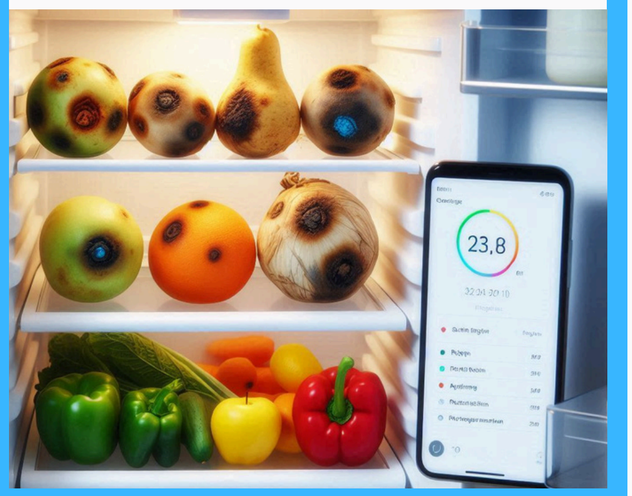
SMART FRIDGE

Mehmet Erkut Erdem[1], Can Ali Ateş[1], Emre Çoban[1], Abdullah Enes Ergün[1], Baha Kırbaşoğlu[1]
[1]Hacettepe University, Department of Artificial Intelligence
https://smartfridgehacettepe.github.io/

Abstract

Food waste is a significant global issue, impacting both the environment and the economy. The "Smart Fridge" project addresses this problem by monitoring the condition of fruits and vegetables stored in household refrigerators, thereby preventing spoilage and reducing waste. Using the YOLOv8 object detection algorithm, the system classifies produce as either fresh or rotten, with rotten items further analyzed by a ResNet-101 model to determine the extent of decay. Our integrated approach has shown high accuracy in differentiating and estimating decay, promising to cut down food waste and encourage sustainable consumption. Future improvements will enhance accuracy, expand the dataset, and integrate additional sensors for comprehensive monitoring.



Dataset

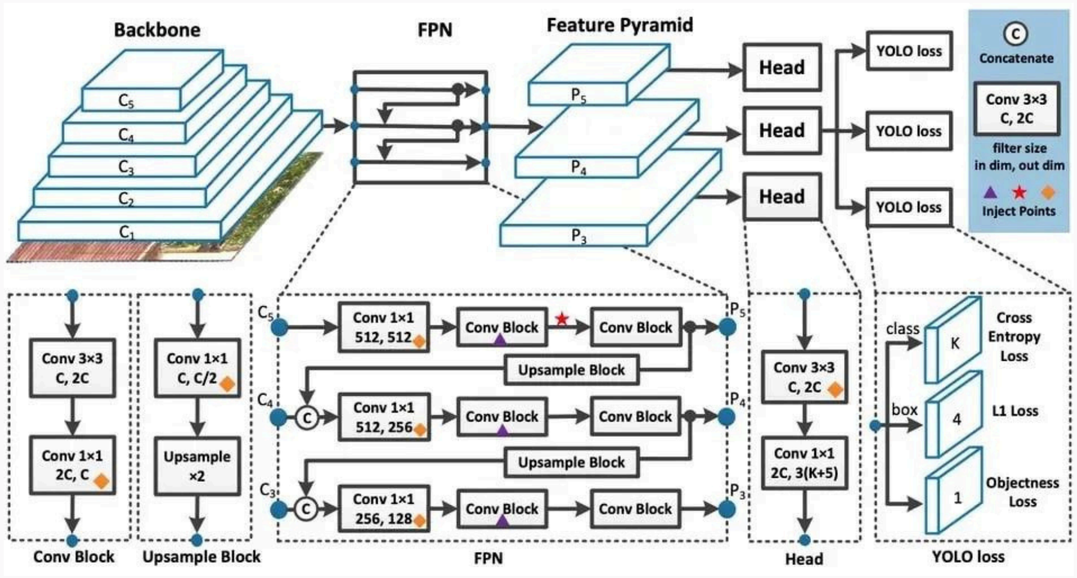
The dataset contains five different types of vegetables and fruits. Hacettepe University Food Engineering Department is provided to fresh and rotten images. The distribution of these images are as follows:

- **Peach: 307 fresh, 252 rotten**
- **Lemon: 132 fresh, 195 rotten**
- **Mandarin: 196 fresh, 220 rotten**
- **Tomato: 253 fresh, 225 rotten**
- **Cucumber: 105 fresh, 39 rotten**

