



## Reward Based Smart Garbage Segregation System for Smart City

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### ABSTRACT

In recent times, waste disposal has become a vast cause for concern in the world. A huge amount of waste is disposed by wrong means which have an adverse effect on the environment. Most of the generated waste is disposed of by unplanned and uncontrolled methods which become injurious to human health as well as to plant and animals' life. Proper means of segregation makes it possible to reuse and recycle the waste effectively. This paper proposes implementation of an automatic waste segregator at domestic level using Arduino UNO microcontroller, to regulate the whole process with ease and simplicity. The main architecture of the segregator consists of an IR sensing element, a metal sensing element, a moisture sensing element, and the segregation bins. The IR sensing element detects the arrival of waste, identification and separation of waste is completed by sensors. The microcontroller controls activity of the sensors used. Results have conferred segregation of waste into metal, wet, others. The aim of this project is to provide an economical and cost-effective waste collection management system thus providing a clean, healthy, and green atmosphere.

**Keywords:** solid waste management, Arduino UNO, IR Sensors, Moisture sensing element, Metal sensing element.

### 1. Introduction

As we move towards a more digitized future, it's directly proportional to extend urbanization. This is often the main reason for the generation of huge quantities of waste. As per the report revealed by World Bank, about 1.3 billion tons of municipal waste is generated per annum and it's expected to rise to about 2.2 billion tons per annum by 2025. Because of this waste lies cluttered within the surrounding, dumped on open lands and this becomes major downside for varied forms of disease inflicting bacteria and viruses that is why waste management is of vital importance. Segregation makes it possible to utilize and recycle the waste effectively. Therefore, the waste Management becomes a vital concern for the health and well-being of the society. Presently, the waste segregation is completed manually by installing different bins for grouping different form of waste like wet, metal and others. However, this methodology has tons of discrepancy, one is being the unawareness of the public towards waste management. Due to lack of proper segregation strategies, an oversized quantity of untreated waste is dumped as landfills. So, this paper aims to create automated segregator system primarily based on waste segregation which may determine the kind of waste and place them in respective bins accordingly and automatically. Implementing the system at domestic level can scale back the expenditure on waste disposal, manual effort needed for waste segregation and therefore the waste can be simply recycled, reused, and reduced. A trend of great increase in domestic solid waste generation has been recorded worldwide. This has been found because of overpopulation growth rate, industrialization, urbanization and economic growth that have ultimately resulted in raised solid waste generation. Final stopping place of solid waste in India is disposal. Most of the waste from urban areas is land filled and dumped. The paper deals with the foremost blistering topic i.e., waste segregation. Efficacious management must be materialized for a better planet to live in. Hence, with this price effective project proposal, we tend to try and bring in the change. An automation of this style not solely saves the manual segregators of the many health problems, however, conjointly proves to be economical to the state. Besides this, the system utilizes low value parts for the prosperous segregation of most kinds of waste.

This waste segregation system is a very innovative system which can facilitate to keep the cities clean. The system makes use of Arduino family microcontroller, LCD screen, RFID reader and Different sensors, The system is power- driven by a 12V battery. The LCD screen is employed to display the status of the amount of waste collected and RFID card reader is used to identify the respective users.

### 2. Background Study

The increment in waste generation has led to much subordinate legislation for changing the mode of disposal and dealing with segregation of waste. Specific forms of waste are subjected to separate rules and require separate consent, mostly in the nature of authorizations, maintenance of records and appropriate disposal method.

With rapid urbanization, the country is facing a very big waste management challenge. Around 377 million urban people live in 7,935 towns and cities and produce 62 million tons of municipal solid waste per year. Only 43 million tons of the waste is collected, 11.9 million ton is treated, and 31 million ton is dumped in landfill sites. Solid Waste Management is one of the basic important services provided by municipal authorities in the country to keep urban centers clean. However, almost all municipal authorities dump solid waste at a dump yard within or outside the city. Experts believe that India is following a fallacious system of waste disposal and management.

The key to effective waste management is to ensure proper segregation of waste at source level and to ensure that the waste goes through different processes of recycling and resource recovery. A report from IIT Kanpur (2006) shows at least 15 percent or 15,000 million tons of waste generated every day in the country.

There has been advancement in technology for segregation, treatment, and disposal of solid waste. Energy-from-waste is an important element of Solid waste management because it decreases the amount of waste from disposal and helps in changing the waste into renewable energy and organic manure. Ideally, it comes into the flow chart after segregation, collection, recycling and before going to the landfill. But most of the waste to energy plants in India is not working to their full potential.

