

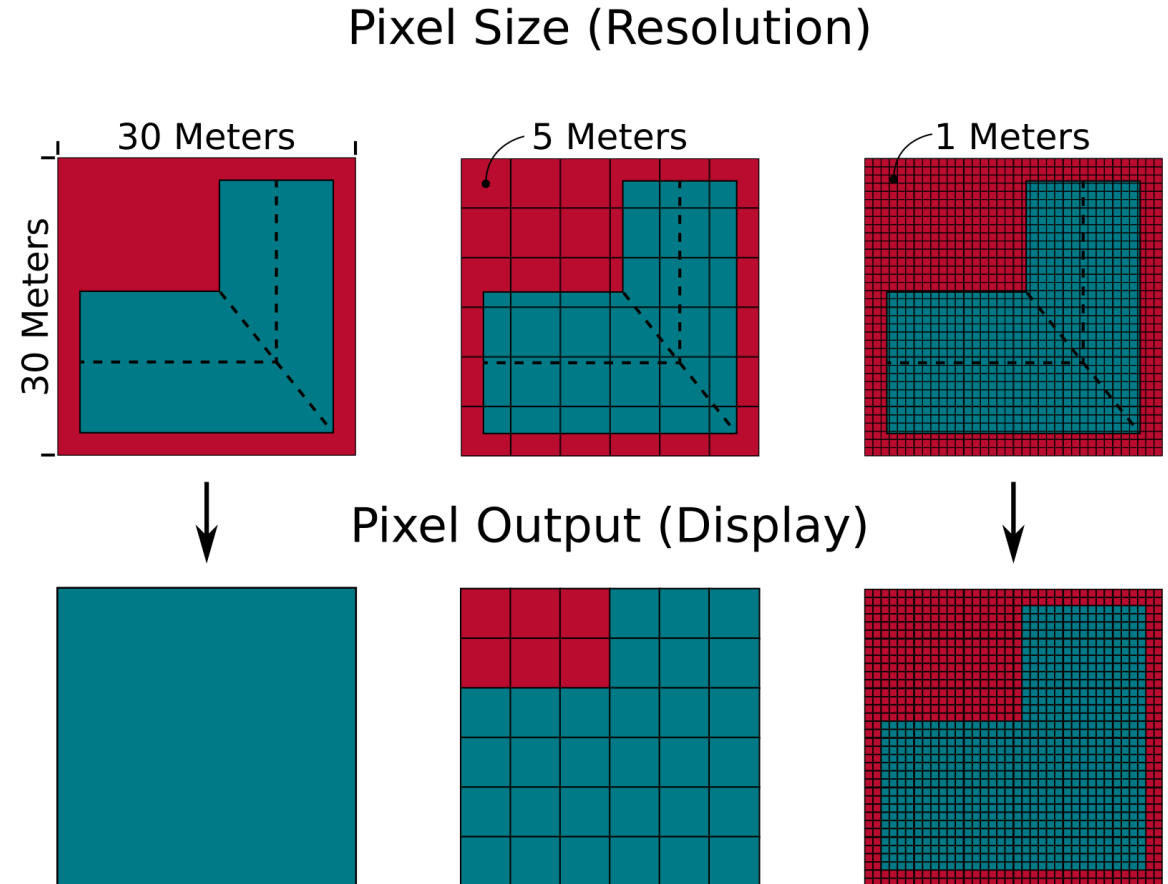
Drone Image Processing

Dr. Su Zhang



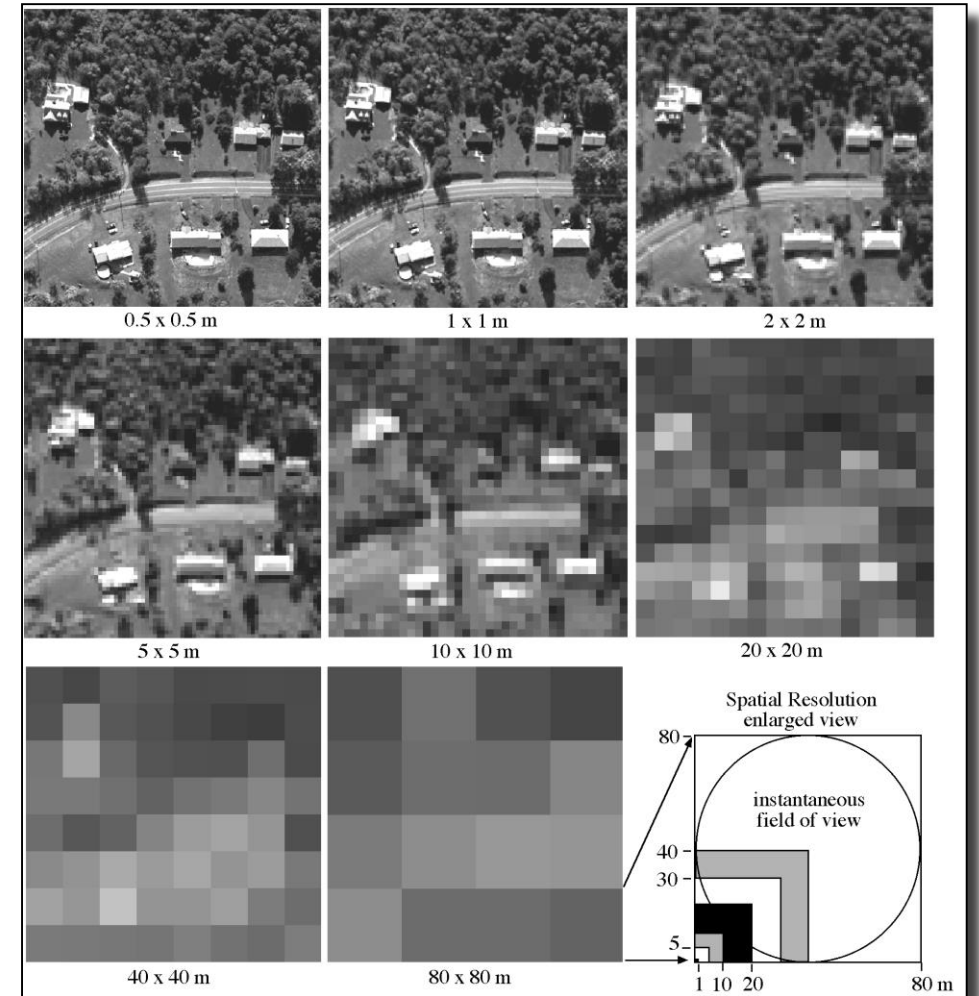
Drone Image Characteristics

- **Spatial Resolution**
 - Sub-inch
 - Millimeter
- **Temporal Resolution**
 - Hourly
 - Daily
- **Spectral Resolution**
 - RGB (Red, Green, Blue)
 - NRGB (Near-infrared, Red, Green, and Blue)
- **Radiometric Resolution**
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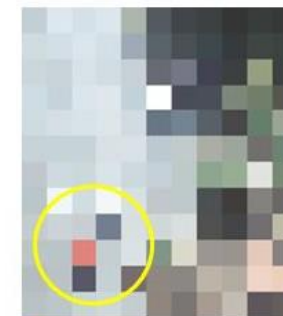
12.8m



6.4m.



