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.

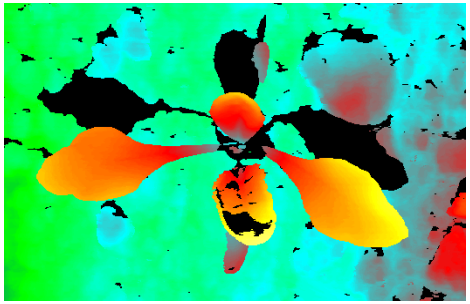
3D-field scanner

- Portable system providing objective criteria for evaluation of plant growth and bio mass production
- 3D and color measurement of plants
- Resolution: $(0{,}3\text{mm})^3$
- Throughput: 1000 plants per day

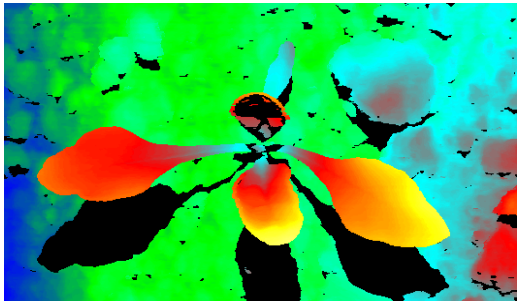
Strube-Dieckmann 2007

Direct feature extraction from data

Data acquisition



False color range image camera 1

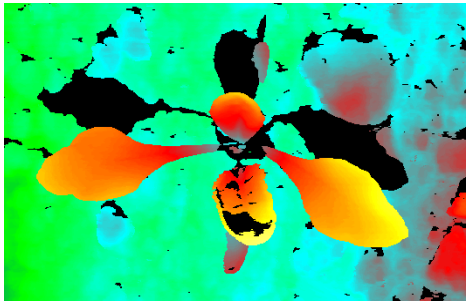


False color range image camera 2

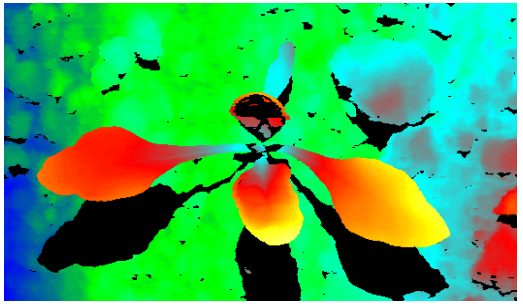
Direct feature extraction from data

Data acquisition

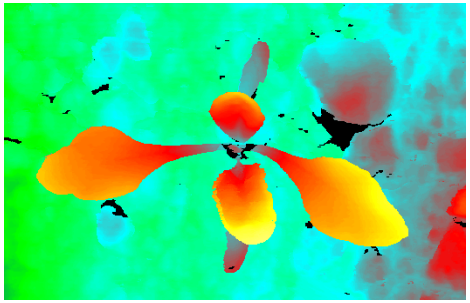
Data fusion



False color range image camera 1



False color range image camera 2



Range image after fusion

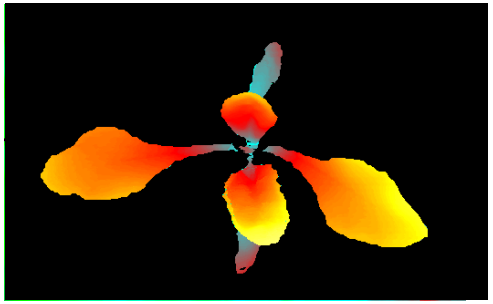
Color image after fusion

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

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Direct feature extraction from data

