3DPotatoTwin: Paired 3D Dataset of Potato Tubers for Plant Phenotyping Applications

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Background

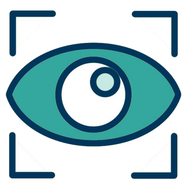
Potato tuber

An important staple crop for food security

Conventional field investigation to capture tuber spatial variation

Time-consuming, labor intensive, inaccurate

High-throughput phenotyping



Computer vision

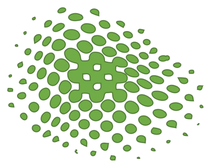
2D image analysis

Low cost
High efficiency
Dimension loss

Inaccurate 3D shape

LiDAR RGBD SfM ...

3D reconstruction

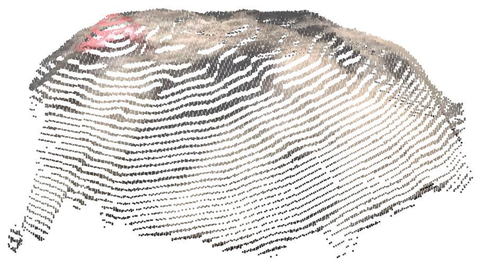


point cloud analysis

3D information

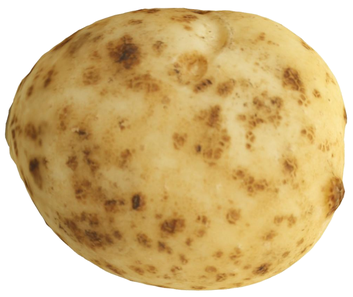
shape classification, yield estimation

Challenge: efficiency and quality trade-off



RGBD Conveyer 3D model

High efficiency **Low quality**

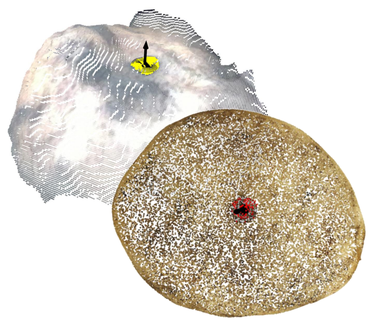


indoor SfM 3D model

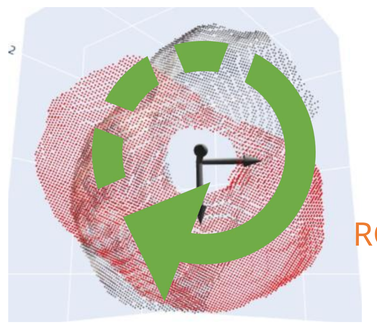
Low efficiency **High quality**

ICP registration failed with large shape and color differences

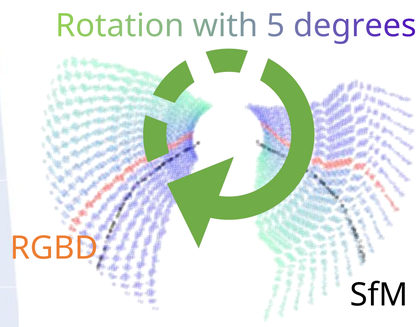
