Smart Grocery AI: Detecting Fresh and Rotten Products with YOLOv8 and Robotic Arm Automation

Yuan Ze University IBPI
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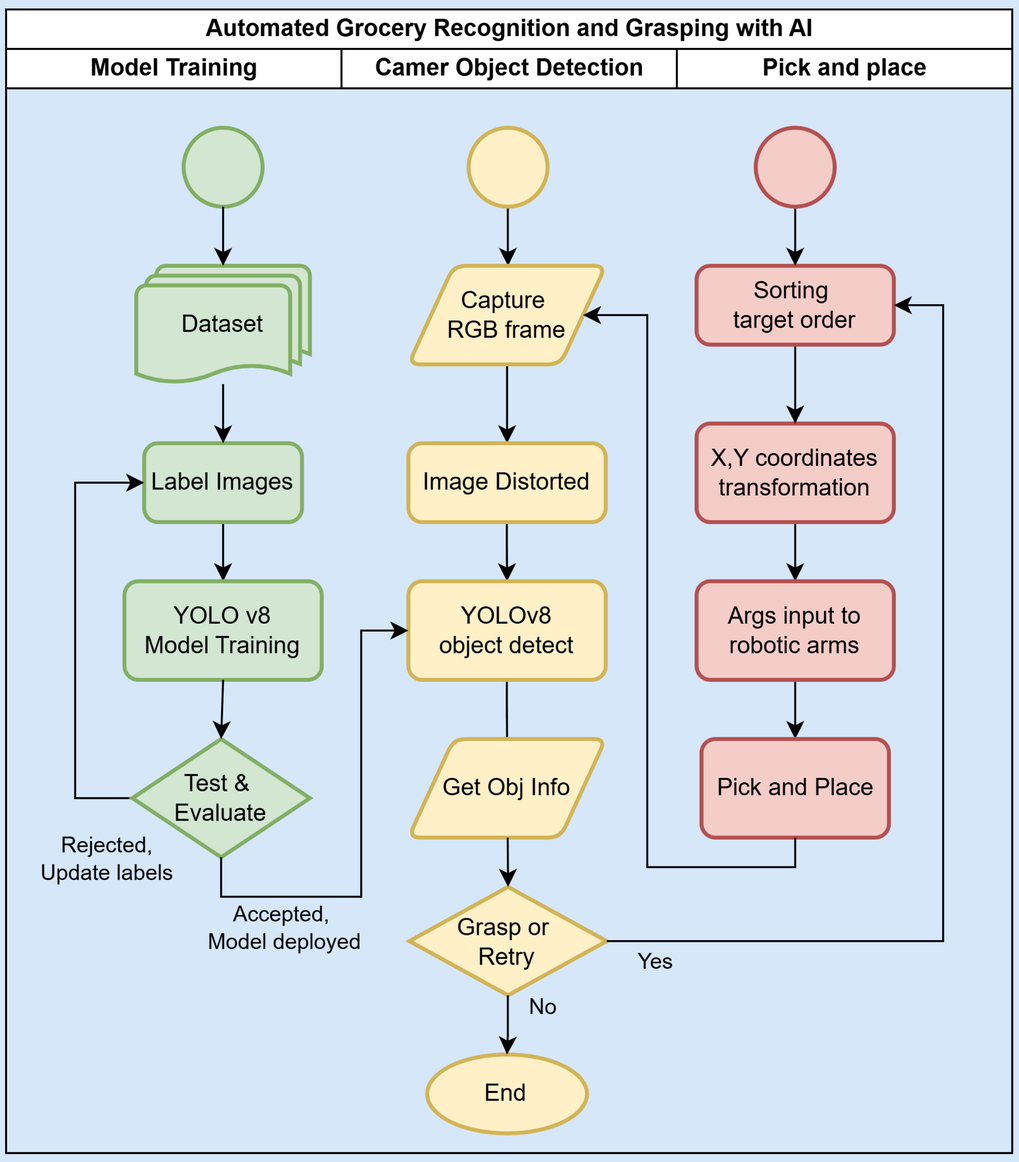
Abstract

