

SYNOPSIS OF PROJECT REPORT

Project ID : NSF-SCH-2025-15

Project Title : **CLEAN FUTURE WITH SMART WASTE**
SEGREGATION SYSTEM USING AI

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“CLEAN FUTURE WITH SMART WASTE SEGREGATION
SYSTEM USING AI”

- SHEIK FAREETH AZEEM. K.U

Abstract:

- Managing waste is one of the biggest challenges in today’s world. Most of the time, waste is not properly separated into biodegradable, recyclable, and non-recyclable categories, which makes recycling difficult and increases pollution.
- This project focuses on creating an **AI-based waste segregation system** that can automatically identify and sort different types of waste. The system will use sensors and a camera with artificial intelligence (AI) to recognize whether an item is plastic, paper, metal, or organic waste.
- The research aims to show how AI can be applied in everyday life to solve environmental problems
- This research explores the potential of smart waste segregation systems to create a cleaner, more sustainable future.
- The goal is to raise awareness and encourage adoption of smart segregation to reduce pollution and improve recycling efficiency.

Introduction:

- An AI-based waste segregation system uses sensors and machine learning to automatically classify waste into biodegradable, recyclable, and non-recyclable categories. This smart method reduces human effort, improves accuracy, and supports a cleaner, greener environment.
- Waste management is a growing global concern. Improper segregation leads to pollution, health hazards, and loss of recyclable materials. A smart waste segregation system uses sensors and automation to sort waste efficiently, reducing human error and promoting sustainability.

a. SELECTION OF PROBLEM AND BACKGROUND INFORMATION:

Improper waste segregation reduces recycling efficiency and increases pollution. Can a simple, low-cost AI system automatically sort common household waste (plastic, paper and metal, organic) more accurately and faster than manual sorting?

- Manual sorting is slow and error-prone.
- AI (computer vision + simple sensors) can recognize material types from images and signals.
- A small prototype can demonstrate how cities could scale this.

b. Research Question:

“Can Artificial Intelligence help segregate waste more efficiently than traditional methods?”

c. Hypothesis:

“If we train a simple AI model on photos of common waste items, then the system will classify new items with at least **80% accuracy**, faster than a human doing manual sorting.”

Literature Review:

- Arduino-based systems sort waste using IR sensors and weight detection.
- Waste Wise project uses affordable electronics to classify waste into four categories.
- AI-based models use image recognition to identify biodegradable and non-biodegradable waste.

Objective:

- To develop an AI-powered system that can automatically identify and segregate different types of waste (e.g., plastic, organic, metal, paper) using computer vision and machine learning.
- Understand current waste segregation practices in schools.
- Explore smart technologies used in waste management.
- Design a prototype for a smart segregation system.
- Promote awareness and behavioural change among students.

Waste Management in Our School

- Waste bins are not labeled.
- Students often mix food waste with plastic.
- No recycling program is in place.
- Teachers and staff are unaware of proper segregation methods.

Methodology:

- Conducted surveys with 50 students and 10 staff.
- Observed waste disposal patterns for one week.
- Designed a basic smart bin prototype using Arduino and sensors.

Materials (Budget-Friendly):