Target-assisting Data fusion method



Pin segmentation & rough registration



Match along z axis of pin position

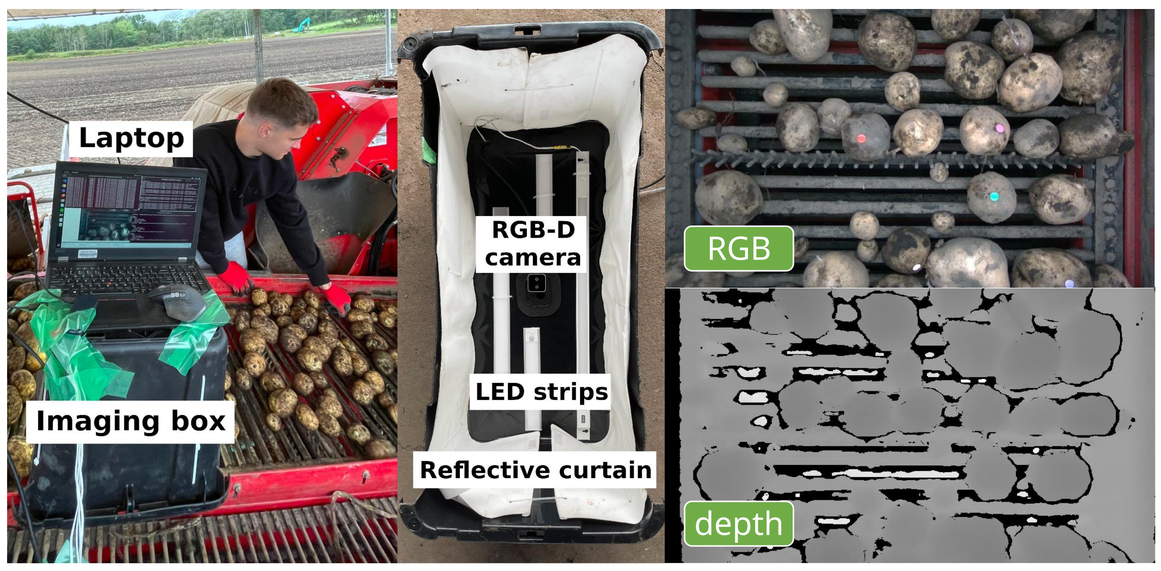


Match along x/y axis of pin position

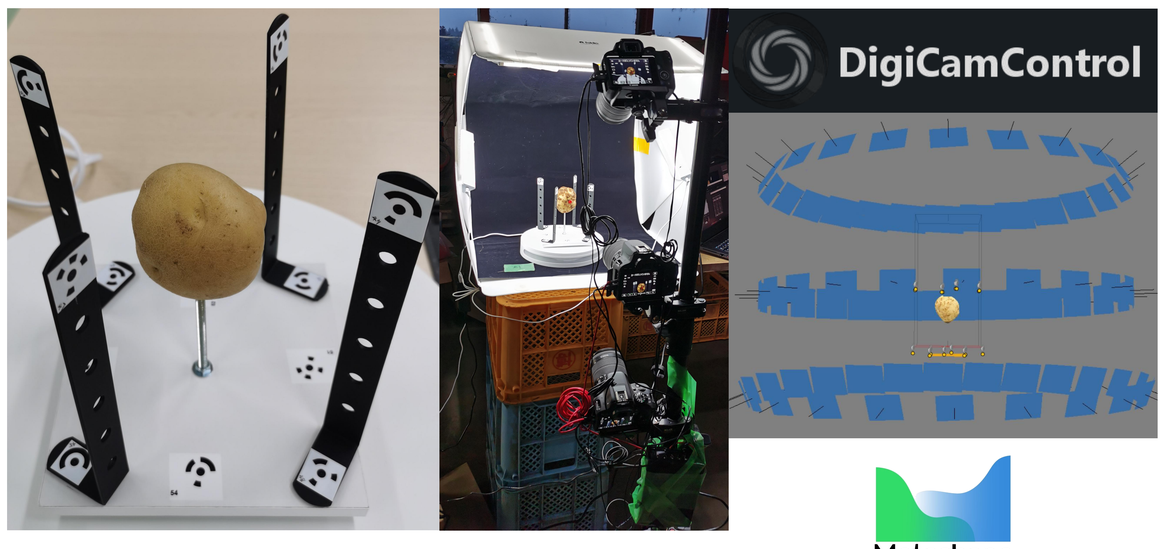
Three-axis stepwise rough matching around pin positions, then apply ICP registration for detail adjustment

Data collection

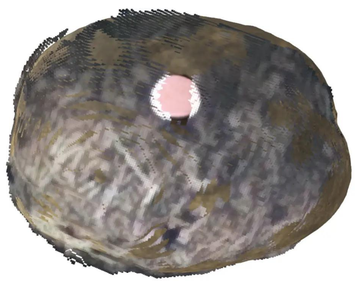
High throughput on conveyer



High quality by indoor SfM



Results



Top view

Right side view

Back side view

Transformation matrix to rotate RGBD to SfM coordinate with 339 potato tubers

Discussion & conclusion

Potential application

- Outdoor and indoor 3D recounstruction pipelines for small objects
- An approach for fusing the 3D models collected by different 3D reconstruction methods

Limitation and future work

- Performs better on irregular shapes, not suitable for standard spherical objects like grapes, tomatos, etc.
- Test the dataset feasibility for training shape completion deep learning networks
- Actual field applications for spatial variation of yield