# Fresh Vegetables Detection using YOLOv8


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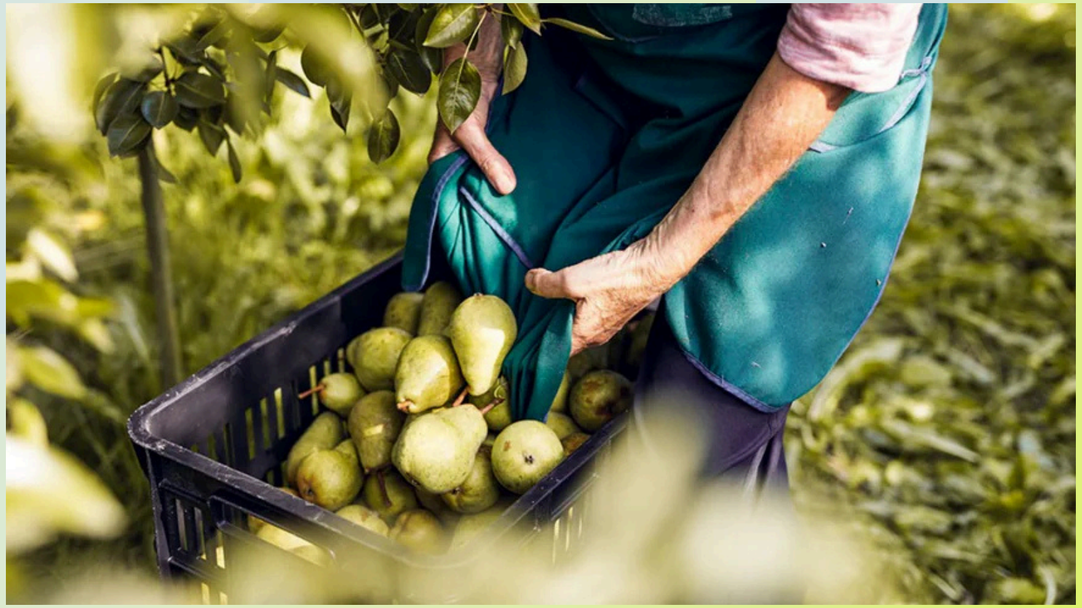
# Introduction

## The Vegetable Industry

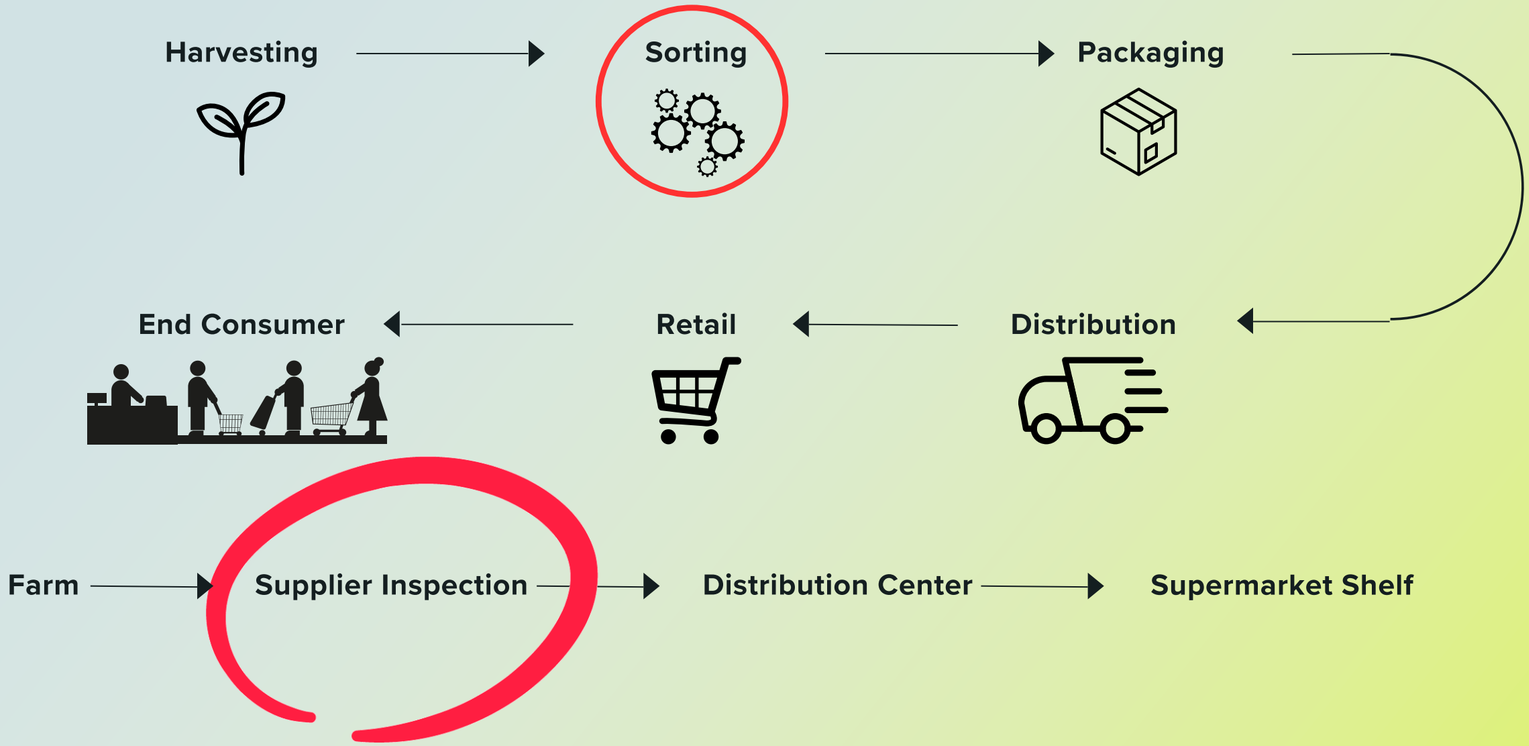
- Vegetables are essential part of the global diet.
- Crucial to public health and food security.
- Global Vegetable Market is projected to reach $921 billion by 2032.
- Due to rising food health awareness and population growth, the demand only increases.



# The Challenge:

## Manual Inspection in Supply Chains:

- Suppliers rely on human inspectors to assess freshness based on appearance, texture and color.
  - Time-consuming
  - Prone to human error or fatigue.
  - Not scalable for large quantities.

