irriDate: A Smart Solution for Palm Tree Irrigation and Health Monitoring

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The irriDate application incorporates two main datasets for building its models: one for palm disease analysis and another for smart irrigation. Here's a summary of the data and preprocessing steps taken for each.

Palm Health Analyzer Data:

The dataset for the palm health analyzer model was sourced from the article "Dataset of infected date palm leaves for palm tree disease detection and classification" by authors Abdallah Namoun, Ahmad B. Alkhodre, Adnan Ahmad Abi Sen, Benhammadi, Yazed Alsaawy, and Hani Almoamari, published on:

https://www.sciencedirect.com/science/article/pii/S2352340924008965#refdata001

This dataset includes a combination of both raw and processed images of palm trees, spanning ten distinct classes. Eight of these classes represent different palm diseases (potassium deficiency, manganese deficiency, magnesium deficiency, black scorch, leaf spots, fusarium wilt, rachis blight, and parlatoria blanchardi), one class is for healthy trees.

To enhance the dataset and improve the model's ability to detect images without palm trees, we added a new class, "No Plant." This class was populated by collecting images from Unsplash (which are free to use), specifically curated to represent scenes with no palm trees. These "No Plant" images help the model distinguish between valid and invalid inputs.

Preprocessing:

For the Palm Health Analyzer Model, images were loaded from a dataset that combined raw and processed images, with additional "No Plant" images sourced from Unsplash. The images were resized to 256x256 pixels and shuffled to ensure diversity.

The dataset was split into 70% training, 15% validation, and 15% testing. Data augmentation was applied in the form of random_flip_left_right to the training set to improve model robustness. The MobileNetV2 model, pre-trained on ImageNet, was fine-tuned by unfreezing the last 30 layers. Regularization methods like Dropout and l2, along with batch normalization, were used to enhance model performance and prevent overfitting.

Smart Irrigation Model Data:

For the smart irrigation model, we generated synthetic data as there was no publicly available dataset specific to palm tree irrigation. The dataset simulates soil moisture levels, temperature, and palm tree growth stages, based on actual weather conditions in Madinah, Saudi Arabia (latitude: 24.4672, longitude: 39.6024).

Weather Data:

The temperature data was collected using the meteostat library, which fetched daily average temperature data for the years 2020 and 2021. Missing temperature values were filled using forward filling to ensure continuity.

Synthetic Moisture and Growth Stage Data:

Soil moisture levels were simulated using a normal distribution, where values were capped between 0 and 1023 to reflect the sensor's moisture readings. The palm trees were categorized into three growth stages: Vegetative (1), Intermediate (2), and Fruiting (3). Each stage has a corresponding moisture threshold that determines whether irrigation is necessary.

Irrigation Simulation:

A custom function was developed to determine whether irrigation (referred to as "pump action") should be triggered based on the current moisture levels, growth stage, and temperature conditions. The model checks if the moisture levels exceed a threshold specific to the tree's growth stage. If the moisture levels are too low or too high, irrigation is either triggered or withheld. The synthetic dataset, which includes temperature, soil

moisture, growth stage, and irrigation decisions, was saved in a CSV file for training and testing the irrigation model.

While this synthetic data was essential for developing the model, we plan to collect real-world sensor data if the irriDate idea is further developed for commercial use. The synthetic dataset allowed us to approximate how irrigation might work based on conditions in Madinah, but real data collection from palm farms would enhance the model's accuracy and reliability.

By incorporating real-world temperature data and simulating soil moisture and growth stages, we strived to create a realistic dataset for the smart irrigation system, while the palm disease analyzer model leverages a robust set of image data from various sources to ensure accurate disease classification.