Methodology

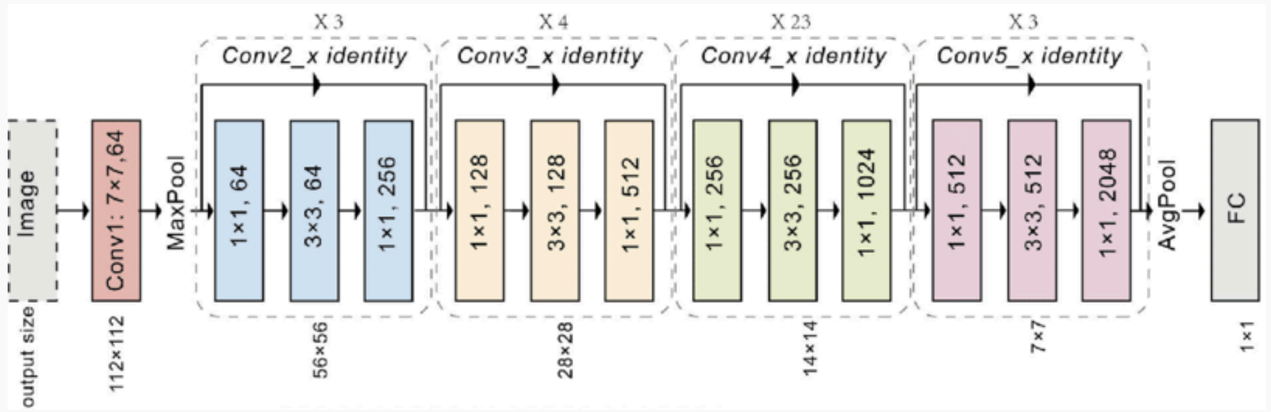
Fruit and Vegetables Detection with YOLOv8

YOLOv8 (You Only Look Once, version 8) was chosen for object detection due to its high speed and accuracy. As a single-stage detector, it simultaneously predicts bounding boxes and class probabilities, making it ideal for real-time applications. The YOLOv8-small) was sufficient for the task. Each dataset image was annotated with bounding boxes for fruits and vegetables, labeled as fresh or rotten, in a YOLOv8-compatible format. The model was initialized with pre-trained weights and trained for 60 epochs with data augmentation. In the training, AdamW optimizer with a 0.000714 learning rate and a batch size of 38.



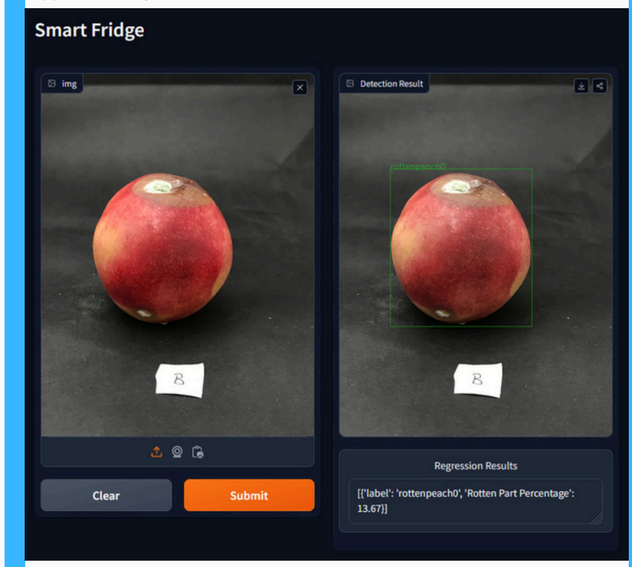
Decay Estimation with ResNet-101

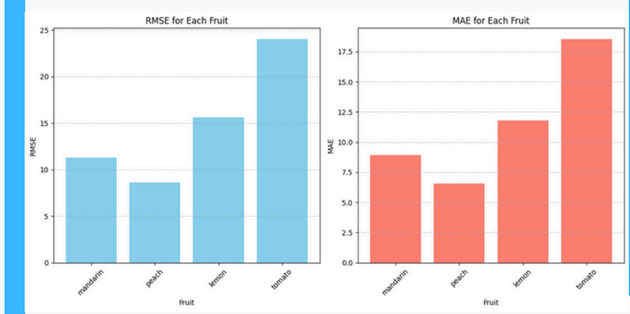
The ResNet-101 model was used after YOLOv8 identified rotten items to estimate the percentage of the rotten part. Chosen for its depth and superior image classification performance, ResNet-101's complex feature extraction was leveraged. Initialized with pre-trained ImageNet weights, the model had three added fully connected layers: the first with 2048 input features and GeLU activation outputting 512 features, the second with 512 input features and GeLU activation outputting 64 features, and the final layer producing a single output node representing the percentage of the rotten part (0-100).



Results & Conclusion

Overall, the YOLOv8 model achieved impressive performance across all classes, with mean Average Precision (mAP) scores exceeding 0.95 for each category. The integrated pipeline demonstrated the ability to accurately differentiate between fresh and rotten items and estimate the decay percentage with a Mean Absolute Error (MAE) of approximately 10-15%.





In conclusion, the Smart Fridge project represents a transformative approach to mitigating food waste through the application of advanced image recognition and deep learning techniques. By enhancing household food management practices, the system not only provides economic benefits to consumers but also contributes to environmental sustainability by reducing the amount of organic waste in landfills. The integration of this technology into smart home ecosystems offers a competitive advantage for manufacturers and valuable insights for future innovations. With ongoing improvements in decay detection accuracy and the incorporation of additional sensors, the Smart Fridge can deliver even more precise assessments of produce conditions. Moreover, the development of a complementary mobile application could enhance user engagement and efficiency in food utilization. Ultimately, the Smart Fridge project has the potential to play a pivotal role in achieving sustainability goals and revolutionizing the way households manage their food resources.