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Early-Season Stand Count Determination in Corn via Integration of Imagery from Unmanned Aerial Systems (UAS) and Supervised Learning Techniques

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Abstract: Corn (Zea mays L.) is one of the most sensitive crops to planting pattern and early-season uniformity. The most common method to determine number of plants is by visual inspection on the ground but this field activity becomes time-consuming, labor-intensive, biased, and may lead to less profitable decisions by farmers. The objective of this study was to develop a reliable, timely, and unbiased method for counting corn plants based on ultra-high-resolution imagery acquired from unmanned aerial systems (UAS) to automatically scout fields and applied to real field conditions. A ground sampling distance of 2.4 mm was targeted to extract information at a plant-level basis. First, an excess greenness (ExG) index was used to individualized green pixels from the background, then rows and inter-row contours were identified and extracted. A scalable training procedure was implemented using geometric descriptors as inputs of the classifier. Second, a decision tree was implemented and tested using two training modes in each site to expose the workflow to different ground conditions at the time of the aerial data acquisition. Differences in performance were due to training modes and spatial resolutions in the two sites. For an object classification task, an overall accuracy of 0.96, based on the proportion of corrected assessment of corn and non-corn objects, was obtained for local (per-site) classification, and an accuracy of 0.93 was obtained for the combined training modes. For successful model implementation, plants should have between two to three leaves when images are collected (avoiding overlapping between plants). Best workflow performance was reached at 2.4 mm resolution corresponding to 10 m of altitude (lower altitude); higher altitudes were gradually penalized. The latter was coincident with the larger number of detected green objects in the images and the effectiveness of geometry as descriptor for corn plant detection.

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