TRASH-E

A solution to proper waste management

Team: Raul Cancho, Hannah Duong, Salina Tran

Introduction

“Every year we trash 79% of recyclables but we don’t need to” (The Recycling Partnership).

Our team aims to create an object-identification system for waste management, addressing challenges faced in both smart-city development and modern recycling infrastructures. Misclassification of waste is a common issue, as many people place items in the wrong bins. By improving the accuracy and reliability of waste sorting, our system seeks to support more efficient disposal processes and reduce contamination in waste streams.

Team Roles

Raul Cancho

- Team Lead
- Documentation
- Testing

Hannah Duong

- Hardware Setup
- Integration

Salina Tran

- Software
- Model Training
- Inference

Objectives & Goals

Design and implement a hardware-based waste classification system for smart cities capable of identifying different types of waste in real time

- Source images of different waste types
- Train a model to classify the images
- Set up the microcontroller/processor and camera
- Deploy the trained model onto the hardware
- Test the system with real items (clothing, bottles, food, etc.)
- Improve accuracy and finalize the prototype

Hardware & Software

Technology stack enabling our waste management system

- Hardware:
  - Raspberry Pi Camera
  - Raspberry Pi 5
  - Raspberry AI Hat
- Software
  - Python
  - ML Framework: Pytorch and leveraging MobileNetV2
  - Matplotlib for performance visuals

Project Road Map

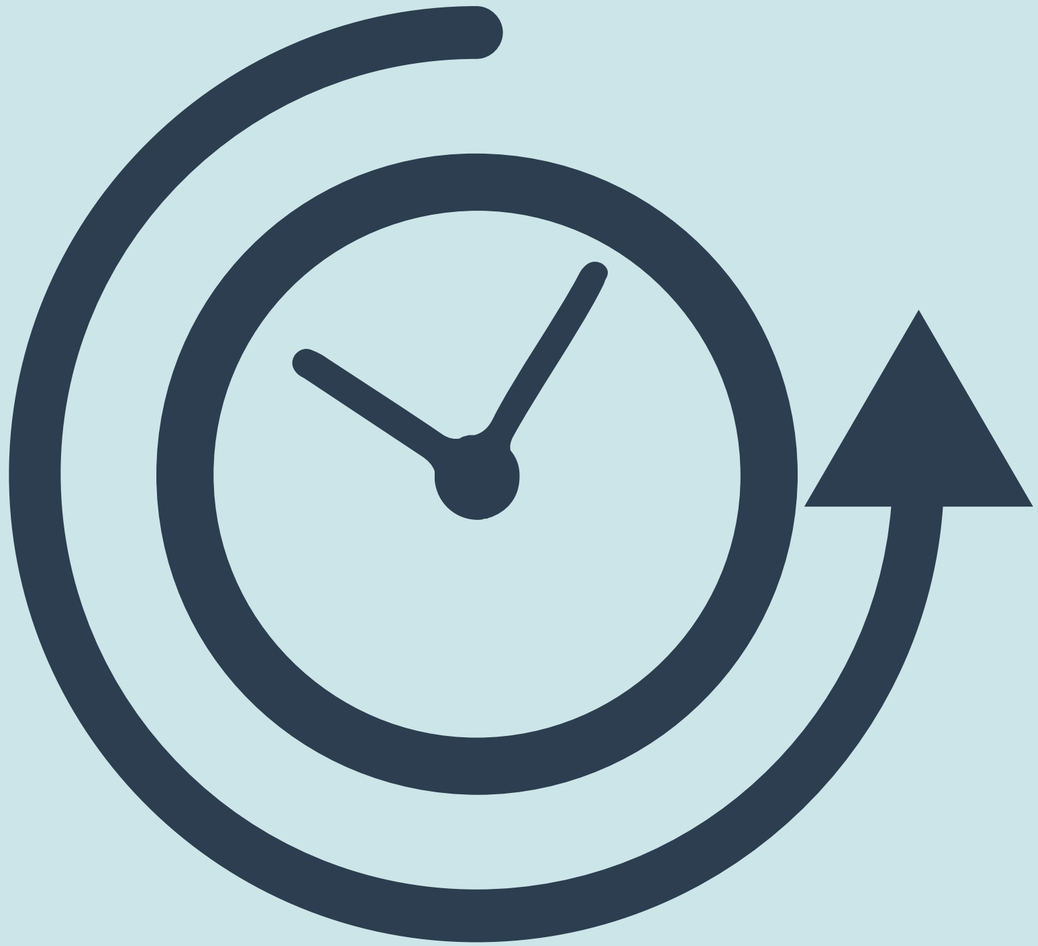
	Objective	Methodology
1	Design and train a machine-learning model capable of distinguishing between multiple waste categories (paper, plastic, glass, textiles, and general trash) with high accuracy while meeting constraints of hardware.	Implemented a transfer learning approach using MobileNetV2. Trained in PyTorch to classify 12 material types, including edge cases like textiles and batteries, into four disposal streams (Recycling, Trash, Donations, Hazardous), prioritizing efficiency without sacrificing performance
2	Develop a system that can reliably capture, process, and interpret images of waste items using a microprocessor–camera architecture, ensuring consistent performance under various environmental conditions.	Develop a image subsystem that captures live video frames via the camera module and process them. System will utilize OpenCV for frame acquisition and preprocessing to ensure there is seamless integration with MobileNetV2
3	Integrate and validate a complete hardware–software prototype that performs real-time classification, generates interpretable outputs, and demonstrates measurable improvements compared to manual identification.	Deploy trained model onto Raspberry Pi 5 with live camera feed, engineer a visual interface that displays icons (e.g. Recycling Symbol) onto identified objects, and benchmark Raspberry Pi with the standard Laptop CPU

Expected Outcomes

- **Classification Accuracy:** Sustain or exceed 90% classification performance when running the model on the hardware with interactive icons (Recycling, trash, donations, hazardous)
- **Inference Rate:** Achieve a processing speed of 10 classifications per minute
- **Throughput:** Successfully identify and classify 5 individual items simultaneously within a single camera frame (scene) under operational conditions.
- **Real-Time Classification Latency:** Achieve an average end-to-end classification time of less than 200 milliseconds per item

Current Status

- **Model Validation:** model successfully identifies different types of waste, including: clothes, plastics, glass, metal, and paper.
- **Performance:** model classifies at a >90% accuracy.
- **Current Phase:** migrating model to the hardware.
- **Next Step:** Implementing the camera system to enable real-time image capture and processing.
- **Final Phase:** Testing for expected outcomes



Thank you.