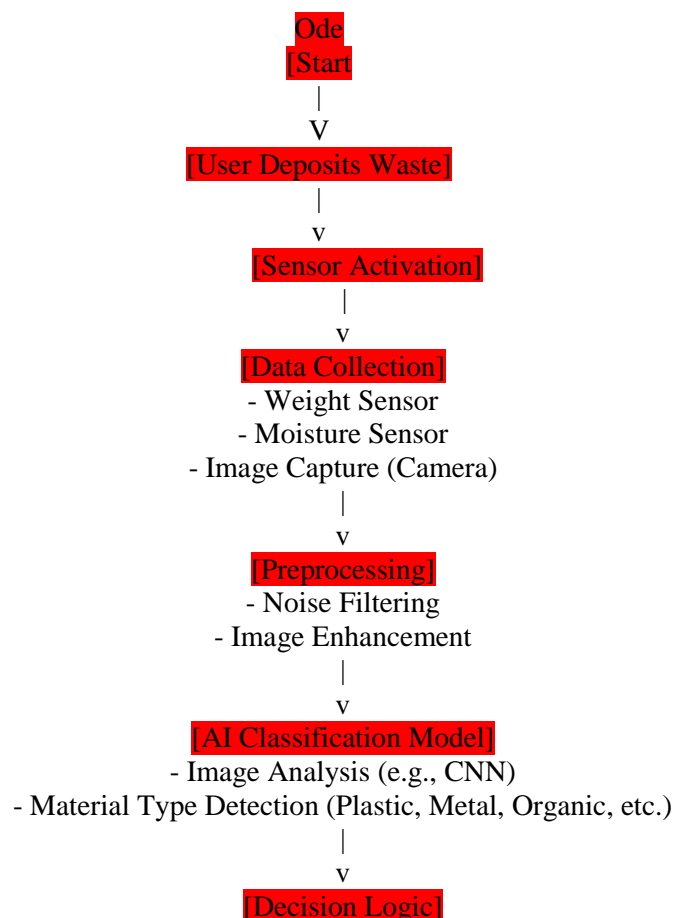
- Raspberry Pi/Arduino (**optional**); a laptop also works.
- USB camera / phone camera.
- Cardboard box for a mini sorting station, 3–4 labeled bins.
- Simple sensors (optional): IR proximity sensor, weight sensor (load cell) for extra features.
- LED/buzzer for feedback.
- Gloves, tongs (safety + hygiene).
- Household waste samples (cleaned): plastic bottles/caps, paper/cardboard, metal cans/foil, fruit/ veg peels (fresh sample on test day).

Smart Waste Segregation System:

- System Components:
- IR sensor to detect object type.
- Weight sensor to measure mass.
- Servo motor to direct waste to correct bin.
- LCD display for feedback.

FLOWCHART:

Include a flowchart showing how waste moves through the system.



- If Organic → Route to Organic Bin
- If Recyclable → Route to Recyclable Bin
- If Hazardous → Route to Hazardous Bin

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[Servo Motor Activation]

- Opens Correct Bin Compartment

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v

[Waste Sorted]

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v

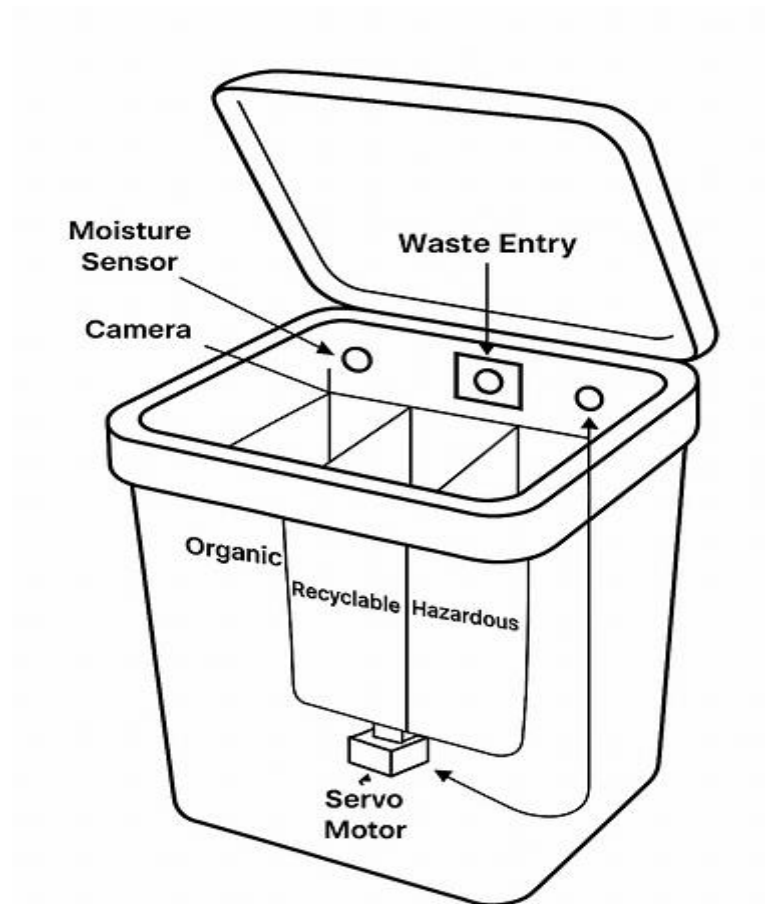
[Data Logging]

- Timestamp
- Waste Type
- Sensor Readings

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[End]

AI-based models use image recognition to identify wastage:



System Components:

- IR sensor to detect object type.
- Weight sensor to measure mass.
- Servo motor to direct waste to correct bin.
- LCD display for feedback.

