



## Smart Garbage Monitoring System using IoT

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### Abstract

The Internet of Things (IoT) will be able to integrate a wide range of various and heterogeneous end systems transparently and smoothly, while also offering open access to chosen subsets of data for the creation of a wide range of digital services. Solid waste management, which apart upsetting the ecological balance also has negative consequences on societal health, has been one of the key environmental issues. One of the main issues in the modern era is the identification, monitoring of wastes. The conventional method of manually checking the wastes in bins requires more human labor, takes longer, and costs more money. It is in no way compatible with modern technologies. This is a cutting-edge approach to automated garbage management. This project IoT Garbage Monitoring system is a very innovative system which will help greatly in preserving the environment and also makes us benefit from garbage and sell it on form raw materials to be recycled again by recycling factories. System is linked to an android application to show us the current level of each type of garbage using Ultrasonic Sensor and give a warning when the level of any of them is filled.

**Keywords:** Internet of Things; Garbage Sorting; Arduino microcontroller; Sensors; Android Application

### 1. Introduction

The proliferation of garbage of various types is a major environmental issue in modern-day Egypt because of the country's rising population and ineffective waste management legislation. With a population of around 104 million, Egypt generates about 90 million tonnes of trash per year, according to experts. This equates to daily trash production of 173 kg per person. The waste situation in Egypt has numerous origins. One problem is that waste management has not been well planned for the future. Garbage collection ranges from 80% in major cities to 0% in rural regions, despite annual waste production of 100 million tonnes (including 20.7 million tonnes of municipal waste) [1]. The rapid increase in the human population also contributes significantly to the garbage problem. To be sure, Egypt's population is expanding at about 1.9% annually. Egypt's municipal solid waste (MSW) comprises 56% organics, 13% plastics, 10% paper & cardboard, 4% glass, 2% metals, and 15% other stuff [2]. The organic proportion of municipal solid waste (MSW) can range from 41% to 70%. In contrast, the plastic fraction can be anywhere from 6% to 16%, the glass fraction can be anywhere from 1.5% to 9.4%, and the metal fraction can be anywhere from 1% to 8% [3]. In 2016, MSW management in Egypt was based on open dumping (81%), a modest recycling share (12%), and only 7% was landfilled, according to the latest statistics released by the Egyptian Ministry of Environment [2]. Using the Internet of Things, a garbage sorting and monitoring system has been developed, which will aid in the cleanliness of urban areas.

The Inductive Proximity Sensor, Capacitive Proximity Sensor, and Soil Moisture Sensor classify the material in this system as either metal, plastic, paper, or biological.

The app also keeps tabs on trash cans and notifies users when they reach capacity. To do this, ultrasonic sensors are installed above the bins to measure the height of the rubbish relative to the bin's depth. A microcontroller called Arduino and a liquid crystal display is used in this setup. A 12V transformer supplies power to the system. The garbage containers' fill levels are shown on an LCD screen. The air temperature, relative humidity, and gas content are displayed on a separate LCD. It aids in the diagnosis of hardware issues within the equipment. On the other hand, an app is designed to update the user on the system's status in real-time. Regarding recycling, this app gets the job done quickly and efficiently by registering businesses and sending them notifications when recyclable materials become available, as well as providing information about the basket and the price of recycled materials.

## **2. Literature Survey**

### **2.1 Smart Waste Management and Classification Systems Using Cutting Edge Approach**

Since our suggested model is not a straightforward system for classifying waste, the primary goal of this research is to provide a system for the segregation of solid waste, particularly recyclables. It is put forth after thoroughly analyzing all of the limitations and characteristics of waste categories. First off, sensors are installed in the trash cans to maintain the level of trash within. Waste is collected by waste management authorities from all commercial and residential areas. Second, a camera is employed to take a picture of the trash dump. The image is segmented into grids using a grid segmentation method. A trained deep learning algorithm called VGG-16 conducts identification using this image. A robotic arm is used by a classifier to further determine each waste object's class and separate it to the appropriate garbage container. To reduce total latency, edge computing and cloud computing are combined. Edge Node Processing, Cloud Processing, and Control Unit make up the three key components that make up the suggested waste classification model's entire system [4].

