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# Self Segregation of Household Waste and Alarm System

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**Abstract -** *Globalization in this era of drastically growing field of technology and science may on one side be providing us ease to do work but on the other side also raising concerns about the by-products that are being disposed off just after their use. The processing and separation of waste is done largely at municipal level, which induces large costs, could be priory managed at households for its easy processing in municipal levels. Hence a Self Segregation of Household Waste and Alarm System which uses latest technology for the segregation of household waste at minimal price of purchase would differentiate the waste in metal using the capacitive proximity sensor and dry and wet waste using the moisture sensor. Once the waste in the bins reaches full level indicated the alarm rises and intimates that there is a need to clean the bin. The system uses arduino which is programmable with minimum amount of electric current to incur any electric charges. The experimental results of the system developed separated the waste put in it in dry, wet and metal bins and gave an indication when the waste reached the full level mark.*

***Key Words*: Self segregator, Arduino UNO, Capacitive proximity sensor, Alarm system**

## 1. INTRODUCTION

Everyday there is new invention in field of science and technology that is helping out humanity with ease of doing the work effectively. The demand of new possible ways of doing work here raises a concern in the waste and the by-product that is generated out from these processes. Every new technique coming up poses its own danger of controlling it and then disposing the by-products generated from it in the end which goes almost useless. When it comes to disposing of this waste product from the place of its origin there are not many advancements made. Most of the waste is generated by factories which by certain regulations of government is made to be dispose at place away from human reach.

India is a low middle income country where the municipal solid waste in 2001 was 168,403,240 tonnes in 2001 which increased to 277,136,133 tonnes in 2016 and would increase to 387,770,524 tons in 2030 and 543,277,457 tons by 2050 with an increased population of 1,658,978,000 as projected by a data. Waste collection in India is 51% of the total waste generated in which only 13.55% is being recycled and nearly 33% or more getting dumped openly at various sites [1].

All this means that if we could separate the waste at first step i.e. at household where it is generated it will help the municipal bodies a lot for further processing. The model uses metal detector sensor, IR (infrared) sensor and moisture sensor along with arduino, PCB (printed circuit board) and motors with very basic structure. Also the model uses the same space as that of a regular dustbin and the rest of the hardware can be placed at anywhere in the house where the alarm would be raised when any of the bin gets filled. This will separate the waste in wet, dry and metal type that could be separately placed in the respective municipal bins. This waste will then be recycled and processed by municipality providing them ease as compared to recent methods.

### 1.1 Literature Survey

Designing of any new system requires the knowledge of all the studies and work that has been done so far in the topic. Based on the understanding of all the models which are present, their method of working and their efficiency we can then decide on to what are the voids that are needed to be filled in the existing methods and thereby develop a unique way of waste management at household levels.

As Claudine Capel et.al. [2] mentioned that as waste is increasing there is a rise in concern of waste management techniques to be developed with growing technology. Various sorting technologies like France based Pellenc ST made a MIR (med-infrared) for segregation of papers and Arrow bio which sorts organic waste from recyclable wastes. Still we see a lack of household waste segregating methods here.

Suchi Gupta et. al. [3] stated that the near infrared sensors could be used to separate various materials based on the way light would be emitted back. This method could be effectively used for sorting of papers for their recycle.

Waste Segregation using Deep Learning Algorithm (WSDLP) [4] defines a method by which the Convolution Neural

Network (CNN) algorithm which is an algorithm of deep learning, an evolution of machine learning can be used to separate the waste products by image recognition using web cam and programming codes. This process is still is in its development phase for its efficiency and recognition capabilities.

Automation of Waste Segregation System using PLC [5] proposes a system and methodology where a PLC (programmable logic control) instead of microcontroller can be used to separate the waste. The paper gives a new and smart way where Bosch Reroth PLC is used along with IR sensors conveyer and fan to ease the waste separation and with minimum human interference.

The Automated Waste Segregator-AWS [6] presents a model where a microcontroller is used for the automation of waste segregation. The model uses IR sensor, ldc1000 which is inductance to digital convertor and capacitive plates along with other material for separating waste into wet, dry, and metal type. The limitation here is that only one type of waste can be dumped at one time for segregation and the size of the waste that can be put through the hole in flap.

Automatic Waste Segregator and Monitoring System [7] is a model proposed which would use a conveyer on which the waste is to be placed. A blower would be used to clean the conveyer from dust of waste. The waste would fall into its respective bin by robotic arm. Any wet waste put in system could cause damage to the conveyer that could not be easily cleaned by blower. The blower needs extra supply of current along with the size of conveyer that could be placed in house being a major issue.