Technology Used:

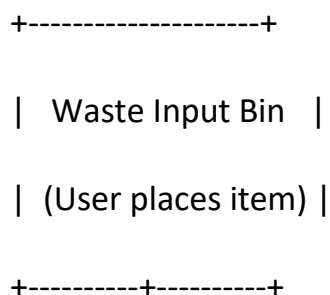
- Arduino Uno: Microcontroller for processing sensor data.
- IR Sensor: Detects material type (plastic, metal, organic).
- Weight Sensor: Helps distinguish between light and heavy waste.
- Servo Motor: Moves flap to direct waste.
- LCD Display: Shows bin status.

d. Procedure (step-by-step):

1. **Choose categories:** Start with 3 classes (plastic, paper, wet food) to keep it simple; you can add more later.
2. **Collect images:** Take 50–100 photos per class of common items (e.g., water bottle, newspaper, and banana peel). Use different angles, backgrounds, and lighting. Keep camera distance similar (about 20–30 cm).

3. **Label images:** Put images into folders named after the class (or use the labeling interface in Teachable Machine).
4. **Train model:**
 - **No-code option (recommended for Grade 7):** Upload images to Google Teachable Machine, train a simple image classifier there (it runs in the browser).
 - **Code option (with teacher help):** Use a small TensorFlow/Keras notebook and train a model (transfer learning from MobileNet) for faster, better results.
5. **Export model:** From Teachable Machine you can export a simple model for local use, or use the web demo. If using Raspberry Pi/phone, export a TensorFlow Lite model for deployment.
6. **Build the prototype:** Connect the camera to the computer/Arduino/Raspberry Pi or just run the model on a laptop. Set up a testing station: a camera points to a small table where the student places an item, the model predicts and lights up the correct bin or displays the label on screen.
7. **Testing:** Run trials with items not used in training. For each item record predicted class and actual class. Do at least 30–50 test trials.
8. **Record data:** Use a table: Trial #, Item, Actual class, Predicted class, Correct? (Y/N), Notes (lighting, confusion)

AI-Based Waste Segregation System – Block Diagram:



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| Camera / Sensor |

| (Image Capturing) |

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| AI Model / Image |

| Classifier (CNN) |

| (Detects: Organic, |

| Recyclable, etc.) |

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| Microcontroller / |

| Embedded Processor |

| (Arduino/RPi/etc.) |

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| Servo Motor / |

| Conveyor Mechanism |

+-----+-----+

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AI WASTE SEGREGATION DASHBOARD