3.2m



1.6m



0.80m



0.40m



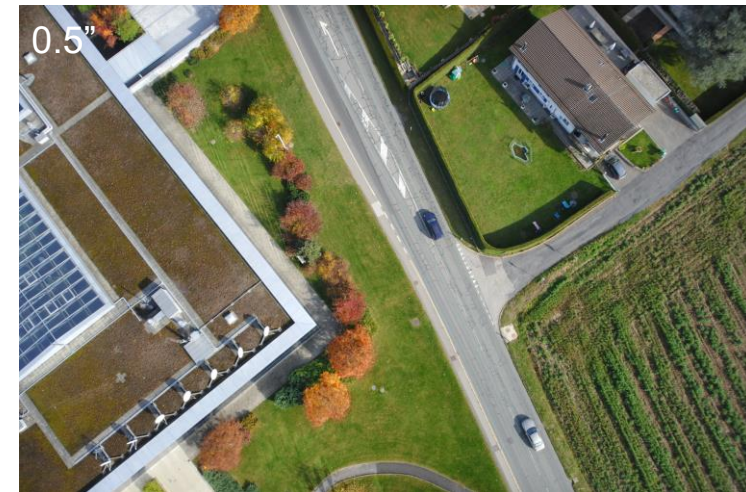
0.20m



0.10m

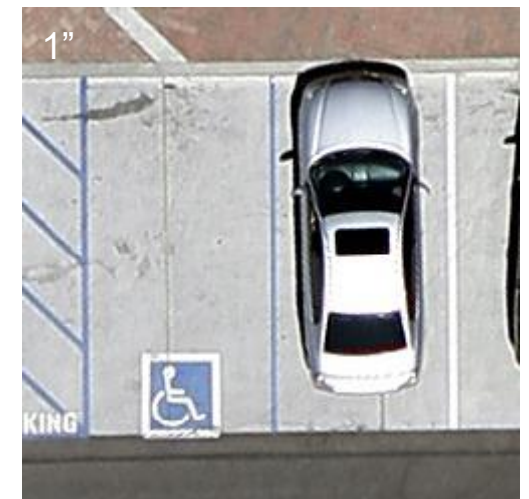
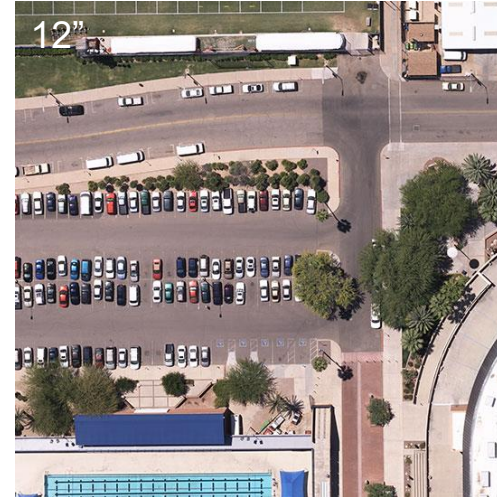
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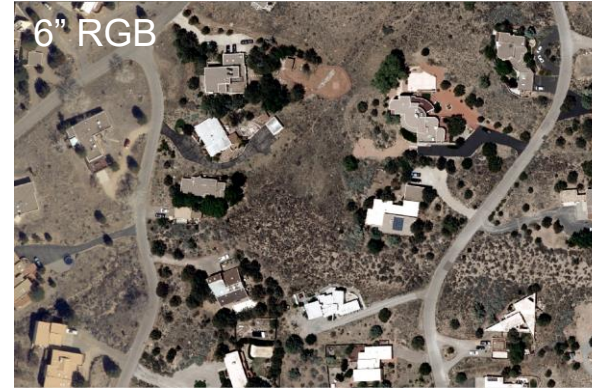
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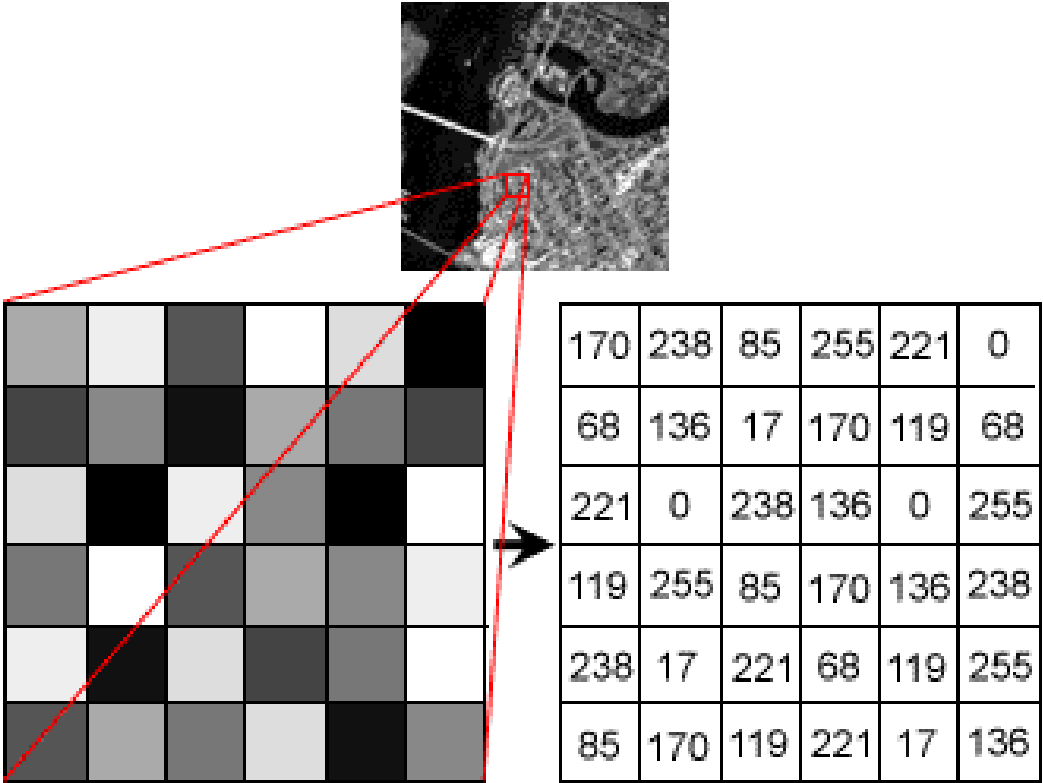
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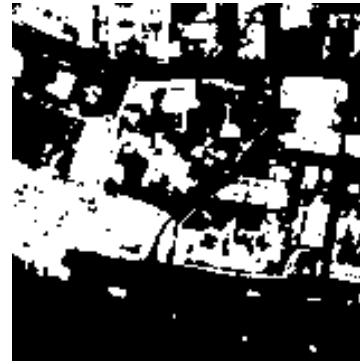
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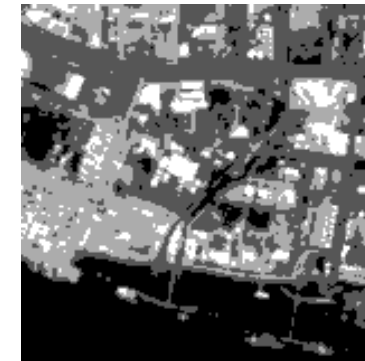