### 3. Problem Statement

Delayed waste segregation is creating hazards and environmental pollution, a fully supervised and controlled handling of waste is required. The biggest Challenge in the urban cities is Solid waste management, not only in India but for most of the countries in the world. Segregation is utilizing manpower to segregate the waste collected from different places. Unsegregated waste is creating adverse effects on human health and the environment.

### 4. Methodology

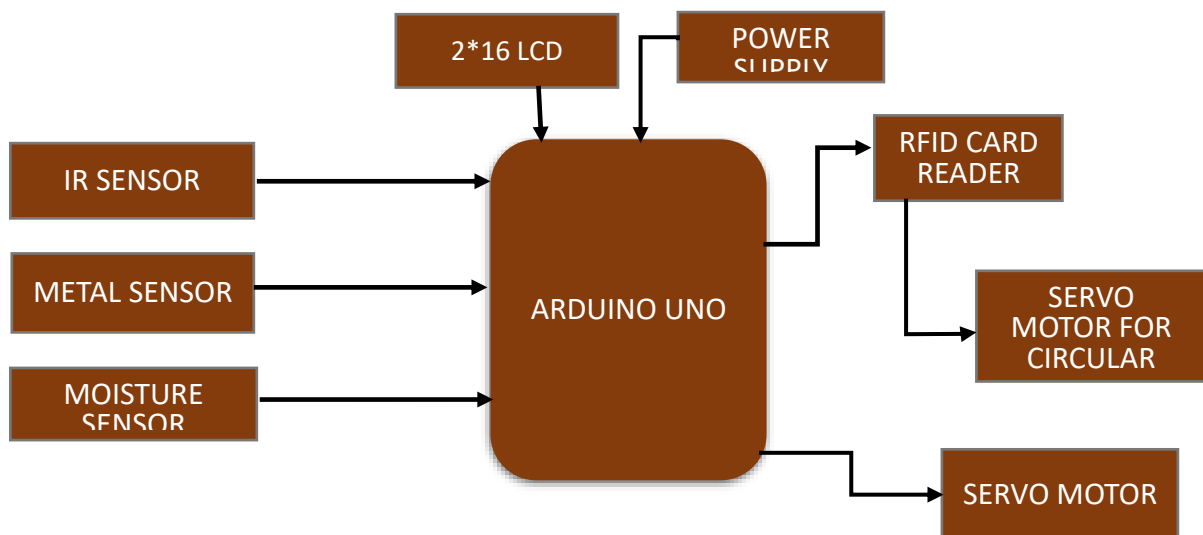


Fig 1: Architecture of Automated garbage segregation system

In this proposed system, the three bins were used to collect the segregated waste. Figure 1.1 represents the architecture of the proposed system. The system contains 3 sensors that is IR sensor, metal sensor and moisture sensor and it has Arduino UNO microcontroller, 16\*2 LCD display, RFID Card Reader, Servo motors and 3 bins.

### 5. Working Principle

#### Step 1: Use an RFID scanner to scan the RFID card.

Users use their RFID card which gets scanned by the low power radio waves of the RFID reader to communicate with the user and store data. The RFID reader then displays the users ID on the LCD display.

#### Step 2: Insert the garbage into the system.

Users put their garbage, one at a time, inside the inlet of the pipe.

**Step 3: Sorting garbage into dry, metal, and moisture categories.**

Presence of the garbage is detected by the IR sensor which generates a voltage of 5V is an input signal to Arduino to start the First cycle of Segregation. After this process is done, Arduino initializes the other two sensors to start their function. When metallic object is passed in front of the metal sensor, it will give a signal to Arduino. This happened because the metal sensor transmits an electromagnetic field which energizes the metal object which in turn retransmits an electromagnetic field of its own.

The moisture sensor is used to measure the volumetric content of water to check if it is wet waste. The sensor is placed inside the inlet and is the last level of check to determine the kind of waste if the waste is not metallic. When the current passes through the object, the low resistance value which is measured signals whether the moisture content of waste is more than 50%. Then only it is considered as a wet waste.

**Step 4: Collecting the waste once it has been sensed by sensors into 3 distinct containers.**

The collection of the waste, once detected as metal, wet or others, is done in rotating platform consisting of bins designated for each type of waste. This circular platform is operated using a servo motor which has a rotational capacity of 180 degrees which is then programmed in the microcontroller. When a certain category of waste is detected by the program through the sensors, the platform is rotated to that degree and the waste falls through the outlet vent of the pipe into the bin.

**Step 5: Show the credits on the LCD.**

The monitoring device used here is 16\*2 LCD display which shows the count, and type of waste detected to the user as well as displays the credits to the user.

