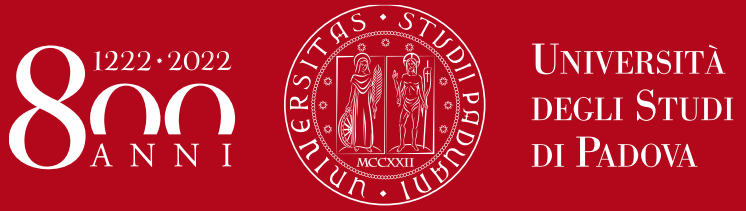


Development of non contact measurement techniques for 3D shape analysis

Iva Xhimitiku - 35th Cycle

Supervisor: Prof. Gianluca Rossi

Admission to the second year of the PhD course - 10/09/2020

Overview of Presentation

- **Steps of research**
- **Illustration research work till now:**
  3D measurement test and application
- **Other application test with software implementation**
- **Further activities**
- **Conclusion**

Steps of research

- **To get familiar with issues related to 3d shape measurement techniques**

Experience in R&D team

- **Depth study and application of standard measurement methods**

Laboratory experience

- **To develop innovative methods and techniques**

Algorithms, tools and software development

- **Application on “ground”**

3D measumerement test and application

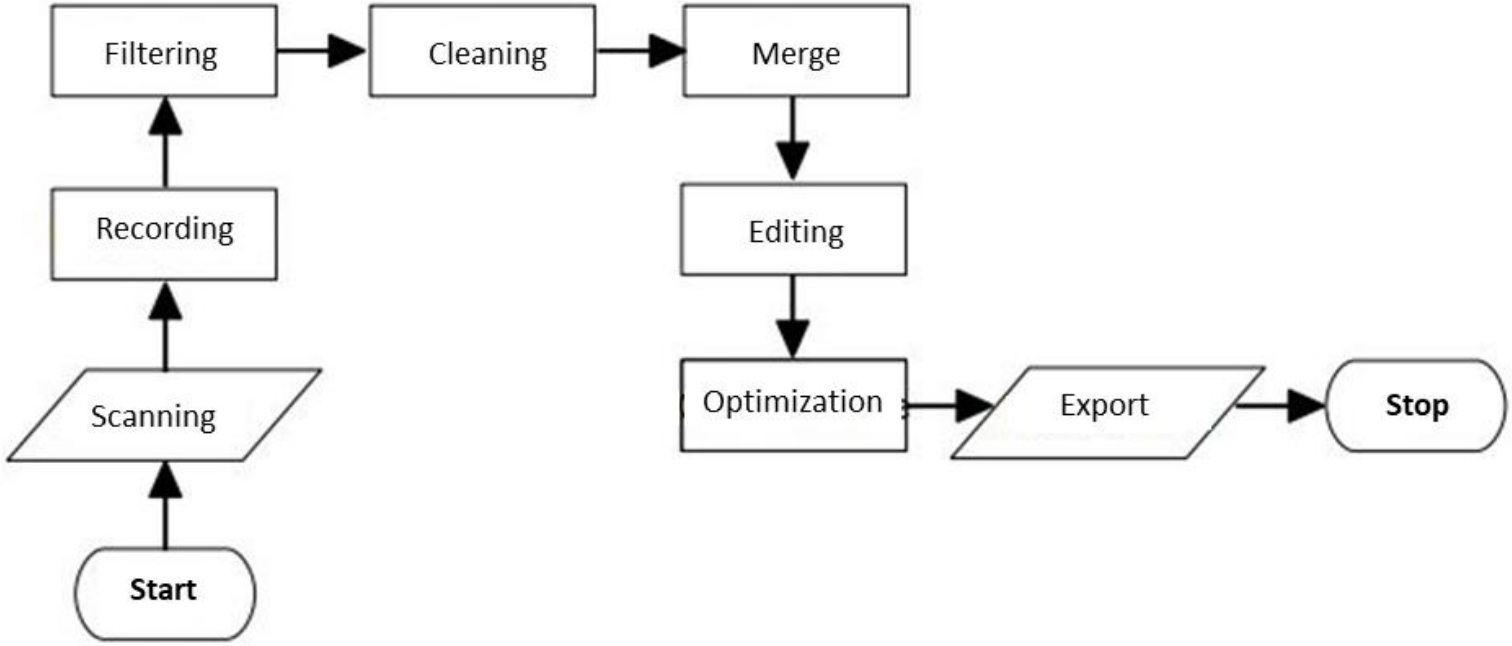
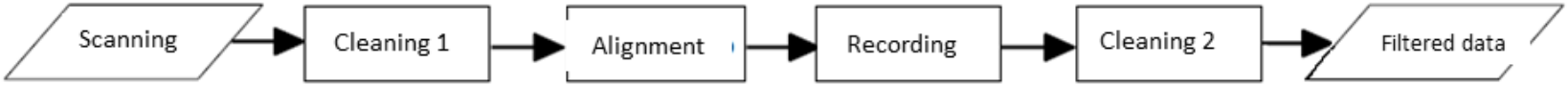
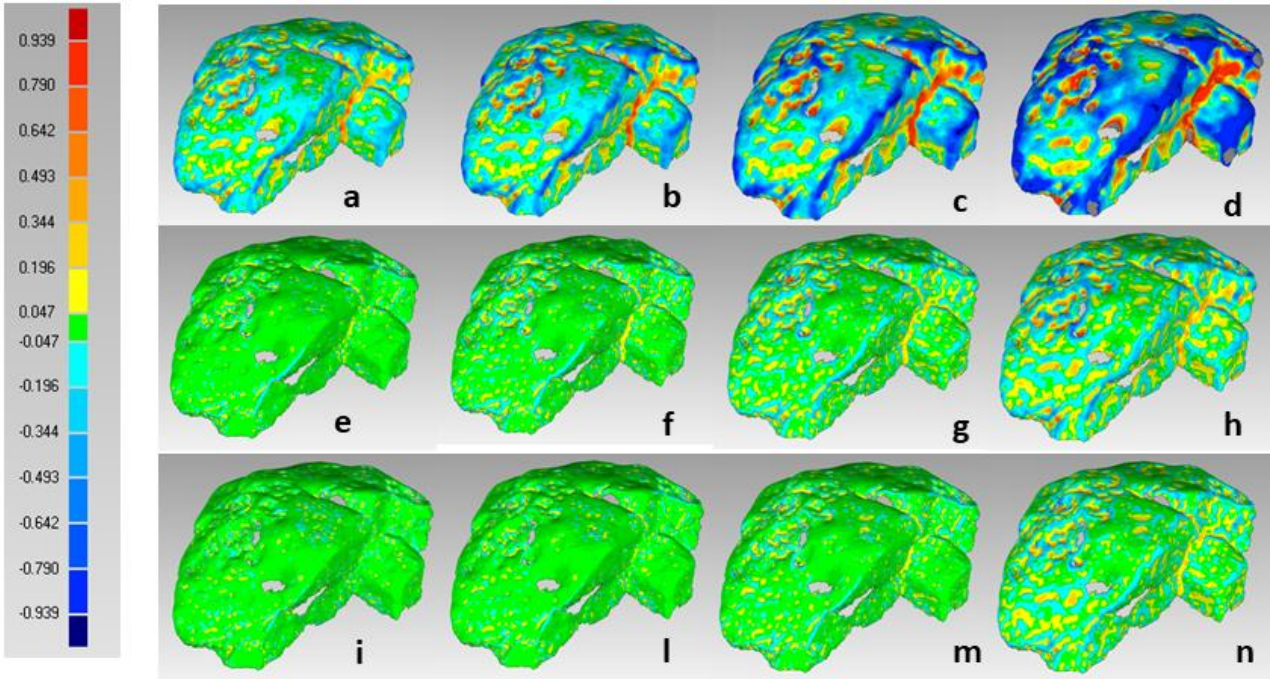


