Universidad de las Américas Puebla

Final Project Definition: Fruit-lens

Ximena Vazquez Mellado Flores, 171319

Alejandro Sánchez González, 167299

Humberto Alejandro Zepeda González, 174653

Mobile App Development - LIS4012

Spring 2025

January 31st, 2025

Problem Statement:

Maintaining a balanced diet is essential for a healthy lifestyle, and consuming fresh fruits plays a key role in this. However, according to a study conducted in EU countries, fresh fruits and vegetables account for 50% of household food waste (De Laurentiis et al., 2018). Many people struggle to determine whether a fruit is still unripe, ripe, overripe, or spoiled, leading to negative experiences and significant waste. This issue is particularly relevant for individuals with little experience in selecting fruits, such as young adults, busy professionals, or those just starting to cook.

While a common solution is manual inspection—evaluating a fruit's color, texture, and smell—this method requires experience and involves trial and error, which still contributes to a high level of waste. To address this issue, Fruit-Lens leverages computer vision with a pre-trained neural network to scan and assess a fruit's ripeness, providing users with real-time feedback. This solution is accessible to a wide range of people and is becoming increasingly viable thanks to the continuous improvement of smartphone cameras and processing power, enabling the integration of artificial intelligence into everyday applications.

Comparing our proposal with existing solutions

Several approaches exist to help consumers determine fruit ripeness, ranging from traditional manual inspection to AI-powered mobile applications. Below, we compare Fruit-Lens with three existing methods: manual inspection, Ripeness detection apps (AI-based), and supermarket freshness labels (RFID/NFC technology).

1. Manual Inspection (Traditional Method)

Manual fruit selection relies on sensory evaluation, including color, texture, and smell. While experienced individuals can accurately determine ripeness, this method has several drawbacks:

- Subjectivity – The accuracy of manual inspection varies between individuals.
- Learning Curve – New consumers must go through trial and error, leading to food waste.
- Time-Consuming – Checking multiple fruits individually takes time.

2. AI-Based Ripeness Detection Apps

Several AI-driven applications, such as Plantix, Fruit Recognizer, and Fruity AI, utilize machine learning models to classify fruit ripeness based on images. While they provide automation, they have limitations:

- Limited Dataset Generalization – Some apps struggle with different lighting conditions or fruit varieties.
- Complexity in Use – Some require manual feature selection (e.g., users need to adjust image settings).
- Internet Dependency – Many rely on cloud-based AI, requiring a stable internet connection.

3. Supermarket Freshness Labels (RFID/NFC Sensors)

Some grocery chains have introduced RFID (Radio Frequency Identification) and NFC (Near-Field Communication) sensors on packaging to track produce freshness. These solutions are effective but have challenges:

- Costly Implementation – RFID technology increases packaging costs, making it unsuitable for small vendors.
- Limited Accessibility – Consumers rely on retailers to provide this information rather than having direct control.
- Environmental Impact – Additional electronic waste from disposable RFID tags.

<u>How Fruit-Lens Improves on Existing Solutions</u>

Compared to these approaches, Fruit-Lens offers a real-time, user-friendly, and accessible solution by combining computer vision and pre-trained neural networks to classify fruit ripeness without requiring additional sensors or manual adjustments. Key advantages include:

- Ease of Use – Users simply scan a fruit with their smartphone camera for instant feedback.
- No Additional Hardware – Unlike RFID/NFC, Fruit-Lens requires no special labels or sensors.
- Offline Functionality – AI models can be optimized to run locally, reducing dependency on internet access.
- Broader Accessibility – Unlike store-based solutions, anyone can use it, regardless of their location.

By leveraging advancements in smartphone cameras and AI-driven image recognition, Fruit-Lens provides a scalable and cost-effective alternative for reducing food waste while improving user experience in fruit selection.

Target Audience

Understanding the key demographics that will benefit from Fruit-Lens is crucial for its successful development. By identifying the primary users, we can modify the app's design and functionality to meet their specific needs. The following groups represent the main target audience for the application:

- **General consumers** who want to ensure they purchase or consume fresh fruit.
- **Grocery shoppers** who are looking for an easy way to select the best produce.
- **Farmers and fruit vendors** that are seeking to evaluate fruit quality before sale.
- **Busy Professionals** who want a quick and reliable way to check fruit quality while grocery shopping.
- **Eco-Conscious Users** who want to reduce food waste by identifying fruits that are still edible but may appear overripe.
- **Students and young adults** who may lack experience in selecting ripe fruits and need guidance.

Key Features

To effectively address the challenges of determining fruit ripeness, Fruit-Lens integrates several core features that enhance user experience and functionality. These features leverage advanced technologies to provide accurate and real-time assessments of fruit freshness:

- **Fruit Ripeness Detection:** Users can scan fruits using their smartphone camera, and the app will analyze the fruit's condition (ripe, unripe, or rotten) using a pre-trained neural network.
- **Real-Time Scanning:** The app supports both real-time camera scanning and photo uploads for convenience.
- **Fruit Identification:** The app can recognize a variety of fruits and provide specific ripe information for each type.
- **User-Friendly Interface:** A simple and intuitive design allows users to quickly scan and receive results without technical expertise.