**5.1 Flow chart**

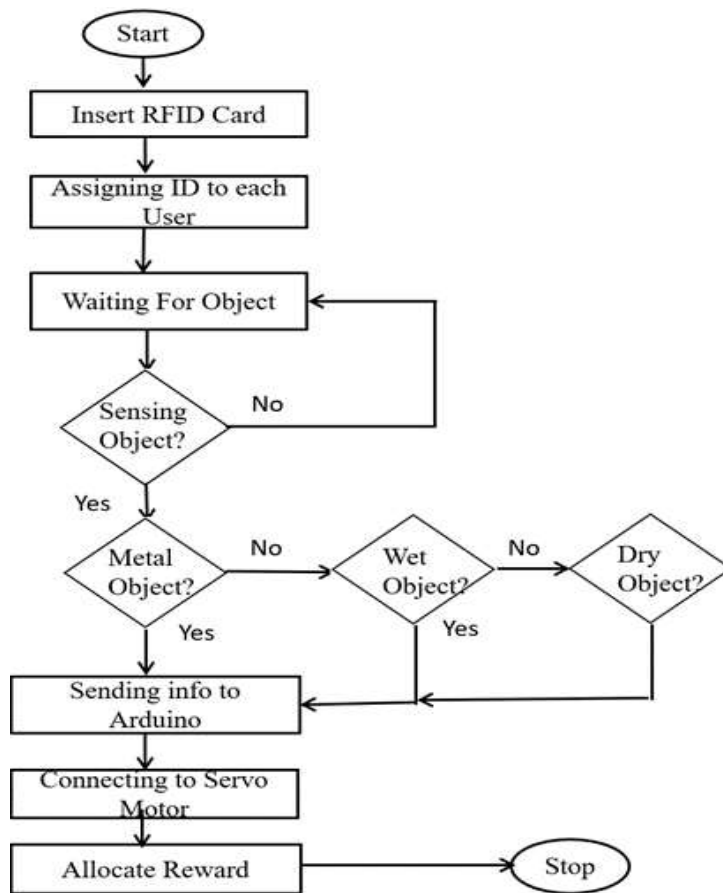


Fig 2: Flowchart of Automated garbage segregation system

## 6. Implementation

### 6.1 Hardware components

**Arduino uno (AVR ATmega 328PU):** The Arduino uno is a microcontroller which has a total of 28 pins. In which 14 are digital I/O pins, 6 are input pins (Analog), 3 are grounded (GND) pins. It is a 16 MHz ceramic resonator and a port for plugging in USB power jack and a reset button. This microcontroller can be connected to a computer with the help of a cable or powered with the battery or with the AC-to-DC adapter to get it start. Here in this project one Arduino uno is used for interfacing. So, with the help of this controller all the hardware components used in the project are moisture sensor, metal sensor, IR sensor, servomotor, LCD and RFID card reader are being connected to it.



- **IR sensor:** Emits or detects IR radiation to sense a specific condition as usually all the objects emit thermal radiation in the infrared spectrum. The IR Proximity sensor detects these radiations which generally is not visible to naked eye. An IR sensor has a receiver and transmitter.



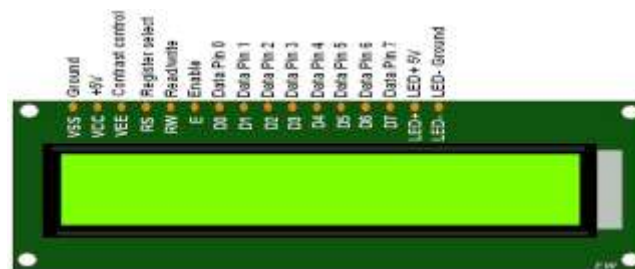
- **Metal sensor:** It is useful to find metal hidden within waste. The handheld unit as a sensor probe which when swept over the objects shows output. The proximity sensor, as per its range predicts metallic object passing over it through an electromagnetic field. Microcontroller then checks the stats of the sensor as per the written program to send it to the bin.



- **Moisture sensor:** disused force aggregating the waste between dry and wet microcontroller constantly checks the status of moisture sensor and if it gets the signal, then bin for wet waste is selected using servo motor otherwise by default it is dry waste.



- **Liquid Crystal Display:** A 16 \* 2 LCD display is used which consists of two rows of display each consisting of 16 characters. It has 16 pins. Pin 1,2,3,15 are power pins. There are 8 pins to transmit 8 bits of data. The LCD can be used either in 8-bit mode or 4-bit mode. The pins 4,5,6 are called control pins and are very important pins.



- **Servo motor:** For the control of angular velocity and acceleration a servo motor is used. It has a desirable motor coupled to a sensor for position feedback. A controller and a dedicated module are also required for use with servo motors. Servomotor is used to rotate the disk which contains trash bins. Its operating voltage is 4.8 to 5 Volt.