### **2.2 IOT-enabled dustbin for trash segregation and Collection, CEUR Workshop Proceedings**

It is a regular sight to see trash overflowing from dustbins into the streets, and this issue requires immediate care. In addition, some animals like birds, dogs, and rats dig through rubbish in search of food, which causes waste to pour onto the streets, pollute the air, and make the area unclean. To solve this issue, the trash can has an automatic lid that closes to prevent physical touch and shield the body from germs that spread disease through waste. Only when the presence of plastics, moisture, metal, and biodegradable components is recognized using a variety of sensors and image processing does the automatic lid open. To distinguish between recyclable and non-recyclable materials, the MS COCO dataset will be employed. But sensors will be employed for moist and metallic garbage. If not, it stays closed to stop the spread of bad odors that lead to pollution and illness [5].

### **2.3 Internet of things (IOT) based Smart Garbage Monitoring System**

It is described how to monitor waste using Thingspeak on an IoT platform. A prototype has been created that measures the weight and level of the rubbish bin using a load cell and an ultrasonic sensor, respectively. It has been put to the test, and it performed admirably. Online waste bin monitoring is done with Thingspeak. Periodically throughout each day, live updates of the rubbish bin status are provided via the social network website Twitter. An update on the status of a trash can that is full or overloading would appear on Twitter, allowing authorized workers to take appropriate action. Public awareness of waste management and waste pollution can be raised through disseminating information. The administrator can more effectively schedule and manage garbage collection with the help of this technology [6].

## **3. Proposed System**

The Purposed IoT Garbage Monitoring System is shown in figure 1. From this figure it has been found that the proposed technique has basically consisted of the following components:

1) The Gate Box

In this subsection the main specifications of the gate box will be discussed. First, the gate box will open automatically when someone throws the garbage bag using ultrasonic sensor and geared motor. Second, The garbage bag will be cut by using a heating coil, so that everything inside the garbage bag will be sorted. Third, The dust will be separated from the rest of the garbage through small holes located in the base of the box, so as not to obstruct the conveyor belt motion in the next stage.

2) The Conveyor Belt

The conveyor belt is used to facilitate sorting process. If the garbage type is metal, the inductive proximity sensor will detect it, and the first arm will push it into the metal bin, but if it is organic the soil moisture sensor will detect it and the second arm will push it into the organic bin, the same of the previous process if it is paper the capacitive proximity sensor will detect it and the third arm will push it into the paper bin, otherwise this type will be plastic and it will come toward to plastic bin as shown in figure 2.

3) The Baskets

The filling level of each basket is tracked by the ultrasonic sensor, and this appears on the LCD screen. When any basket is filled, an alert message is sent through the application. There is also a weight sensor in each basket to measure the weight of the garbage in order to be sold through the application.