Data acquisition

Data fusion

Leaf segmentation

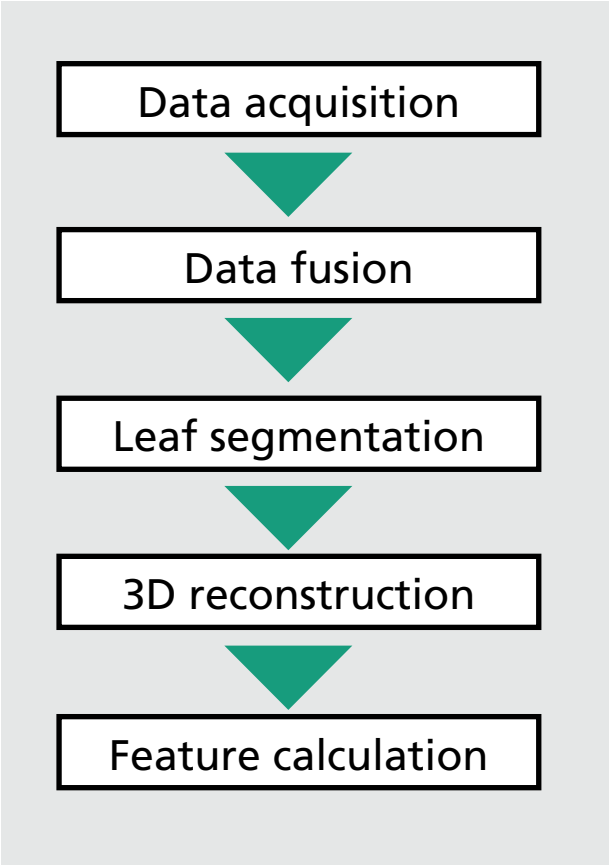
3D reconstruction

Feature calculation

3D reconstruction

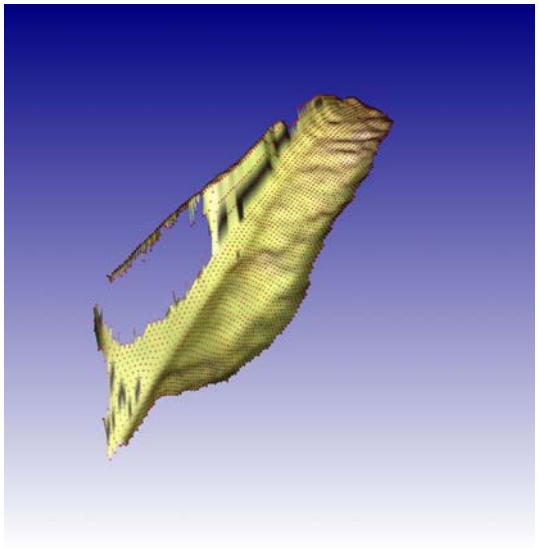
- Number of leaves
- Area leaf 1: …
- Area leaf 2: …
- …

