EcoSort AI

AI-Powered Waste Classification & Automation

Overview

01 - Problem Statement

- Current recycling systems are inefficient and often rely on manual sorting.
- Misclassification leads to contamination and reduces the value of recyclables.
- Labor costs and human error are high in waste management.

The problem

Waste Generation in Egypt

- Egypt produces approximately 100 million tons of waste annually, constituting a significant portion of municipal waste.
- Urban areas achieve waste collection rates up to 85%, while rural regions lag at 35%.

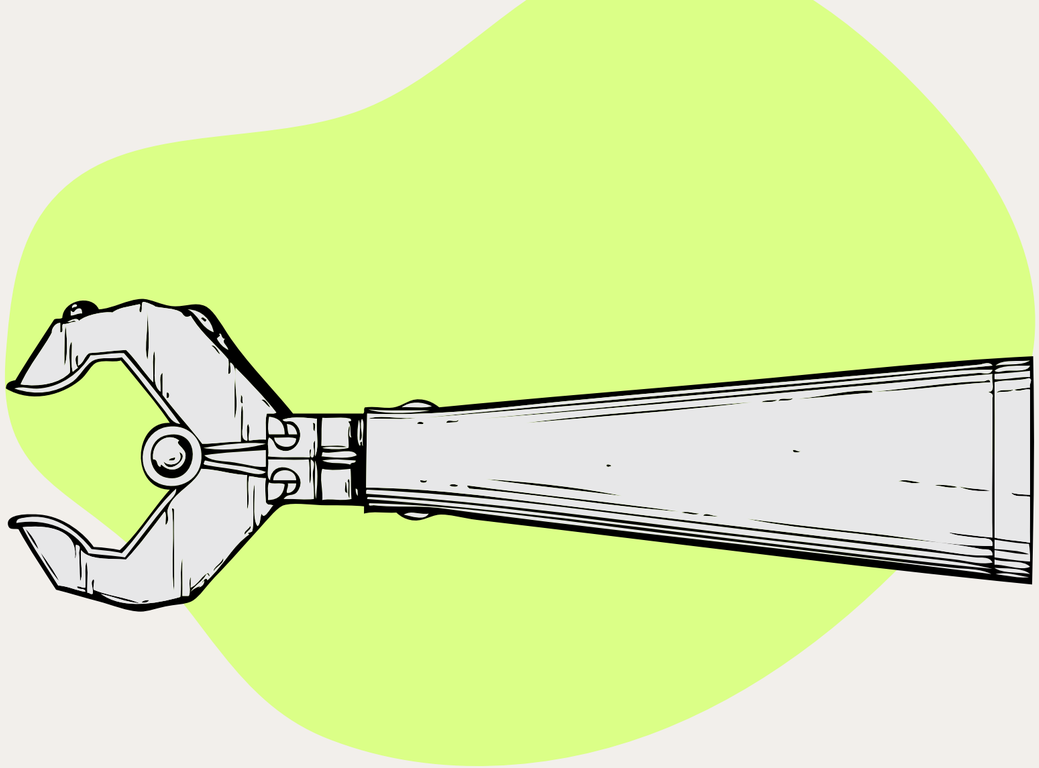
Waste Disposal Challenges

- An estimated 80-88% of municipal waste ends up in open dumpsites.
- Only about 7% is directed to sanitary landfills.

Environmental Impact

- Inefficient waste management contributes to pollution, health hazards, and loss of recyclable materials.