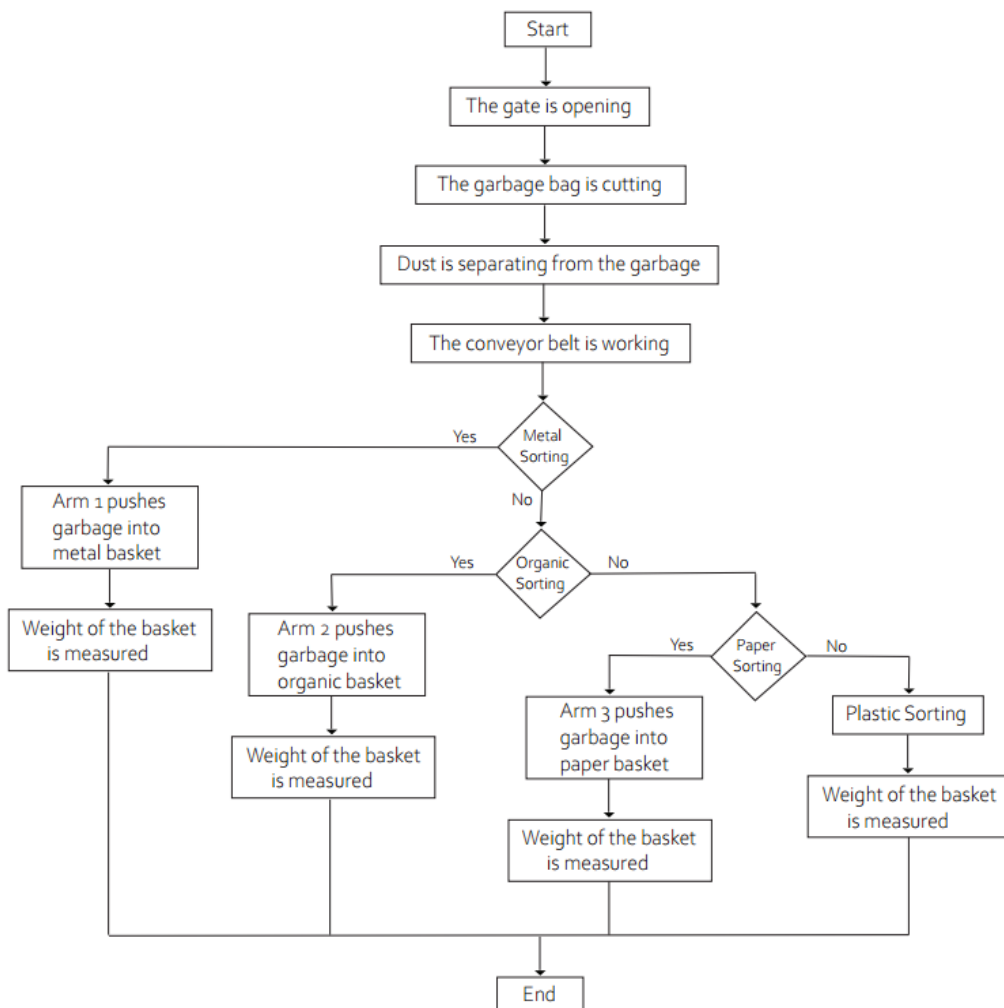


Figure 1: The Flowchart of the Proposed System

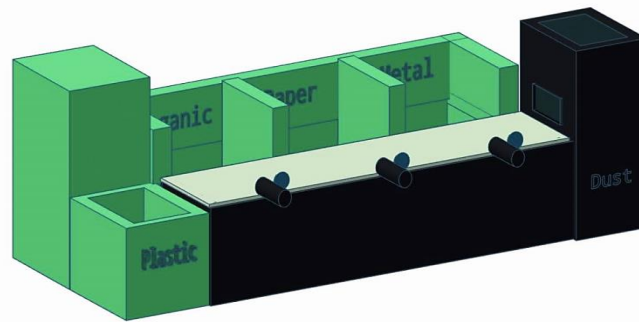


Figure 2: The Design of the Conveyor Belt

### 3.1 Hardware Implementation

#### 3.1.1 Sorting Sensors

The circuit diagram of the system is shown in figure 3. From this figure, we found the components of the system are Arduino Mega, Ultrasonic Sensor, Inductive Proximity Sensor, Soil Moisture Sensor, and Capacitive Proximity Sensor. The following subsections show the uses of these components.