Limitations of direct feature extraction

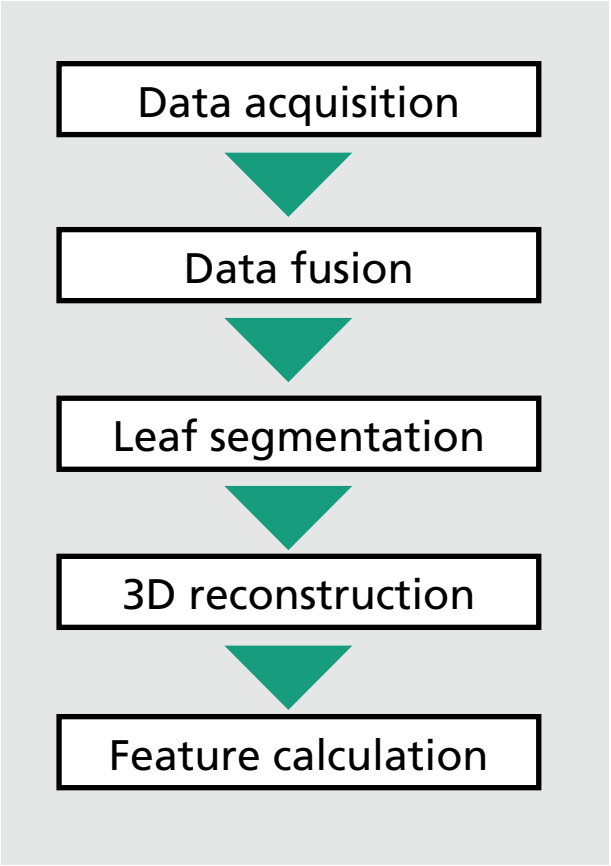


Algorithm must handle

- Incomplete data

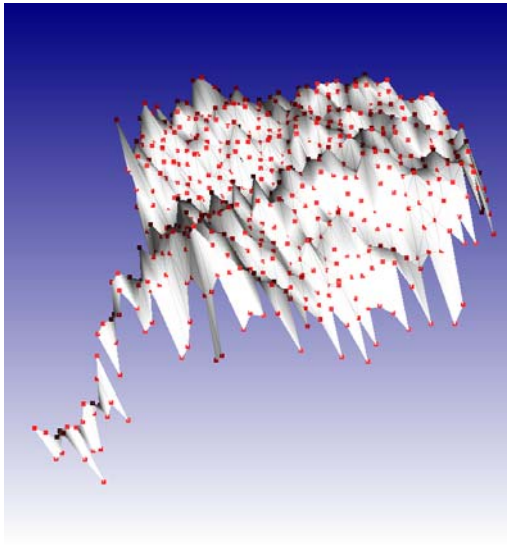


Limitations of direct feature extraction

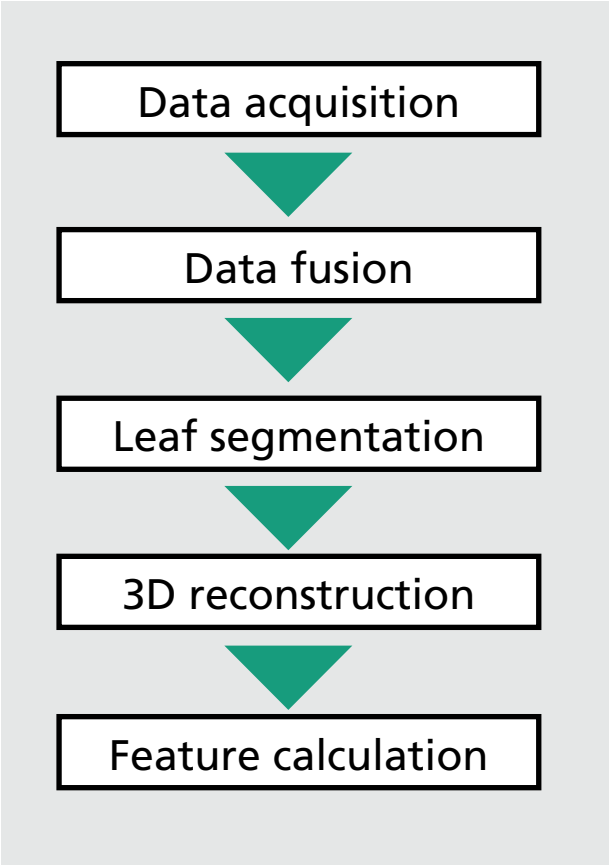


Algorithm must handle

- Incomplete data
- Noisy data

