Applications of Photogrammetry and 3D Modelling Techniques for Plant/Crop High-Throughput Phenotyping using Small Unmanned Aircraft System (sUAS)

Nan An, Kevin P. Price, Stephen M. Welch

Abstract:

Plant/crop phenotyping has been studied for decades for understanding of the relationship between plant/crop genotype, phenotype and environment. Improved accuracy and efficiency in plant/crop phenotyping is a critical factor in expediting plant breeding and selection process. In the past, plant/crop phenotyping information was extracted from human field-based measurements and field notes, which is time-consuming, labor-intensive and cost-inefficient. More importantly, the accuracy of the field-based measurements can be highly variable. Using photogrammetry and 3D modelling techniques to extract plant/crop phenotyping information has been introduced recently, but still no cost-efficient methods using these two techniques has been yet been developed for large-scale plant genotyping studies or large crop field. Increasingly, Small Unmanned Aircraft System (sUAS) are being evaluated as a potential imaging platform for 3D modelling of plants at the leaf and canopy scales. The application of sUAS in agriculture is in its infant stages, but it is believed the temporal and spatial resolutions of these systems are well matched to many crop phenotyping needs. Besides crops, similar data sets can be used for 3D modelling of wildland plants which has applications to plant genomic studies and wildlife habitat assessment.

In this study, we introduce the method of using affordable imaging system and 3D modelling software – Agisoft PhotoScan Pro to build image orthophotos and 3D plant canopy models. Using sUAS imagery, 3D crop canopy models are derived and plant/crop height extracted, while spectral measurements are used to differentiate crop treatments and genotype.