SmartBin

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SmartBin: Purpose and Vision

The Problem We Solve

Employs AI to detect, classify, and sort waste, addressing the challenge of improper disposal and promoting responsible waste management practices.

Our Motive

Leverage AI-driven computer vision models to develop an accurate waste detection system.

Understanding the Need for Waste Detection

- Waste is an inevitable part of daily life, yet we rarely acknowledge it.
- It's always there — more in our subconscious mind
- As a result, much of it goes unnoticed and mismanaged

Effective waste detection reduces environmental footprint, improves recycling, and supports the development of smarter waste management solutions

Impact of Mismanaged Waste

- Contributes to pollution in land, water, and air
- Harms wildlife and disrupts ecosystems
- Increases health risks due to toxic waste exposure
- Worsens climate change through methane emissions from landfills

Inside SmartBin: Key Features

Technology Overview

- ❑ Windows application using the detect-waste ResNet50 AI model
- ❑ Designed to run on Snapdragon X Elite laptop sponsored by Qualcomm
- ❑ Functions as a standalone product

How SmartBin Works

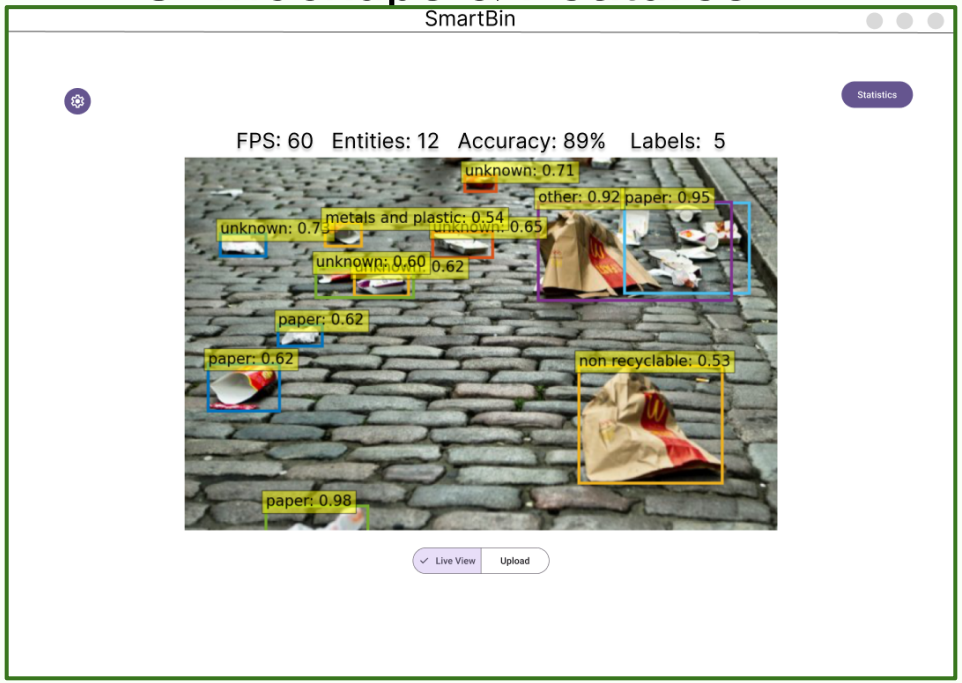
- ❑ Single-page application for simple navigation
- ❑ Toggle to upload or live video feed
- ❑ Image is processed by AI to detect and categorize waste
- ❑ Labeled bounding boxes around detected waste
- ❑ Settings button opens a new window

Non-Functional Requirements

Performance	User Accessibility
❑ Response Time ❑ Fast, Responsive, Snappy	❑ Seamless design ❑ Natural, Common Sense
❑ Resource Efficiency ❑ Lightweight, economic	❑ Dynamic Font Scaling ❑ Normalized to context window
❑ Smooth rendering ❑ No stutters, screen tears	❑ Color blind friendly ❑ Change UI for user needs
❑ Inference Speed ❑ Real-time detection	❑ Error messaging ❑ Prevent fatal system failure and recover

