Applications of Photogrammetry and 3D Modelling Techniques for Plant/Crop High-Throughput Phenotyping using Small Unmanned Aircraft System (sUAS)

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What is the high-throughput crop/plant phenotypying?

- Phenotyping is acquiring "a set of observable characteristics of plants/crops resulting from the interaction of their genotypes with the environment". (Wanscher 1975; Mayr 1982). For example, plant height, leaf length/width, leaf angle, etc.

- High-throughput phenotyping is using computer algorithms and imaging systems to acquire phenotype characteristics for a large number of plants/crops in a relative short period of time.

Why we should care high-throughput crop/plant phenotypying?

- The traditional phenotyping is very slow and labor-intensive.
- Accuracy of the field-based measurements can be highly variable.
- Computer and imaging system –based high-throughput phenotyping can change this.

The ground-level high-throughput phenotyping

- The ground-level experiments are needed for developing algorithms.
- Two cameras are mounted on a well-controlled platform.

The ground-level high-throughput phenotyping and 3D modeling

- 3D plant models using photogrammetry techniques.

The high-throughput phenotyping using sUAS platforms

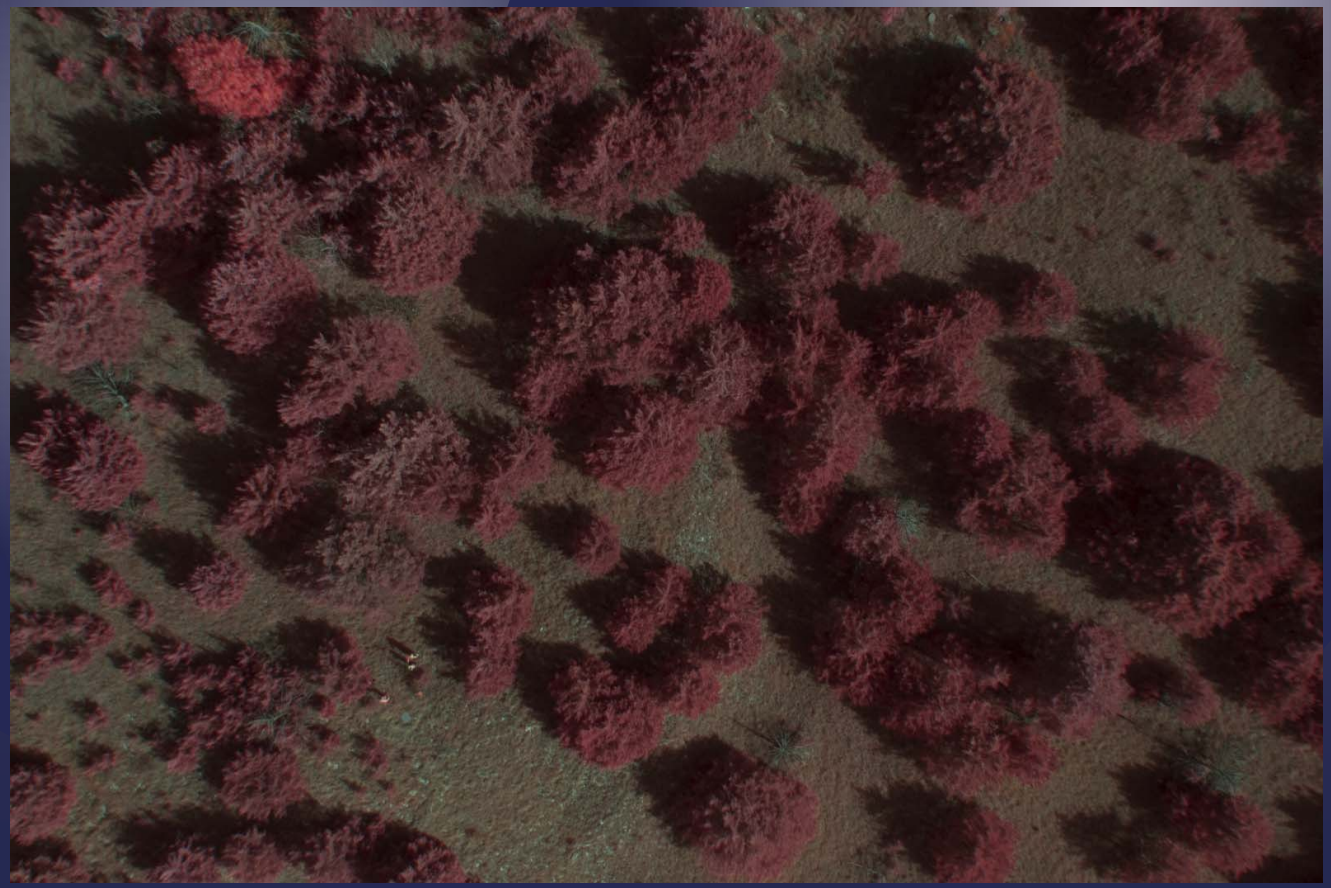
sUAS = small Unmanned Aerial System

DJI S800 Hexcopter

Canon T4i crop-sensor camera with 24mm L lens

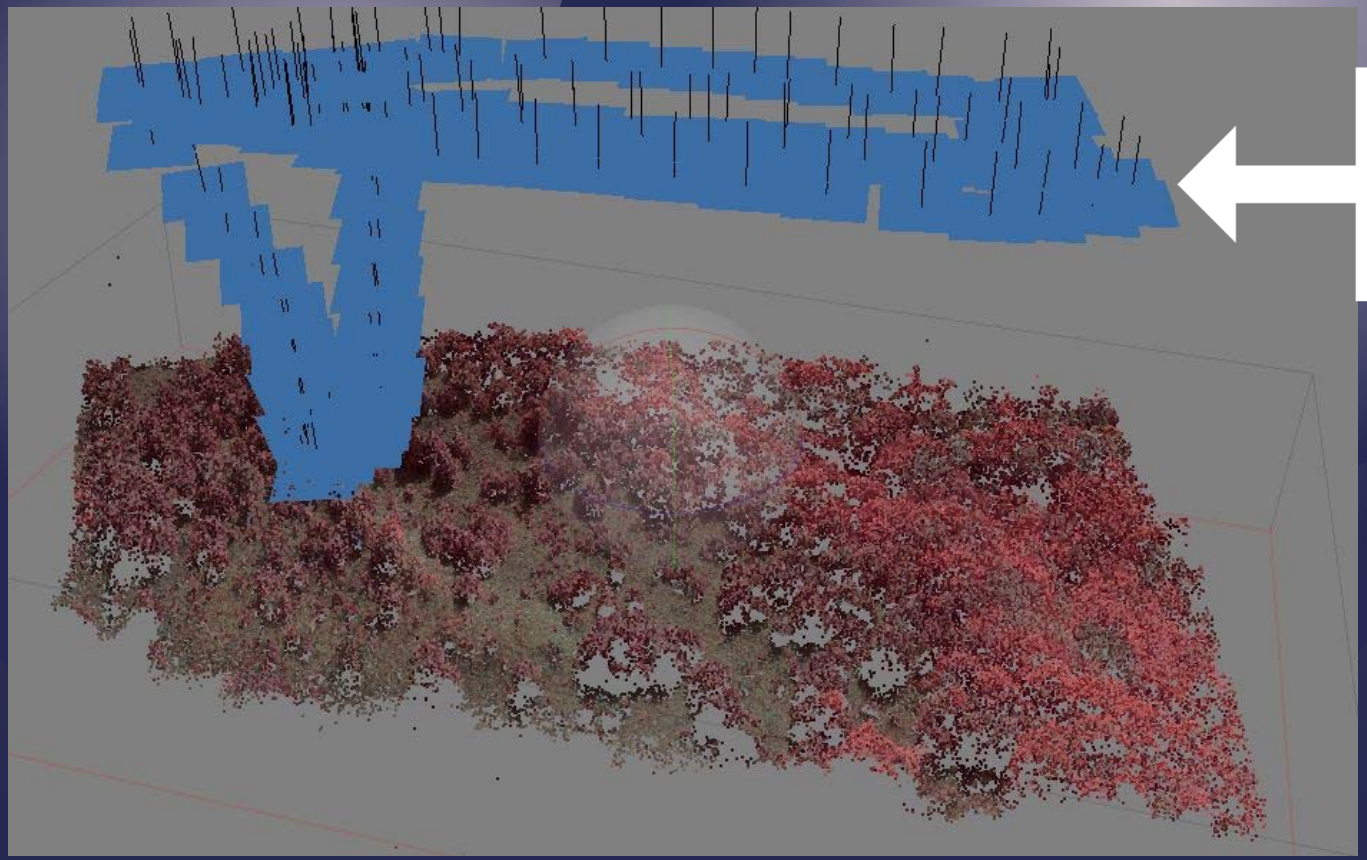
sUAS platform and 3D modeling

- This is example is using a set of images from a Redcedar site



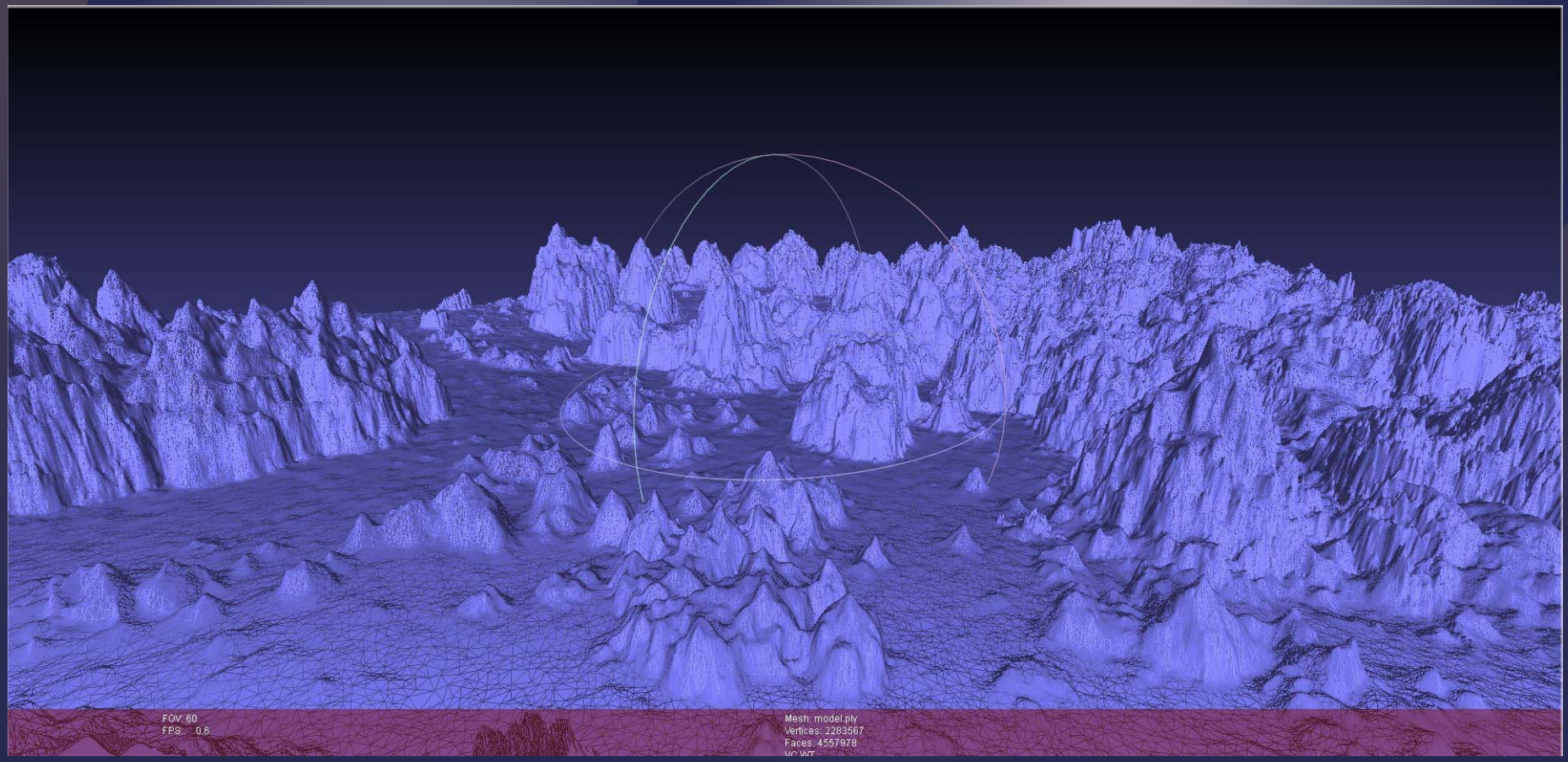
sUAS platform and 3D modeling

- Photogrammetry-based 3D software: Agisoft Photoscan Pro
- Step 1: Building 3D space and finding “Common Points”