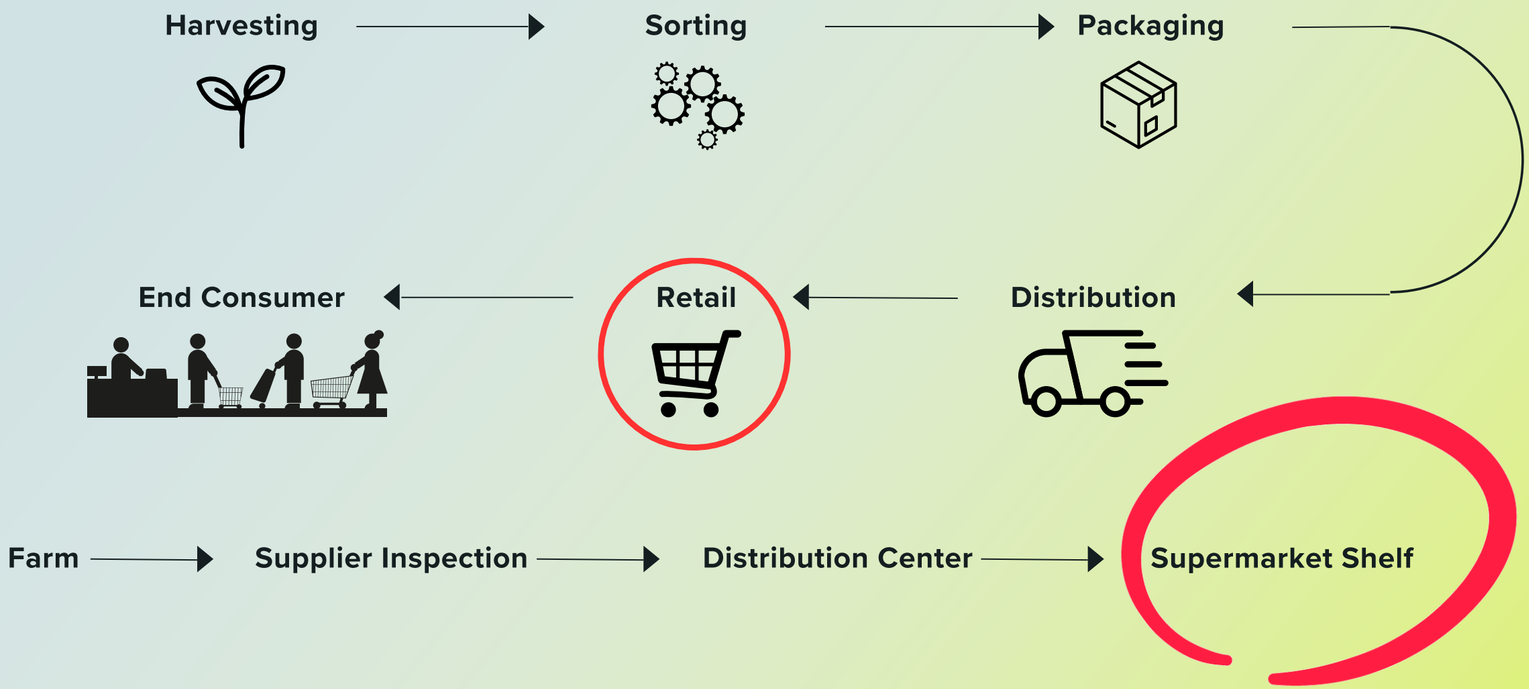


# The Challenge:

## Maintaining freshness in retail stores:

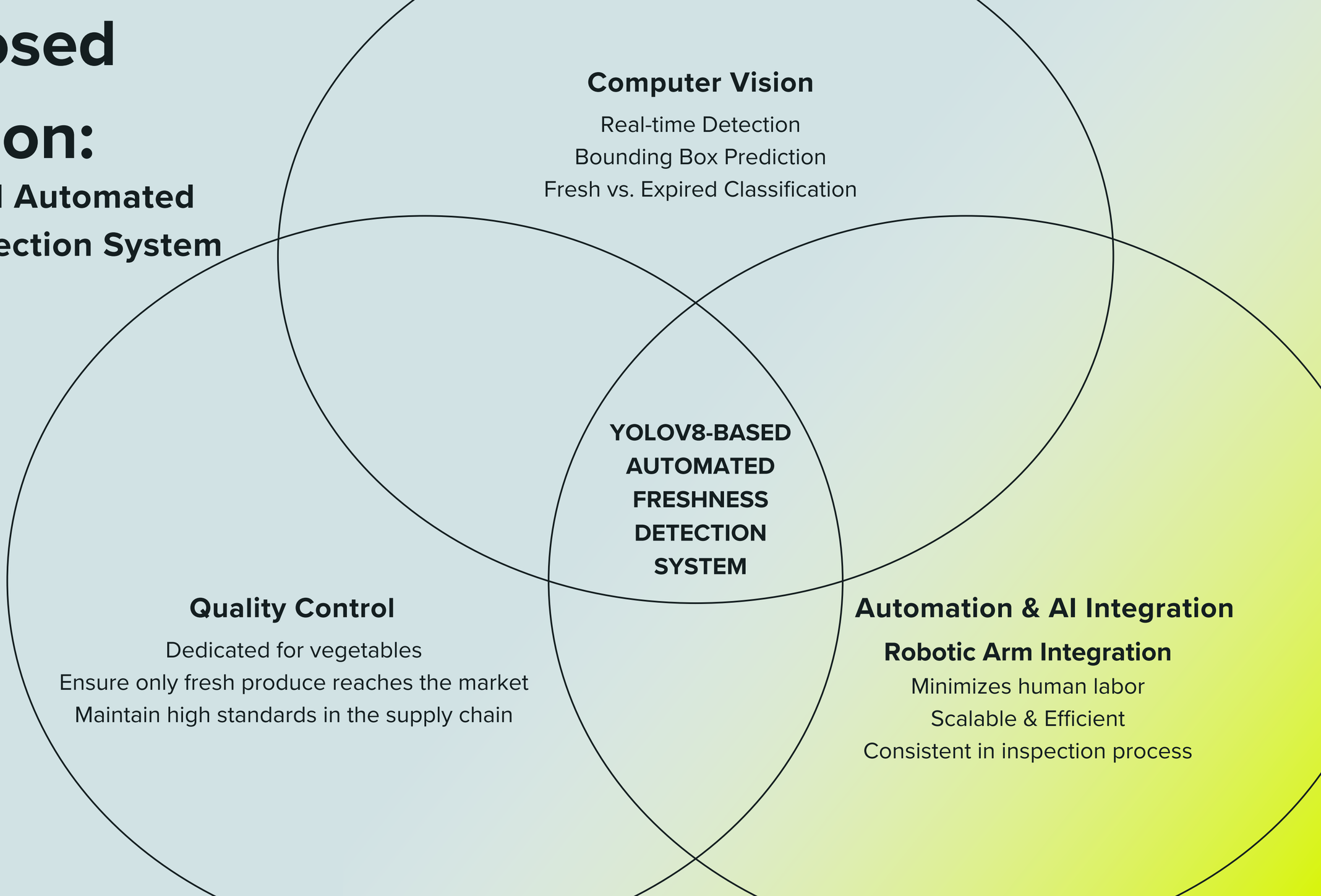
- Vegetables are highly **perishable**.
- The longer they sit on the shelf, the more likely they **degrade** in all aspects.
- Spoiled produce contributes to **food waste → increases operational costs**.

