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**1. Project Overview**

The **Peach Farming Assistant** is a streamlined and interactive tool designed to help farmers improve their peach farming operations by leveraging machine learning and computer vision models. The system assists in three critical areas:

1. **Soil Classification**: Identifies the type of soil in a peach orchard and provides tailored farming advice to optimize peach yield.
2. **Disease Detection**: Detects common diseases that affect peach trees and offers recommended treatment methods.
3. **Peach Counting**: Utilizes video input to count the number of peaches visible on trees, aiding in yield estimation.

The core of this application lies in its ability to process visual inputs (images and video) and make predictions based on pre-trained models. The models are designed using deep learning techniques and YOLO (You Only Look Once) object detection. The app is developed using **Streamlit**, a framework that simplifies the process of creating machine learning-powered web apps.

**1.1. Problem Statement**

Peach farming, like most agricultural industries, requires careful management of soil conditions, disease control, and yield estimation to ensure optimal production. However, manual assessment of soil, identification of diseases, and counting peaches in an orchard can be labor-intensive and prone to human error. This project automates and enhances these tasks using machine learning.

The primary objectives are:

* **Classify different types of soil** and provide farming suggestions.
* **Detect peach tree diseases** using leaf or tree images.
* **Estimate the number of peaches** from videos using object detection.

**2. Model Implementation**

In this project, three models are used, each for a different task. These models are built using deep learning algorithms, including Convolutional Neural Networks (CNNs) and YOLO for real-time object detection.

**2.1. Soil Classification Model**

The soil classification model is based on the **InceptionV3** architecture, which is a CNN model widely used for image classification tasks. The model has been trained on soil image data and can categorize soils into five classes: **Black Soil, Cinder Soil, Laterite Soil, Peat Soil, and Yellow Soil**. Each type of soil has different properties, and the model’s predictions are accompanied by recommendations on how to treat the soil to optimize peach farming.

**Preprocessing for Soil Classification**:

* Images are resized to 224x224 pixels.
* Pixel values are normalized (scaled between 0 and 1) to prepare them for input to the model.
* The model outputs probabilities for each class, and the class with the highest probability is selected as the predicted soil type.

**Model Training**:

* The model was trained using a labeled dataset of soil images.
* Techniques such as data augmentation (flipping, rotating, etc.) were applied to improve generalization.
* Loss function used was categorical cross-entropy with an optimizer such as Adam to update the weights during training.

**2.2. Disease Detection Model**

Similar to the soil classification model, the **InceptionV3** architecture is used for disease detection. This model predicts common peach tree diseases by analyzing images of tree leaves or branches. The model classifies diseases into five categories: **CJB (Crown and Root Gall Bacteria), CKB (Coryneum Blight), GAB (Gummosis), HFB (Peach Leaf Curl), and TJB (Twig Blight)**.

Each disease class is mapped to specific recommendations for treatment, such as fungicide application, pruning, or irrigation adjustments.

**Preprocessing for Disease Detection**:

* Input images are resized to 224x224 pixels, normalized, and expanded to fit the model's input shape.
* The model predicts probabilities for each disease, and the class with the highest probability is selected as the detected disease.

**Model Training**:

* The model was trained on a dataset of images of infected peach trees.
* Preprocessing techniques such as rescaling, augmentation, and data normalization were used.
* The final layer of the model uses softmax activation for multi-class classification.

**2.3. Peach Counting Model**

The **YOLOv5** model is employed to count the number of peaches in video frames. YOLO is a state-of-the-art object detection model that processes images in real-time. The model takes video input, analyzes each frame, and detects objects (peaches) in the scene.

**Preprocessing for Peach Counting**:

* Each frame of the video is processed to extract peaches using the YOLOv5 model.
* Bounding boxes are drawn around detected peaches, and a peach count is calculated by counting the boxes in the frame.
* The app continuously updates the peach count as the video plays, providing a real-time estimate of the number of peaches in the orchard.

**Model Training**:

* YOLOv5 was trained on a custom dataset of peach images annotated with bounding boxes.
* The model detects objects by predicting bounding boxes and class probabilities, enabling it to count peaches in real-time.

**3. Application Functionality**

The **Streamlit** framework powers the front-end of the Peach Farming Assistant, providing an easy-to-use interface for farmers. The app offers three main functionalities: soil classification, disease detection, and peach counting.

**3.1. Soil Classification**

Farmers can upload an image of soil from their farm to determine its type. The app will preprocess the image and pass it through the soil classification model. After prediction, the app displays the soil type and provides actionable advice on how to treat the soil to enhance peach tree growth.

The soil advice is customized based on the specific soil type, addressing issues such as nutrient content, drainage, and pH levels, which are critical for optimal peach yield.

**3.2. Disease Detection**

This section allows farmers to upload an image of a peach tree or its leaves to detect potential diseases. Once the image is uploaded, it is passed through the disease detection model, which predicts the disease affecting the tree. The app then suggests treatments, such as applying fungicides, adjusting irrigation, or pruning to control the disease.

This feature helps farmers quickly identify diseases in their orchards, potentially reducing the time it takes to respond to outbreaks and minimizing crop damage.

**3.3. Peach Counting**

The peach counting feature accepts a video input of the peach orchard. The video is processed frame by frame, and the YOLOv5 model detects and counts the peaches visible in each frame. The app then provides an ongoing count of peaches in the orchard, offering valuable insights into expected yield.

Farmers can use this feature to estimate the number of peaches on their trees without manually counting them, saving time and improving accuracy.