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1 - bit



2 - bit



8 - bit

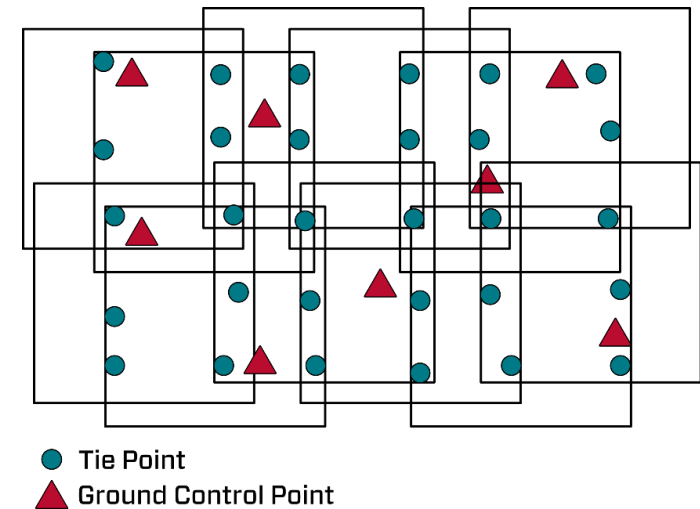
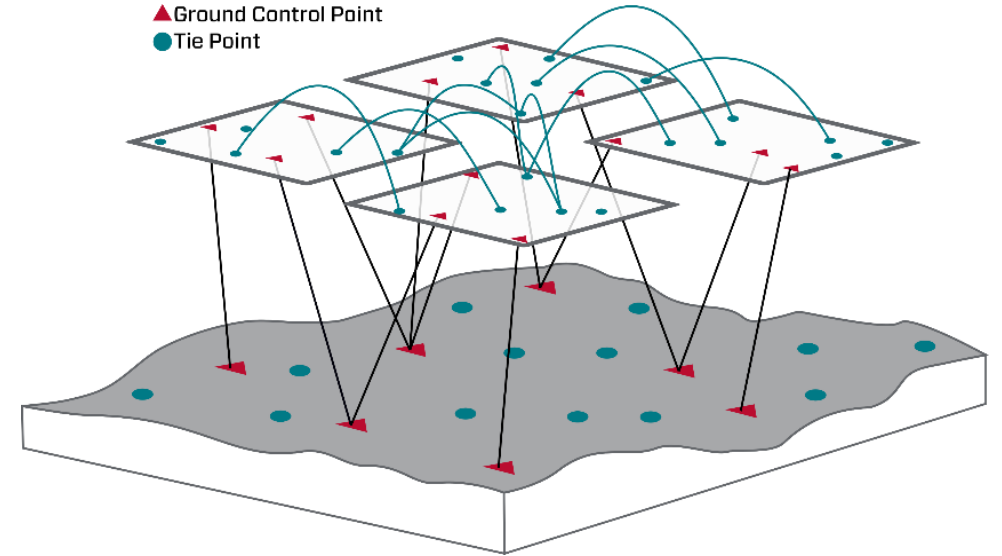