- As demand increases, the industry needs **automated**, **real-time**, and **accurate systems** for freshness detection.

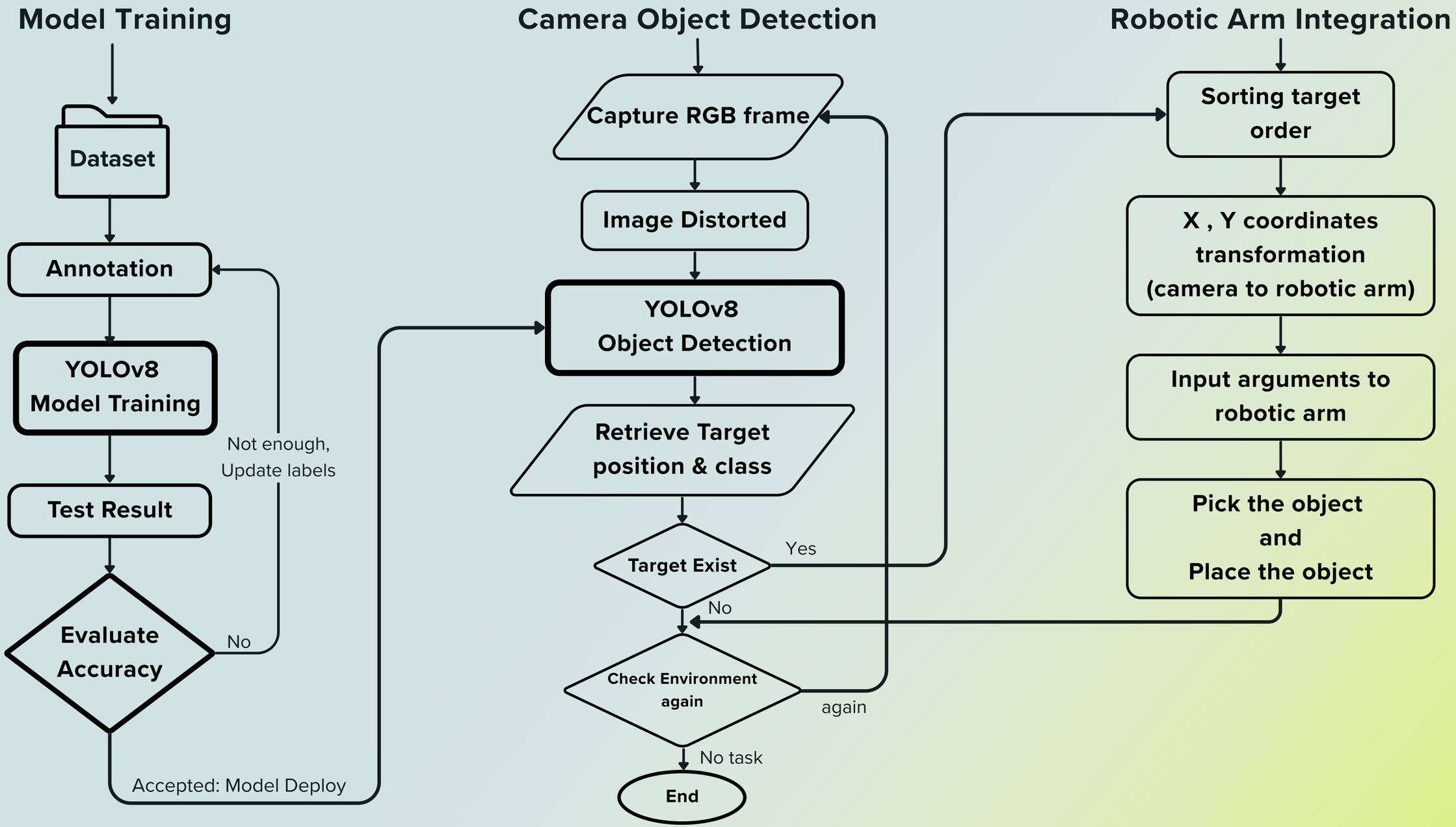


# Proposed Solution:

## YOLOv8-based Automated Freshness Detection System



# SYSTEM ARCHITECTURE OVERVIEW

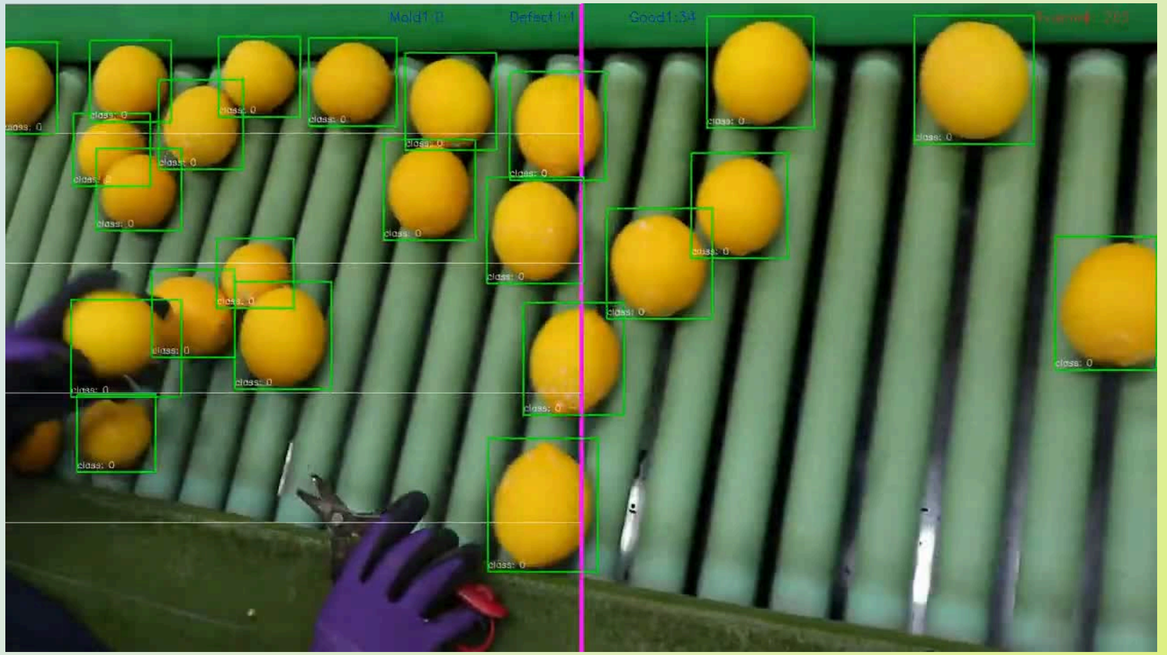


# YOLOV8 ARCHITETURE

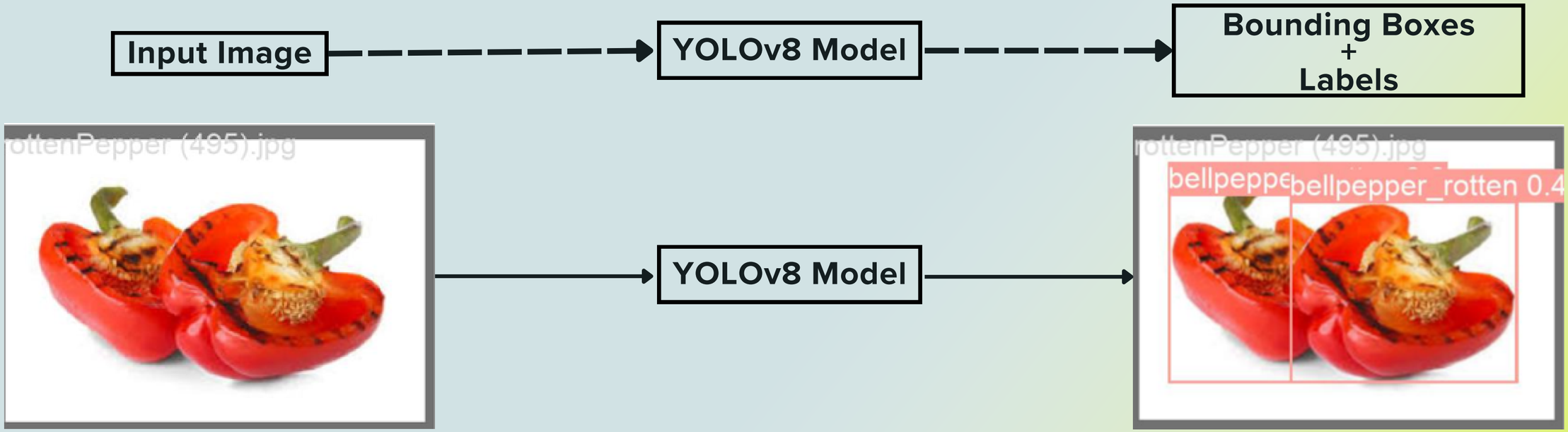
**YOLOv8 (You Only Look Once) is a state-of-the-art real-time object detection model developed by Ultralytics, capable of detecting and localizing objects in images with high accuracy and speed.**

### Why YOLOv8 for our Project?

- ⚡ Fast and lightweight — ideal for real-time detection
- 🧠 Accurate bounding box predictions
- 🛠️ Pretrained models available (quick fine-tuning)
- 💻 Compatible with low-powered devices and robotic integration



