MEASURING PLANT GEOMETRY IN THE FIELD

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Introduction

- Assessment of cultivars is important in breeding.

- Visual inspection is difficult due to small differences between cultivars.

- An objective method is required.

- Approach: 3D and color measurement of plants.
3D-field scanner

- Portable system providing objective criteria for evaluation of plant growth and biomass production
- 3D and color measurement of plants
- Resolution: \((0.3\, \text{mm})^3\)
- Throughput: 1000 plants per day

Strube-Dieckmann 2007
Direct feature extraction from data

Data acquisition

False color range image camera 1

False color range image camera 2
Direct feature extraction from data

- Data acquisition
- Data fusion

- False color range image camera 1
- False color range image camera 2
- Range image after fusion
- Color image after fusion
Direct feature extraction from data

Data acquisition → Data fusion → Leaf segmentation

Segmented range image
Segmented color image
Direct feature extraction from data

Data acquisition
Data fusion
Leaf segmentation
3D reconstruction

3D reconstruction
Direct feature extraction from data

- Data acquisition
- Data fusion
- Leaf segmentation
- 3D reconstruction
- Feature calculation

- Number of leaves
- Area leaf 1: ...
- Area leaf 2: ...
- ...

3D reconstruction
Limitations of direct feature extraction

Algorithm must handle
- Incomplete data

Data acquisition

Data fusion

Leaf segmentation

3D reconstruction

Feature calculation
Limitations of direct feature extraction

Algorithm must handle

- Incomplete data
- Noisy data
Limitations of direct feature extraction

Algorithm must handle
- Incomplete data
- Noisy data
- Different plant species
Model-based feature extraction from data

- Data acquisition
- Data fusion
- Leaf segmentation
- 3D reconstruction
- Plant model
- Fitting
- Features

- Model: knowledge about plant’s morphology
- Fitting model to measured data
- Complex plant features directly from fitted model representation
Dynamic Leaf Model

- Geometric surface model $M(\tilde{c})$
- Abstraction with interpretable parameters $M(\tilde{p})$

$M(\tilde{c}) \leftrightarrow M(\tilde{p})$

Variation of parameter “Curvature”

Variation of parameter “Twist”
Results

Plant reconstruction  Model after optimization  Overlay of reconstruction and model
Results

Incomplete measurement data  Model after optimization
Results

Noisy measurement data  Model after optimization and measured points  Model after optimization
Future work

- Evaluation of a large plant population
- Long-time parameter tracking
- Vitality assessment
Future work

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Conclusion

- Portable measurement system to assess geometry of small plants

- Robust and flexible model-based feature extraction from measured data

- Future work: Model parameters as basis for plant diagnostics