Technical Approach

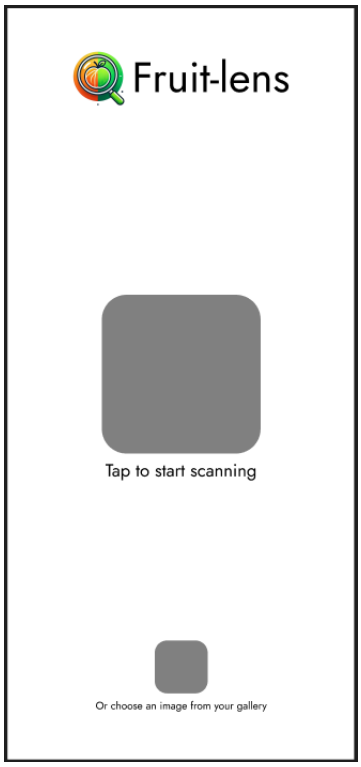
The development of Fruit-Lens requires a well-structured technical strategy to ensure seamless performance across different platforms. This section outlines the key technologies and methodologies that will be used to develop and deploy the application:

- **Development Platform**: The app will be developed as a cross-platform mobile application to support both Android and iOS.
- **Key Technologies & Frameworks**:
    - Frontend: React Native will be used for building the user interface and ensuring a seamless experience across platforms.
    - AI/ML Model: A pre-trained neural network (e.g., TensorFlow Lite) will be integrated for fruit detection and ripeness analysis. The model will be trained on a dataset of fruit images labeled by ripeness levels.
    - Computer Vision: OpenCV or a similar library will be used for image processing and analysis.
    - APIs: The app may use device-specific APIs for camera access and image capture.

User Interface Sketches

A well-designed user interface is essential for ensuring an intuitive and accessible user experience. This section provides an overview of the main screens within the app, illustrating how users will interact with the various functionalities.

- **Home Screen:** A simple screen with a large camera button for scanning, along with options to upload a photo from the gallery.
- **Scanning Screen:** A live camera view with a bounding box to highlight the fruit being scanned. Real-time feedback (e.g., "Scanning...") will be displayed.
- **Gallery screen:** A phone gallery view where the user can select a photo from their phone gallery to scan.
- **Results Screen**: After scanning, the app displays the fruit name, ripeness status (e.g., "Ripe," "Unripe," "Rotten"), and cooking ideas.



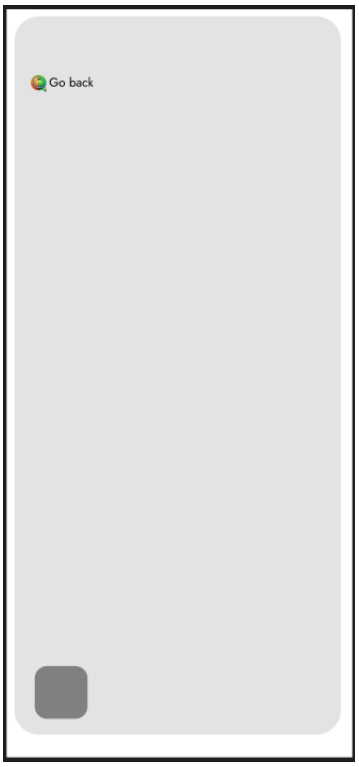


Image 1: home screen (left); image 2: scanning screen (right);

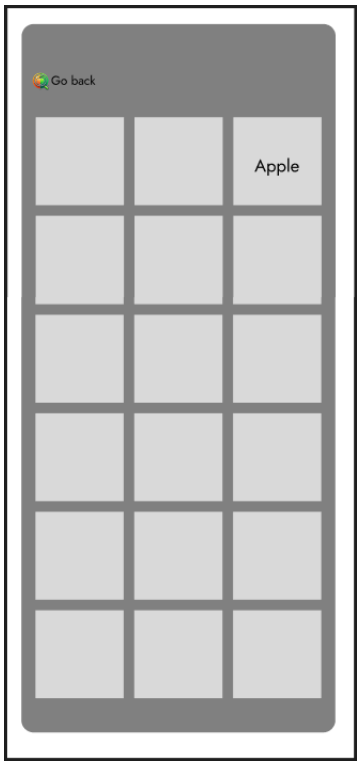


Image 3: gallery screen (left); image 4: results screen (right);

Challenges & Risks

Like any technological project, the development of Fruit-Lens comes with potential challenges and risks. This section identifies key issues that may arise during the development process and outlines strategies to mitigate them effectively:

- **Accuracy of the AI Model:**
  - Challenge: The AI model's ability to accurately detect fruit ripeness or spoilage depends on the quality and diversity of the training dataset. If the dataset is limited or biased, the model may produce inaccurate results.
  - Mitigation: Use a diverse dataset of fruits under various lighting conditions and stages of ripeness. Continuously test and refine the model to improve accuracy.