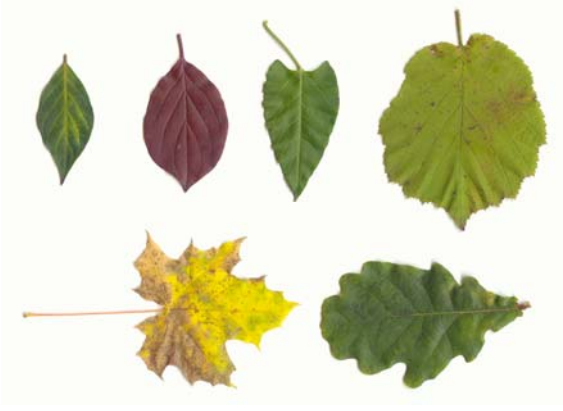


Limitations of direct feature extraction

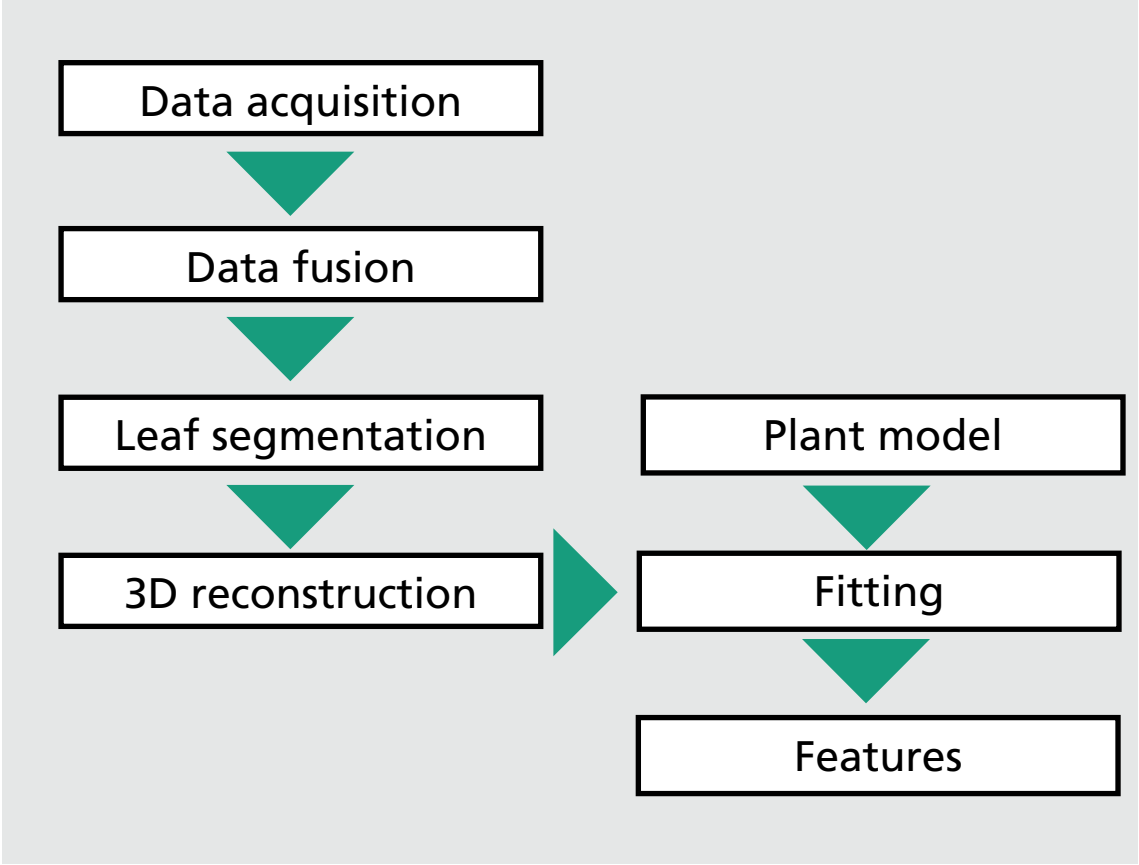


Algorithm must handle

- Incomplete data
- Noisy data
- Different plant species



Model-based feature extraction from data



- 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 $M(\vec{c})$