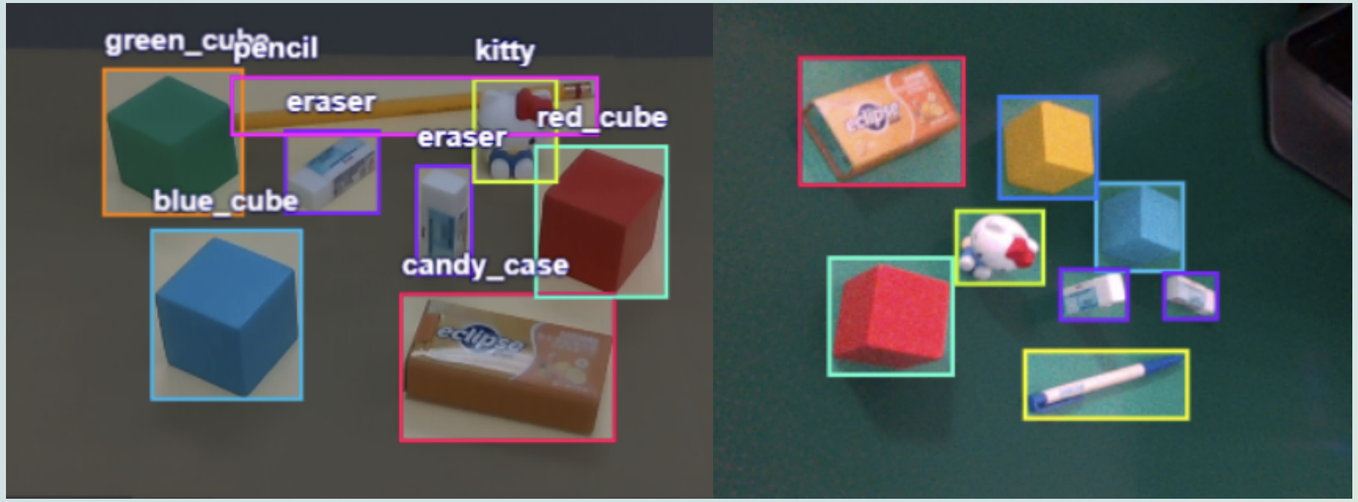
# YOLOV8 ARCHITECTURE



# Datasets  Overview

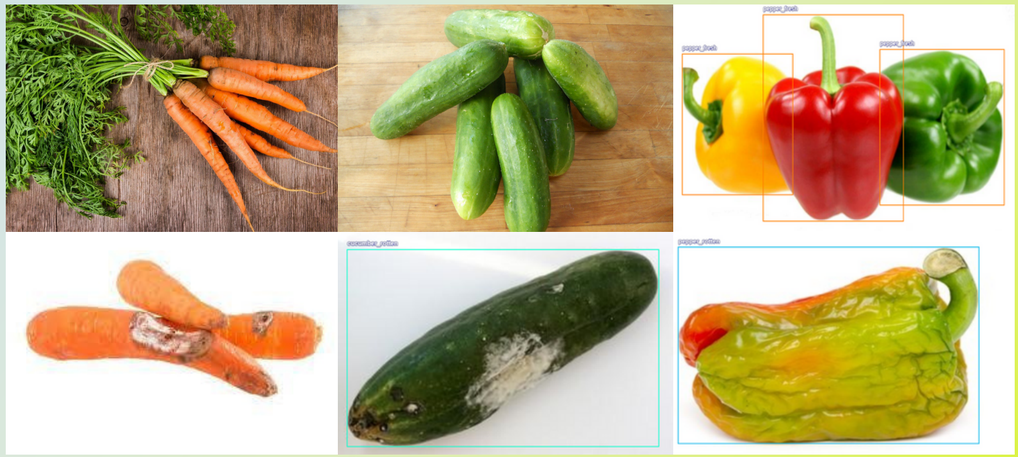
## Small Objects Dataset

- 9 classes
- 281 images




## Vegetable Dataset

- 12 classes
  - 6 Vegetables
  - Fresh / Rotten
- 6484 images



# Our Dataset

| Vegetable | Class ID | Total Amount of Images |
|---|---|---|
| Fresh Bellpepper | 0 | 600 |
| Expired Bellpepper | 1 | 591 |
| Fresh Bitter Gourd | 2 | 327 |
| Expired Bitter Gourd | 3 | 357 |
| Fresh Capsicum | 4 | 990 |
| Expired Capsicum | 5 | 901 |

| Vegetable | Class ID | Total Amount of Images |
|---|---|---|
| Fresh Carrot | 6 | 620 |
| Expired Carrot | 7 | 580 |
| Fresh Cucumber | 8 | 608 |
| Expired Cucumber | 9 | 593 |
| Fresh Potato | 10 | 615 |
| Expired Potato | 11 | 585 |

# Evaluation Method

**Objective:**

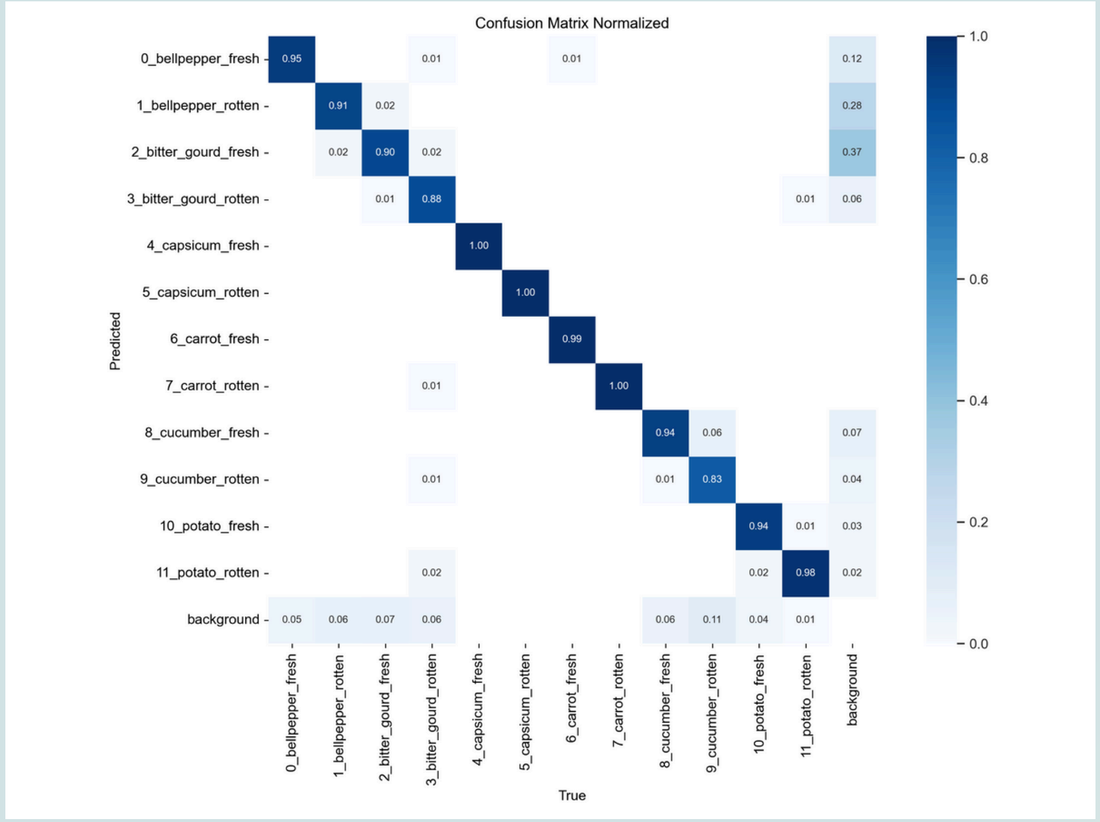
- Detect objects and perform robotic pick-and-place.

**Standard Metrics:**

- Precision (misclassify)
- Recall (non-detected)
- mAP@50 (Comprehensive of PR)
- mAP@50-90

