

Automated morphometric quantification of maize cob kernels via lightweight RGB image analysis and cellpose-based deep learning segmentation

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I. INTRODUCTION

- Maize kernel number and morphology are key phenotypic traits for yield assessment, varietal evaluation and breeding.
- Manual kernel counting and measurement are labour intensive, time consuming and poorly suited to high-throughput phenotyping.
- Cellpose-based instance-segmentation enables automated separation, counting and morphometric analysis of individual kernels from standard RGB images.
- The workflow was tested on 27 maize cob images with varying cob shapes and images conditions



Fig. 1. RGB image of the 27 maize cobs used for workflow evaluation.

II. METHODS

- Preprocessing:** RGB images were converted to HSV color space for foreground segmentation and cob isolation.
- Segmentation:** Kernel instances were identified using the pretrained Cellpose model.
- Morphometrics:** Projected area, centroid position and total kernel count were extracted for each kernel.
- Classification:** Non-edge kernels were grouped into small, medium and large classes based on projected area percentiles.
- Quality control:** Edge kernels were excluded from size classification, and abnormal instances were flagged using IQR based outlier detection ($K = 1.5$).



Fig. 2. Image-analysis workflow for automated maize kernel segmentation, counting and size classification.

References

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Fig. 3. Individual kernel instances arranged according to projected kernel area from smallest to largest.

III. RESULTS AND DISCUSSION

- The workflow generated individual kernel masks and automated kernel counts across the 27 maize cob images with variable cob morphology.
- Cellpose enabled instance level separation of adjacent kernels following HSV based foreground isolation.
- Automated kernel counts showed close agreement with manual counts (MAE = 4.52 kernels, RMSE = 5.08 kernels, MAPE = 2.05%, $R^2 = 0.987$).
- Projected kernel area enabled relative classification into small, medium and large-size classes.
- The generated overlays enable visual verification of kernel segmentation, counting and classification based on size.

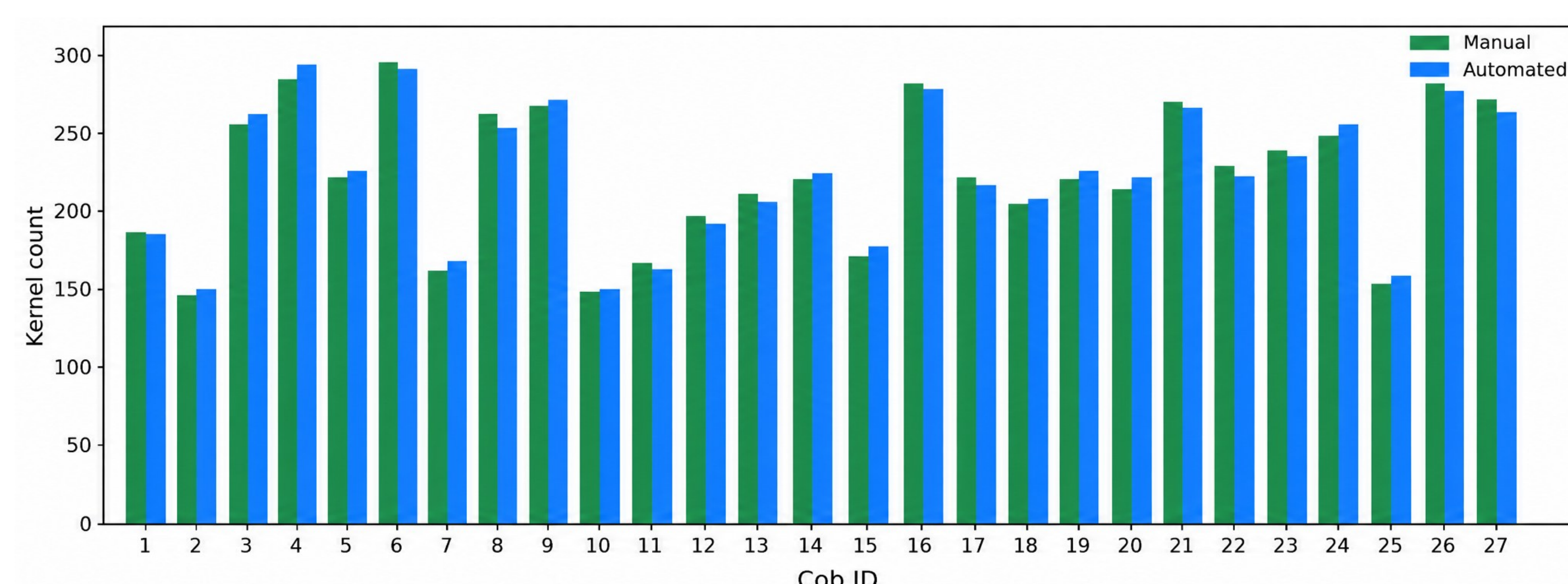


Fig. 4. Comparison of manual and automated kernel counts across the 27 maize cob images.

Table 1. Performance metrics for automated kernel counting compared with manual counts.

Metric	Value
MAE	4.52 kernels
RMSE	5.08 kernels
MAPE	2.05%
R^2	0.987

IV. CONCLUSION

- The RGB Cellpose workflow enabled automated kernel segmentation, counting and 2D morphometric characterization from maize cob images.
- The method generates consistent outputs for kernel number, projected area, size classification and visual quality control across the samples.
- Single view imaging remains limited by the partial visibility of lateral kernels, which may bias projected area-based size estimates.
- Future work should integrate multi-view imaging or 3D reconstruction for more complete whole cob phenotyping.



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