- Abstraction with interpretable parameters $M(\vec{p})$

$$M(\vec{c}) \quad \leftrightarrow \quad M(\vec{p})$$

Variation of parameter “Curvature”

Variation of parameter “Twist”

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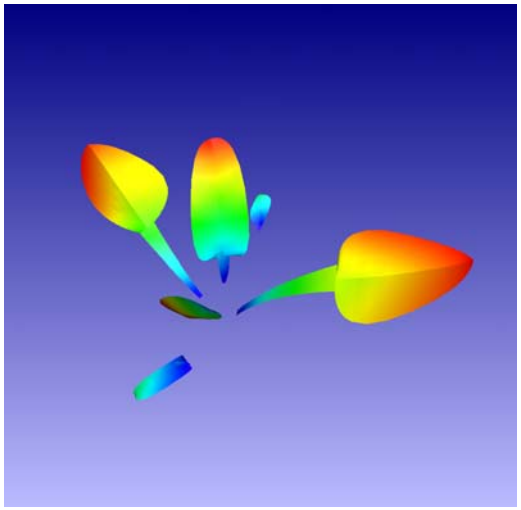
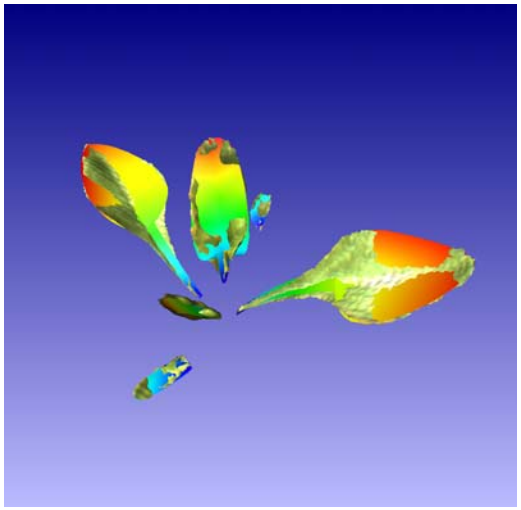
Results

