EWASTE-NET: A Yolo+Qwen Combination That Extracts Text From Electronics

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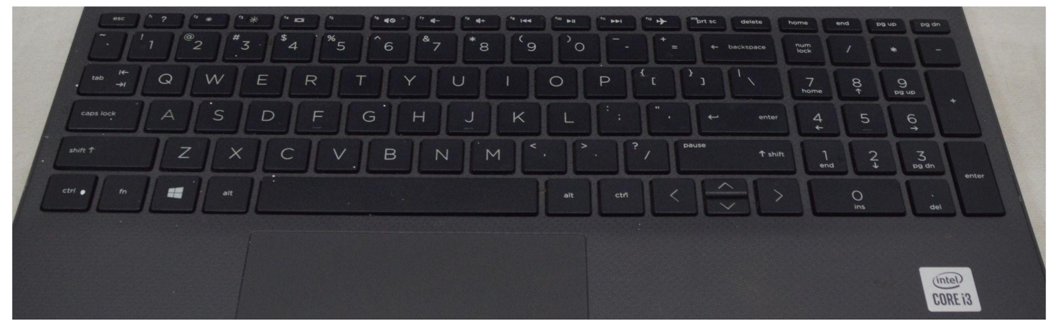
Introduction

In today's fast-paced world, companies like Apple release new phones every year, prompting many consumers to replace their devices long before they reach the end of their usable life. This cycle generates an enormous amount of electronic waste (e-waste), creating significant environmental challenges.

Our project addresses this problem by leveraging YOLO and large language models to develop and train two specialized models. These models combined are designed to extract textual information from electronic waste items. By successfully retrieving text data, we lay the foundation for future work: analyzing and classifying e-waste based on extracted information, determining whether and how products can be recycled.

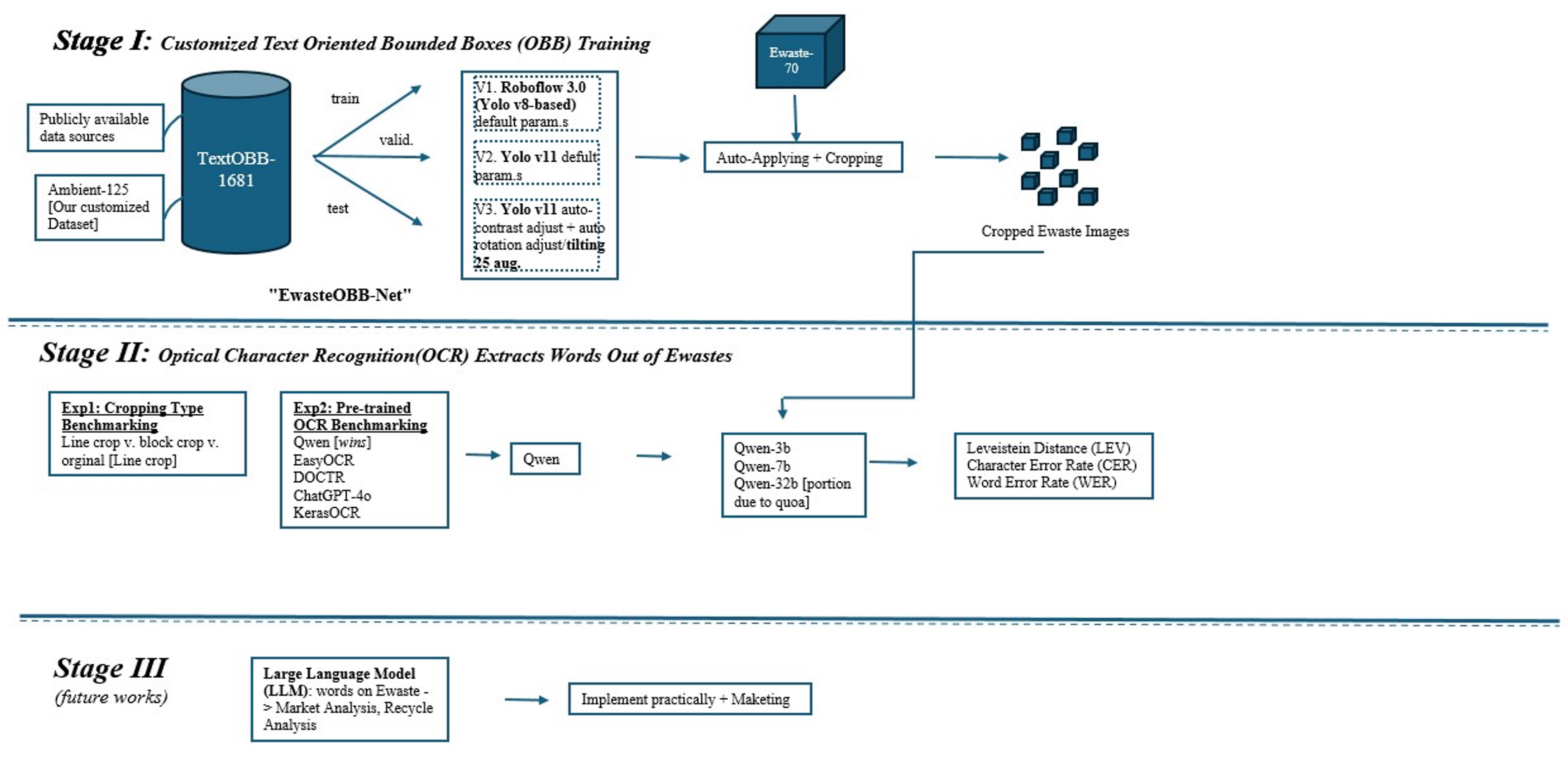
This technology has the potential to greatly reduce human labor in the e-waste recycling process, and our project forms a critical first step toward building a smarter, more efficient recycling solution.