From all the studies and research papers so far studied in this field it can be concluded that the separation of waste has been developed but not successful for use in household with effectiveness. Some papers stated use of IR sensors and metal detectors with conveyer belt which is not advisable in household whereas some models used inclined surface for detection of waste which limits the size and weight of waste. The other papers stated the use of induction algorithms along with Artificial Neural Networks (ANN) or Connectionist Networks for image processing of waste which is an area of research. Therefore we have developed a model that would eliminate all such barriers.

### 1.2 Design Considerations

There are a lot of factors that need to be considered while designing any new system. We need to be precise with many design techniques available and then deciding on to which can be easily and effectively used for the project. The major aspects which must be looked on for the development of model are as stated -

**A. Designing a simpler model** - There are various models and theories present in the market for the development of an automatic waste segregator. The study shows that all the system developed so far have a very complex construction and mechanism. This limits the system for their use in households where a layman has to use it. Thus need is to develop simpler model which would use modern techniques and mechanism that could be readily used by any member in the house.

**B. Space** - Also we need to consider the issue of the space that would be available for keeping the waste segregator. The system is being developed for the household waste and much of space in the house cannot be given to a dustbin. The installation of the total system has to be made in such a way that it occupies least space in the house.

**C. Segregation type -** The main aim of the project is to separate the garbage in the house in different types. Once the waste is segregated it has to be further processed by the local municipal body. So the concern is to decide on to which types the waste is to be segregated.

**D. Ready for further processing** - The waste that would be so far segregated has to be however processed further. This waste segregation method allows the separation of waste only at household levels for its further processing at municipal levels.

## 2. COMPONENT DESCRIPTIONS

### 2.1 List of components

**Table -1:** List of the major components used

| Sr. No. | Name of the component | Quantity |
|---|---|---|
| 1 | Collection jars | 5 |
| 2 | Arduino UNO | 1 |
| 3 | Infrared sensor | 2 |
| 4 | Capacitive proximity sensor | 1 |
| 5 | Resistance moisture sensor | 1 |
| 6 | Motor driver module | 1 |
| 7 | Geared DC motor | 3 |
| 8 | Battery | 1 |
| 9 | Metallic plates | - |
| 10 | Nuts and bolts | - |
| 11 | Wirings | - |

## 2.2 Specifications of components

### A. Arduino UNO

The Arduino UNO is a very popular integrated circuit board that contains microcontroller ATmega328P and ATmega16U2 in it. The board has a USB port of A-type to connect the board to the computer for data transfer and an external supply through which battery can be connected. It has 14 digital pins of input and output types and 6 analog pins. This is a open source microcontroller type board and very widely used in many models.

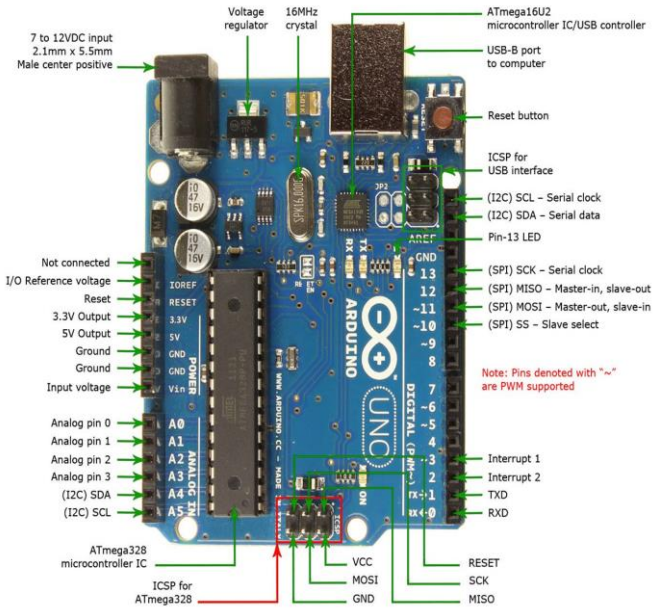


**Figure-1:** Arduino UNO

### B. Moisture sensor

This sensor in the system is used to detect the waste that is put in the collecting jar and then segregate it into wet or dry type. The segregation of waste is done by using two pointed arrow shaped strip of the sensor. Sensor consists of potentiometer, resistors, capacitors, input-output pins and LED inbuilt in it.

**Figure-2:** Moisture Sensor

### C. Infrared sensors

The IR sensor module uses a transmitter to transmit IR rays from it and a receiver to receive back the rays after they reflect back from a target. This also consists of a potentiometer which can vary the distance that is to be measured for the target ranging from 2 cm to a maximum of 15 cm.