Total Items 4202

● Biodegradable 1823

Biodegradable

1823

Recyclable

1679

Hazardous

700

Waste Classification



Prediction:
Biodegradable

Fill Levels



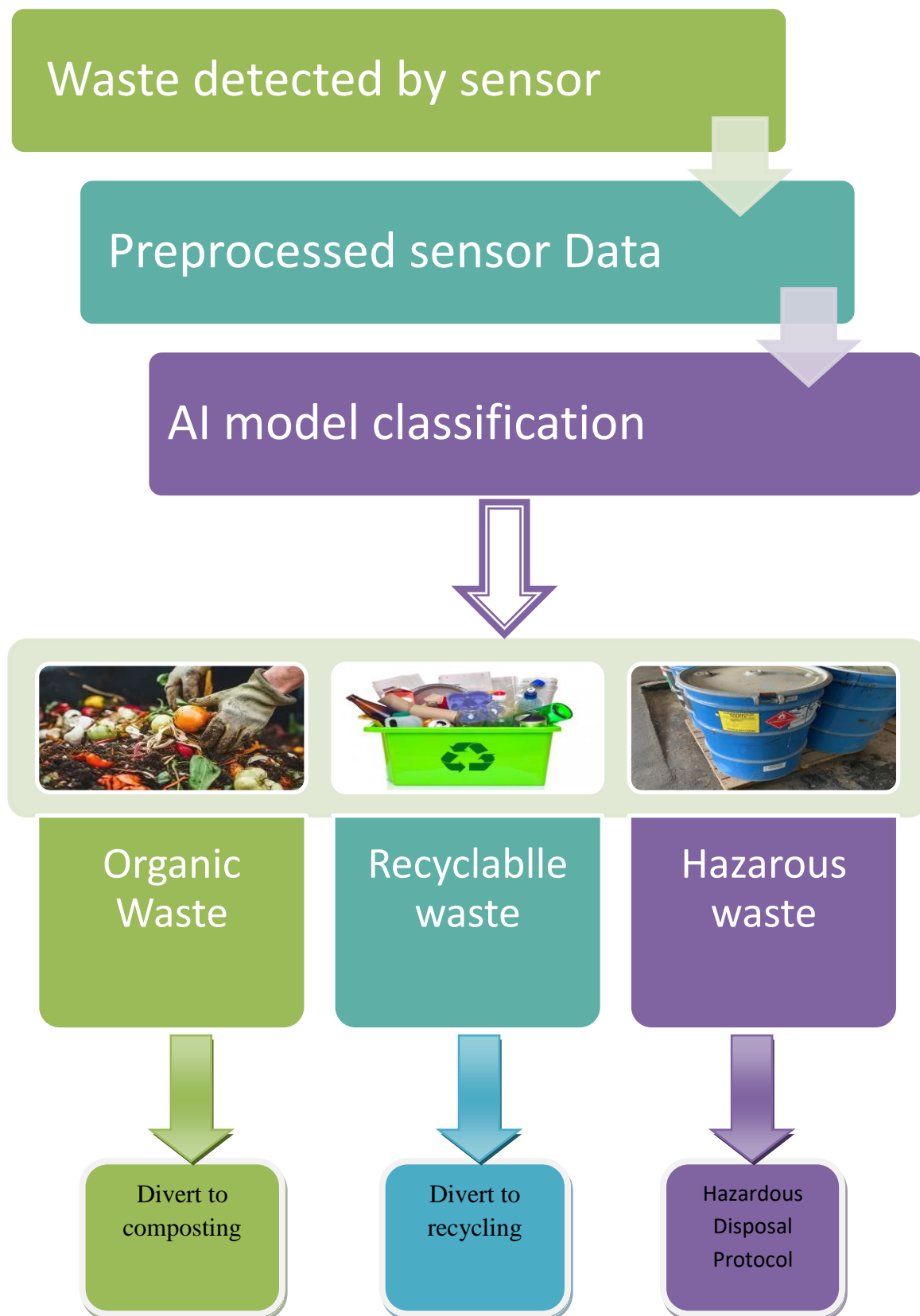
● Biodegradable ● Fill

Analytics Overview



● Biodegradable ● Haz

Flow chart for waste segregation process:



Bin Fill Levels:

Waste Type	Fill Level	Status
Biodegradable	80%	Near Full
Recyclable	45%	Moderate
Hazardous	25%	Low

e. Data Table:

Type of Waste	Number of Items Tested	Correctly Classified by AI	Incorrectly Classified by AI	Accuracy (%)
Biodegradable	20	18	2	90%
Recyclable	20	19	1	95%
Non-Recyclable	20	17	3	85%
Total	60	54	6	90%

Evaluation & Calculations:

