CORN SKELETON RECONSTRUCTION BY UAS-BASED STRUCTURE FROM MOTION

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Abstract

Physiological dynamics at plant level are essential but also challenging for precision agriculture applications linked to plant phenotyping. In this study, we explore not only the spatial dynamics of corn in field conditions but also their temporal analysis via skeleton reconstruction of individual plants as a shape descriptor. For this purpose, an optimized approach for high-throughput was developed by point cloud data derived from UAS imagery. The curve-skeleton extraction is calculated based on a constrained Laplacian smoothing algorithm. The experimental setup was performed at the Indiana Corn and Soybean Innovation Center at the Agronomy Center for Research and Education (ACRE) in West Lafayette, Indiana, USA. On July 27th and August 3rd of 2021, two flights were performed over a trial with more than 200 maize plants using a custom designed UAS platform with a Sony Alpha ILCE-7R photogrammetric sensor. RGB images were processed by a standard photogrammetric pipeline by Structure from Motion (SfM) to get a scaled 3D point cloud of the individual corn. Filtering techniques and labeling algorithms were joined together to reconstruct a robust and accurate skeleton of individual maize. Therefore, significant traits such as number, length, growth angle and elongation rate of leaves and stem can be easily extracted. Height variations computed from the skeleton at the two dates show a coefficient of correlation with on-field measurements better than 92%. Our experimental outcomes demonstrate the UAS-data's ability to provide practical information to efficiently select phenotypes in plant breeding programs.

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Keywords: skeleton, corn, phenotyping, Unmanned Aerial System, point cloud, structure from motion.

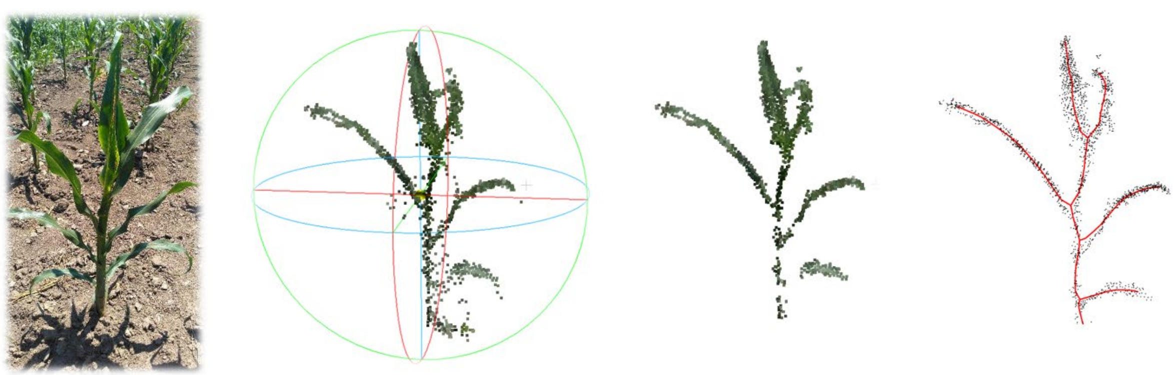

Figure: 3D Photogrammetric reconstruction and analysis of corn: (a) 2D manual picture, (b) scaled 3D point cloud from UAS imagery, (c) outlier removal and (d) curve-skeleton extraction.