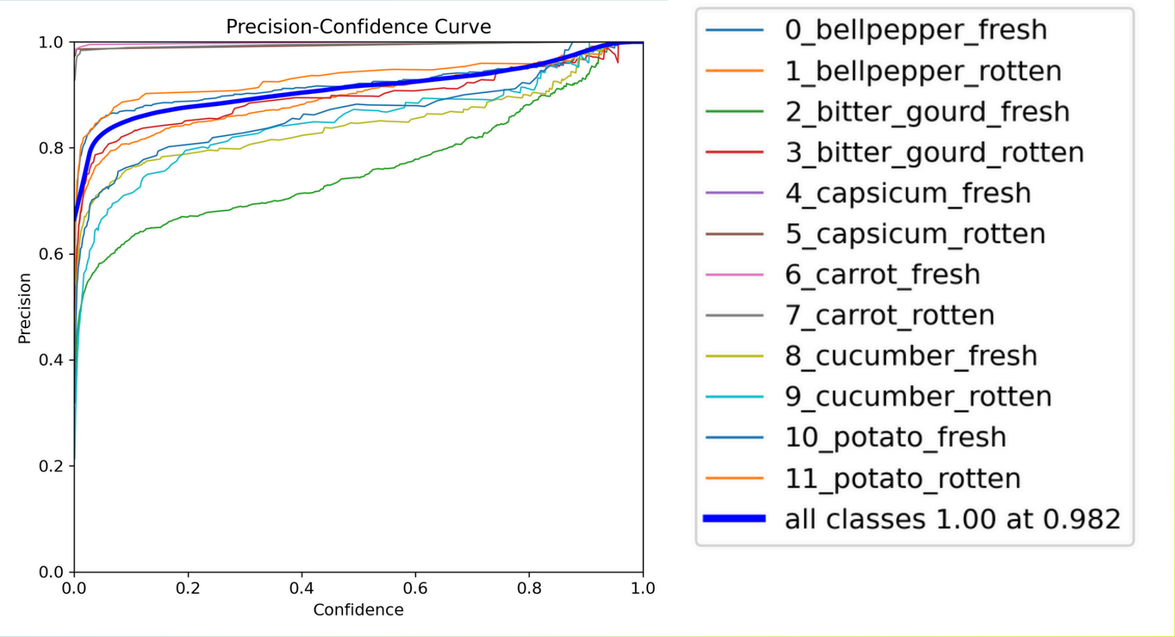
# Test Data Analysis

## Vegetable Dataset



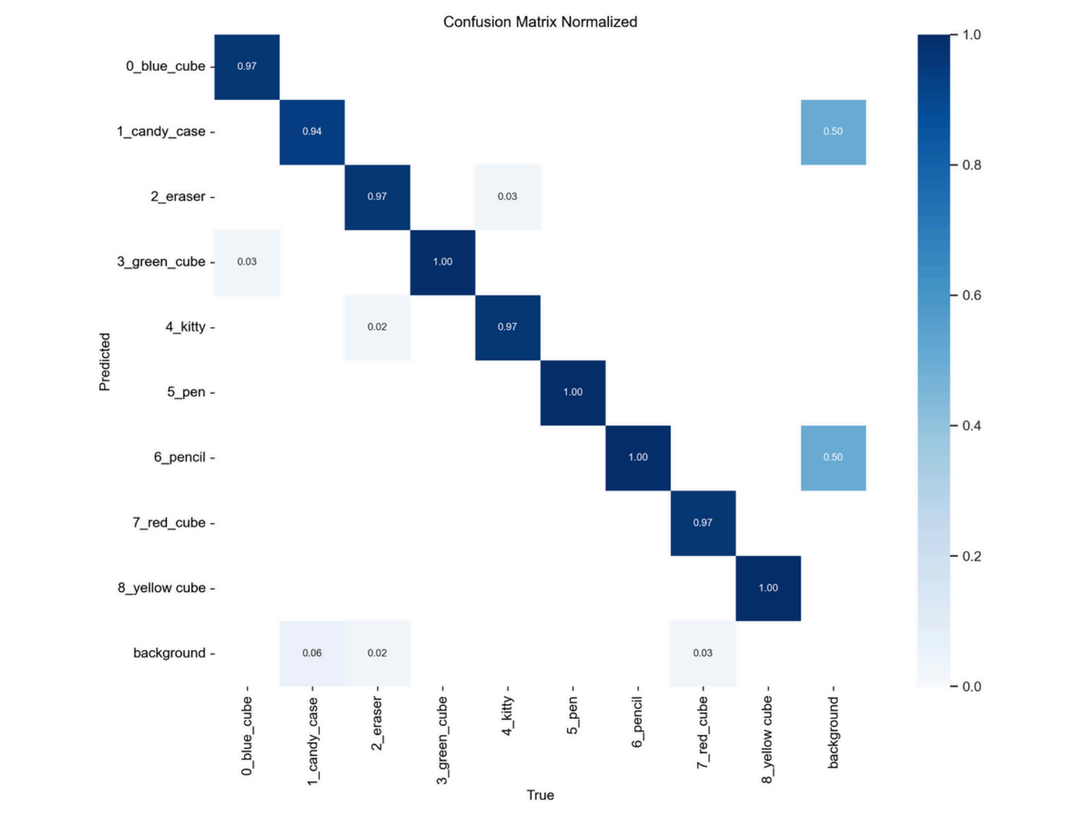

## Model Performance Summary

| Dataset | Precision | Recall | mAP@50 | mAP@50:95 |
|---|---|---|---|---|
| Vegetables | 0.918 | 0.894 | 0.938 | 0.855 |