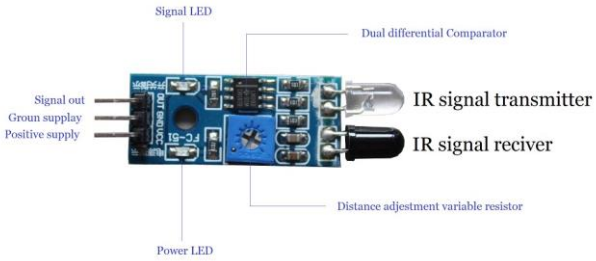


**Figure – 3:** Infrared sensor

### D. Capacitive proximity sensor

This proximity sensor is used for the detection of metal and non-metal material in solid, liquid or powdered state with the advantage of not actually touching the target. The negative terminal of the sensor is the target object and the positive plate is already inside the sensor. Air acts as the dielectric medium. The target changes the dielectric value given to the oscillator thereby generating an output signal.

### E. Geared DC motor

A DC motor is a motor from which mechanical work is taken as output. This works on direct current which is supplied form a battery. The current supplied to the device and the magnetic field inside the motor gives mechanical output in the form of shaft rotation. This rotation of the shaft is then used to move the collecting jars and the lid. The shaft is connected to gears to get the desired output and torque.

**Figure – 3:** Geared DC motor

**F. Collecting jars**

Proper collecting jars should be used for the collection of garbage in them. 5 such jars are used in total of which one is the buffer jar in which the complete garbage is dumped at once. The other is the collection jar equipped with sensors and the other 3 being the jars in which waste is segregated.

**H. Motor driver module**

The motor driver module has L293D motor driver containing 16 pins. There are 8 pins on either side. 2 such motor drivers used for controlling the 3 geared dc motors. The module also consists of input and output connections to the motors and the arduino board.

## 3. WORKING

The garbage collected in the house is completely dumped into the segregation machine. This garbage that is put in the system is first collected in the buffer jar that has larger capacity when compared to other jars in the system. The waste in the buffer jar can be of single type or may consist of many types of wastes.

### 3.1 Entry of garbage and system initialization

The garbage is put in the buffer jar which passes along its periphery and goes to the bottom of the jar. The jar has funnel shape with its narrow end at the bottom that has a movable flap under it. This flap is placed horizontally and is allowed to rotate at an angle of $90^0$ to one side of its initial position which is under the neck of the buffer jar. The flap is connected to a geared dc motor which is controlled by the arduino board. When the infrared sensor placed at the collection jar does not sense any object in its working distance it sends an output to the arduino board. The ATmega328P microcontroller on the arduino board receives this output and then commands the motor driver module to start the geared dc motor at the buffer jar. The motor moves and opens the flap for 3 seconds which makes the waste in the buffer jar to fall in the collection jar and then the flap is closed. Now the infrared sensor in the jar senses the waste and prompts the microcontroller to command all the other devices to exit idle state. This then starts the moisture sensor and the capacitive proximity sensor to detect for the type of waste.

### 3.2 Sensing operation

The ATmega328P microcontroller directs the capacitive proximity sensor to work first and detect the waste in the jar. The sensor already has a fixed threshold value with air as the dielectric medium and the target being nothing. The waste here acts as the negative terminal for the sensor with the positive terminal already placed inside and the air as the dielectric medium. This generates a change in the value of capacitance and the waste is sensed as metal or non-metal type. If the waste is detected as the metal waste then the moisture sensor will not work. Otherwise the moisture sensor would then sense the waste for dry or wet type depending on the change in its resistance values. The type of waste detected by any of the two sensors is done and the same output is carried to the arduino board.

### 3.3 Segregation operation

As soon as theATmega328P microcontroller receives the input that the type of waste has been detected it commands motor driver module to move the geared motors. The first operation is of the motor connected at the base of the segregation jars which needs to be aligned with the movable flap of the collection jar. The motor is driven in such a way that it has to perform minimum rotation. Once the appropriate jar is placed under the flap of collection jar the infrared sensor placed under the base of the jars checks for the alignment of the jar so placed. Then the geared dc motor at the flap of collection jar is given the command by the motor driver module to move and open the collection jar flap. This puts the waste in appropriate bin.

After the waste is segregated into the respective bin the infrared sensor at the collection jar again senses for any remaining. If no waste is found then the microcontroller commands motor driver module to start the motor at buffer jar for further processing of waste left in the buffer jar. In case no waste is detected in the collection jar after the opening of buffer jar flap the microcontroller puts the system in idle state. Also there are sensors in the dry, wet and metal jar that will give an alarm if the waste in the jar reaches the maximum level of its capacity. This alarm system ensures that the waste does not spill out of the jars and the area near the bin remains clean by the LED giving indication of alarm. In this way the segregation is done.