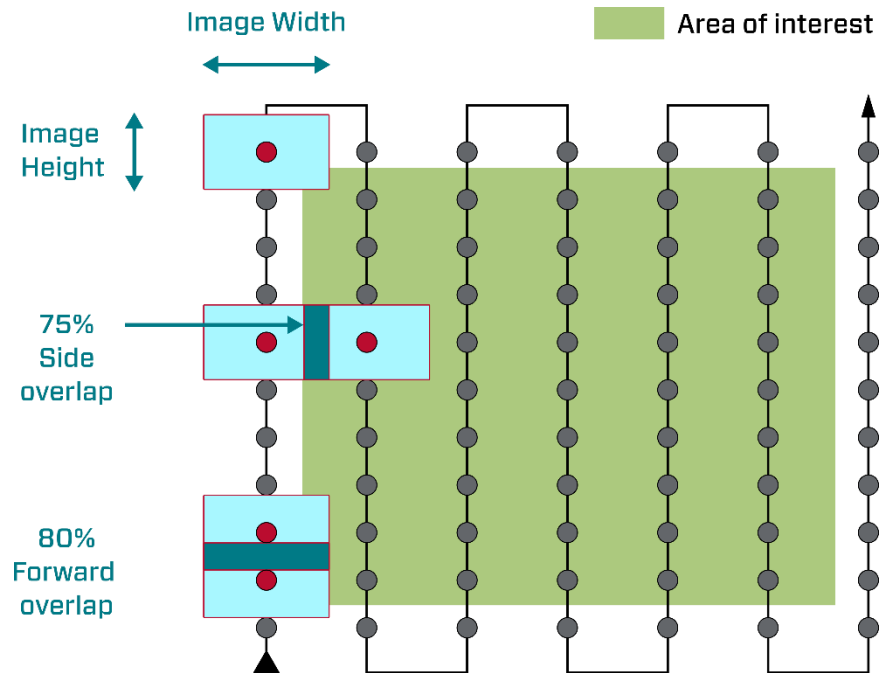
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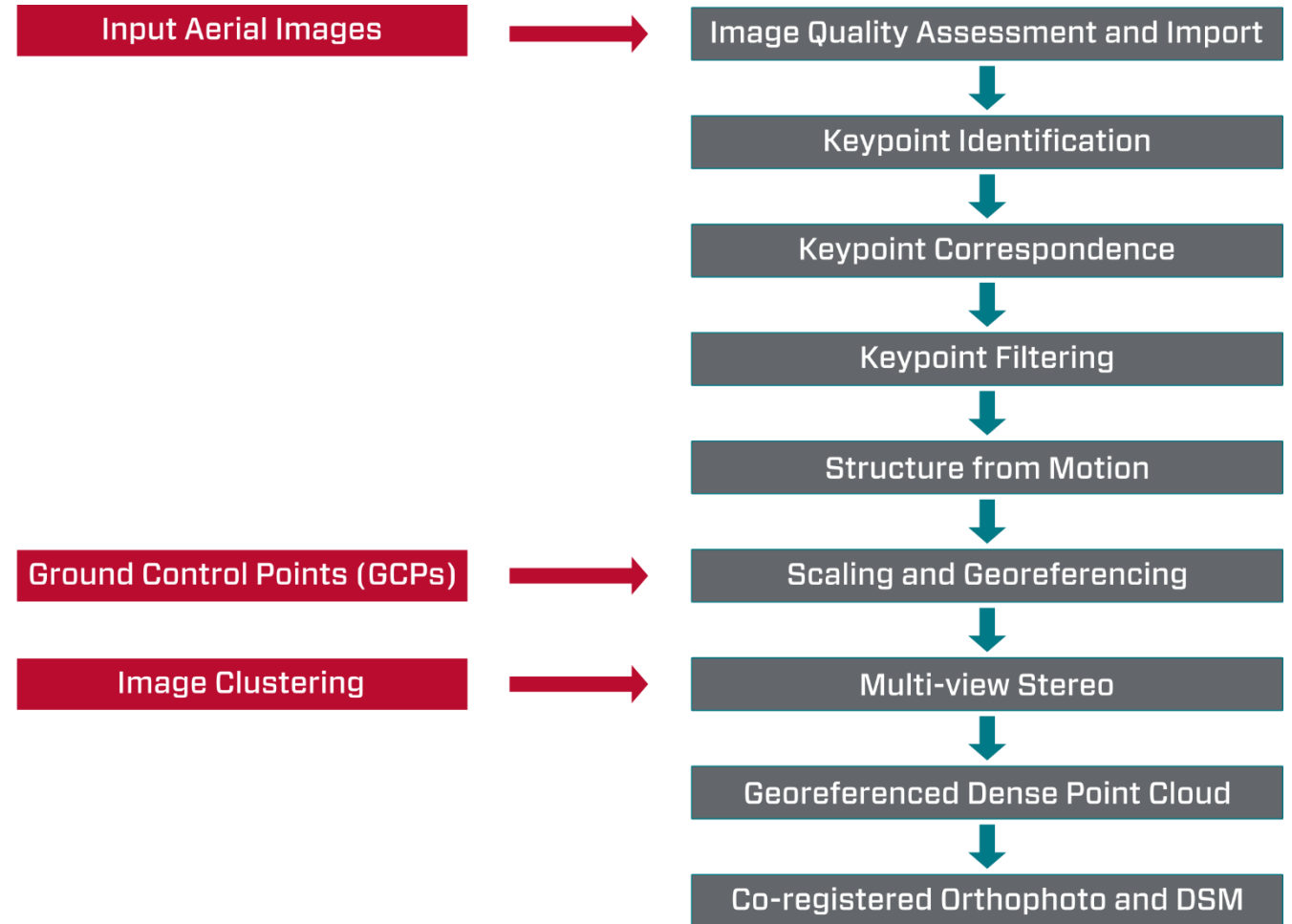
Aerial Triangulation

