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

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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 phyllotaxy 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 [2] is used to reconstruct the 3D model of the plant.

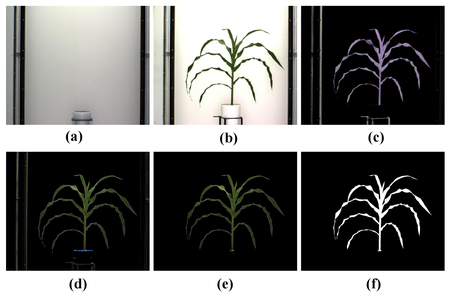

Fig. 1: Segmentation process.

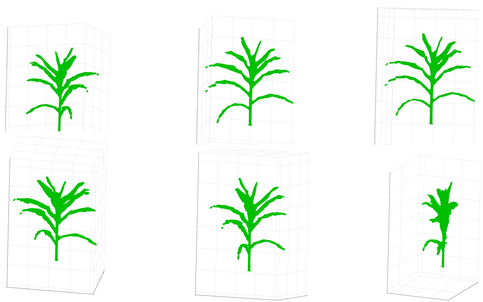

Fig. 2: Different views of a reconstructed 3D model of a plant.

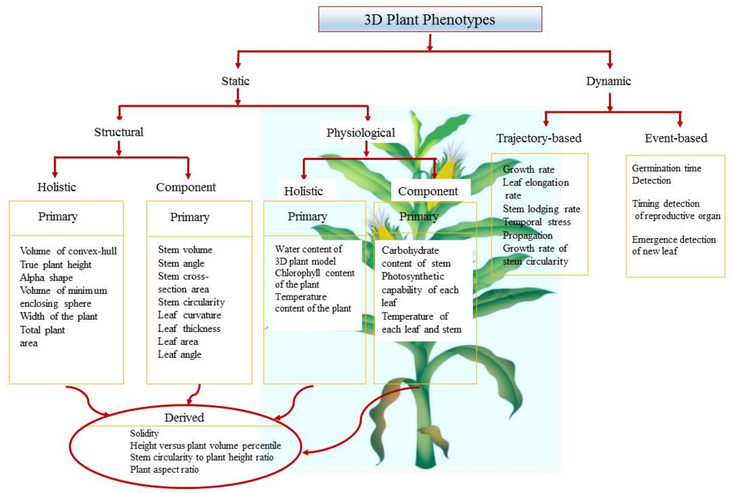

Fig. 3: Taxonomy of 3D phenotypes.

Dataset

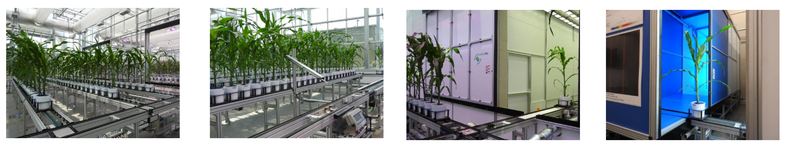

Fig. 4: LemnaTec Scanalyzer 3D plant phenotyping system.

- 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.

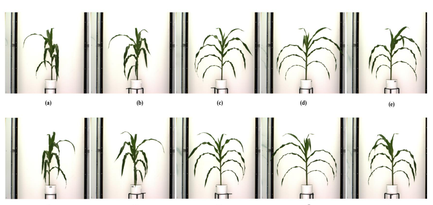

Fig. 5: Sample images of UNL-3DPPD.

Phenotype Computation

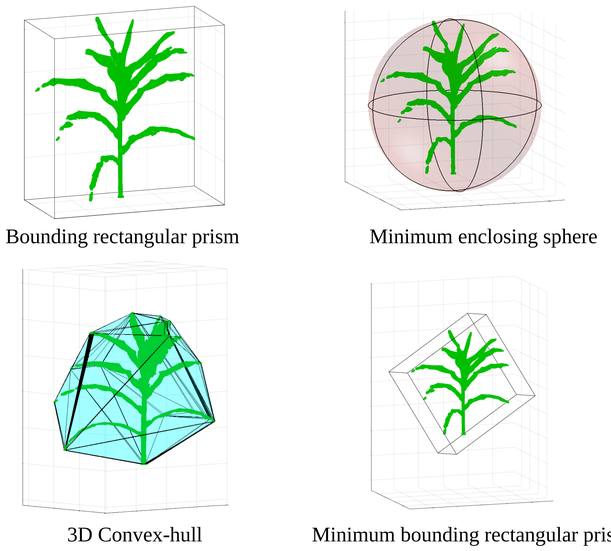

Fig. 6: Illustrations of 3D phenotypes.

Conclusion

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

Acknowledgement

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References

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[2] K. N. Kutulakos and S. M. Seitz, A Theory of Shape by Space Curving, International Journal of Computer Vision, 38(3), 199-218, 2000.