

CLASSIFICATION OF CHEMICAL COATING QUALITY IN SOYBEANS USING CONVOLUTIONAL NEURAL NETWORKS

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Introduction

Seed treatment ensures early protection against pests and diseases, but failures in the chemical coating process can compromise field performance. Evaluating coating quality is typically subjective and slow, requiring automation.

Objective

Develop an image-based approach using convolutional neural networks (CNNs) to classify soybean seeds according to their chemical coating quality.

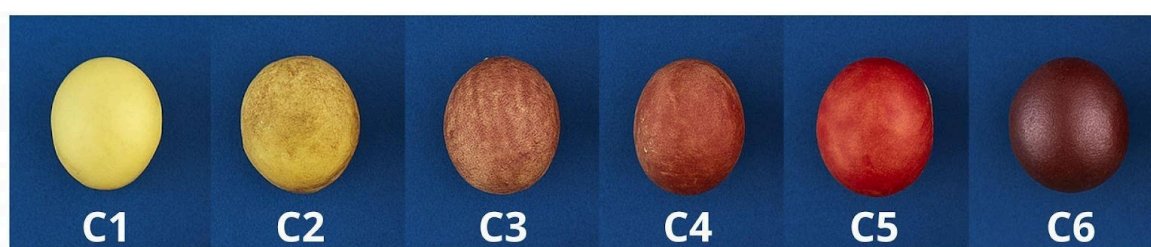


Figure 1 - Quality levels of the chemical treatment

Results

The model achieved an average F1-score of 0.96, demonstrating high accuracy in distinguishing all six coating-quality classes. Performance remained consistent across categories, indicating the network's ability to generalize well to different levels of chemical coverage. The classifier successfully captured subtle variations in color intensity, coating uniformity, and coverage patterns, which are often difficult to detect visually. Additionally, the approach proved robust under varying lighting conditions, performing reliably on images acquired in both natural and artificial illumination.

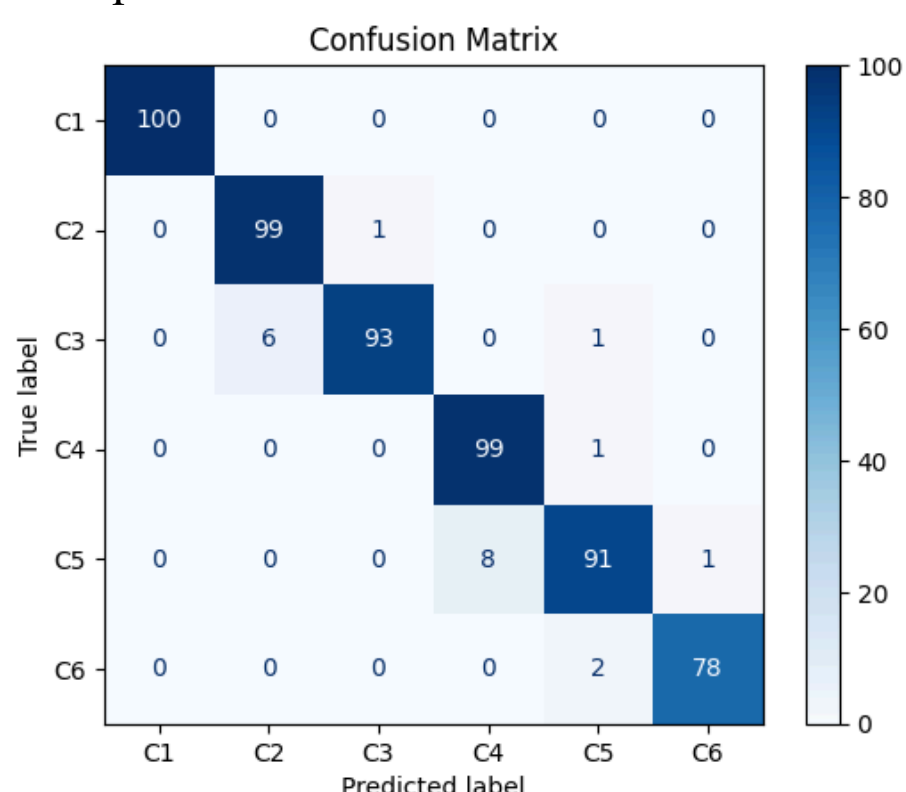


Figure 3 - Confusion matrix showing the results for each class

Method

The dataset consisted of 1,165 RGB images of soybean seeds, captured under two lighting conditions: 50% under natural light and 50% under artificial illumination. Each seed was assigned to six coating-quality levels, ranging from C1 (no chemical treatment) to C6 (adequate coating).

In the segmentation stage, granulometric analysis and morphological processing techniques were applied, enabling the isolation of individual seeds from the images. Following segmentation, classification was performed using a convolutional neural network based on the MobileNetV2 architecture, trained with fine-tuning and data augmentation strategies to enhance generalization. The model was trained using a standard training/validation split and .

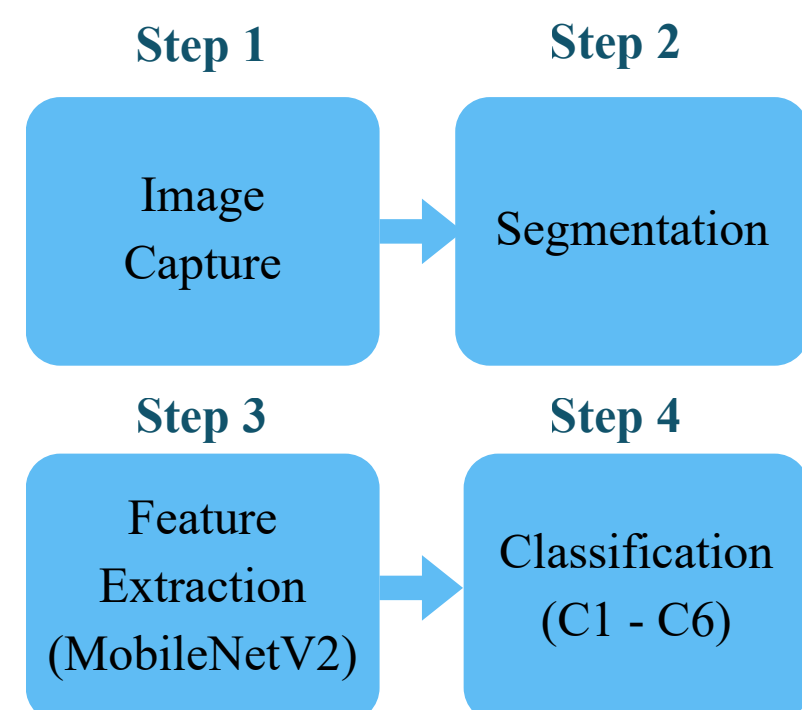


Figure 2 - Flowchart of the method used in this study

Conclusion

The proposed CNN-based approach accurately classifies soybean chemical coating quality, achieving an F1-score of 0.96. It identifies fine visual differences in coverage and performs well under varied lighting conditions. The method demonstrates high potential for automated and embedded screening systems, contributing to standardization and efficiency in seed quality evaluation.