring and management for green environment.

The advantages of automatic waste segregator and monitoring system are listed below:

Sorting of waste at the primary stage will make the waste management more effective and fruitful.

The dustbins are cleared as and when they are filled, thus giving way to a cleaner environment, Eco friendly system.

Lower initial investment including lower cost of installation.

Few disadvantages are given below:

Waste separation is time consuming, Size of waste must be less than or equal to the dimension of funnel.

| S. No. | Type of metal | Discarded not |
|---|---|---|
| 1 | Safety pin | Yes |
| 2 | Paper clip | Yes |
| 3 | Battery | Yes |
| 4 | Nail | Yes |

Table.4.3: Result of metallic waste separation

| S. No. | Types of organic waste | Discarded not |
|---|---|---|
| 1 | Kitchen waste | Yes |
| 2 | Leftover food | Yes |
| 3 | Vegetable feel/fruit feel | Yes |
| 4 | Rotten fruit and vegetable | Yes |

Table.4.4: Result of organic waste separation

| S. No. | Types of dry waste | Discarded not |
|---|---|---|
| 1 | Paper | Yes |
| 2 | Small bottles | Yes |
| 3 | Heavy cartons | Yes |
| 4 | Milk cover | Yes |
| 5 | Dry leaves | Yes |
| 6 | Cloths | Yes |
| 7 | Tetra pack | Yes |

Table.4.5: Result of dry waste separation

## 3. CONCLUSIONS

The waste segregator as the name suggests, segregates the waste into three major classes: plastic, organic, metallic. The proposed system would be able to monitor the solid waste collection process and management of the overall collection process. The inlet section is provided with open and close mechanism to regulate the flow of waste on to the conveyor. Inductive proximity sensor is used to detect the metallic waste.A blower mechanism is used to segregate dry and wet waste. The timing and movement of the conveyor belt is controlled by Arduino Uno. Continuous and unnecessary operation of any particular section is thus avoided.

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