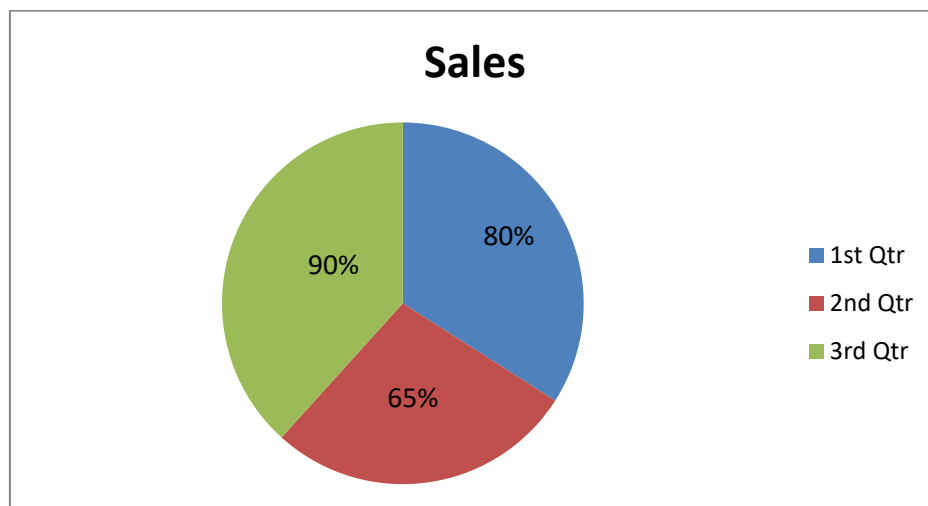
- **Accuracy (%)** = (Correct predictions ÷ Total items) × 100
- **Average Time (s)** = Sum of times ÷ Total items
- **Error Patterns:** Note common confusions (e.g., metal foil vs. plastic wrap).

Survey Results:

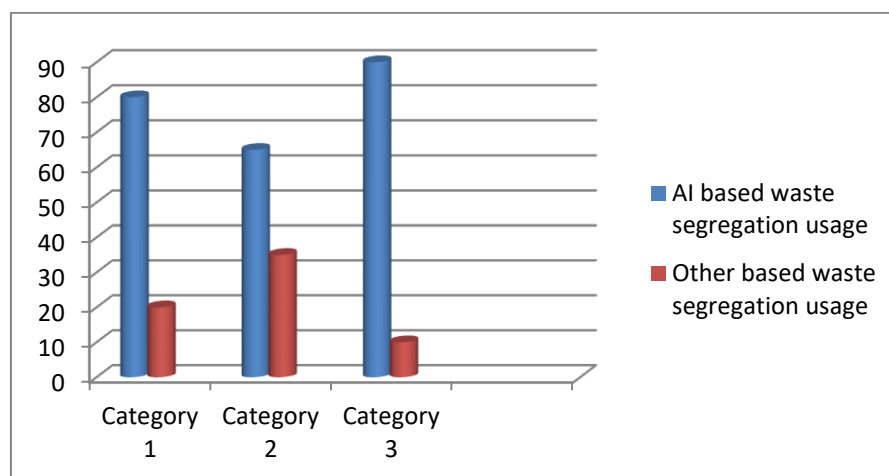
Key Findings:

- 80% of students don't know how to segregate waste.
- 65% are willing to use smart bins.
- 90% agree that waste segregation is important.

Pie chart:



Bar chart:



Constraint Function:

It describes what conditions must be met for the AI waste segregation system to function properly.

Benefits of Smart Segregation:

- Reduces landfill waste.
- Improves recycling rates.
- Promotes environmental awareness.
- Saves time and labour.

Challenges and Limitations:

- Cost of sensors and microcontrollers.
- Maintenance and calibration.
- User behavior and misuse.
- Limited sorting categories (e.g., cannot detect hazardous waste).

Implementation Plan:

Step-by-Step Rollout:

- Educate students via workshops.
- Install labeled bins and posters.
- Deploy smart bin prototype in cafeteria.
- Monitor usage and collect feedback.
- Expand to other areas of school

f. Safety & Hygiene:

- Use **clean/dry** waste samples.
- Wear gloves; wash hands after handling.
- Keep electronics away from wet organic waste.

Future Scope:

- Integrate AI for better classification.
- Connect bins to mobile apps for tracking.
- Expand to community centres and public spaces.
- Collaborate with municipal waste departments.

Future Expectations:

- AI prototype achieves **≥80% accuracy** and faster average sorting time than manual sorting.
- Second training round improves accuracy by **5–10%** on confusing items.

Conclusion:

Smart waste segregation systems offer a promising solution to our waste crisis. By combining technology with education, schools can lead the way in creating cleaner, greener communities. This project demonstrates that even small steps can make a big impact.

g. BIBLIOGRAPHY:

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