Plant reconstruction

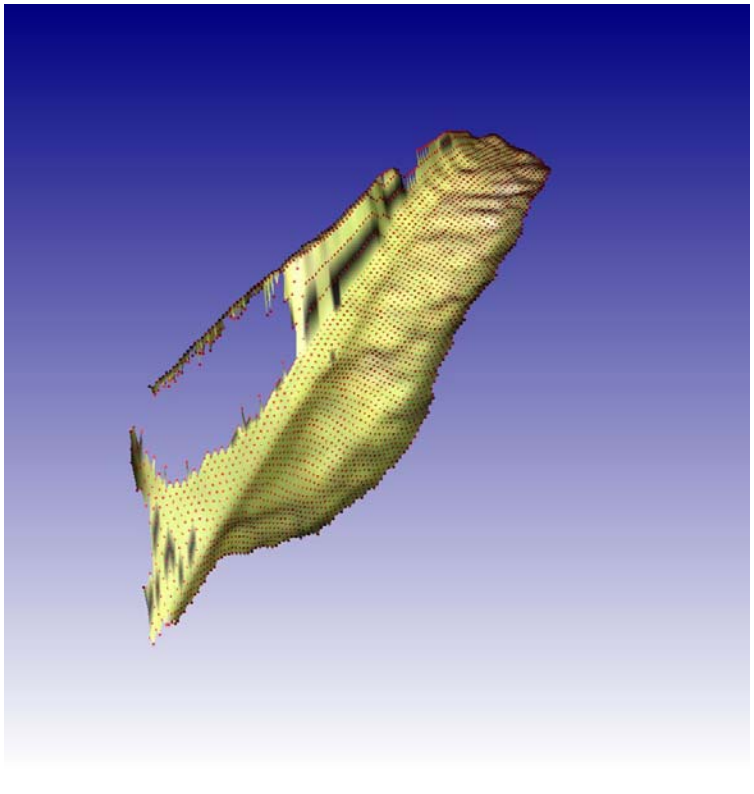


Model after optimization

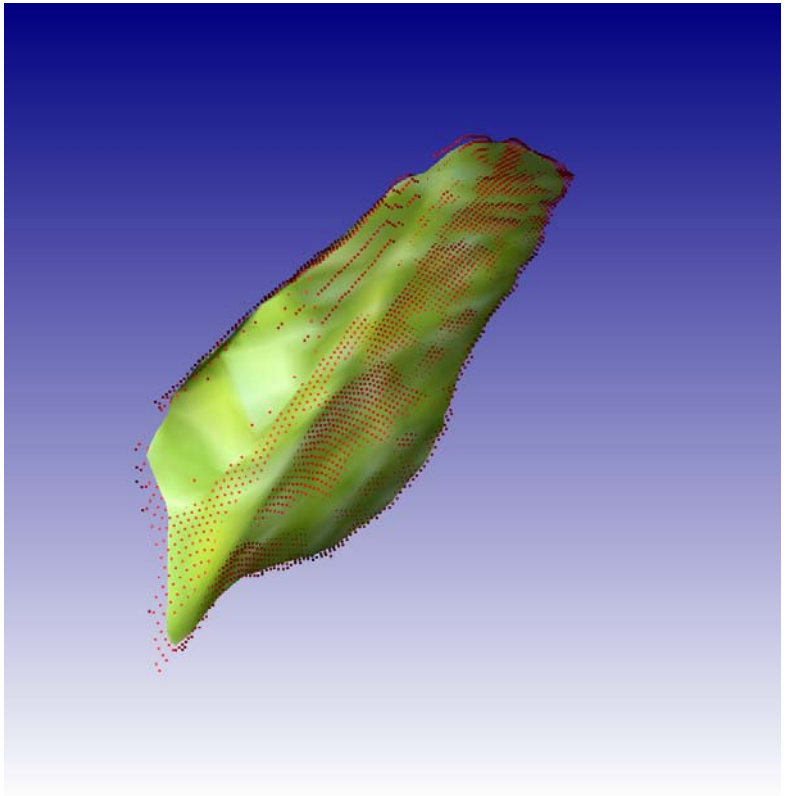


Overlay of reconstruction and model

Results



Incomplete measurement data



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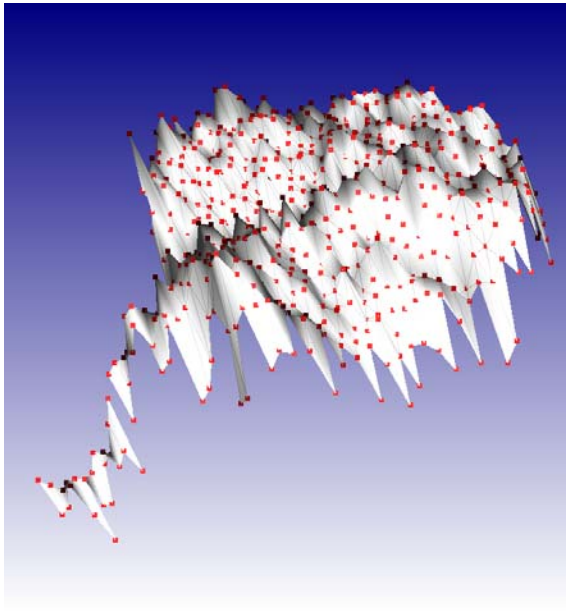
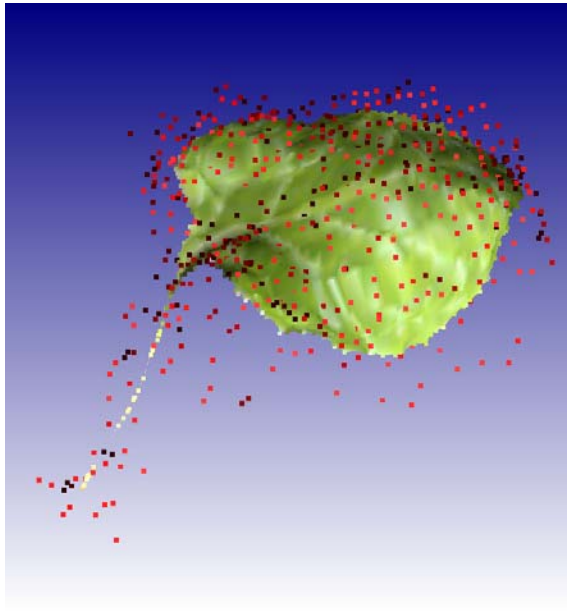