- **Aerial Triangulation (AT)**
 - **Structure from Motion**
 - **Multiple-View Stereo (MVS)**
 - **Determines ground coordinates of points on the aerial photos**



Aerial Triangulation

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 - **Determines ground coordinates of points on the aerial photos**



Input Aerial Images

- Collected from UAS
 - Autonomous flight
 - High-spatial resolution
 - Copy from Micro SD Card to local storage drive

szhang (\\prosperon\users) (P:) > Workshop > Past > LTAP > UAS > LTAP_UAS > images

Name	Date modified	Type	Size
EP-00-00012_0119_0001	3/13/2018 6:37 PM	JPG File	4,426 KB
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EP-00-00012_0119_0003 Properties

General Security Details Previous Versions

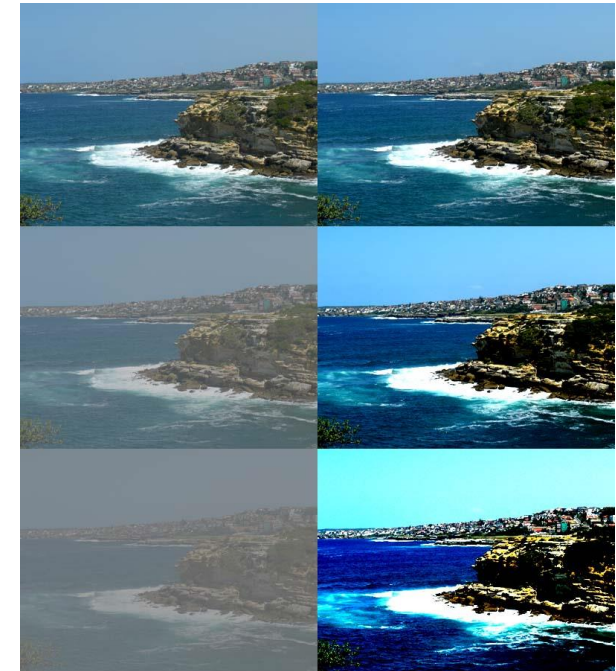
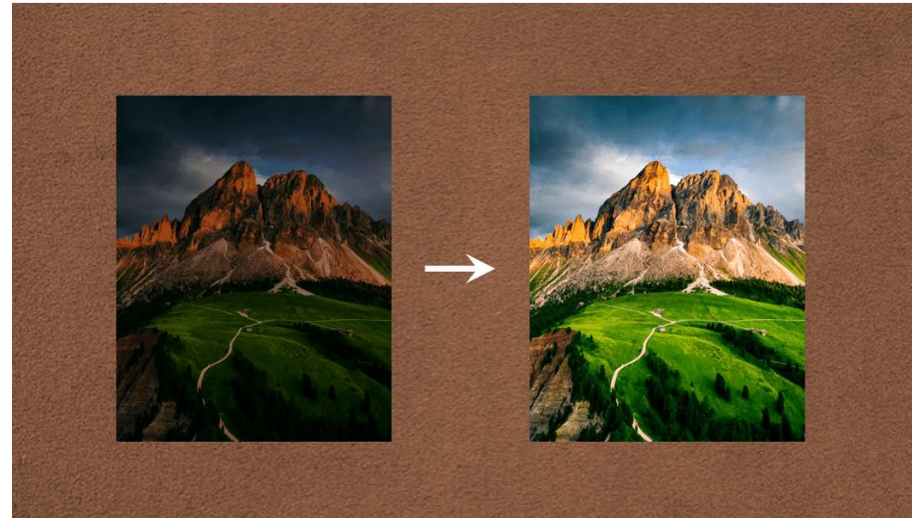
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Photometric interpretation	
Digital zoom	
EXIF version	
GPS	
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Longitude	6; 35; 28.1939999999993063
Altitude	722.5724
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Date modified	3/13/2018 6:37 PM
Size	4.45 MB
Attributes	ALI
Availability	
Offline status	
Shared with	

