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Plant Nutrient Deficiency Detection Using Ensemble Learning

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Abstract: *Early detection of plant nutrient deficiencies is a critical aspect of precision agriculture, as it enables timely intervention to prevent negative impacts on crop health, yield, and soil fertility. Undetected nutrient imbalances can significantly reduce agricultural productivity and compromise the quality of the produce. This research proposes an image-based detection system that leverages advanced machine learning techniques for automated identification of nutrient deficiencies in plants. A hybrid deep learning framework combining MobileNet and ResNet50 is used for efficient and robust feature extraction from leaf images. These features are then processed using ensemble classifiers such as Random Forest and Gradient Boosting, which offer improved accuracy and generalization by aggregating predictions from multiple learners. Experimental results show that this ensemble-based approach consistently outperforms individual classifiers in terms of performance metrics like accuracy and precision. MobileNet's lightweight architecture ensures compatibility with mobile and edge devices, while ResNet50 adds depth to feature representation, making the model suitable for real-time deployment in agricultural settings. By providing early and accurate insights into plant health, this system supports informed decision-making, reduces reliance on manual inspection, and optimizes the use of fertilizers. Ultimately, it contributes to sustainable farming by enhancing crop management practices, minimizing environmental impact, and supporting food security through increased efficiency and productivity.*

Keywords: Ensemble Learning, MobileNet, ResNet50, Precision Agriculture, Sustainable Farming, Feature Extraction