This project integrates YOLOv8-based deep learning object detection with a robotic arm for recognizing fresh and rotten vegetables, followed by automated pick-and-place operations.
Identifying rotten produce is challenging due to non-uniform decay patterns and the difficulty of sustaining manual inspection. Furthermore, variation in object size affects detection consistency and classification performance.
The system was trained on a vegetable dataset, achieving 94% mAP@50, and a custom small-object dataset, achieving 97% mAP@50. These results enable stable grasp , with a 97% success rate for single-object picking and 92% for multi-object picking.

Methodology



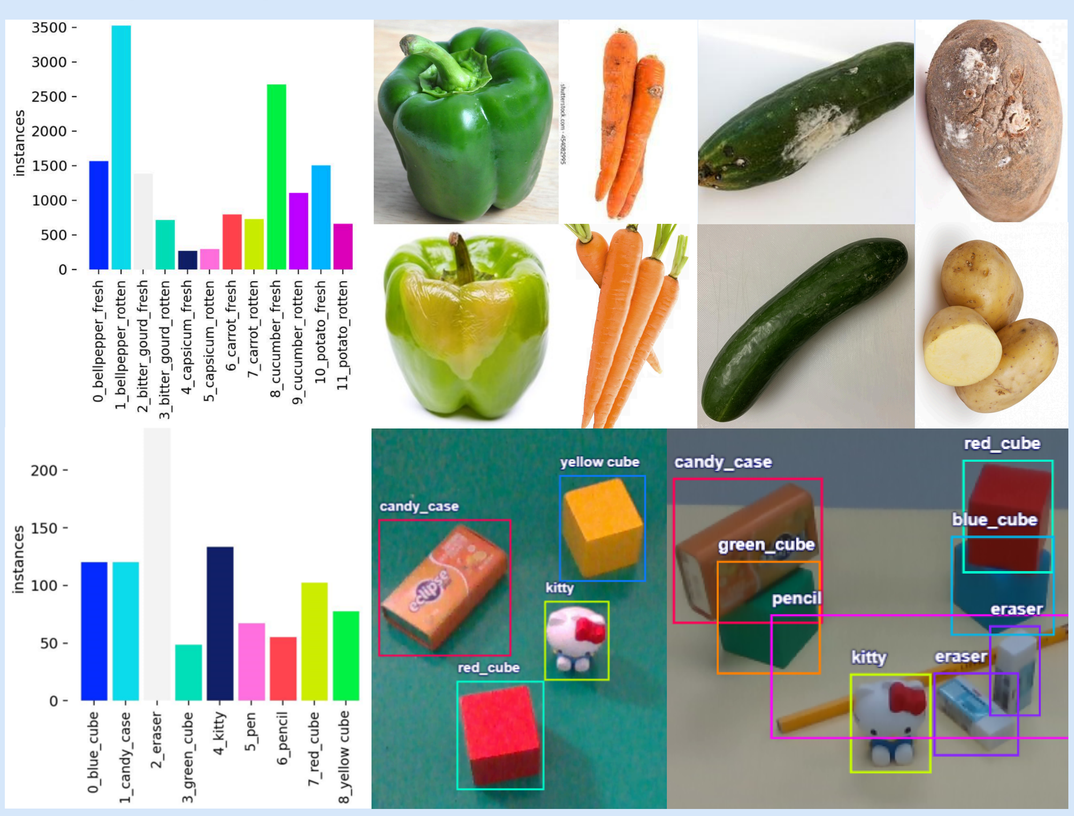
Test Dataset

Vegetable Dataset:

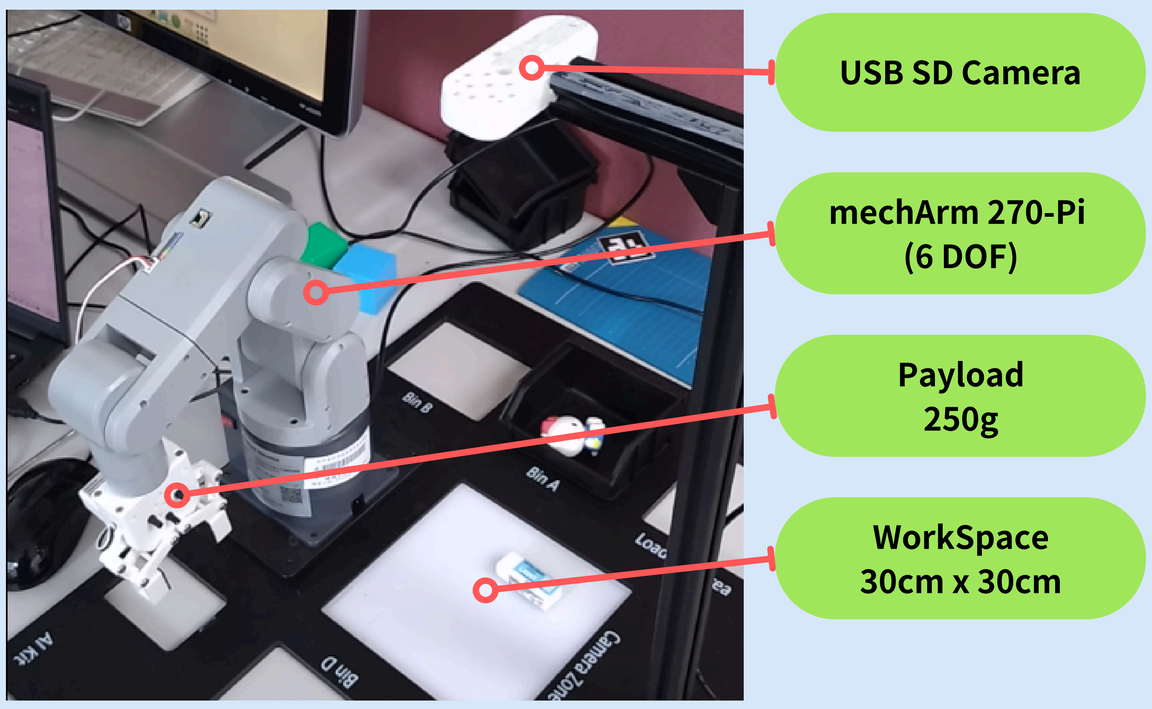
- 6484 images, 12 classes (6 veggies x rotten / fresh)
- Fresh and rotten vegetables often exhibit inter-class visual similarity, which can lead to misclassifications.

Small Object Dataset:

- 251 images, 9 classes
- For grasping test (easy to control)



System Enviroment



Data Analysis

Table1:

- Precision: correct predictions of all positive detections
- Recall: Actual objects correctly detected

Table2:

- Grasp success rate tested for 30 trials.
- Stablility: No object dropped after grasping

Dataset	Precision	Recall	mAP@50	mAP@50:95
Small Objects	0.982	0.973	0.987	0.924
Vegetables	0.918	0.894	0.938	0.855

Table 1: Yolov8 Detection Evaluation Metrics

	1st Pick	2nd Pick	3rd Pick	4th Pick
Success Rate(%)	86	93	83	80
Stability(%)	5	2	5	0

Table 2: Continuous Pick-and-Place

Conclusion

The performance of the model is shown in Table 4.
It achieved 94% precision and 93% mAP@50 on the vegetable dataset, and 97% precision and 93% mAP@50 on the small object dataset.
Precision above 90% is a key requirement to ensure the stability and reliability of robotic pick-and-place operations. Furthermore, the pick-and-place success rate confirms the practical utility of our model.
The experiment used only a simple grasp strategy, so the high accuracy in object recognition and spatial localization played a crucial role in achieving 97% success on the first pick, and 92% on the third consecutive pick.