[Remove Properties and Personal Information](#)

OK Cancel Apply

Image Quality Assessment and Import

- **Quality Assessment**
 - **Brightness**
 - **Contrast**
 - **Sharpness**
 - **Coordinate**
- **Import**
 - **Load images to image processing software**
 - **Load all images at once**
 - **Load images in chunks**



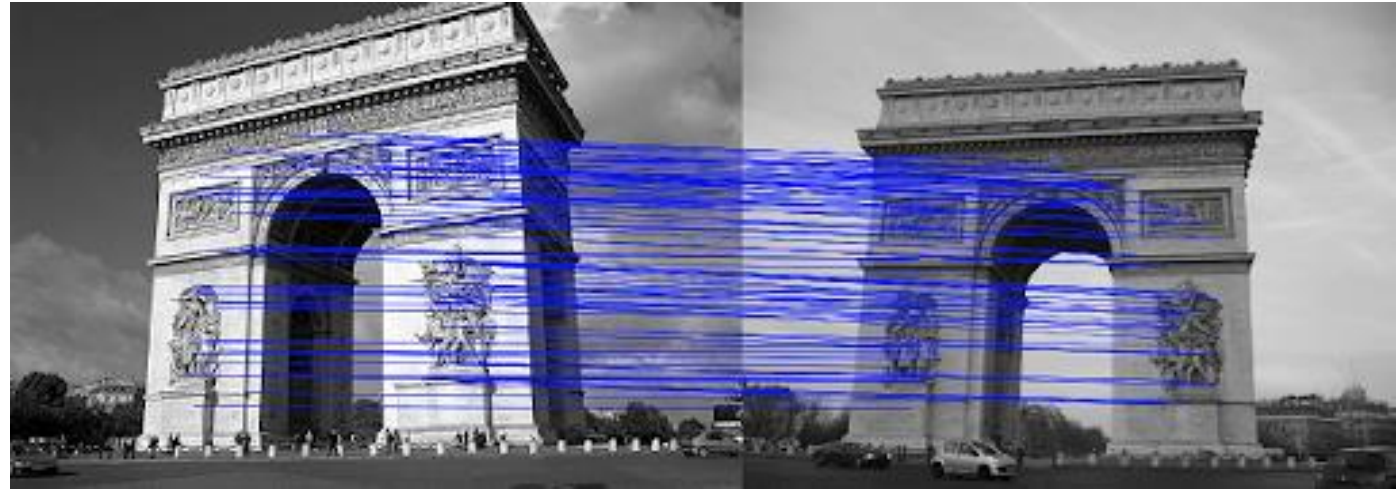
Keypoint Identification

- **Keypoints**
 - Also known as tie points
 - Features that can be clearly identified on an image
 - Have different 3D position, scale, and orientation
- **Keypoints Identification**
 - Enables image matching and scene reconstruction
 - Many algorithms exist, but the most common one is scale-invariant feature transform (SIFT)



Keypoint Correspondence

- **Keypoint Correspondence**
 - Essentially correspondence lines
 - Needs to be determined and established
- **Noting**
 - There is no assurance that any given keypoint in an image will have a matching keypoint in another image
 - Keypoint correspondence involves discarding keypoints that do not have a matching partner