Diagram of data processing

Development of non contact measurement techniques for 3D shape analysis



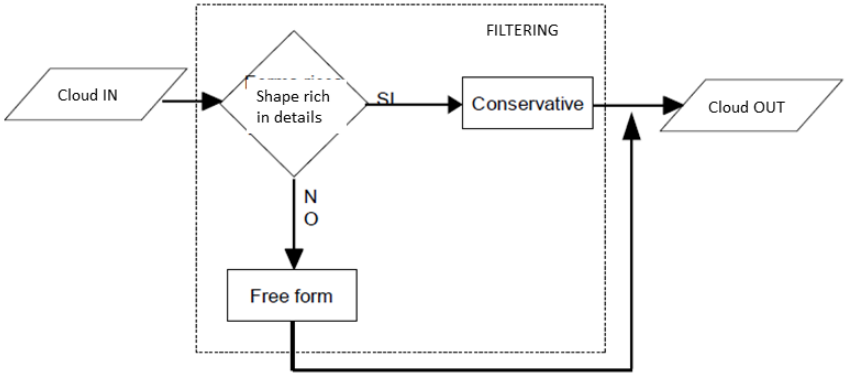


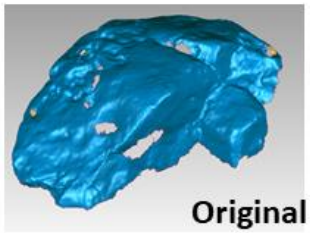
Map of deviation between the raw cloud and the cloud with the application of the smoothing algorithms.
The red areas indicate the maximum deviation, the green areas the deviation established as acceptable.
Intermediate values occupy the colors of the chromatic scale between red and green.
Blue indicates the points that have not changed.
(The lowercase letter refers to the letters shown also in the next table that indicate the type of algorithm applied to the cloud)

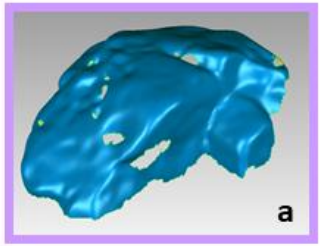
Development of non contact measurement techniques for 3D shape analysis

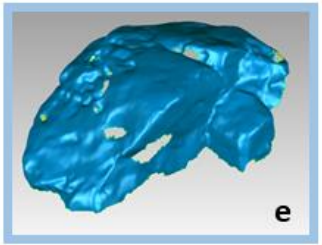
Type of noise reduction	Smoothing level	Max distance (mm)	Avarage distance (mm)	Standard Deviation (mm)	
Free form	1	1	0,119	0,157	a
Free form	2	1	0,182	0,236	b
Free form	3	1	0,260	0,328	c
Free form	4	1	0,343	0,400	d
Aggressive	1	1	0,025	0,038	e
Aggressive	2	1	0,041	0,062	f
Aggressive	3	1	0,064	0,095	g
Aggressive	4	1	0,120	0,169	h
Conservative	1	1	0,015	0,022	i
Conservative	2	1	0,024	0,036	l
Conservative	3	1	0,038	0,057	m
Conservative	4	1	0,074	0,107	n

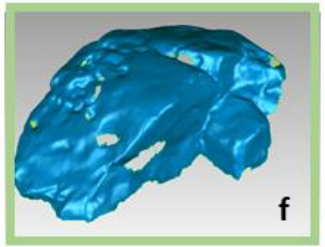
Application of different smoothing and iteration levels on the raw cloud; The various parameters indicate the difference of the cloud treated with the raw cloud.