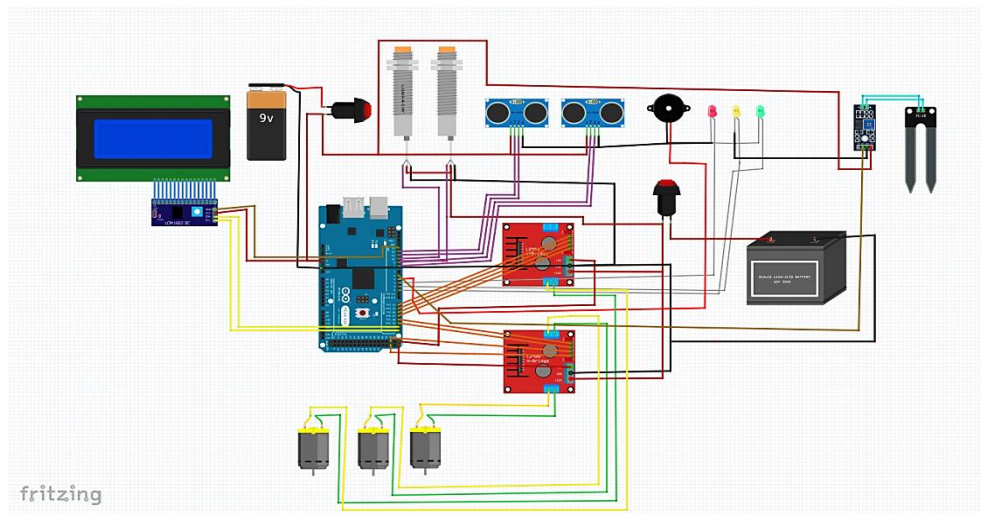


Figure 3: The Circuit Diagram of the System

- Ultrasonic Sensor

At the rim of the basket's uppermost rim is the HC-SR04 ultrasonic sensor shown in figure 4. The waste can's fill level can be detected and shown on the LCD panel. After crashing into an obstruction, it shoots a high-frequency sound wave and waits for the tide to return. The wave propagation time is used as a proxy for distance. The ultrasonic sensor reports whether or not the garbage can is entire via a radio signal to the control unit. When it reaches or exceeds a concentration of 100%, for this reason, the red light and alarm will activate, and the system will cease functioning.

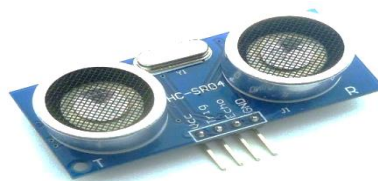


Figure 4: Ultrasonic Sensor

- Inductive Proximity Sensor

A proximity sensor can be utilized to determine whether a metal object is close by without physically touching it. This makes it possible to detect the presence of things in the surrounding space. The PNP and NO outputs of the LJ12A3-4-Z/BX sensor are accessible via the device's three pins (Normal Open) as shown in figure 5. In other words, it is Low in the absence of an object and gets HIGH once one is detected. Detection at 4 mm is limited to metals like copper, aluminum, iron, etc.



Figure 5: Inductive Proximity Sensor

- Soil Moisture Sensor

We have used a soil moisture sensor to determine the moisture content of the waste material (organic). The volumetric water content of the soil is determined using the soil moisture sensor shown in figure 6. It measures the dielectric permittivity of the surrounding medium using the capacitance principle. The water content in this scenario affects the dielectric permittivity. The sensor generates a voltage proportional to the soil moisture content and the soil's dielectric permittivity. In comparison to dry waste, a wet waste material will contain more water. Therefore, wet waste material will have a higher dielectric constant than dry waste material [7]. The amount of water in the trash is determined by its resistance to the current, which is carried through the electrodes and through the waste. More water means less resistance, which allows more current to flow through the material. The sensor module, on the other hand, produces a significant level of resistance when the water content is low [8]. Wet waste and dry waste are separated using this idea.

