



PROJECT REQUIREMENTS SPECIFICATION

Smart Waste Segregation

UE17CS490A – Capstone Project Phase – 1

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1. Introduction

This section contains the details of the project such as its scope, features, functional requirements, hardware requirements, and software requirements. It also discusses the assumptions made regarding the project and the risks that could evolve in the course of the completion of the project.

1.1. Project Scope

Purpose: One of the major problems faced today is the improper and inefficient disposal of waste produced, which has adverse effects on the environment. The economic value of waste is realized only when it is segregated. The consequences of traditional practice cause health hazards, environmental pollution, and the loss of precious resources that can be recycled. Therefore, we aim to build a cost-effective and easy-to-use solution that can handle the entire segregation process automatically.

Benefits: Automating the process of waste segregation is helpful in many ways such as:

- 1) It reduces environmental pollution caused by the improper disposal of mixed waste.
- 2) It reduces the amount of manpower required since the waste segregation happens automatically, which was traditionally done manually by the laborers.
- 3) It reduces the hazards on the health of workers who manually segregate the waste by automating it.
- 4) Since the waste is segregated into different categories at the source, we can directly send the segregated waste into a recycling plant rather than first sending it to a segregation plant, which in turn reduces the overall time.

Objectives: This project is aimed at building an automatic waste segregator, capable of separating the waste into different categories such as wet waste, glass, plastic waste, and metallic waste.

Limitations: This system works efficiently when one waste at a time is given to it rather than dumping the mixed waste all at once. Another possible limitation is the fact that the system may not work as desired if the waste is mixed with different types.

2. Product Perspective

The automatic waste segregator aims to segregate the waste into different categories such as wet waste, glass, plastic waste, and metallic waste.

2.1. Product Features

The proposed system consists of a conveyor belt system and a combination of various types of sensors to achieve the aforementioned objective. The main purpose of using the conveyor belt system is to help in the movement of the waste from the source to their respective bins after being segregated. The sensors are used to detect and classify the incoming waste into different categories.

2.2. User Classes and Characteristics

The main user of this product could be anyone who wishes to segregate their waste automatically under the condition that one material is given at a time. Various types of users could be household users, industrial users, and city municipal corporations.

2.3. Operating Environment

The entire system is planned to be operational on the Arduino platform which is compatible to be configured using almost all the operating systems such as Windows, Linux, macOS, and many more.

The Arduino used Arduino IDE for writing the programs to control its operation and the programs are written in supported languages such as C and C++.

2.4. General Constraints, Assumptions, and Dependencies

Constraints: Garbage mixed and given for separation may not be classified into the correct category. For example, a plastic material dipped in water may not be classified as plastics due to the limitations of the hardware such as sensors used.

Assumptions: We need to place the garbage one by one for separation rather than dumping it all at once.

Dependencies: The dependency type of this system is Finish-to -Start that is the first task has to be completed before the second task can start. In our system, the separation of dry waste from wet waste needs to be completed first before further classification of dry waste into different categories. Likewise, the non-metallic waste

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needs to be segregated first from metallic waste before further classification of non-metals into plastic or glass.

2.5. Risks

This system works only when one waste at a time is given to it rather than dumping the mixed waste all at once. There could be some unforeseen failures in the hardware that could pose a problem during its final delivery.

3. Functional Requirements

The major functional requirements that are to be satisfied are as follows:

- The system should start working as soon as the waste material is placed on the conveyor belt. If this is not the case then the system should be in a stationary state to reduce the system power consumption.
- The system should first detect the wet waste placed on the belt with the help of a moisture detection sensor. If any materials are detected as wet waste, then it should be discarded into the respective bin.
- After the wet waste is segregated, the next type of waste detected should be metal waste. This is achieved through the usage of a metal detection sensor.
- Later the leftover waste should be classified into two categories namely, plastic and glass. This is achieved using a capacitive sensor.

Input to our system is waste that is unclassified given one by one and the output of the system is that the waste should be classified and discarded in the correct bin.

4. External Interface Requirements

4.1. User Interfaces

The only interface the user interacts with is the conveyor belt. The user is needed to place the garbage on the belt and then all the other interactions are abstracted from the user which is done automatically. Then after segregation, the waste bins will need to be cleared off which is a manual process.

4.2. Hardware Requirements

- 1) Arduino: This is the main microcontroller that is responsible for controlling the operation of the entire system.
- 2) DC motors: These motors act as a driver for the conveyor belt.
- 3) Belt: This is the main component of the conveyor system on which the waste to be segregated is placed.
- 4) Inductive proximity sensor: This sensor is used to detect any metallic objects that are present in its proximity.
- 5) Capacitive proximity sensor: This sensor is used for classifying the waste into glass or plastic based on the concept of dielectric constant.
- 6) Moisture detection sensor: The purpose of using this sensor is to segregate the waste into either dry or wet categories.
- 7) Servo motors: This motor is used to push the waste into its respective bin off from the belt.

4.3. Software Requirements

The main software required for our project includes:

Arduino Integrated Development Environment:

- Name: Arduino IDE
- Description: This is an open-source software tool that facilitates the easy writing of the code which helps in faster development. This software tool also allows us to upload the written code into the Arduino board.
- Operating systems: This software is compatible with Windows, Mac OS X, and Linux.
- Source: The software can be downloaded from the official site which is <https://www.arduino.cc/en/software>

C programming language:

- Name: C language
- Description: This is a general-purpose, procedural programming knowledge that can be used for various purposes.
- Operating systems: This software is compatible with Windows, Mac OS X, and Linux.
- Source: The software can be downloaded from the official site which is <https://www.cprogramming.com/>

5. Non-Functional Requirements

5.1. Performance Requirement

The system works efficiently when the waste is placed on the conveyor belt one by one rather than dumping it all together. The system may fail to segregate if the mixed waste is placed on the belt.

5.2. Usability

The system should be easy to use. This is achieved by automating the entire system where the user will just place the garbage and all other things are taken care of by the system itself.

5.3. Power Consumption

The system should consume only a limited amount of power. This is achieved by starting the major portion of the system only when the garbage is near the system.