smart waste detection and sorting using CV

presented by

salma mohammed elsayed	model training and CV
Mohammed hossam	data preprocessing
ahmed elsaeed mohamed	data collection
nour el-din ahmed mansour	GUI development
abd allah medhat salah	deployment

Project Idea & Aim

The project focuses on building an intelligent waste classification system that uses computer vision and deep learning to automatically identify different types of waste in real time. By capturing images through a camera and analyzing them with a trained AI model, the system helps users sort waste correctly without manual effort or prior knowledge. The aim is to improve recycling accuracy, reduce human error, and support sustainable waste management practices. Through automation and smart detection, the system encourages proper disposal habits, minimizes contamination of recyclable materials, and contributes to a cleaner and more environmentally friendly community.

Project Explanation

This project introduces an intelligent waste classification system that leverages computer vision and deep learning to automatically detect and classify waste in real time. A camera captures the waste item, and a YOLO-based model analyzes the image to determine its correct category, such as plastic, paper, metal, organic waste, or other recyclable materials.

The system is designed to improve recycling processes by reducing human error and increasing the accuracy of waste sorting. Additionally, an API and a user-friendly interface built with Streamlit allow users—or even factory operators—to interact easily with the model. Whether implemented in households, universities, public facilities, or industrial sorting lines, the project provides a fast, smart, and effective solution that supports environmental sustainability and proper waste management.

Project Advantages

- Real-time Smart Classification: Automatically detects and classifies waste using AI and computer vision.
- Improved Sorting Accuracy: Reduces human error and ensures waste is sorted correctly.
- Supports Recycling Efficiency: Minimizes contamination and boosts the effectiveness of recycling centers.
- User-friendly Interface: Streamlit interface makes the system easy to use for any audience.
- Scalable Deployment: Can be used in homes, schools, companies, or industrial waste-sorting facilities.
- Cost and Time Reduction: Automating the sorting process helps organizations save operational time and resources.
- Environmental Impact: Encourages proper waste disposal and contributes to sustainability efforts.

data collection

data preprocessing

image cleaning

balanced classes

image resizing

data preprocessing

data augumentation

remove bad samples

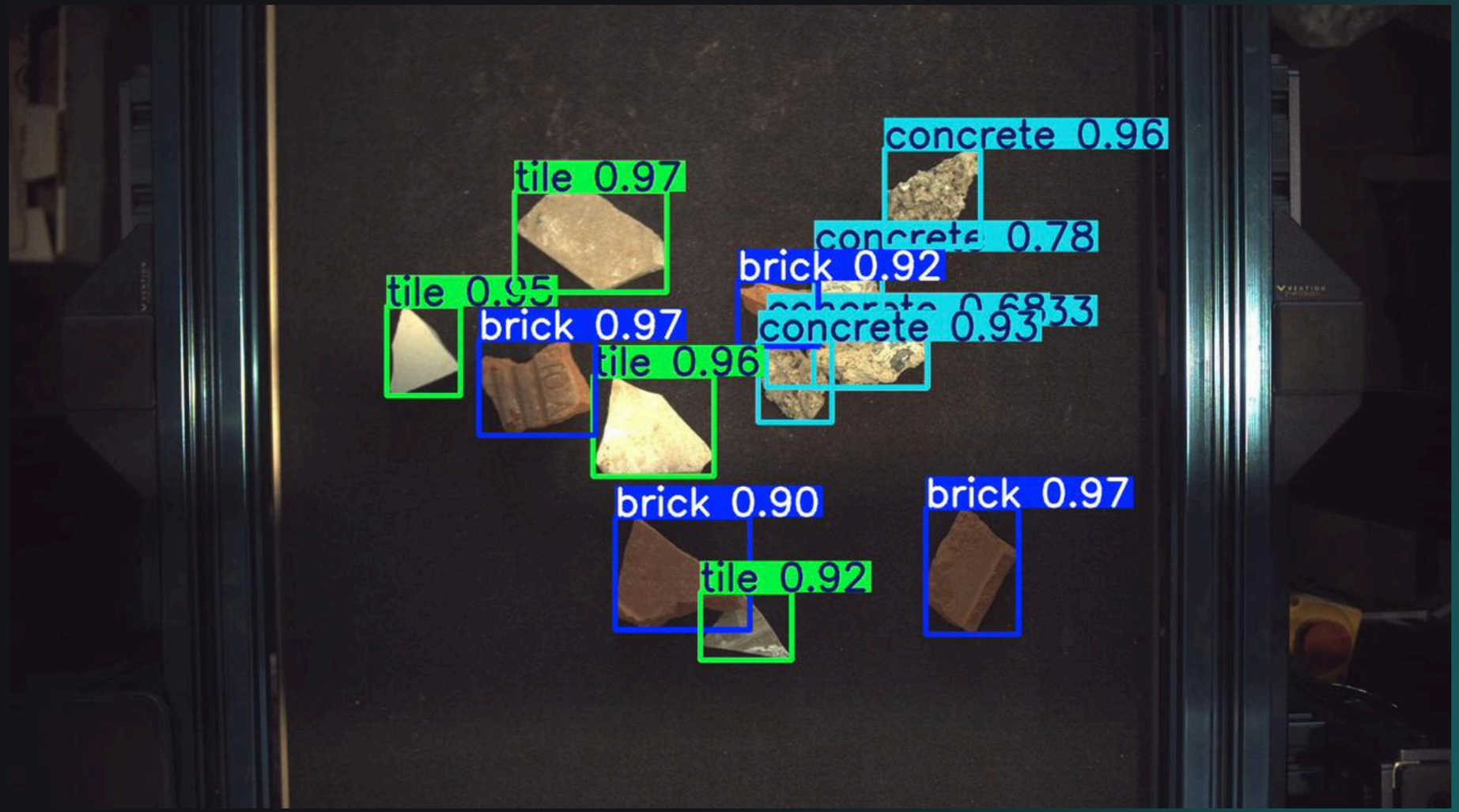
train / val / test split

Model Development & Training Phase

The model development phase focused on selecting a high-quality dataset, optimizing class balance, and training an object detection model capable of accurately classifying different types of waste in real time. Several datasets were evaluated and tested to determine which one provided the best performance in terms of image quality, annotation accuracy, class distribution, and compatibility with YOLO models. Throughout this process, different YOLO versions were experimented with, and data augmentation was applied where necessary to improve robustness.

After extensive experimentation, the Construction and Demolition Waste Object Detection Dataset (CODD) was identified as the most suitable dataset. It offered strong image diversity and balanced waste categories, leading to stable training results. The final YOLOv8 model achieved 97% accuracy on the training set and 90% accuracy on the validation set, making it the highest-performing model among all attempts.

To illustrate the model’s performance, the slide includes an inference example where the trained model successfully detects and classifies waste objects from a validation image.



deployment

Prepare the Trained Model

Choose Deployment Platform

Develop Inference Pipeline

Integrate with Application

test deployment

Future Improvements & Feature Ideas

- Automated Sorting System: Add motors/actuators to automatically move waste into the correct bin.
- Continuous Model Improvement: Add data-collection mode to gather new images and retrain the model.
- User-Friendly Enhancements: Provide recycling tips, confidence scores, and voice feedback after detection.
- Dashboard & Analytics: Display detection statistics, waste distribution, and system performance.
- Mobile & Cloud Integration: Connect to a mobile app and support cloud-based model updates.
- Multi-Camera Support: Allow multiple cameras for better accuracy, especially in factories.
- Lightweight Offline Version: Optimize the model to run on low-power devices like Raspberry Pi.

thank you