3DPotatoTwin: Paired 3D Dataset of Potato Tubers for Plant Phenotyping Applications

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Abstract

Potatoes are an important staple crop for food security worldwide because of their nutritional value. To assist breeders and farmers in improving potato yield and quality, plant phenotyping technologies, including computer vision and artificial intelligence, have been utilized to evaluate potato conditions more efficiently. The emergence of 3D technology has further improved accuracy in assessing potato shape, offering more insights than conventional 2D imaging. However, in practical applications, there is often a trade-off between the quality and efficiency of 3D model collections. RGB-Depth (RGB-D) cameras offer high throughput, while the close-range photogrammetry (structure from motion, SfM) approach provides high model quality. One potential solution to get the most out of the two approaches is to train a deep learning completion network to recover high quality 3D models from low quality ones collected by RGB-D camera. However, the success of this solution relies heavily on a clean and well-organized paired dataset from both approaches. With this objective in mind, we developed a paired 3D dataset consisting of three popular potato cultivars in Japan. To create this dataset, we established RGB-D and close-range photogrammetry pipelines specifically designed for 3D potato model collection. Additionally, we developed 3D model registration algorithms to pair the models captured by RGB-D cameras and photogrammetry for the same potato. The resulting paired dataset includes 341 potatoes with various sizes and shapes. We believe that this dataset can serve as a benchmark tool for developing and evaluating the performance of different 3D phenotyping algorithms and approaches.

Keywords: Depth Camera, Intel RealSense, Structure from Motion, Point Cloud Registration, Precision Agriculture