02 - Our Solution

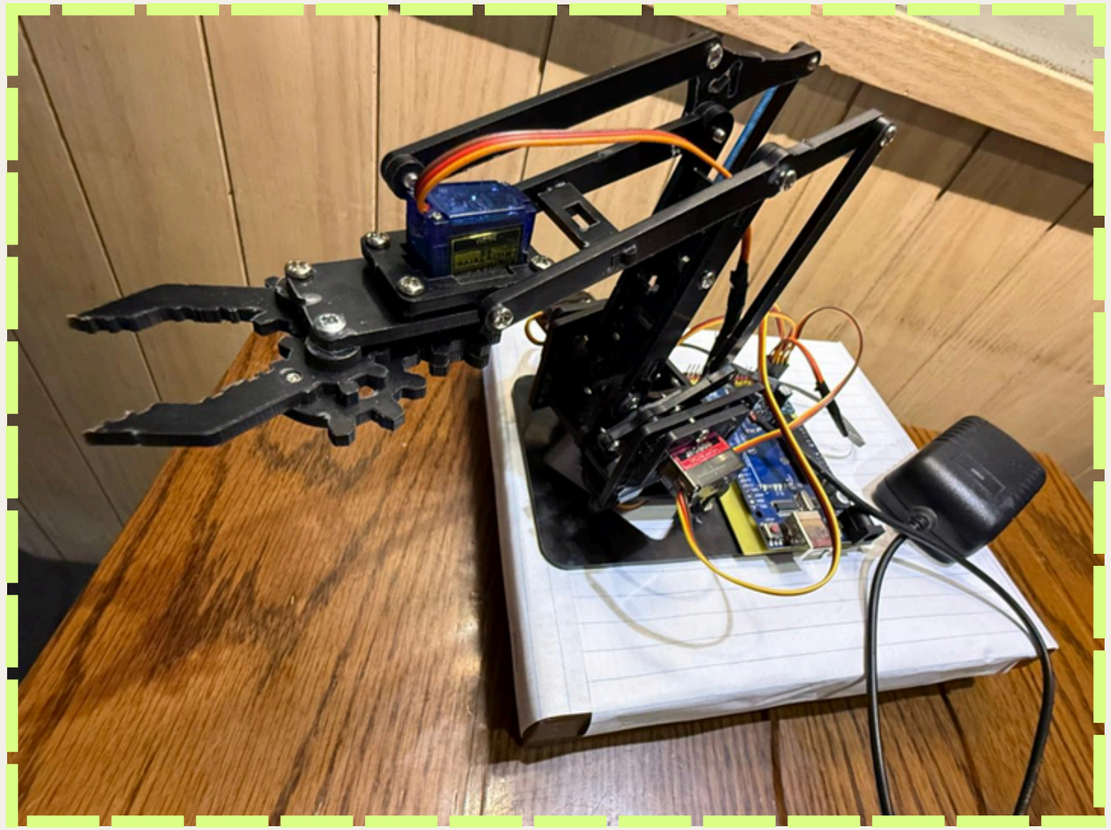


Smart Recycling Bin

- Utilizes AI-powered image classification to identify and sort waste into categories: paper, glass, metal, and trash.
- Integrates with a microcontroller to physically direct waste to the appropriate compartment.

Benefits

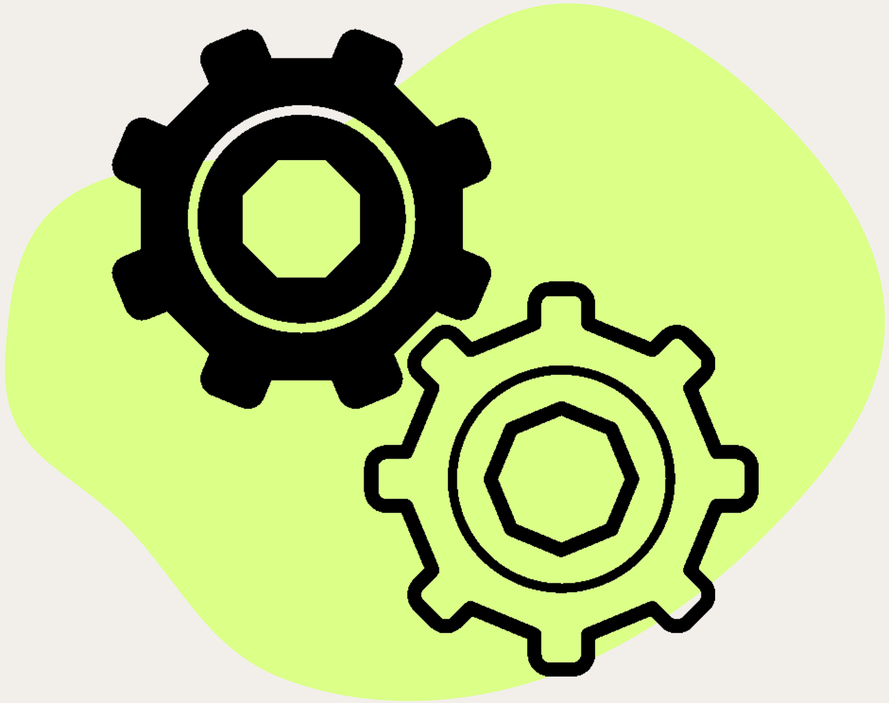
- Enhances recycling efficiency.
- Reduces human error in waste sorting.
- Provides environmental sustainability.