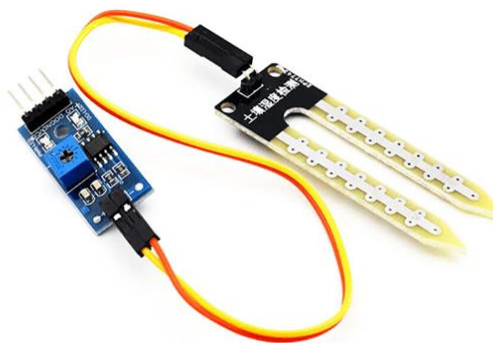


Figure 6: Soil Moisture Sensor

- Capacitive Proximity Sensor

Objects nearby can be detected using "Proximity Sensors." in contrast to inductive proximity sensors, capacitive sensors generate an electric field, allowing them to see metallic and nonmetallic objects. As in figure 7, there are three terminals on the LJC18A3-B-Z / BX sensor, with NPN and NO on the output pin (Normal Open). In other words, it starts off High and goes Low when it senses something. The sensor has an 8 mm range and can pick up on metal and non-metal things like ceramic, plastic, paper, etc. However, we limited its functionality to identifying paper.



Figure 7: Capacitive Proximity Sensor

### 3.1.2 Safety Sensors

The circuit diagram of the safety system is shown in figure 8. From this figure, we found the components of the system are Arduino Mega, Gas Monitor, Temperature and Humidity, and RFID. The following subsections show the uses of these components.

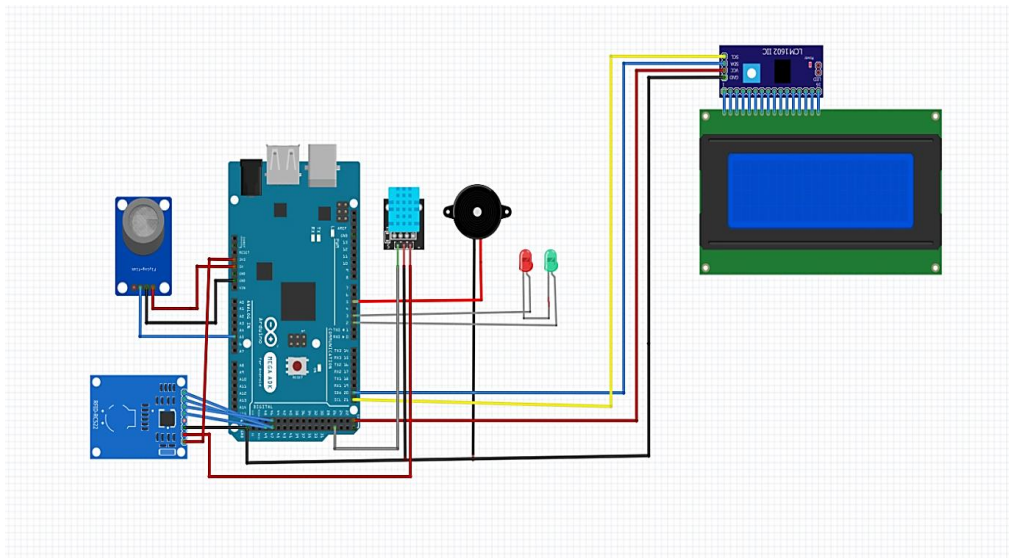


Figure 8: The Safety system circuit diagram

- Gas Monitor (MQ-2)

Dangerous gases are a significant issue today. All typical levels of these gases need to be tracked so that any deviation necessitates immediate action for public safety. The problem is that the systems we have now aren't efficient; they're also expensive and complicated to implement. Since a gas sensor is utilized in the system to detect toxic gas leakage, the risks that negatively impact electrical components are disregarded. The MQ2 gas sensor is an electronic detector for airborne gases such as LPG, propane, methane, hydrogen, alcohol, smoke, and carbon monoxide shown in figure 9. It can identify potentially dangerous or flammable gases or smoke when the level rises above 600 parts per million. For this reason, the red light and alarm will activate, and the system will cease functioning.



Figure 9: Gas sensor MQ2

- Temperature and Humidity (DHT-11)

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor shown in figure 10. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use, but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds; the sensor readings can be up to 2 seconds old. A DHT11 sensor detects the temperature and humidity become high inside the bin or not. If it the temperature becomes more than 30 °C. So, the red led and buzzer are turned on, also the system stop work.