## 4. RESULT

The above discussion concludes a very unique and modern way in which the garbage in the household is separated in the dry, metal and wet types. The buffer jar aids the system with the advantage of collecting the complete garbage at once like any traditional dustbin. Wastes like vegetable peels, fruits leftover are separated in the wet bin due to the moisture content in them that gives a sufficient change in the values of resistance in moisture sensor. Aluminum foils and other metallic wastes like screws are put in the metal bin. The leaves for the garden, plastics like pen and all other such wastes are dry waste.

**Table -1:** Result of waste segregation

| Waste put in the jar | Type of waste detected |
|---|---|
| Vegetable peels | Wet waste |
| Aluminum foil | Metal waste |
| Banana and other fruits | Wet waste |
| Leaves for garden | Dry waste |
| Plastics like pen etc. | Dry waste |

The rotation of the movable flap and the base on which the three jars are placed are also discussed and presented below. The following table below shows the rotation of the motor upon the detection of the type of the waste and the jar that is placed below the movable flap.

**Table -2:** Direction of rotation of the motor at the base

| Type of detected waste | Bin under the lid | Rotation of motor at base of jar |
|---|---|---|
| Wet waste | Wet bin | No rotation |
| Wet waste | Dry bin | Clockwise rotation |
| Wet waste | Metal bin | Anticlockwise rotation |
| Dry waste | Dry bin | No rotation |
| Dry waste | Wet bin | Anticlockwise rotation |
| Dry waste | Metal bin | Clockwise rotation |
| Metal waste | Metal bin | No rotation |
| Metal waste | Wet bin | Clockwise rotation |
| Metal waste | Dry bin | Anticlockwise rotation |

## 5. CONCLUSION

The conclusion that could be made is that the Self Segregation of Household Waste and Alarm System has been developed and tested successfully for its operation to segregate the household waste into dry, wet and metal type. The ceramics are put in wet waste but they are rarely generated in the household waste. The total time in which this process is done is less so that system is readily available for another cycle of waste segregation.

The system is also able to monitor the level of the waste in the jars and thereby send the relevant data to raise or not raise an alarm. In this way the separation of household waste is efficiently done with the use of modern day technology that is easily operable by anyone in the house at cheap price of production and electricity consumption.

## 6. FUTURE SCOPE

The dry jar can be equipped with crusher system for crushing metallic and plastic waste. The waste in the wet jar could be used to produce fertilizers for organic farming.

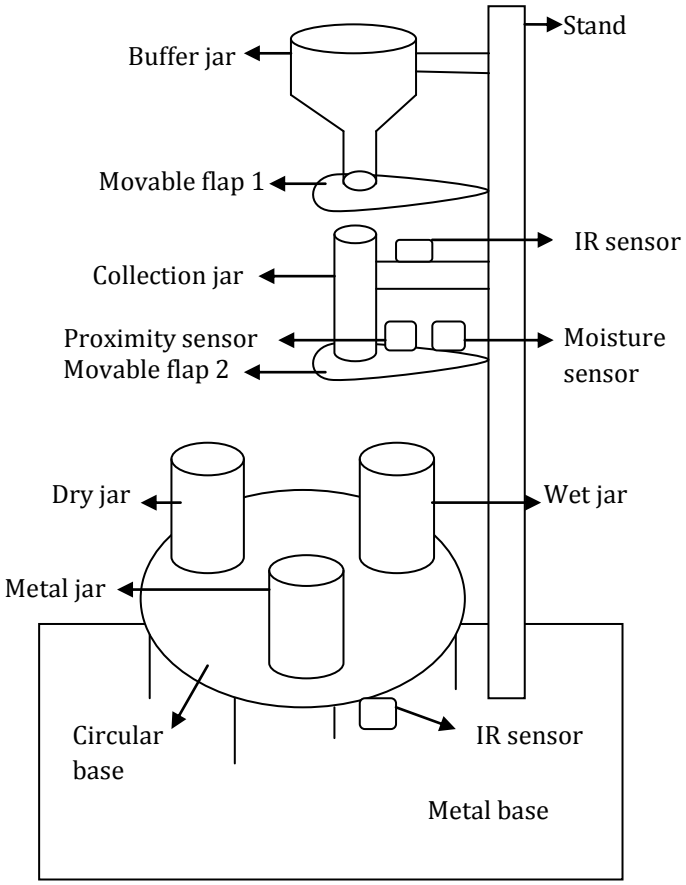


**Figure – 5:** 2-D model of the system

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