03 - Components Used

Components	Quantity	Internal components	Limitation
180° Micro Servo Motor	4	**DC Motor**: Provides rotational force. **Gearbox**: Reduces speed and increases torque. **Potentiometer**: Measures the current angle (feedback).	**Torque**: ~1.2–2.5 k **Speed**: ~0.1–0.2 sec/60° (faster with higher voltage). **Voltage**: Typically, **4.8V–6V** (do not exceed 6V!).
Arduino uno	1	-Micro controller -I/O pins -Power 5v logic	-speed -good for small project only
Servo Motor Driver	1	**-PWM Generator** ➔Produces **50Hz (20ms) PWM signals** to control servo angles. ➔Adjusts pulse width (e.g., **1ms = 0°, 1.5ms = 90°, 2ms = 180°**). **-I2C Interface** ➔Communicates with Arduino (SDA/SCL pins). ➔Allows **multiple drivers** on the same bus (addressable). **-Output Channels** ➔Typically **16 channels** (PCA9685) for controlling multiple servos.	-High-torque servos -No feedback -I2C Speed 400KHz max

04- How it works



Waste detection

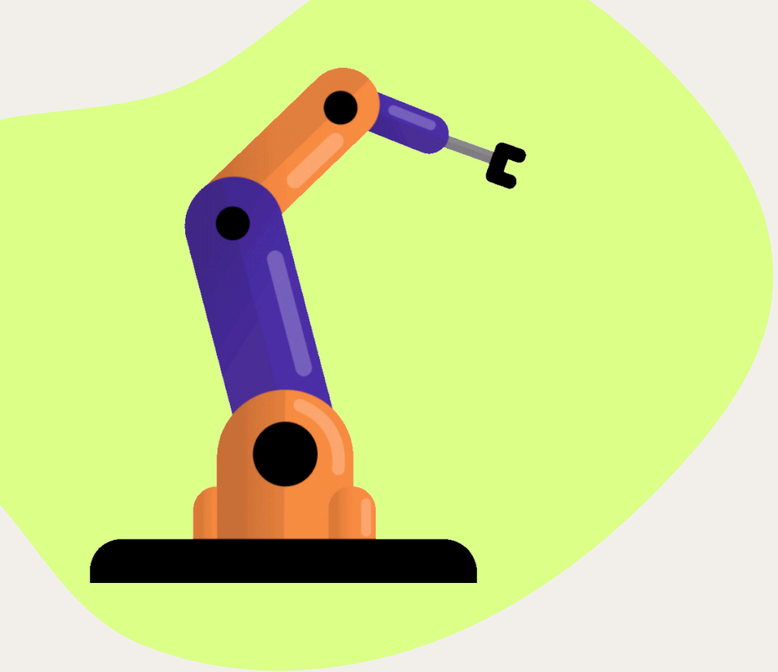
- The ultrasonic sensor will sense when an item is placed in front of it.
- The camera captures an image of the item.

AI Classification

- The AI model processes the image and classifies the waste type.

Mechanical Sorting

- The microcontroller receives the classification result and actuates the mechanism to direct the waste to the correct bin.



Servo Motor Functions

COMMAND	ACTION
moveArm	Moves shoulder + auto-adjusts elbow
moveBaseSmooth	Rotates base smoothly
setServoAngle	Opens gripper (90°) , close gripper (0°)

05- Key Features

Real-Time Processing

- Immediate classification and sorting of waste items.

