Improvements on Multiway ICP Registration for Reconstructing Individual Plants from 3D Field Scans

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Abstract

We present several methods for improving plant reconstruction from multiple 3D observations. Producing 3D data useful for plant phenotyping requires proximal sensing (e.g. line scanner, depth camera) at multiple incident angles (φ) and often with multiple passes. These resulting individual point clouds must then be assembled into a single point cloud for analysis. Our interest in improving the registration of individual plants is focused specifically on observations made within field settings which present additional challenges over laboratory 3D scans, where background, overlap and light conditions can be controlled. To develop these methods, we use several season's worth of data from the University of Arizona's Field Scanalyzer located in Maricopa, Arizona. Our approach prioritizes: (1) plant completeness, (2) noise reduction, (3) temporal similarity and (4) computational efficiency. The first priority is accomplished simply by prioritizing individual point clouds that contain the majority of the individual plant. 3D field scanning can result in component point clouds that are from near-identical φ and cover the same portions of the individual plant. This results in both additional noise and uncertainties due to small georeferencing errors and plant movement between scans. Thus, we remove the data that is furthest in time with non-unique φ in order to achieve priorities 2 and 3. Our method results in small scene reconstruction which has low memory and computational demands. In order to improve registration further, we investigate iterative closest point (ICP) registration fitting using weights defined by crop height distributions and semantic segmentation point labeling.

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