- **Camera Performance Across Devices:**
  - Challenge: Different devices have varying camera qualities, which may affect the app's ability to capture clear images for analysis. Low-light conditions or poor camera resolution could lead to inaccurate results.
  - Mitigation: Optimize the app to work with a wide range of devices. Provide users with guidance on how to capture clear images (e.g., proper lighting, steady hands).

- **Compatibility Issues:**
  - Challenge: Ensuring the app works seamlessly across different operating systems (Android and iOS) and device models can be challenging, especially when using platform-specific features like the camera.
  - Mitigation: Use a cross-platform framework like React Native to ensure compatibility. Test the app on multiple devices and operating systems during development.

- **Battery and Performance Optimization:**
  - Challenge: Continuous use of the camera and AI processing can drain the device's battery and slow down performance, especially on older devices.
  - Mitigation: Optimize the app's performance by reducing the computational load of the AI model. Use lightweight frameworks like

TensorFlow Lite for on-device processing.

- **App Store Approval:**
    - Challenge: The app may face rejection from the Play Store or App Store if it does not comply with their guidelines, especially regarding camera usage and data privacy.
    - Mitigation: Carefully review and adhere to the app store guidelines. Ensure the app requests camera permission properly and does not store user data without consent.

Expected Outcome & Impact

Fruit-Lens aims to provide visible benefits for users and the environment by reducing food waste, enhancing convenience, and promoting healthier eating habits. This section discusses the expected impact of the app and how it contributes to a more sustainable food consumption model:

- **Improved Food Waste Reduction:**
    - Impact: By helping users determine the ripeness or spoilage level of fruits, the app will encourage them to consume fruits before they go bad. This will contribute to reducing food waste at the household level.

- **Enhanced User Convenience:**
    - Impact: Users will no longer need to rely on guesswork or manual inspection to determine if a fruit is ripe or spoiled. The app provides a quick and accurate solution, saving time and effort.

- **Health and Nutrition Benefits:**
    - Impact: The app will encourage users to consume fresh and ripe fruits, promoting healthier eating habits. It will also help users avoid consuming spoiled fruits, which can be harmful to health.

- **Cost Savings for Users:**
    - Impact: By reducing food waste, users will save money by making better use of the fruits they purchase. The app will also help users avoid buying overripe or spoiled fruits in the future.

- **Environmental Impact:**
    - Impact: Reducing food waste has a positive environmental impact by decreasing the amount of organic waste that ends up in landfills. This contributes to lower greenhouse gas emissions and a more sustainable food system.

Updates – March 25th, 2025

We have made progress in the following 3 sections of the project:

1. User Interface Progress

We have completed the development of four key screens for the Fruit-Lens app:

- Home Screen: Implemented navigation to subsequent screens and finalized the functionality for the "Scanning" button.
- Scanning Screen: Includes navigation logic directing users to either the results screen or an error screen, along with a simulated scanning process using a five-second timer.
- Fruit Results Screen: Designed dynamically to display detected fruit, including an image, name, ripeness status, and estimated time before spoilage.
- Error Screen: Displays an error message when no fruit is detected and includes a "Go Back" button for users to return to the home screen and retry scanning.

2. Camera and Photo Access

We evaluated different libraries for accessing the device camera and processing images. After comparing options, we selected the most suitable library based on ease of setup, platform compatibility, and performance for real-time scanning. Our chosen approach ensures reliable camera access across iOS and Android while supporting the computer vision requirements of our application.

3. Artificial Vision Model Training

We conducted initial training for our artificial vision model, which is designed to:

- Detect Fruit Quality: Classifies fruits as "fresh," "rotten," or another quality level based on visual analysis.

- Analyze Images: Evaluates color, texture, and blemishes to determine fruit ripeness.
- Provide Labels: Assigns a category to each scanned fruit.
- Generate Confidence Scores: Returns a probability score indicating the certainty of each prediction.

This initial phase of model training has demonstrated promising results, and further refinements will be made as we expand our dataset and optimize performance.

These updates mark significant progress in our development, bringing us closer to a functional prototype for testing and user feedback.

References

De Laurentiis, Valeria, et al. "Quantifying Household Waste of Fresh Fruit and Vegetables in the EU." Waste Management, vol. 77, July 2018, pp. 238–251, https://doi.org/10.1016/j.wasman.2018.04.001.

Patel, K. K., Kar, A., Jha, S. N., & Khan, M. A. (2012). Machine vision system: A tool for quality inspection of food and agricultural products. Journal of Food Science and Technology, 49(2), 123-141. https://doi.org/10.1007/s13197-011-0293-6

Reyes, J., & Ventura, J. (2020). Automated fruit ripeness detection using deep learning techniques. Computers and Electronics in Agriculture, 170, 105247. https://doi.org/10.1016/j.compag.2020.105247

Food and Agriculture Organization of the United Nations. (2011). Global food losses and food waste – Extent, causes and prevention. FAO. https://www.fao.org/3/i2697e/i2697e.pdf

Opara, L. U., & Al-Ani, M. R. (2010). Reducing food waste by improving fruit quality management. Postharvest Biology and Technology, 57(3), 195-200. https://doi.org/10.1016/j.postharvbio.2010.03.006