- **Power Supply:** A 12V power is supplied to the whole system directly from the power source of electricity.
- **RFID card reader:** Electromagnetic fields are used to automatically identify and track tags. This is going to act as an incentive program for our waste segregator which will push people to keep their surrounding clean to redeem points in their own RFID tags which could have benefits. Like a simple metro card, this can also be made easily accessible to everyone.



## 6.2 Software components

Arduino IDE is an open-source Arduino software used to write codes which can be uploaded to the Arduino board. The text editor helps us to write codes and consists of a message area, a text area, a text console, toolbar, and menus. These programs are also called sketches. Out of a lot of Arduino modules, Arduino IDE is the most common programming approach which utilizes the embedded C programming language. Below given is the code we have learnt and written to make the system function better. The code is given as the functioning input to the microcontroller through which rest of the components are controlled and the system works.

```

Blink (Arduino 1.8.5)

Blink 5

This example code is in the public domain.

http://www.arduino.cc/en/Tutorial/Blink

// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(LED_BUILTIN, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(LED_BUILTIN, HIGH); // turn the LED on (HIGH is the voltage level)
  delay(1000); // wait for a second
  digitalWrite(LED_BUILTIN, LOW); // turn the LED off by making the voltage LOW
  delay(1000); // wait for a second
}

```

## 7. Results And Discussion

The system tests following types of waste.

### 1) Metal waste

S.no	Type of waste	Discarded?
1	Battery	Yes
2	Coin	Yes
3	Keys	Yes
4	Small screw	Yes
5	Safety pin	Yes

**Table 1: result of metallic waste separation**

### 2) Wet waste

S.no	Type of waste	Discarded?
1	Wet tissue	Yes
2	Wet cloth	Yes
3	Wet wood	Yes
4	Vegetable feel/fruit feel	Yes
5	Leftover food	Yes

**Table 2: result of wet waste separation**

### 3) Dry waste

S.no	Type of waste	Discarded?
1	Glass	Yes
2	Plastic	Yes
3	Paper	Yes
4	Cloth	Yes
5	Small bottles	Yes

**Table 3: result of Dry waste separation**

The proposed paper represents the automated segregator that segregates garbage into three different categories dry, wet, and metal wastes. in the above table 1 different metal wastes such as coin, key, battery, etc., are segregated as metal wastes by the system. similarly, the wet wastes in the table 2 are

also segregated with the help of moisture sensors. The dry waste that are observed in the table 3 such as glass, paper, cloth are also detected correctly and segregated successfully.



**Fig 3. The proposed system**



**Fig 4. putting dry waste into the entry system**



**Fig 5. Display of credits for Dry waste**



**Fig 6. putting wet waste into the entry system**



**Fig 7. Display of credits for wet waste**



**Fig 8. putting metal waste into the entry system**



**Fig 9. Display of credits for metal waste**

The above fig 3 shows the proposed automated segregator system. Fig 4 shows the arrival of dry waste in the inlet and the fig 5 shows the display of credits to the users for dry waste segregation. In the fig 6 the arrival of wet waste is detected using moisture sensor and the fig 7 shows the corresponding credits for the wet waste. Fig 8 shows the presence of metal waste and the fig 9 shows the respective credits for metal waste in the LCD display.

## 8. Advantages

- This system keeps our surroundings free, clean, and green from the odour of trashes supports good environmental conditions and keeps towns more beautiful.
- It also helps to reduce the requirement of manpower to manage the waste collection process.
- The automatic waste segregation process also helps to reduce the health issues and work stress of workers who manually segregate the wastes.
- It also plays a major role in the reduction of environmental pollution.

## 9. Future Scope

The waste segregator can be improvised to include the segregation of wastes such as plastics, biomedical wastes etc., Following are some of the improvements that can be done in adopting the system:

- Range of the inductive proximity sensor can be increased.
- More sensors can also be used, to segregate more categories of waste.
- Plastics can be segregated from the collected dry waste and be processed based on their types, grades, and colours.
- Machine learning can also be used for segregation.
- Sensitivity of sensors can be increased.
- Provisions can be made for on-spot decomposition.
- Provision can be made for the segregation for 2-3 different types of waste at the same time.
- Power generation and biogas generation can also be done at the bins.

## 10. Conclusion

This paper enhances the cleanliness of the smart cities by the practical application of “automatic waste management and segregation system using IoT”. With urbanization and increasing population, disposal of waste is a major concern. This proposed system is an effective waste segregation system that has no human intervention or interference to separate dry, wet and metal waste. It provides timely collection and disposal. The proposed system can be deployed on a domestic scale in household or a large scale in public places. The simplest way in which this can be implemented practically and realistically is on the railway systems that accounts for the busiest of all transportation channels used by the public of India. This can be a small start that spreads awareness quickly and builds a platform for more recycling and helps in determining the true value of waste disposal.

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