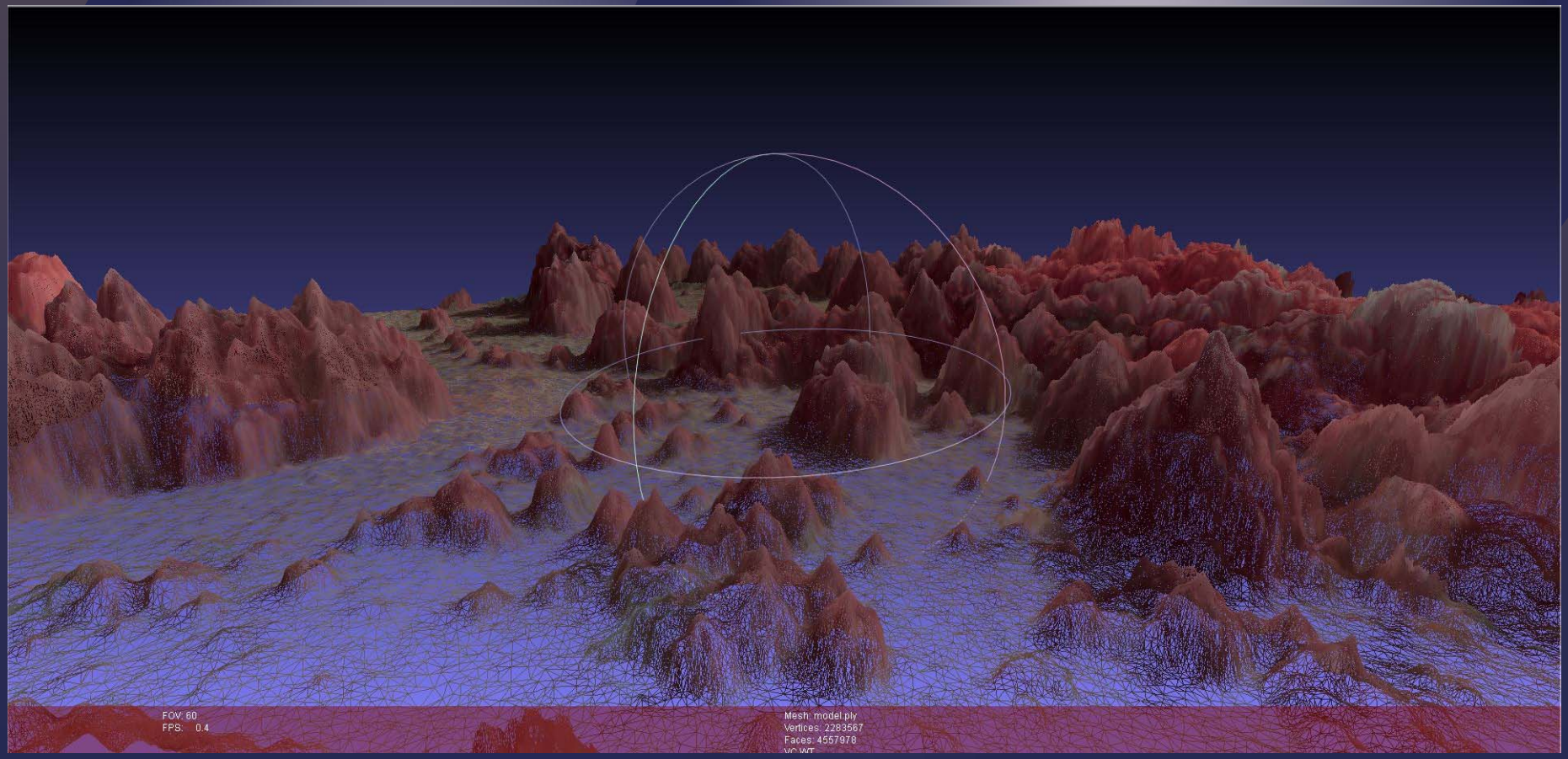
sUAS platform and 3D modeling

- Step 2: A triangulated irregular network (TIN) model



