Classification of Okra (*Abelmoschus esculentus*) Maturity Using Thermal Images and Machine Learning

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Abstract:

Agriculture is fundamental to sustaining the global population, with okra (*Abelmoschus esculentus*) playing a key role in global food production, particularly in tropical and subtropical regions such as India. This nutrient-rich vegetable is highly valued for its health benefits, and its maturity is crucial in determining its quality, with tender, immature pods being the most desirable for consumption. Traditionally, okra maturity has been assessed manually, a process that is both time-consuming and prone to human error. However, advancements in machine learning have provided opportunities for automating this classification process. In this study, we investigated the use of machine learning algorithms as k-Nearest Neighbors (kNN), Support Vector Machine (SVM), and Logistic Regression (LR), combined with various feature extraction methods (DeepLoc, SqueezeNet, and VGG19) to classify okra maturity using thermal images. Logistic Regression consistently achieved the highest classification accuracy, reaching 97.00% with SqueezeNet features and 95.40% with VGG19 features. SVM also demonstrated strong performance across different feature sets, while kNN showed relatively lower results. The findings highlight that machine learning models, when paired with thermal imaging, offer a promising approach for automating okra maturity classification, improving accuracy and efficiency, and addressing the growing quality control demands within the agricultural sector.