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Comparison of Image Processing Methods for Better Point Clouds of Sagebrush

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Background

- Native sagebrush steppe habitats are some of the most diminished ecosystems in the western United States due to agricultural conversion, fragmentation, degradation and suffer negative pressure from invasive annual plants, such as cheatgrass.
  - Sagebrush: woody evergreen herbaceous shrub native to the United States.
    - Spring sagebrush leaves (ephemeral): grow quickly & larger than their secondary leaves but turn yellow and drop by mid-summer.
    - Perennial sagebrush leaves (persistent): remain on the plant and are smaller.
- Biologists require multi-spectral data to monitor changes in 3D scale. Remote sensing technologies allow accurate monitoring and provide extensive data for models used in restoration outlooks.

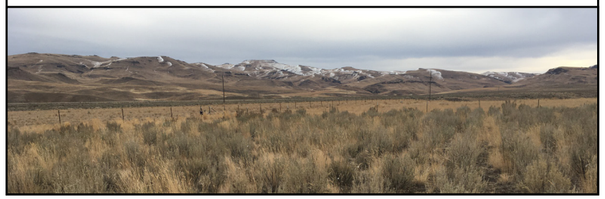

Figure 1. Image of Soda location in fall 2020 provided by Andrii Zaiats.

Agisoft Program

Agisoft Metashape: Software product that processes digital images using structure from motion techniques.

- Takes images provided by UAVs (unoccupied aerial vehicle) and creates a 3-dimensional structure along with producing a point cloud 3d model.
- This imagery can be used, in the case of monitoring sagebrush, to identify new plants or compare growth.
- Key points: a distinct feature in a single image.
- Tie points: identifiable feature in multiple images that is used as a reference point.
- Point cloud: a set of data points in space that represents the 3d structure and can generate a high-level model providing algorithms to reconstruct the ground surface.

Methods

Align Photos → **GCP's Target Matching** → **Gradual Selection** → **Building Model**

- Import and align, choose processing parameters
- Important for positional accuracy
- Data cleaning to remove bad points
- Orthomosaic, dense cloud, Digital Elevation Model

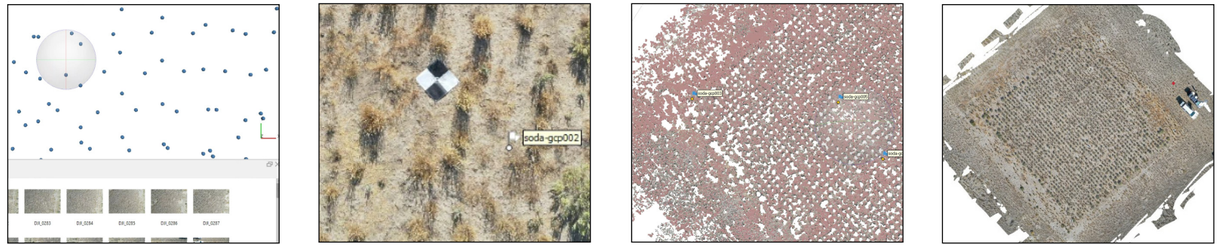

Figure 2. Flow chart of the methods used in Agisoft. Screenshots reflecting the steps taken throughout the 2020 parameter comparison projects A-I.

Comparison

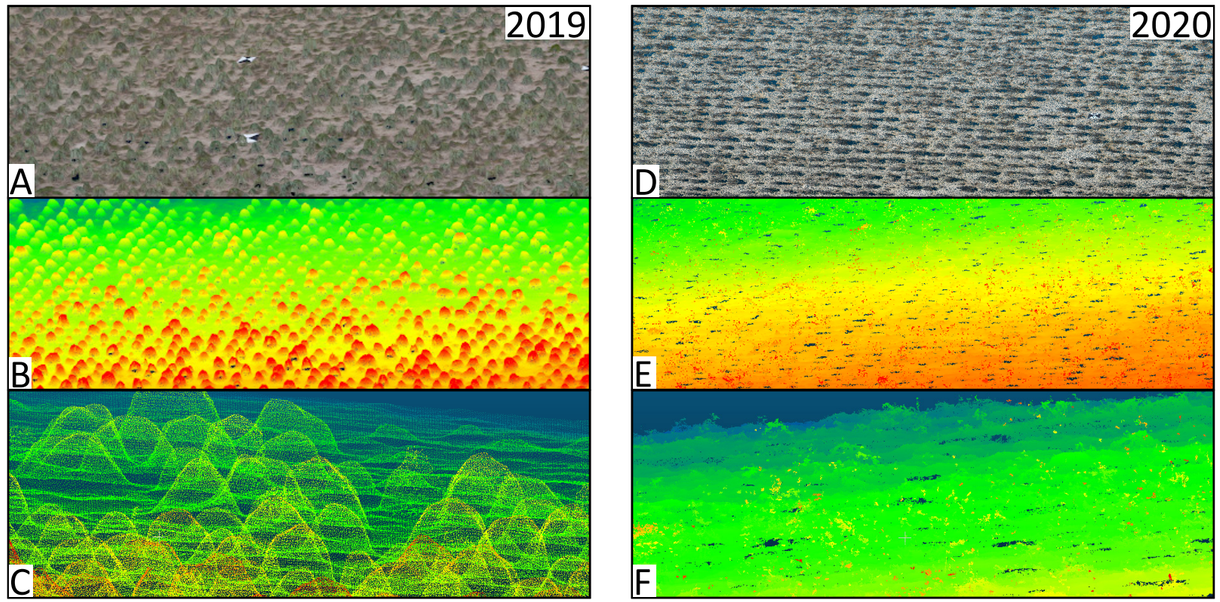

Figure 3. Soda garden output comparison of June 2019 to September 2020 flights. A/D) Point cloud with true color on points, B/E) colored by height, C/F) zoomed in to show individual points, colored by height. Images provided by Peter Olsoy.

Results

Table 1. Inputs and outputs for projects A-I using Soda garden 2020 data. Agisoft input values in blue, and output values in yellow. After varying the combinations of tie point/key point amounts, results showed no difference in dense cloud size or density.

Project	key point limit	tie point limit	# of tie points	# of points in dense cloud	density of points /cm2	GCP error (cm)
A	0	0	6,282,697	356,117,121	6.24	10.6855
B	0	60K	424,257	327,589,581	6.23	9.13066
C	0	150K	2,532,437	403,749,027	6.21	6.39077
D	60K	0	302,989	417,509,572	6.25	8.24989
E	60K	60K	241,806	389,048,012	6.22	5.20258
F	60K	150K	247,660	400,383,892	6.20	4.90759
G	150K	0	725,070	369,060,036	6.25	8.52481
H	150K	60K	531,988	368,967,571	6.22	7.3356
I	150K	150K	531,255	370,328,772	6.22	7.28641

Conclusions

- Changes made to several tie points and key points made no difference to the final product models.
- Images from 2019 were easier to differentiate sagebrush from surrounding ground compared to images taken in 2020.
- Sagebrush leaf phenology was found to make a considerable difference in the quality of photos.
- Late summer long shadows also made distinguishing sagebrush plants difficult to identify from setting.

Next Steps

- Further testing on different parameters such as gradual selection steps to test product models.
- Compare to know how much selection is necessary versus over deletion that hinders outputs.

Acknowledgements

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GEM3 Genes by Environment Modeling · Mechanisms · Mapping

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