3D Image-based Plant Phenotyping Research: Dataset, Algorithm and Analysis

Sruti Das Choudhury\textsuperscript{1,2}, Srikanth Maturu\textsuperscript{2}, Vincent Stoeger\textsuperscript{3}, Ashok Samal\textsuperscript{2} and Tala Awada\textsuperscript{1}
\textsuperscript{1}School of Natural Resources, \textsuperscript{2}Department of Computer Science and Engineering, \textsuperscript{3}Agricultural Research Division
University of Nebraska-Lincoln, USA

Introduction

- Image-based plant phenotyping facilitates the extraction phenotypic traits non-invasively by analyzing a large number of plants in a short time period with precision.
- The variations in phylloaxy and self-occlusions pose challenges to accurate estimation of phenotypes from 2D images.
- We introduce an algorithm to reconstruct a 3D model of a plant for accurate phenotype estimation.
- We provide a new taxonomy of phenotypes computed from 3D plant model.
- To evaluate our method and stimulate 3D plant phenotyping research, we publicly release a benchmark dataset called University of Nebraska-Lincoln 3D Plant Phenotyping Dataset (UNL-3DPPD).

Method

- The plant images for all views are segmented using background subtraction followed by color based thresholding techniques.
- Space curving approach based on orthographic projection \cite{2} is used to reconstruct the 3D model of the plant.

![Fig. 1: Segmentation process.](Image)

![Fig. 2: Different views of a reconstructed 3D model of a plant.](Image)

Dataset

- To evaluate the algorithm, we publicly release a benchmark dataset called UNL-3DPPD.
- The images of the dataset are captured using LemnaTec Scanalyzer 3D high throughput plant phenotyping facility in the UNL.
- The dataset contains RGB images of 15 maize plants and 13 sorghum plants for 27 days from 10 views.

![Fig. 4: LemnaTec Scanalyzer 3D plant phenotyping system.](Image)

![Fig. 5: Sample images of UNL-3DPPD.](Image)

Phenotype Computation

- 3D plant model is reconstructed to compute 3D phenotypes. A benchmark dataset called UNL-3DPPD is introduced to evaluate our method.

Conclusion

The authors would like to thank the Digital Agriculture - Unmanned Aircraft Systems, Plant Sciences, and Education (UAASPSE) seed grant sponsored by the NSF, for funding this research.

Acknowledgement

References

\cite{1} S.D. Choudhury, S. Maturu, V. Stoeger, A. Samal, T. Awada, 3D Image-based Plant Phenotyping Research: Dataset, Algorithm and Analysis, Plant Methods, under review, 2018.