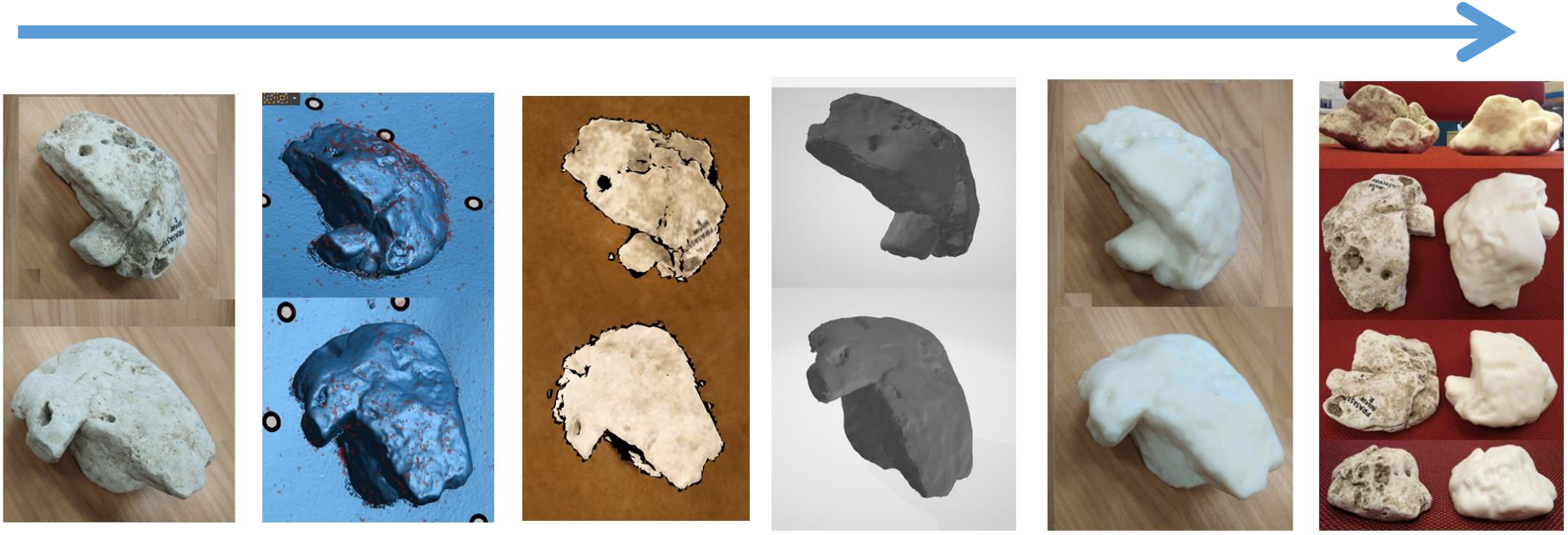




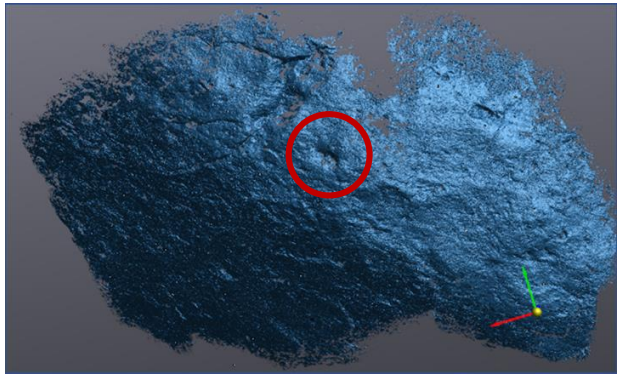


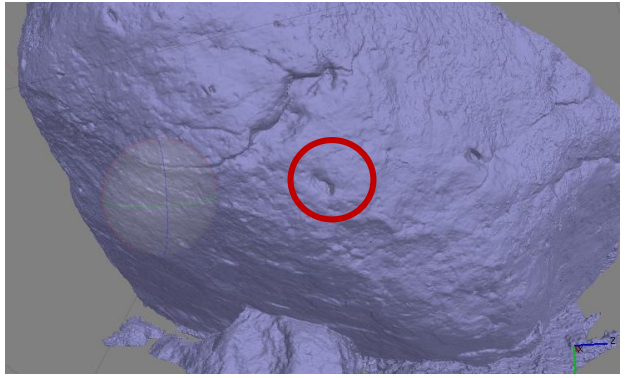
APPLICATION TEST

From scanning to 3D printing: Resolving the alignment problems of scanned data



Scanning → Cleaning





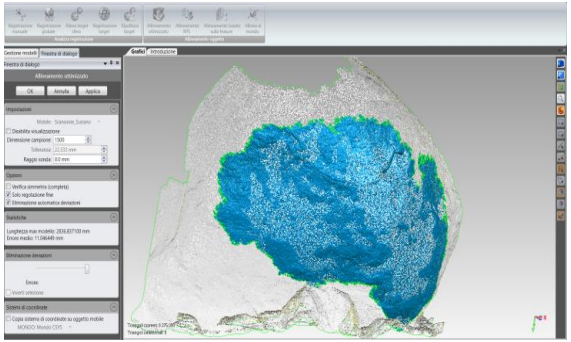
FALEGNAMERIA
Semilavorati in legno - Imballaggi
Innocenzi Franco & Americo