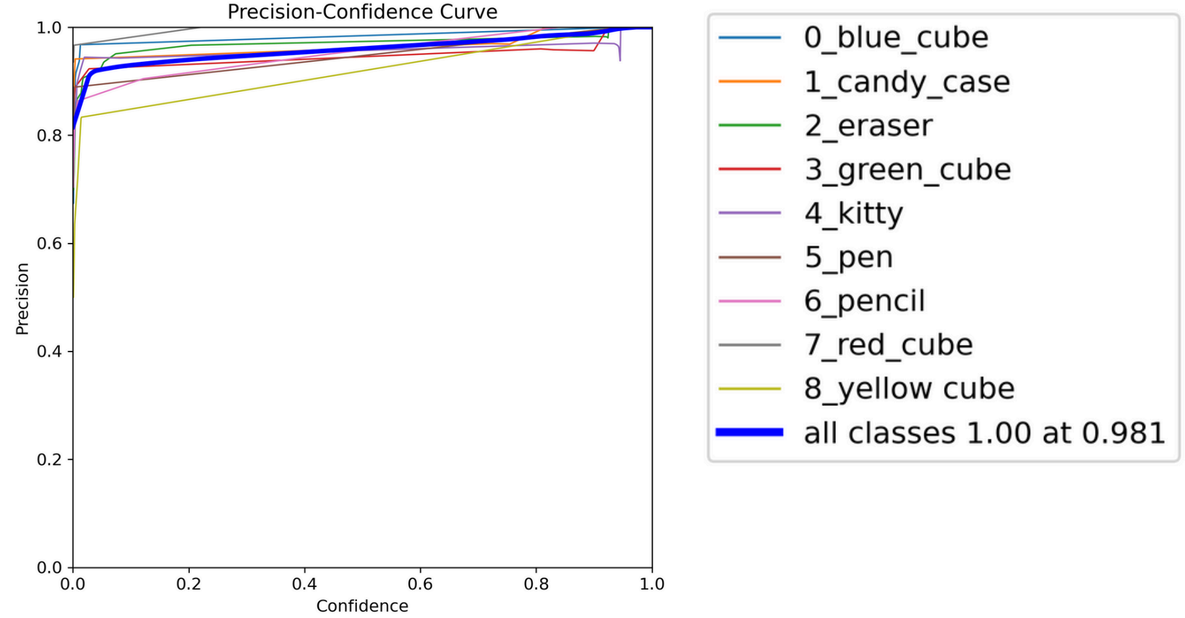
# Test Data Analysis

## Small Object Dataset




## Model Performance Summary

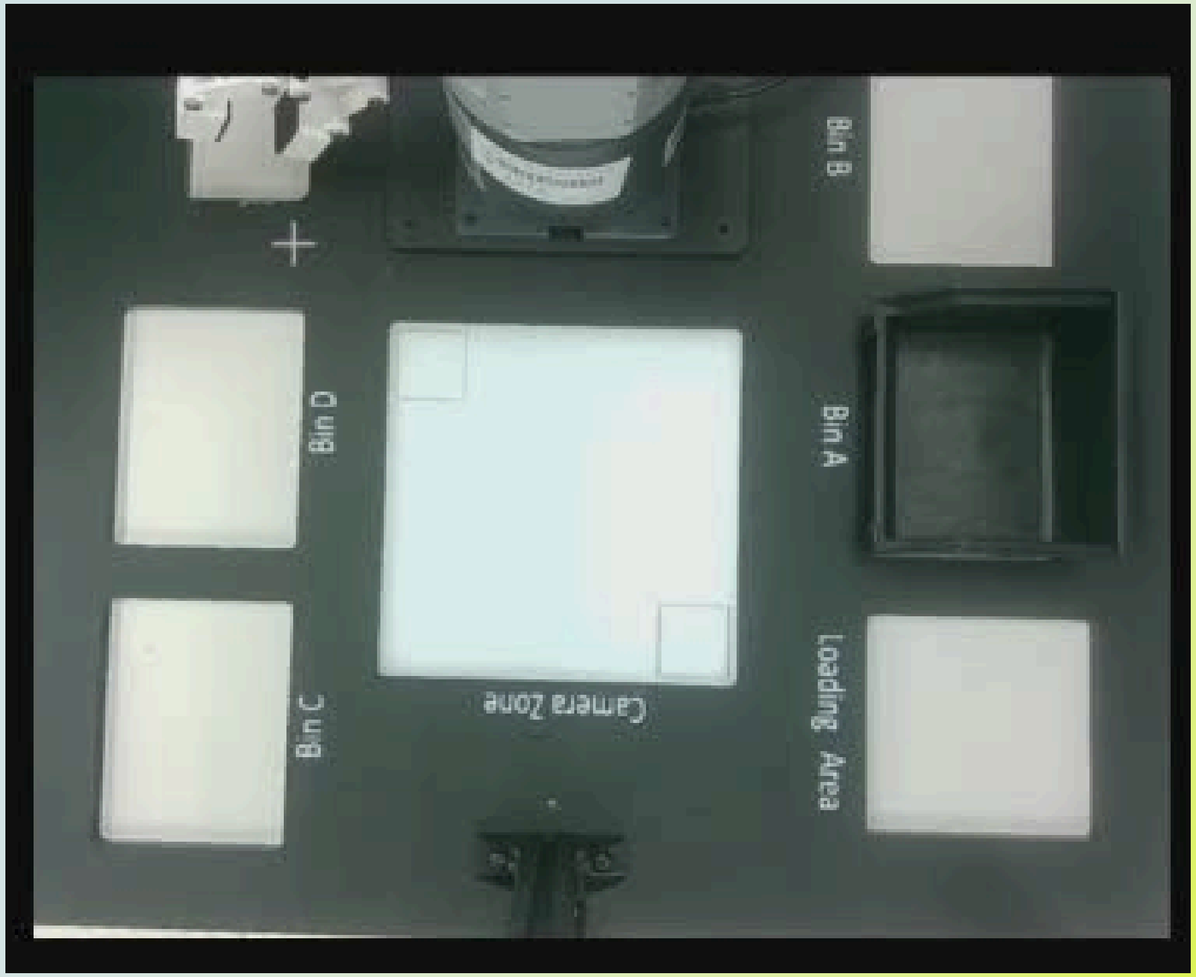
| Dataset | Precision | Recall | mAP@50 | mAP@50:95 |
|---|---|---|---|---|
| Small Objects | 0.982 | 0.973 | 0.987 | 0.924 |