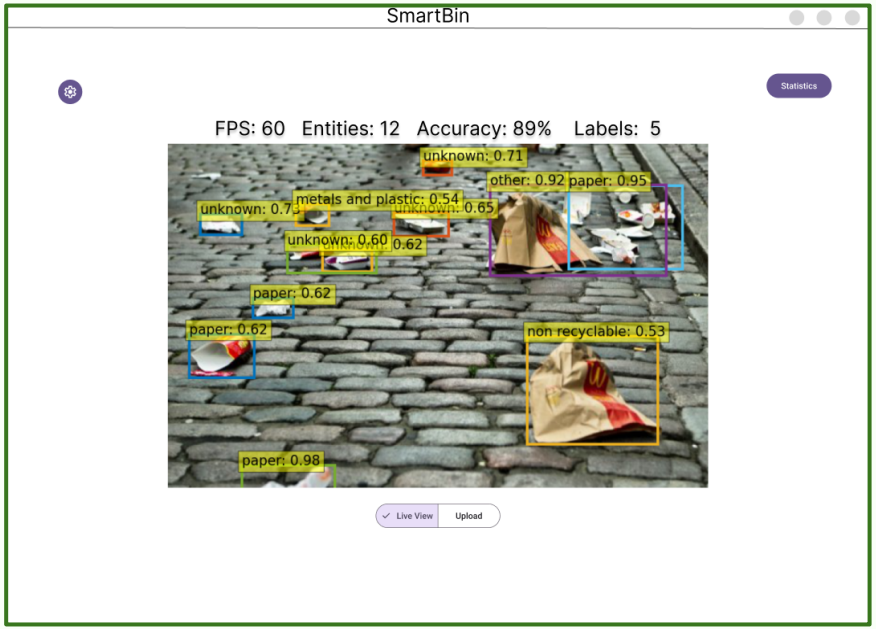
User Interface Design

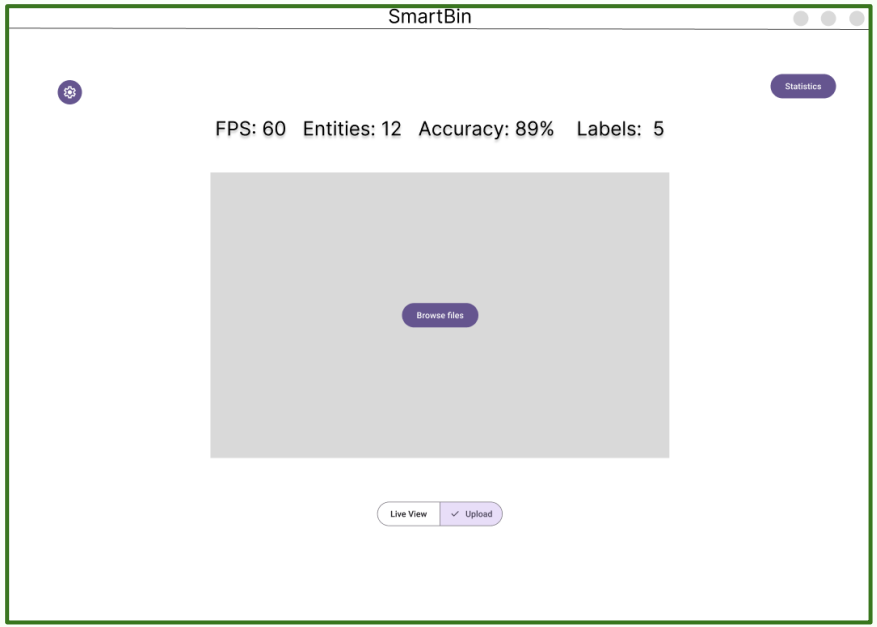
UI Mockups & Features



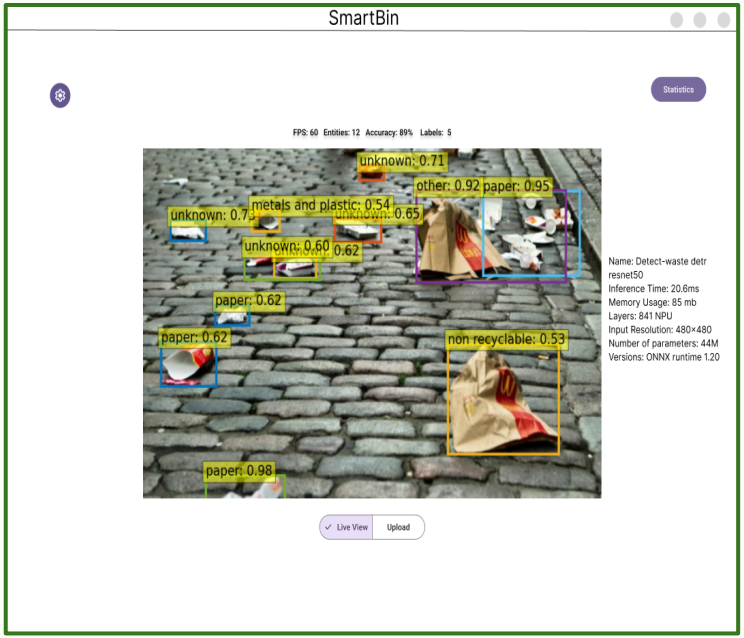
User Interface Design

Live Feed vs. Image Upload





User Interface Design



Name: Detect-waste detr resnet50
Inference Time: 20.6ms
Memory Usage: 85 mb
Layers: 841 NPU
Input Resolution: 480×480
Number of parameters: 44M
Versions: ONNX runtime 1.20