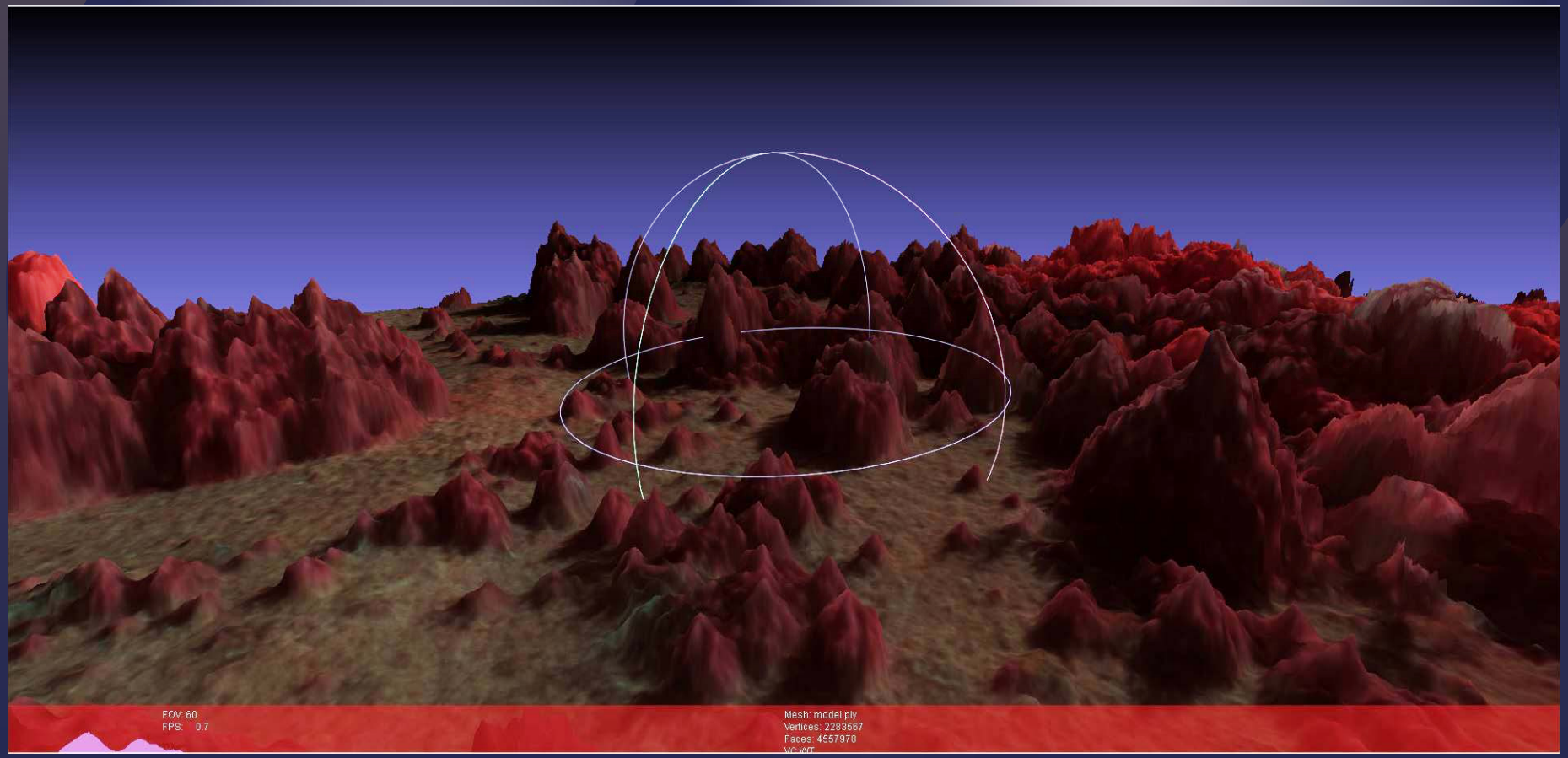
sUAS platform and 3D modeling

- Step 3: The original image pixel brightness values (BVs) are assigned to each vertex