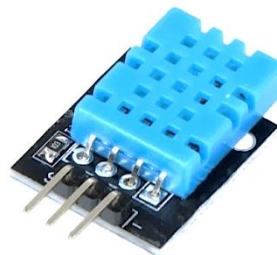


Figure 10: DHT11

- RFID (RC522)

RFID, or radio frequency identification, systems have two essential parts: the tag, which is affixed to the object, and the reader, which scans the tag. The electromagnetic field produced by a reader's antenna and radio frequency module is extremely high frequency. While tags are typically non-interactive (it does not have a battery). An antenna for receiving and sending signals, plus a microprocessor for storing and processing data. Bringing the tag close to the reader causes the reader to produce an electromagnetic field, which the tag may detect. This activates the tag by driving electrons via its antenna. The chip then gives a radio signal back to the reader, including the data provided. There has been what is known as backscatter. This backscatter is picked up by the reader, processed, and transmitted to a host device [9]. In this project we used (RC522) RFID sensor which shown in figure 11. We use it by the maintenance workers to allow them to get into the system and fix it when there is a problem.



Figure 11: RFID

#### 4. Software Application

Nowadays, smartphone applications have become a very important part of technology in recent years. They are defined as applications or software applications that are installed on mobile devices or tablet devices with a specific function. In the early days of the smartphone era, developers were restricted to creating specific or native apps for specific devices and operating systems and any platforms using java and kotlin for Android or swift for IOS. Our proposed software was implemented using android studio. The proposed mobile application presents a new application that allows officials, users and companies to monitor basket weight and available prices for recycled materials in the market at anytime and anywhere through a communication protocol that enables data exchange. It also allows companies to communicate with the owners of the basket in order to purchase the number of recyclable materials in the basket, and this is in the interest of the user, as each weight that the user puts in the basket gets a percentage of it in currencies that he can benefit from at another time. The flowchart of software applications shown in figure 12. The splash of the mobile application is shown in figure 13, while the login screen is shown in figure 14. The profile screen shown in figure 15, and the proposed RIG application is shown in figure 16.