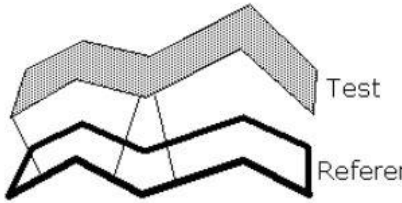
ideare
ideas & research hub

Structured light scanner
Go! Scan 50 by Creaform

Photogrammetry
Canon Eos 7D

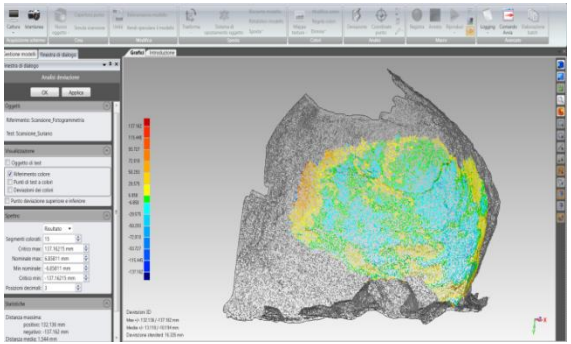
Cloud comparison

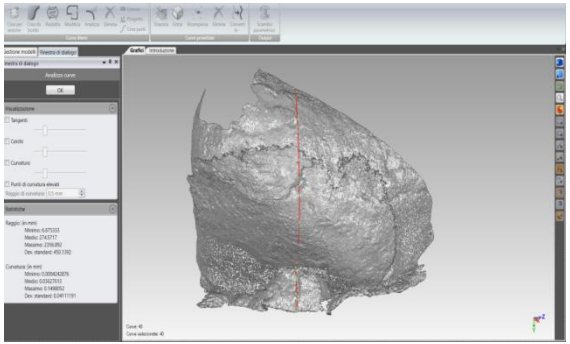




Scheme of comparison between the polygonal and the row cloud

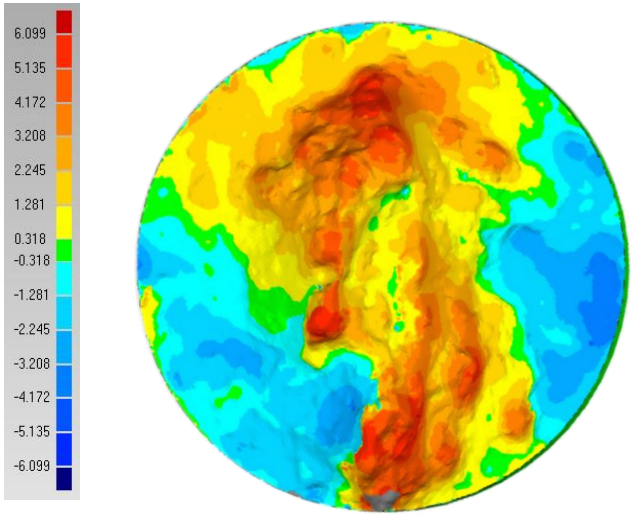
3D Deviation
Max +/-: 132,126/-537,162 mm
Min +/-: 13,118/-10,124 mm
Standard Deviation: 16,326 mm

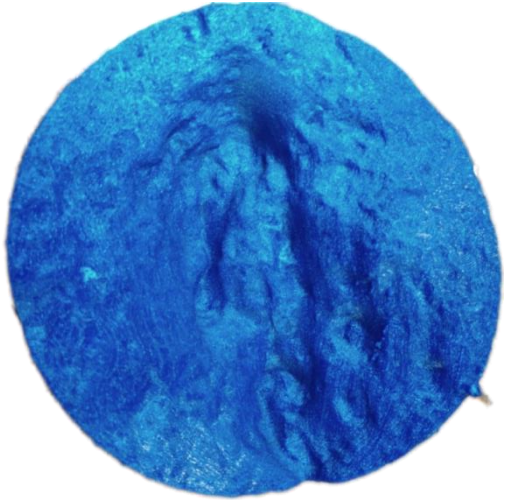




Export → 3D Printing

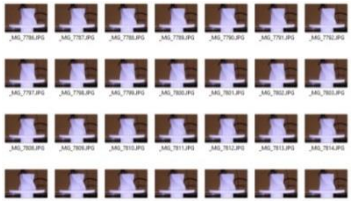
3D Deviation
Max +/-: 6,099/-5,44 mm
Min +/-: 0,691/-0,563 mm
Standard Deviation : 1,275 mm





Evaluation of shape of small 3D printed object using photogrammetry: Automatic mask generation