Keypoint Filtering

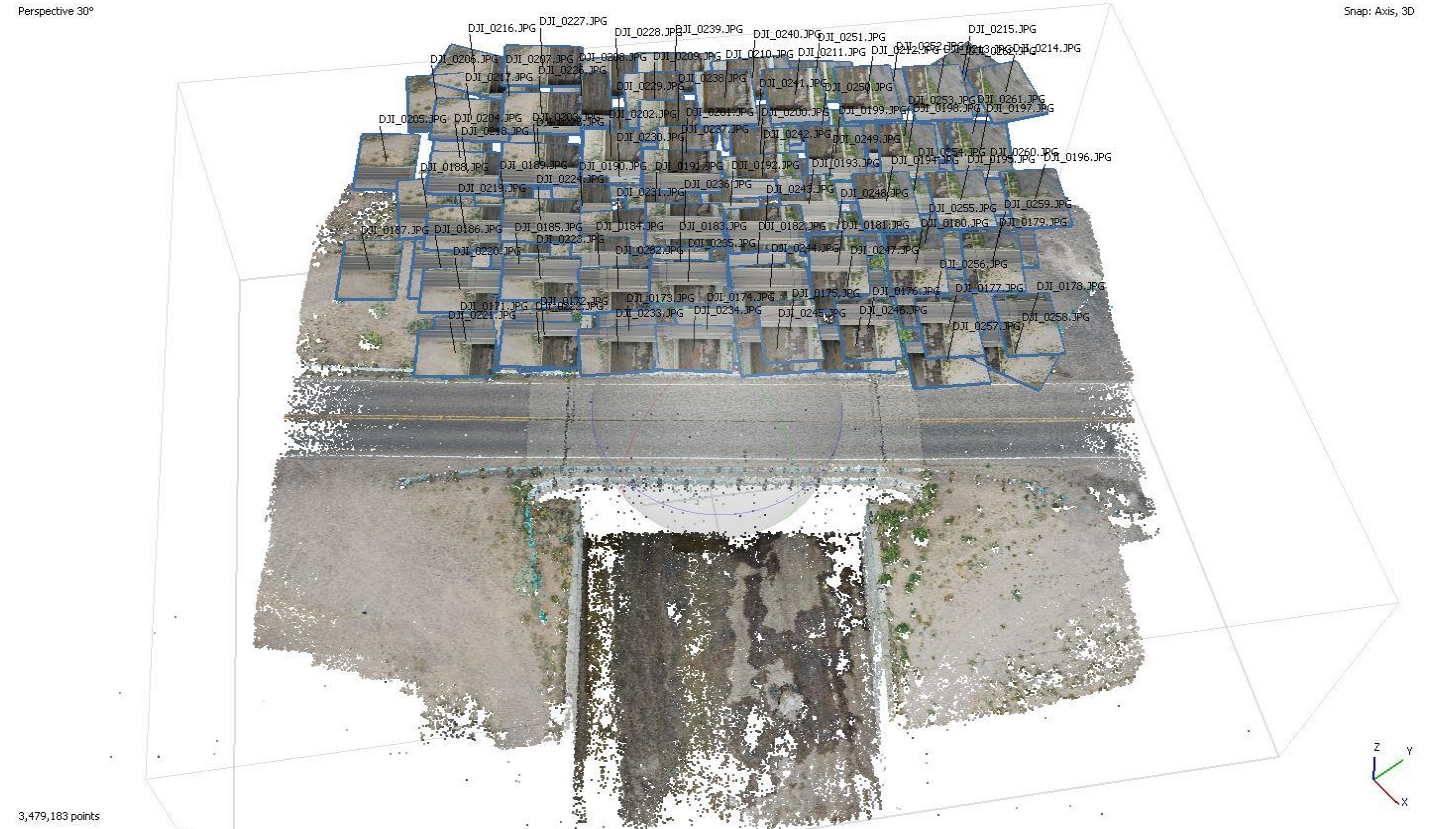
- **Further Processing**
 - **Keypoint correspondence to filter out any erroneous matches**
 - **Many methods are available, but one of the most robust and accurate one is Random Sample Consensus (RANSAC)**



Structure from Motion

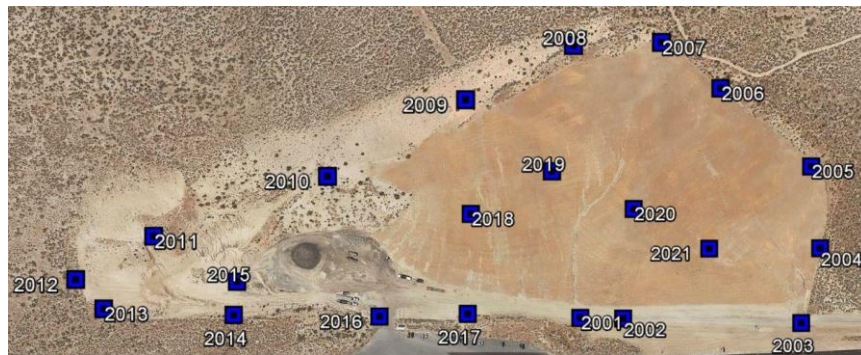
- SfM

- Focuses on estimating camera poses and then reconstructing the 3D geometry of a scene
- Intrinsic parameters
- Extrinsic parameters
- Bundle block adjustment
- Sparse point cloud



Scaling and Georeferencing

- **Accurate Dimensions of 3D Geometry**
 - Previous steps only estimates camera locations and scene geometry
 - Absolutely distances between cameras and reconstructed 3D points cannot be resolved from aerial images
- **Scaling and Georeferencing**
 - A set of Ground Control Points (GCPs)
 - Collected by survey-grade GPS equipment such as RTK



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Markers	Longitude	Latitude	Altitude (m)	Accuracy (m)	Error (m)	Projections	Error (pix)
✓ point 1	-106.599462	35.204256	1513.585000	0.005000	0.198197	36	0.953
✓ point 2	-106.599424	35.204270	1513.600000	0.005000	0.170981	38	0.572
✓ point 3	-106.599384	35.204337	1513.629000	0.005000	0.137583	43	0.590
✓ point 4	-106.599271	35.204423	1513.607000	0.005000	0.115457	29	0.361
✓ point 5	-106.599255	35.204388	1513.853000	0.005000	0.113435	29	0.550
✓ point 6	-106.599411	35.204239	1513.724000	0.005000	0.114228	31	0.712
✓ point 7	-106.599290	35.204441	1513.570000	0.005000	0.182897	34	0.867
✓ point 8	-106.599361	35.204361	1513.618000	0.005000	0.157935	42	0.540
✓ point 9	-106.599458	35.204303	1513.567000	0.005000	0.162073	40	0.673
✓ point 10	-106.599488	35.204254	1513.586000	0.005000	0.121016	34	0.512
Total Error							
Control points					0.150333		0.656
Scale Bars	Distance (m)	Accuracy (m)	Error (m)				
Total Error							
Control scale ...							
Check scale b...							

