

Smart Waste Recycling Container



Team Number : 5 – Term 232

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Background

Under Vision 2030, Saudi Arabia targets enhanced waste management to increase recycling and reduce environmental impact. Our project introduces advanced technology for efficient sorting to meet these sustainability goals.

Problem Statement

Waste management in Saudi Arabia struggles with inefficient sorting, increasing recycling costs and pollution. Our project introduces a sophisticated sorting system with computer vision and sensors, accurately categorizing waste and featuring a reward system to boost user engagement and environmental awareness.

Constraints

Budget Constraints: Limited funding necessitates cost-effective solutions.

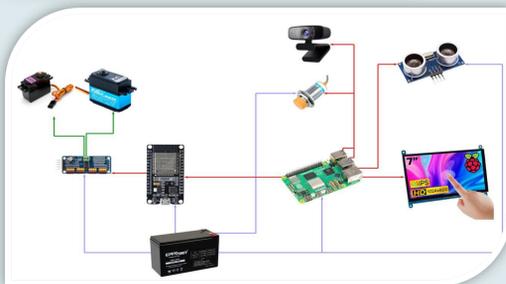
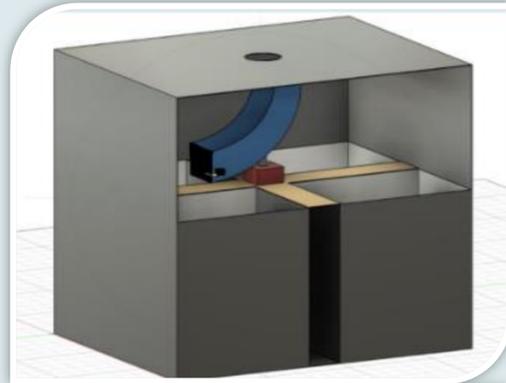
User Engagement: High participation through the credit system is critical for success.

Regulatory Compliance: Compliance with environmental regulations is mandatory.

System Uptime: High uptime with minimal downtime for maintenance is essential.

Local Coordination: Effective collaboration with local waste management services is required.

Prototype Design



Test / Validation

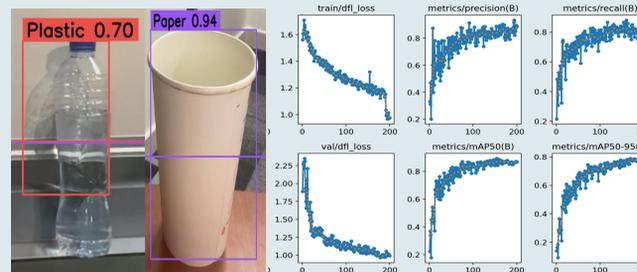
Proximity Capacitive Sensor

The proximity capacitance sensor measures item capacitance, with the microcontroller calculating dielectric constant. It sends a signal to the receiver via a voltage divider, capped at 3 volts.

$$\epsilon_r = \frac{C}{C_0} \quad C_0 = \frac{\epsilon_0 \cdot A}{d}$$

Computer Vision

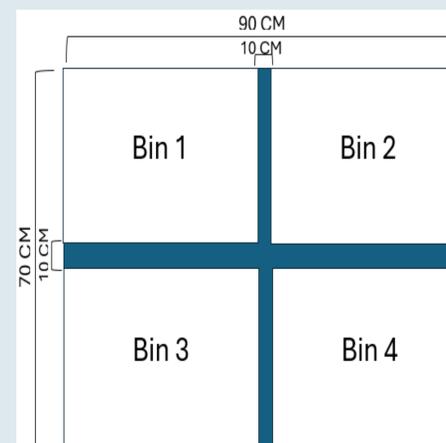
Our computer vision model is trained to distinguish plastic, paper, and general waste.



We trained our model to detect plastic and paper with 200 epochs and we achieved an average accuracy of 76%.

Optimization model

Optimizes placement and travel within recycling start and drop points, ensuring swift, efficient waste sorting while minimizing distances and adhering to constraints.



Decision Variables

X_s, Y_s : Starting coordinates.

X_t, Y_t : Drop coordinates

DX_t, DY_t : Travel distances

Z_x, Z_y : Penalties (binary).

W_t : Weight.

Constraints

$$DX_t \geq X_s - X_t \quad \forall t$$

$$DX_t \geq -(X_s - X_t) \quad \forall t$$

$$X_s \geq 40 - M(1 - Z_y)$$

$$X_s \leq 50 + M(1 - Z_y)$$

$$5 \leq Y_1 \leq 25$$

$$5 \leq X_1 \leq 35$$

Objective function

$$\text{Min } Z = \left(\sum_{t=1}^4 W_t \cdot (DX_t + DY_t) \right) + 1000 \cdot (Z_x + Z_y)$$

Test / Validation

Rewarding System

We have created and tested our own unique rewarding system. The application was developed using flask microweb framework with a database implementation of SQLite and deployed on the cloud on render cloud service, with the utilization of socket programming we created a communication path in order to handle all the communications between our application and our waste sorting module.

Logged in successfully!

Welcome Majed!



Done!

Welcome to Our Smart Recycling Bin

Choose an option to continue:

Log In

Continue without Logging In

Target Specifications

Metrix	Target Specifications
Power Consumption	$X < 500$ Watt
Processing time	$X < \text{per min} 10$
Error percentage	$X < 5\%$
maximum allowable item dimensions	$X < W 10\text{cm}, L 28\text{cm}$
Capacity	$X > 55$ Litter
cost	$X < 5400$ SAR

Project Impact

Economic: Enhances recycling efficiency, attracts investments, and meets regulatory standards, fostering significant commercial opportunities.

Technological: Features advanced computer vision and sensors for precise sorting, paired with an interactive, reward-based system to engage users.

Societal: Encourages community participation and eco-consciousness through education and incentives.

Environmental: Cuts landfill waste, preserves resources, and enhances recycling quality, lessening environmental harm.

Conclusion

Our Smart Recycling Bin features advanced computer vision and sensors for high-accuracy sorting. Its reward system boosts user participation, supporting Saudi Arabia's Vision 2030 with innovations that elevate global standards for sustainable waste management.

Acknowledgment

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