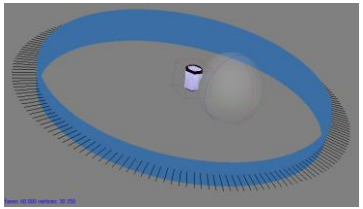
Acquisition



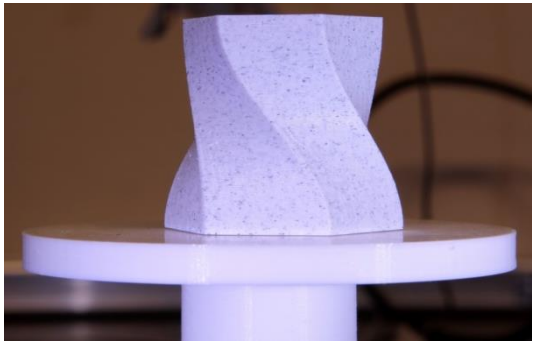
Mask

Masking by color

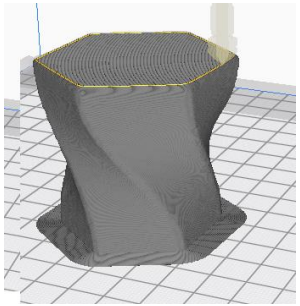
3D object reconstruction



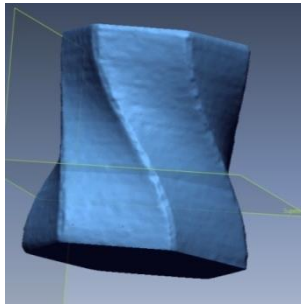
Setup

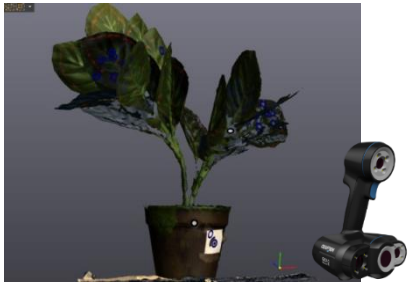


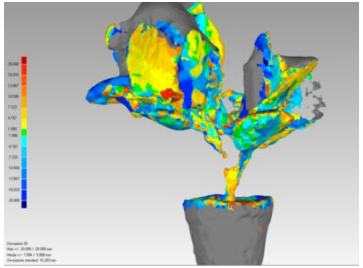
Printed object



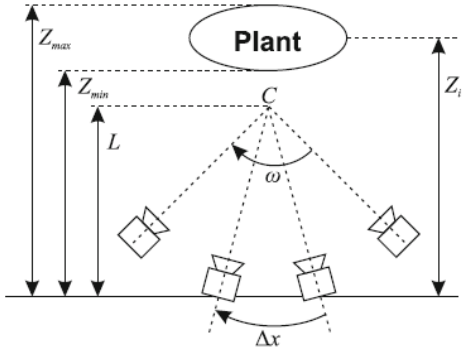
Reconstructed object







Selection of Appropriate Number of Images for 3D Plant reconstruction



$$\Delta x_{max} = \frac{1}{f_l}\frac{Z_{max}}{Z_{min}}$$

$$f_{nyq} = \frac{L}{2\Delta x_{max}}$$

$$L = \frac{2 \times Z_{max} Z_{min}}{Z_{max} + Z_{min}}$$

$$N_A = \frac{\omega L}{\Delta x_{max}}$$

Results of experiments:

- Plant 3D reconstruction is feasible with a low budget
- The appropriate number of images were selected and used for reconstruction of an entire 3D model with limited images: less computation time to process few images.
- Automatic mask generation.

This 3D reconstruction system is gives a cost-effective and efficient platform for non-invasive plant phenotyping, containing informations such as, fruit volume, leaf angles, leaf area index, which are important for assessing the stress and growth on plant features.

Conclusion

- **Bibliographic study on 3D scanning techniques for shape measurement**

Experience in R&D team, scan techniques

- **To get familiar with 3d shape measurement techniques**

Test procedures, issues

- **Application of measurement methods at some test case**

Laboratory experience: tests on the ground

FURTHER ACTIVITIES

Next steps and further activities

- **Innovative measurement chain (Also using GPS, gimbal, drones)**
- **Definition of new measurement procedures**
- **Definition of calibration procedures**
- **Software development**

Thanks for the attention