# Pick-and-Place Demo

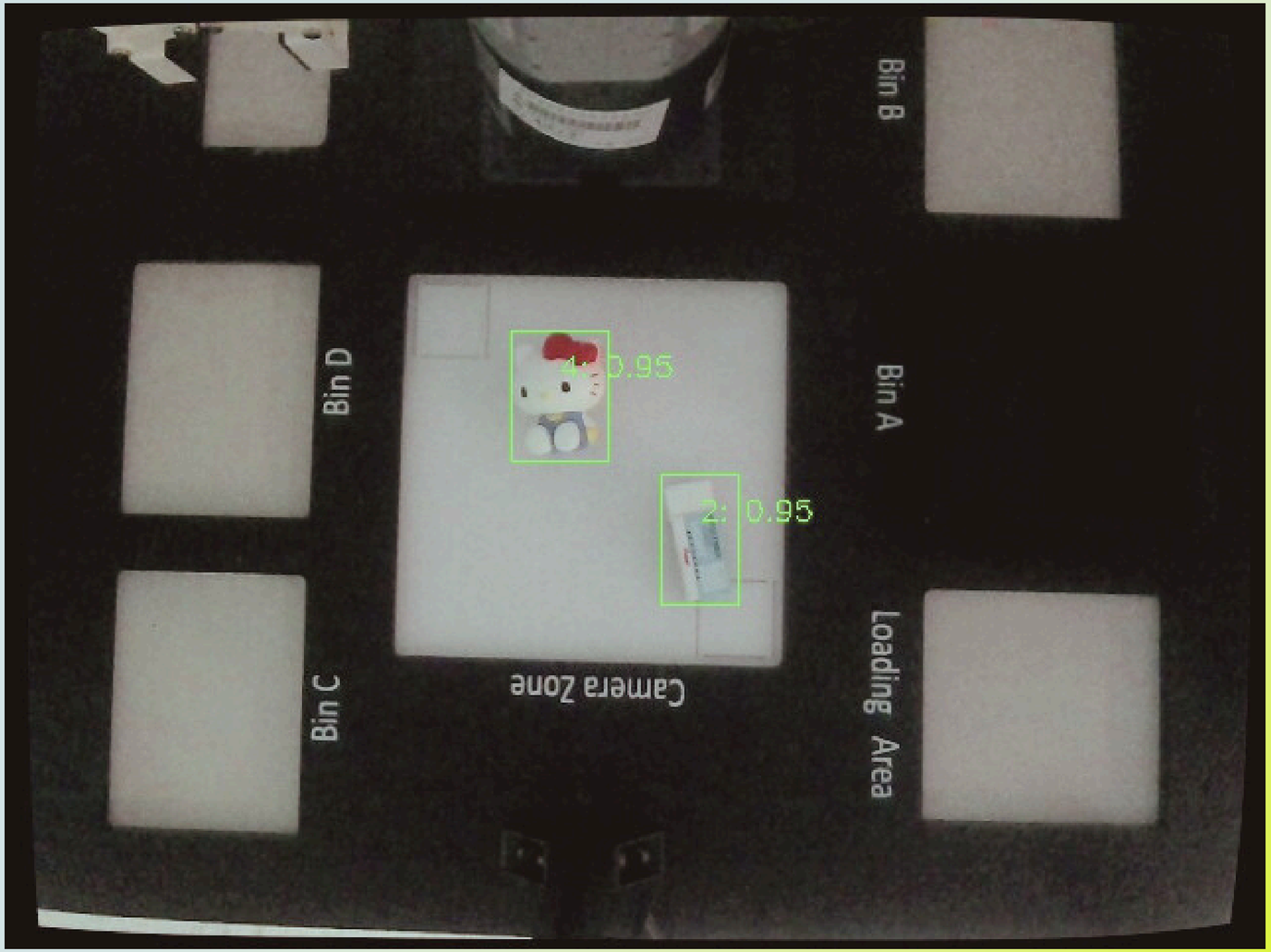
## Homography Calibration

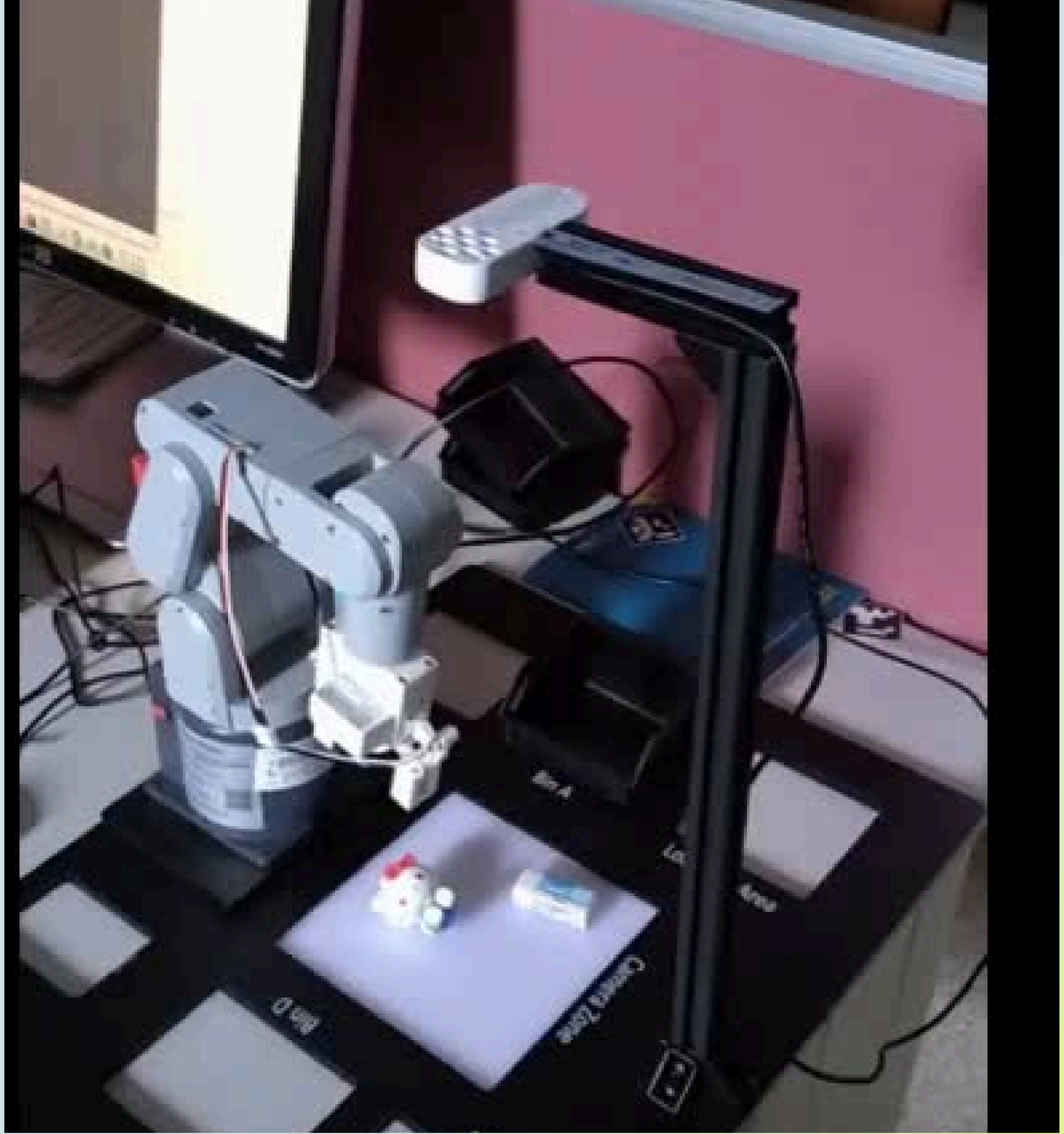
Transform pixel coordinates from the image plane into the robotic arm’s spatial coordinate system.



# Pick-and-Place Demo

## YOLOv8 Model Prediction





# Limitation & Future Work

- Collect and utilize higher-quality image data to further enhance the model's accuracy and robustness.
- Integrate object detection with tracking techniques to enable dynamic object capture in motion scenes.
- Incorporate depth features and pose estimation for precise 3D spatial localization of complex-shaped objects.

# Q&A