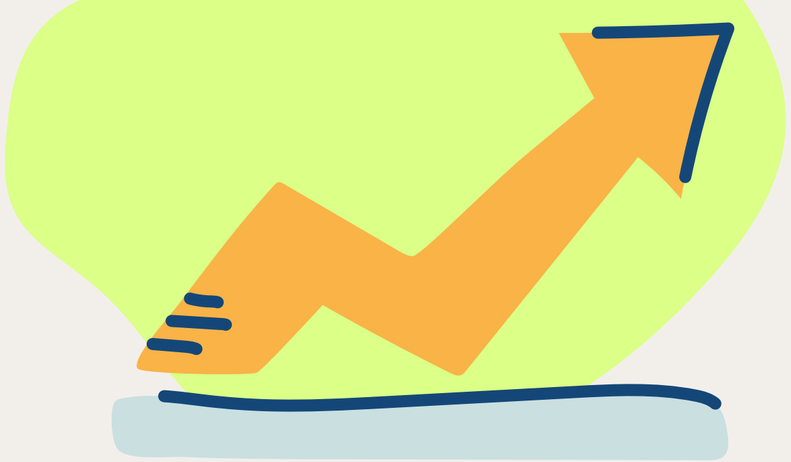
High Accuracy

- Achieved a validation accuracy of 91% during model training.

Scalability

- Design allows for easy scaling and integration into various settings.

06 - Target Market



Primary Markets

- Urban municipalities aiming to improve waste management.
- Educational institutions promoting environmental awareness.
- Corporate campuses seeking sustainable waste solutions.

Market Potential

- Egypt's plastic recycling market was valued at USD 380.25 million in 2024 and is expected to reach USD 473.96 million by 2030, indicating a growing demand for recycling solutions.

07- AI Development

Dataset

- Utilized the TrashNet dataset from Kaggle, comprising images of various waste categories.

Challenges Faced

- Data Imbalance: Certain classes, like paper and metal, were underrepresented.
- Overfitting: The model performed well on training data but poorly on unseen data due to low sample diversity.

Solutions Implemented

- Data Augmentation: Applied techniques like rotation, scaling, and flipping to increase dataset diversity.
- Regularization: Introduced dropout layers to prevent overfitting.

Two-Phase Training

Transfer Learning

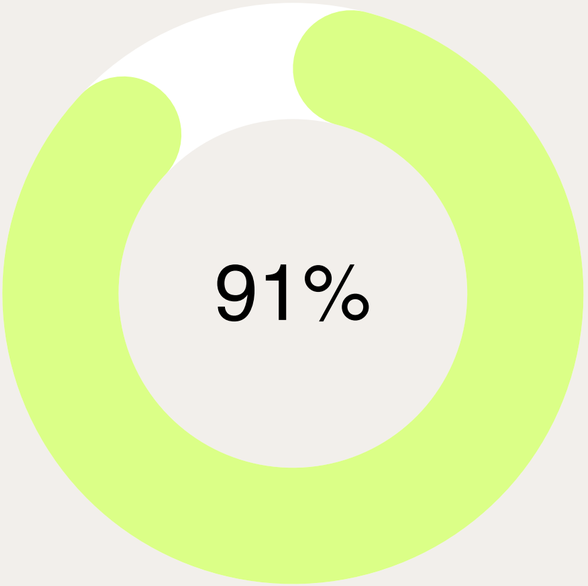
- Used a pretrained model (VGG16) to extract useful low-level features like edges, textures, and shapes
- Froze all convolutional layers and trained custom dense layers for classification
- Chosen for efficiency and robustness given our limited dataset