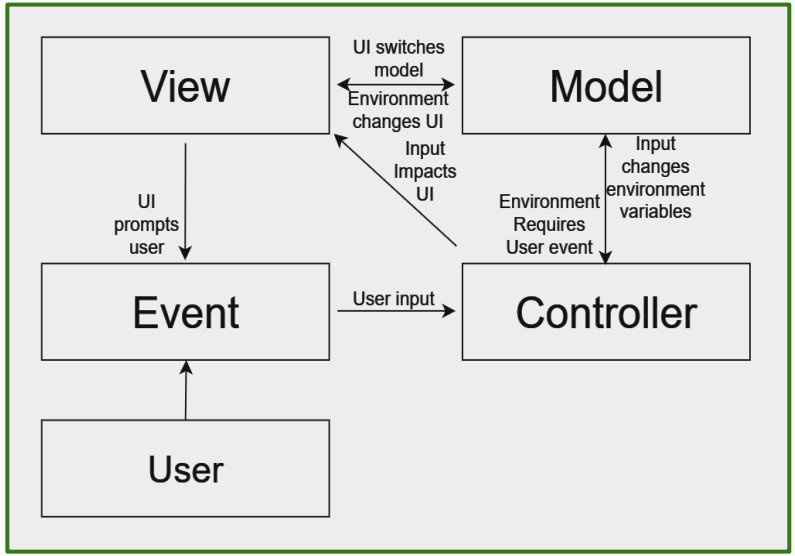
Information Chart

User Interface Design

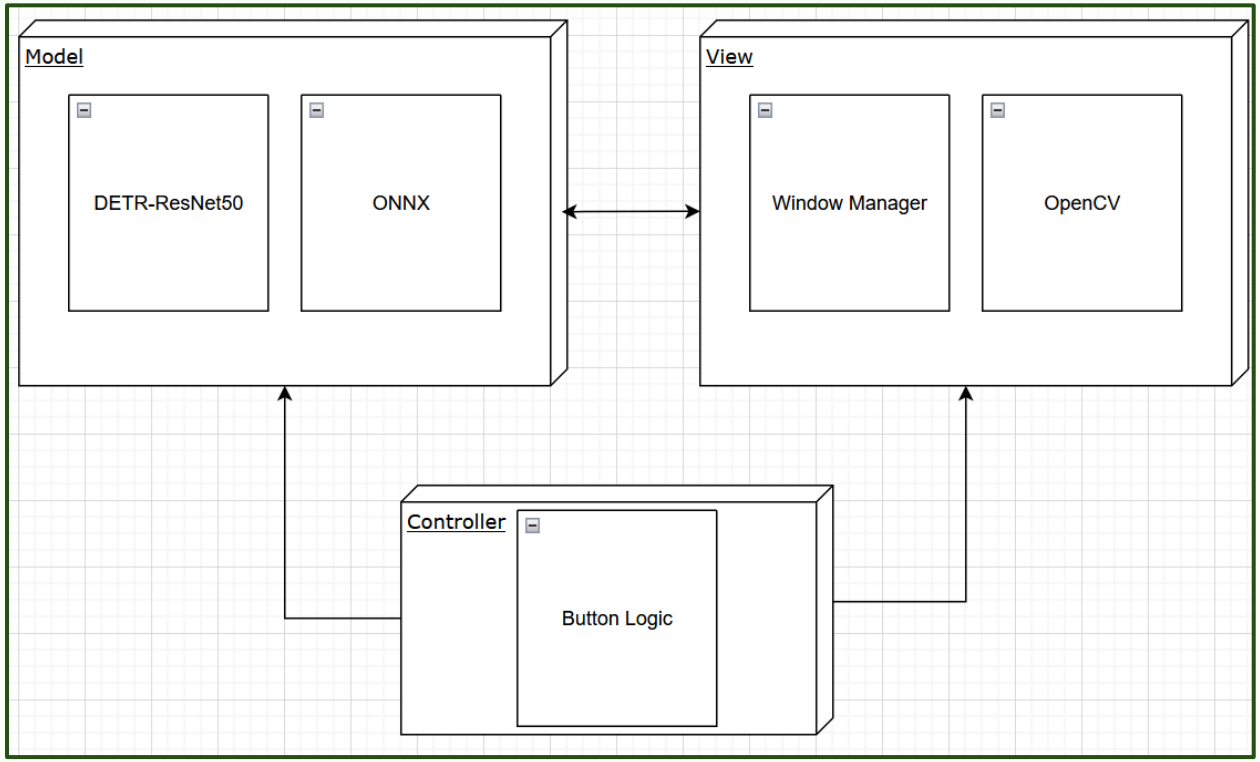
Settings Page

Architectural Design

- ❑ Single Page Application
- ❑ Model - DL Model, ONNX
- ❑ View - OpenCV, WinUI
- ❑ Controller - User Input

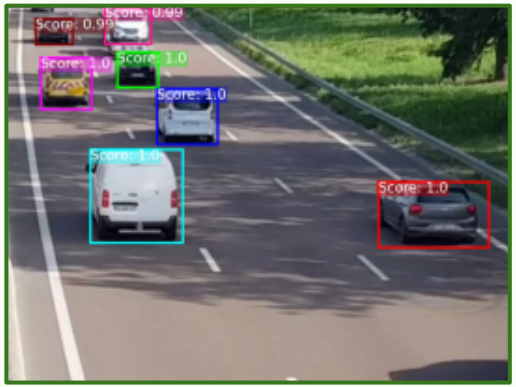


Architectural Design



DeTr ResNet50

- The model has a transformer based deep learning architecture.
- This model has no need for post-processing like NMS (Non-Maximum Suppression).
- Model has refined bounding boxes around objects rather than anchor boxes.



ONNX RUNTIME

ONNX Runtime Integration

- ONNX Runtime will be how we run the model
- ONNX Runtime will be a critical tool in terms of testing and looking for possible optimization opportunities in the model.

Implementation Plan

Development Tools & Frameworks

- ❑ Visual Studio
- ❑ Docker
- ❑ Pytorch
- ❑ ONNX Runtime
- ❑ Open CV

Implementation Tasks

- ❑ Import model (DeTr ResNet50)
- ❑ Train model
- ❑ Develop Windows App
- ❑ Implement model with OpenCV
- ❑ Backend
- ❑ Develop controller UI

Schedule

Category	Development Activities	Outcomes	Timeline	Personnel
Model	Run, compile and preform inferences on our deep learning model (DeTr ResNet50)	To confirm our model performs as expected.	3/3 – 3/6	Diego Chiok, Edgar Legaspi, Curtis Hayes, Svetya Koppisetty
UI	Develop the UI and make the functionality	To make sure user can interact with our program	3/10 - 3/12	Diego Chiok, Edgar Legaspi, Curtis Hayes, Svetya Koppisetty
Window App	Develop the main window application our model will run using DWM api for the window framework	Have a basic windows application	3/13-3/27	Diego Chiok, Edgar Legaspi, Curtis Hayes, Svetya Koppisetty

Challenges & Solutions

- ❑ The Model misidentifies Trash as plastic or vice versa due to too broad of categories on COCO
- ❑ To fix this we are using a different Dataset Called TACO which is specifically trash images
- ❑ The Model Has low Detection confidence due to Bad Lighting or weird surface since COCO does not diversify the scene
- ❑ The TACO dataset has images of trash in all different scenes like Grass, pavement and Water
- ❑ Malware being uploaded in the upload image.
- ❑ We could Have Strict validation for the files and or run the fills in a test environment to check for harmful Malware.

Future Enhancements

- ❑ Expanding to Autonomous Systems
- ❑ Detecting biohazard Material Like used needles
- ❑ Detecting hazardous Material like Car Batteries

SmartBin is a step toward a cleaner, more sustainable future.