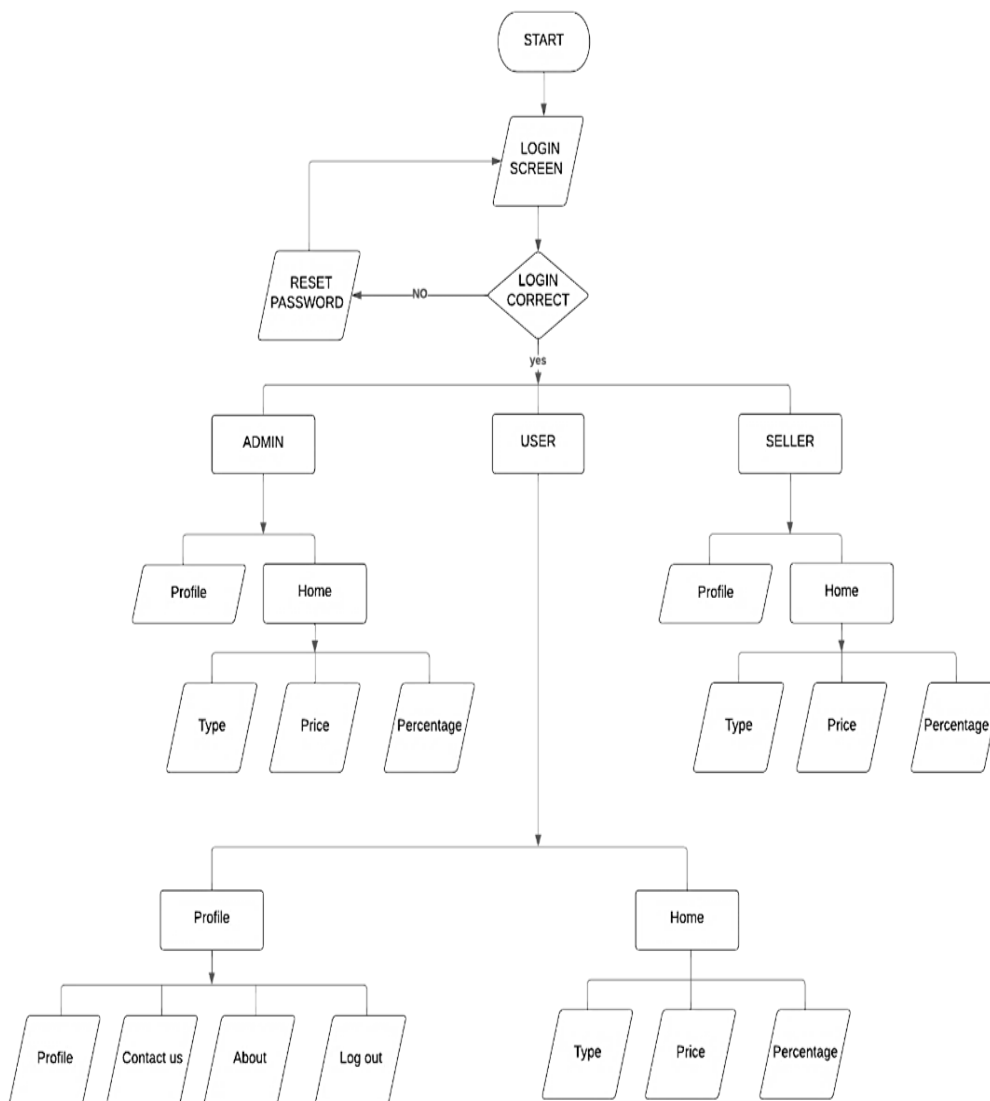


Figure 12: The Flowchart of the Software Application



Figure 13: Splash Screen

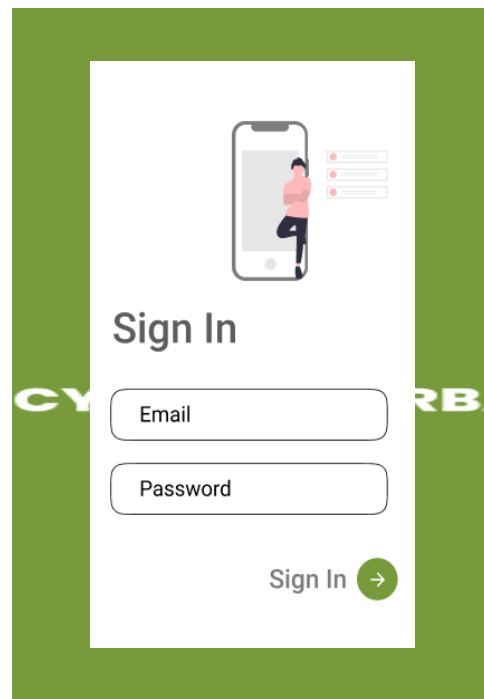


Figure 14: Login Screen



Figure 15: Profile Screen



Figure 16: The purposed RIG application

## 5. Conclusion

The Smart Garbage Monitoring System using IoT is a great way to reduce waste and increase efficiency in the waste management process. It can help reduce the amount of time and resources needed to sort, monitor, and dispose of garbage also it facilitates recycling process. It can also help reduce the environmental impact of waste by reducing the amount of materials that end up. With this system, garbage can be monitored more closely and sorted more efficiently, leading to a cleaner environment for everyone.

## 6. Future Work

One limitation that can be overcome is the dustbin's immobility by incorporating a bot mechanism and garbage-picking mechanical arms. Another important limitation is the need for a camera to record and process photographs to help further assist in waste classification. We really hope that upcoming contenders will be able to address these issues in their thoughts. The suggested paper just represents the beginning of using IoT for garbage management. Future modifications to this framework could result in something that helps keep the environment clean, healthy and a better place to live. A few potential improvements include: The current study examines how AI and robotics can be used to turn a stationary trashcan into a moving trash-bot. This garbage can also include GPS trackers for a particular area, allowing them to be easily identified.

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