Fine-Tuning

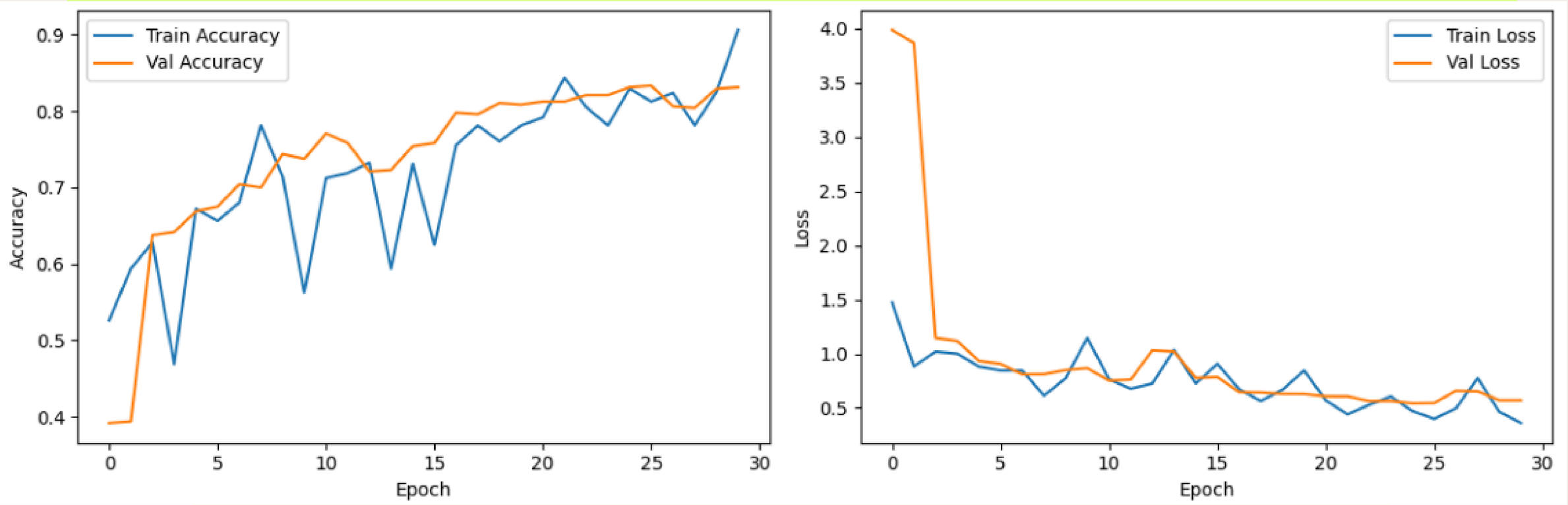
- Unfroze the last 4 layers of VGG16 to adapt the model to our dataset
- This improved our model's ability to distinguish similar materials and better adapt to real-world waste images.

Results

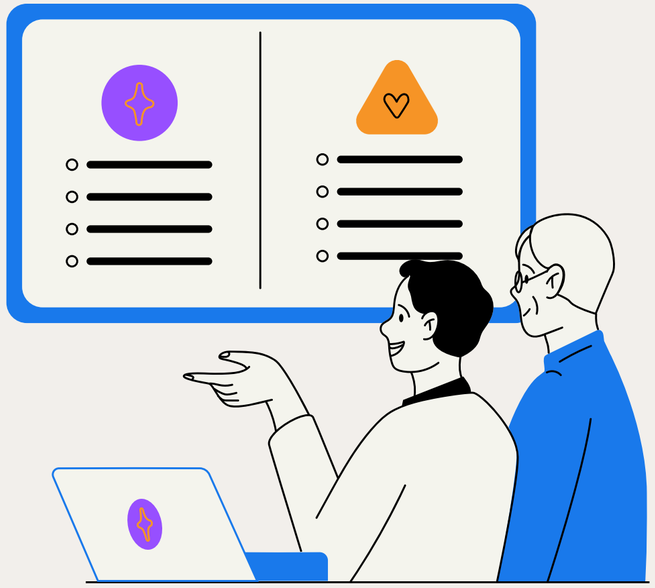
- Training accuracy: ~91%
- Validation accuracy: ~82%



Analysis


Train Accuracy
Val Accuracy
Accuracy
Epoch
0.4
0.5
0.6
0.7
0.8
0.9
0
5
10
15
20
25
30
Train Loss
Val Loss
Loss
Epoch
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0

09 - Competitive Advantage



Innovative Integration

- Combines AI with mechanical systems for automated waste sorting.

Cost-Effective

- Reduces the need for manual labor in waste management.

Environmental Impact

- Promotes recycling and reduces landfill usage.

Adaptability

- System can be adapted to recognize additional waste categories as needed.

Thanks