Inputs to be Noticed



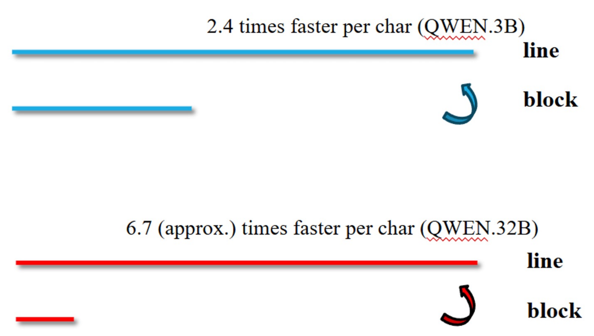
Above are several identical inputs for our model. Images on the upper right and lower are the identical inputs for high error rate, while our model identifies most of the text correctly, it will record some recognized text multiple times, causing a comparable high error rate.

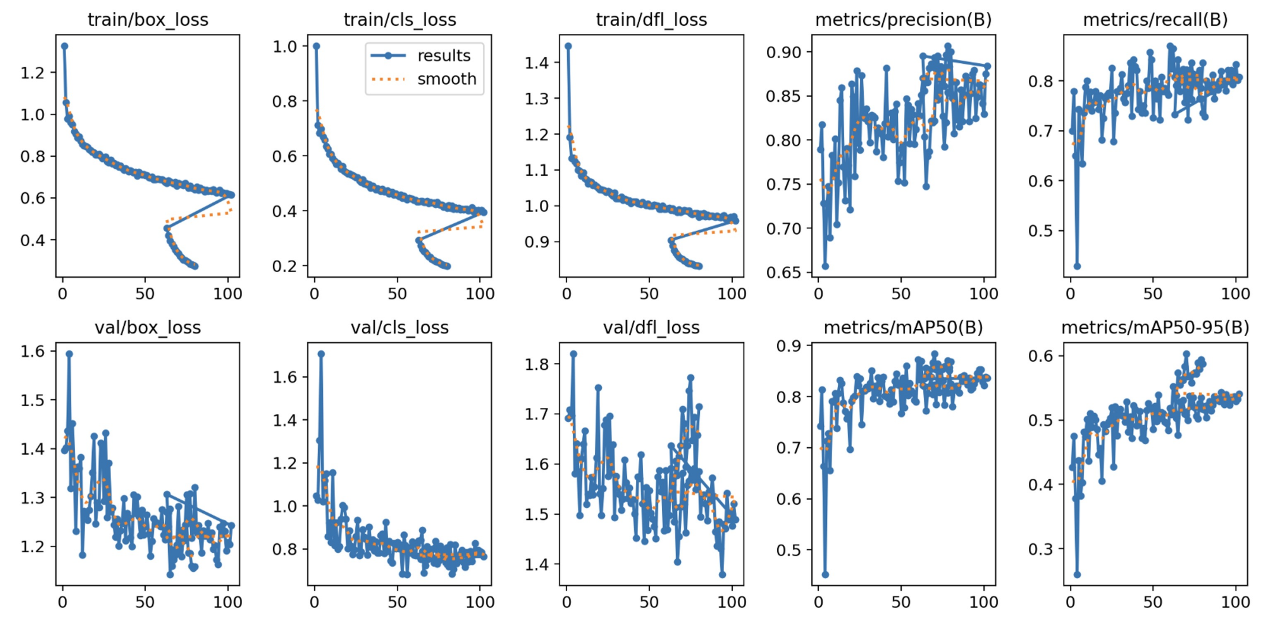
Methodologies and Workflow

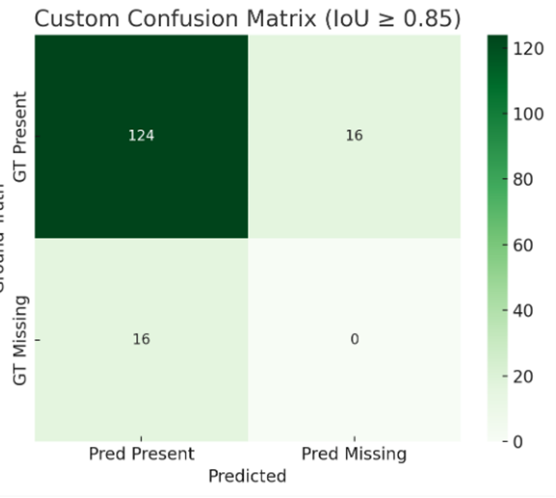


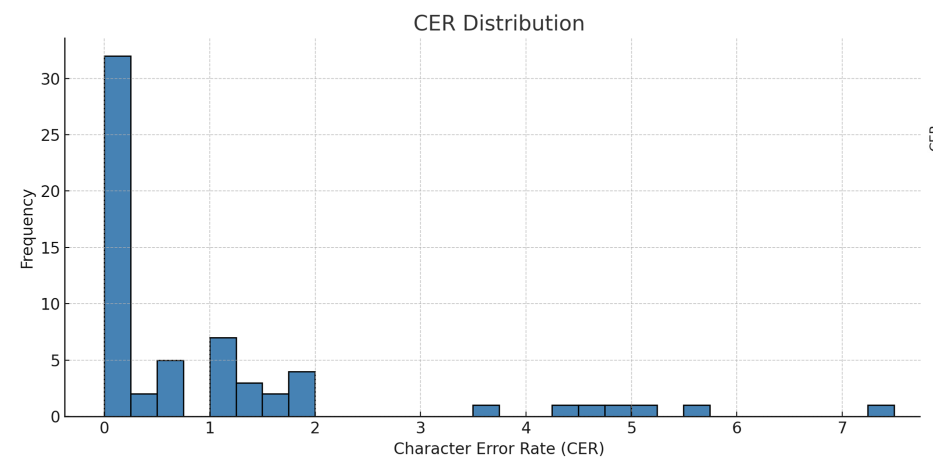
Results

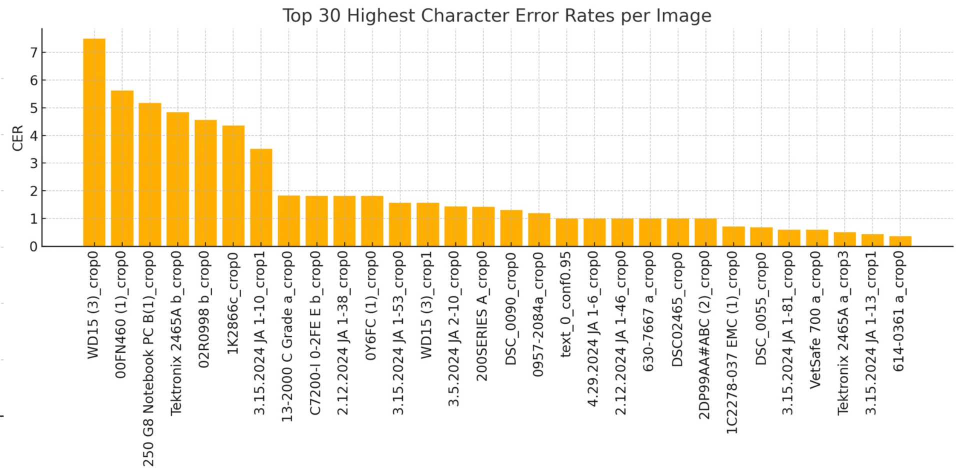
	EasyOCR	GPT-4o	Qwen	DOCTR	Keras-ocr
WER	0.853	0.32	0.03	1.30	0.40
CER	0.5646	0.38	0.13	0.71	0.65
Lev	39.6	28.54	8.18	51.1	58.1











Conclusions and Expectations

Our pipeline was built in three key stages, leveraging cutting-edge technologies such as **YOLOv8**, **Qwen OCR models**, and **Large Language Models (LLMs)**. Each stage was validated using diverse and representative datasets, including Ambient-125, Ewaste-70, and the comprehensive TextOBB-1681 collection that aggregates public images, in-house captures, and D3 Engineering contributions. This robust dataset base helped ensure the reliability, generalizability, and scalability of Ewaste-Net across varied electronic product types and conditions. In **Stage I**, object detection models were trained to locate and crop text-bearing regions from images of e-waste components. Utilizing the YOLOv8 framework and Roboflow API, we iteratively trained four versions of the object detection system. Version 3, which employed data augmentation strategies like automatic tilting (±25 degrees), yielded particularly strong performance on Google Colab's T4 GPU, achieving an F1 score of **0.8857**. This robust detection capability is crucial for accurately isolating serial numbers, brand names, and model information that often appear in obscure or distorted formats on used electronics. Moving to **Stage II**, we integrated the **Qwen OCR** model to interpret the text found in the cropped regions. We conducted two key experiments here: the first compared line-based cropping to block-based cropping for OCR accuracy and efficiency. Qwen-3B was **2.4 times faster per character** when using line crops, while the more powerful Qwen-32B showed an even greater speed advantage—**6.7 times faster**. In our benchmark evaluations, we achieved an average **Character Error Rate (CER) of 0.9890** and **Word Error Rate (WER) of 1.0538**, confirming Qwen's reliability in extracting high-quality, structured text from raw e-waste images. The broader significance of Ewaste-Net lies in its potential to revolutionize how we handle, recycle, and resell electronic waste globally. Rather than manually inspecting labels or barcodes—often degraded by age or wear—our pipeline automates and streamlines the entire process.

References

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