Melon Macronutrient Deficiency Classification using HOG and MobileNetV2 with SVM

This project aims to classify images of melons into categories based on macronutrient deficiencies using a combination of traditional image processing techniques and deep learning methods. The image classification process involves two different feature extraction methods: **Histogram of Oriented Gradients (HOG)** and **MobileNetV2**, followed by a **Support Vector Machine (SVM)** classifier for classification.

Steps Involved:

1. **Dataset Preparation**:
    - The dataset consists of images categorized into four classes, representing different types of macronutrient deficiencies in melons.
    - The images are resized to a fixed size of 224x224 pixels, which is a standard input size for CNNs like MobileNetV2.
2. **Feature Extraction Using HOG**:
    - **HOG (Histogram of Oriented Gradients)** is a classical feature extraction method used for object detection, focusing on capturing the structure and shape information from images.
    - The HOG features are extracted from the preprocessed images and then used as input for the SVM classifier.
3. **Feature Extraction Using MobileNetV2**:
    - **MobileNetV2** is a lightweight, pre-trained deep learning model that is used to extract high-level features from the images. The top layers of the model are removed (via `include_top=False`), and global average pooling is applied to obtain a 1280-dimensional feature vector for each image.
    - MobileNetV2 is particularly effective in extracting rich features while being computationally efficient.
4. **Scaling the Features**:
    - The extracted features, both from **HOG** and **MobileNetV2**, are scaled using **StandardScaler**. This normalizes the data to ensure that each feature has a mean of 0 and a standard deviation of 1, which is crucial for SVM performance.
5. **Data Splitting**:
    - The dataset is split into **training (70%)** and **test (30%)** sets using **train_test_split** from scikit-learn. This ensures the model is evaluated on data that it has not seen during training.
6. **Training the SVM Classifier**:
    - A **Support Vector Machine (SVM)** with a **linear kernel** is trained using the scaled features from both HOG and MobileNetV2.
    - The model is evaluated on the test set to assess its ability to classify images into one of the four deficiency categories.
7. **Model Evaluation**:
    - **Confusion Matrix**: A confusion matrix is generated to visualize how well the model performs across each class.
    - **Classification Report**: This report includes important performance metrics like precision, recall, and F1-score, allowing for a detailed assessment of the model's effectiveness.

Key Tools and Libraries:

- **TensorFlow/Keras**: Used for implementing the MobileNetV2 model and extracting deep features.
- **scikit-learn**: For data scaling, splitting, and training the SVM classifier.
- **OpenCV**: For image loading, preprocessing, and HOG feature extraction.
- **Matplotlib/Seaborn**: For visualizing performance metrics like confusion matrices and classification results.

Results:

- The performance of the model is evaluated using the confusion matrix and classification report. The model leverages both traditional image processing features (HOG) and deep learning features (MobileNetV2) to achieve high accuracy in classifying melon images based on macronutrient deficiencies.

Comparison of Feature Extraction Methods:

- **HOG**: A classical feature extraction method that focuses on capturing edge and gradient information from images. It's computationally efficient but may not capture complex patterns as well as deep learning methods.
- **MobileNetV2**: A deep learning model that extracts high-level semantic features from images, allowing for better performance on more complex image classification tasks. It is lightweight, making it suitable for real-time applications.

Future Improvements:

- Hyperparameter tuning of the SVM classifier to enhance performance.
- Exploring other CNN architectures (e.g., VGG16, ResNet) for feature extraction and comparing the results with MobileNetV2.
- Implementing a real-time classification system for agricultural applications to diagnose macronutrient deficiencies in melons.

Project Data:

`data`: https://www.kaggle.com/datasets/binnassor89/melon-macronutrient-deficiency-dataset

Feel free to adjust this description further based on any other specific details or updates in your project! This version clearly highlights the use of both **HOG** and **MobileNetV2** for feature extraction, along with their roles in the overall pipeline.