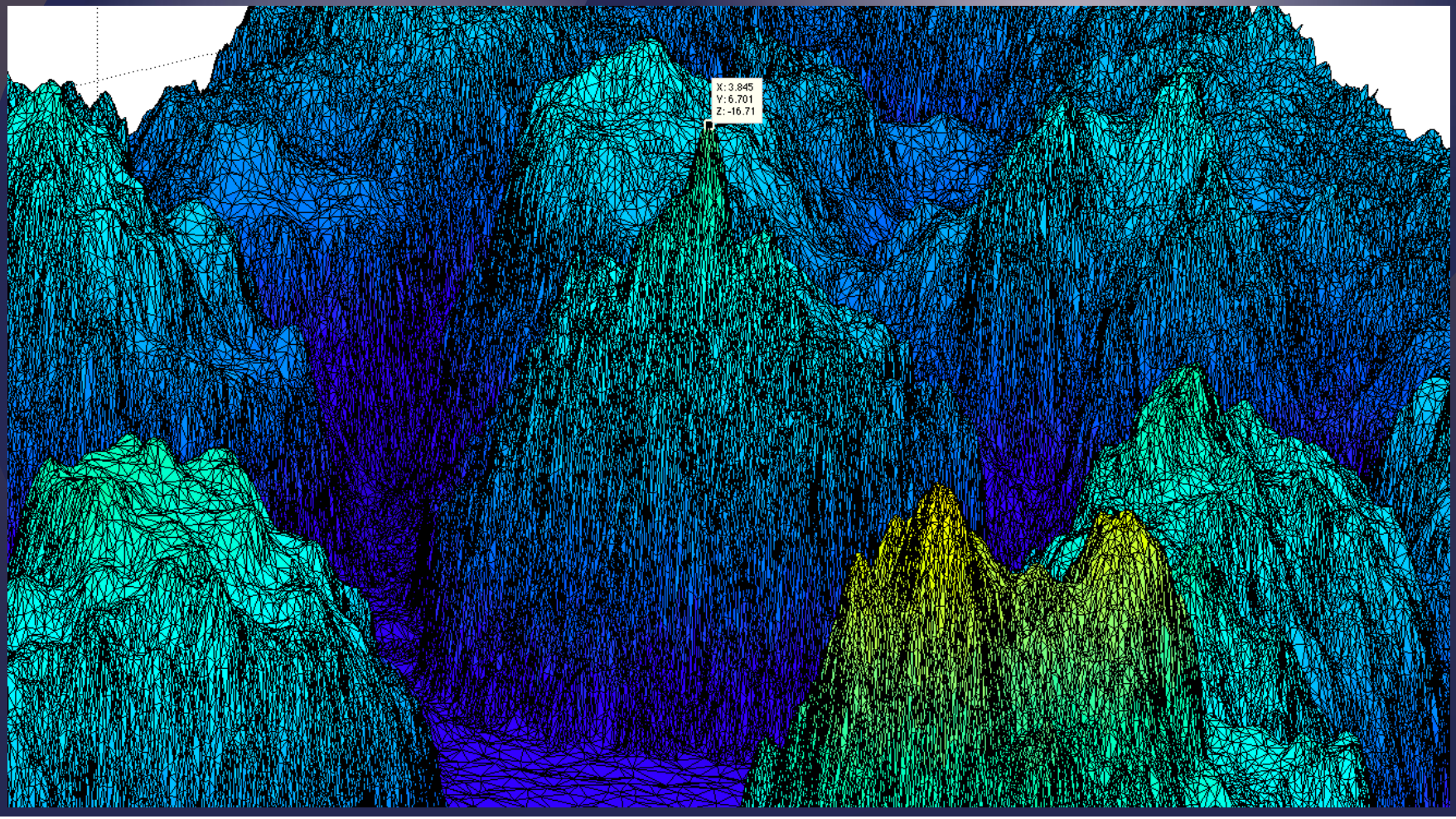
sUAS platform and 3D modeling

- Step 4: The original images are mosaiced and laid on the top of the 3D model.



sUAS platform and 3D modeling

- Step 5: The 3D model can be analyzed and the phenotyping information like tree height can be extracted.



Conclusions

- The old traditional plant phenotyping methods are slow, labor-intensive, time-consuming, expensive, and can be "inaccurate".
- High-throughput phenotyping is fast, relatively cheap.
- A large area/field can be flown in a short period of time.
- The algorithms for exacting phenotype information can keep measurements stable and accurate.

Our sUAS team at the beginning. Now we have been growing.

Thank you!! Questions?