Noisy measurement data

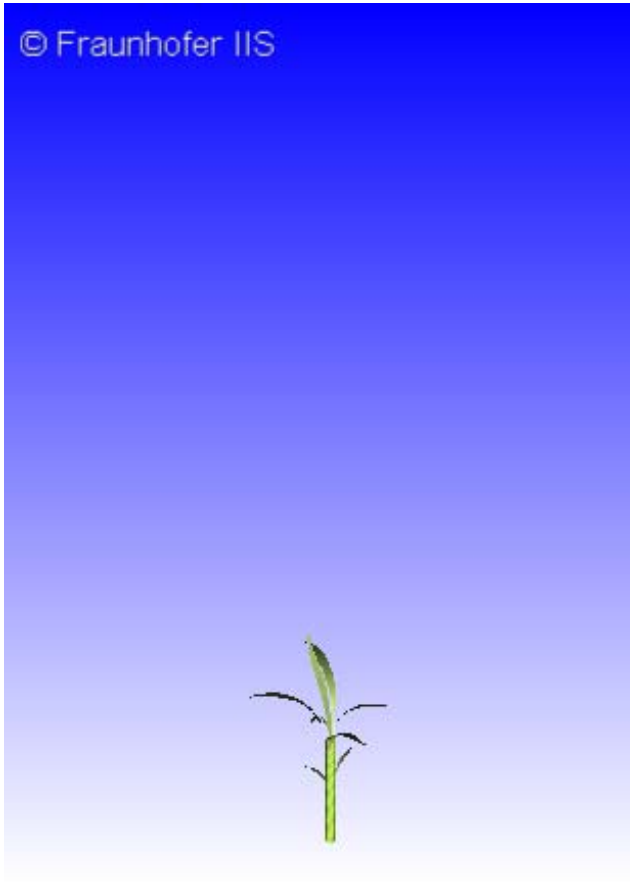


Model after optimization and measured points

Model after optimization

Future work

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



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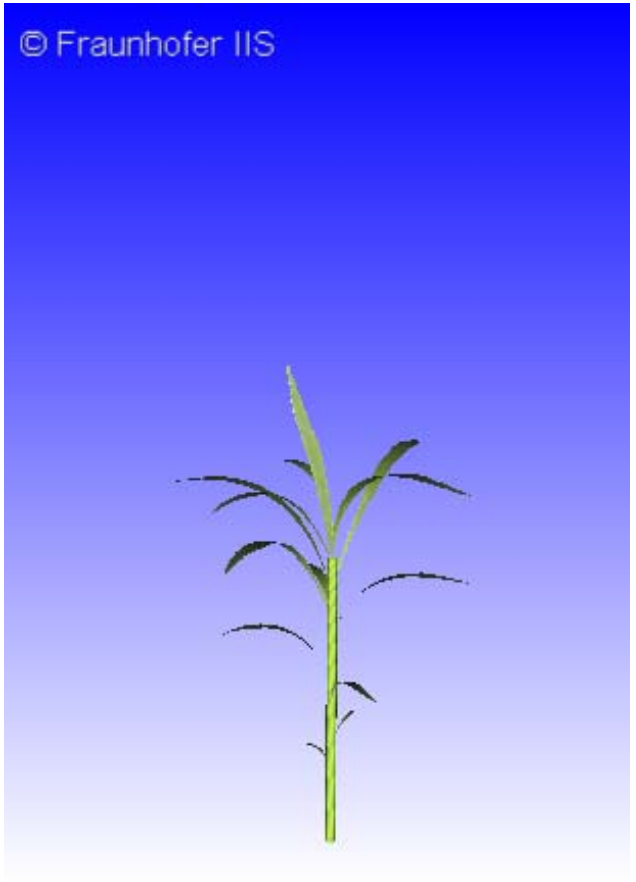

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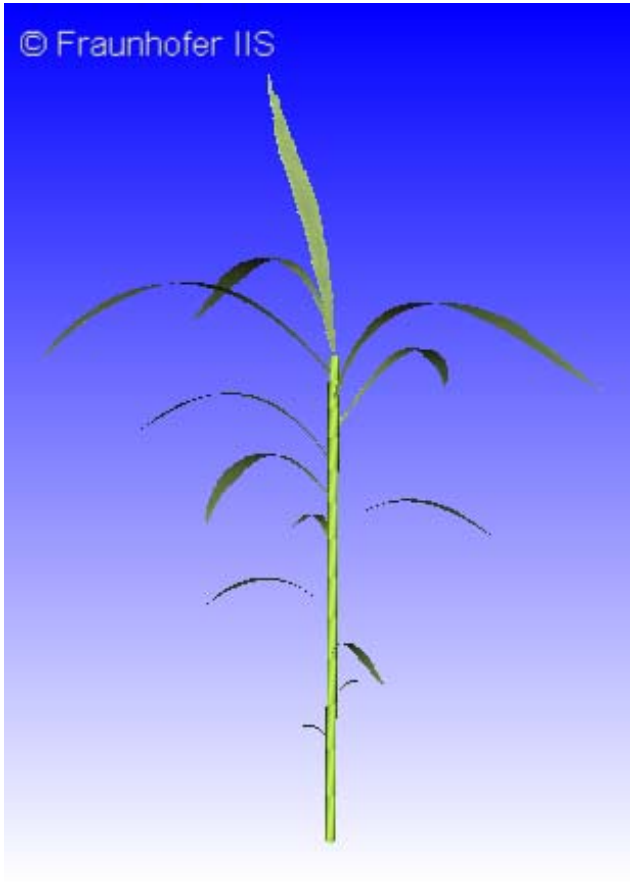

Conclusion

- 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