Multi-View Stereo

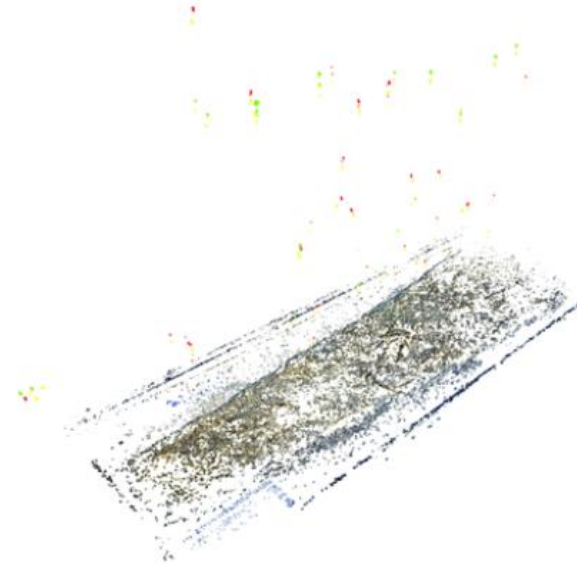
- **MVS**
 - Uses SfM estimated camera calibration parameters to create depth maps which are used to reconstruct dense 3D geometry
 - Many methods exist, but generally can be classified into four groups, including Voxel-based methods, surface evolution-based methods, depth map merging methods, and patch-based methods
 - Dense point cloud



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2.1



Sparse Point Cloud

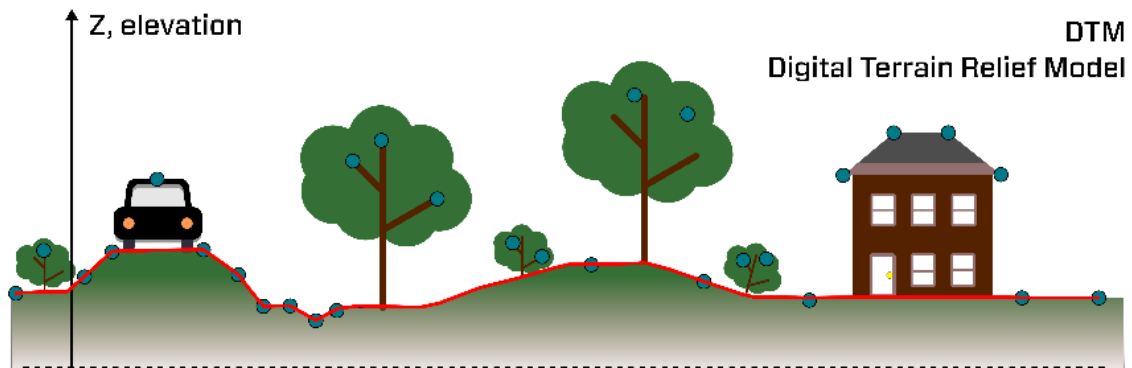
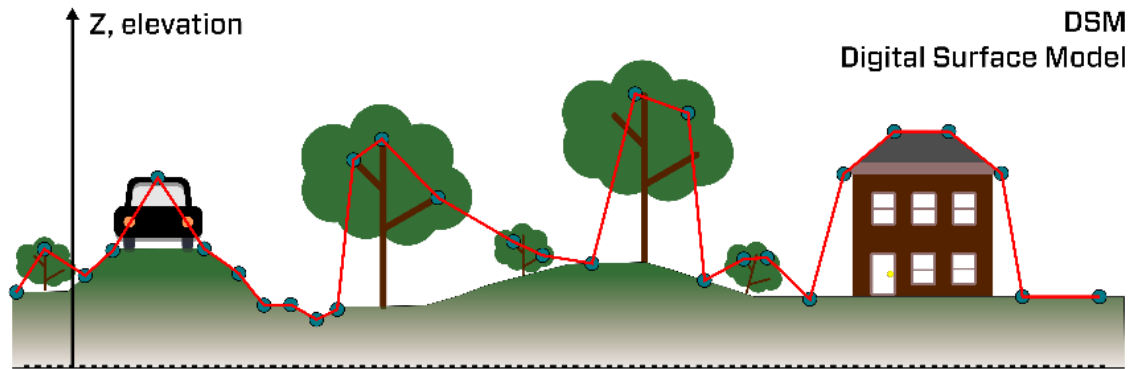
2.2



Dense Point Cloud

Co-Registered Outputs

- Co-registered Outputs
 - Orthophotos
 - Digital Surface Models (DSMs)

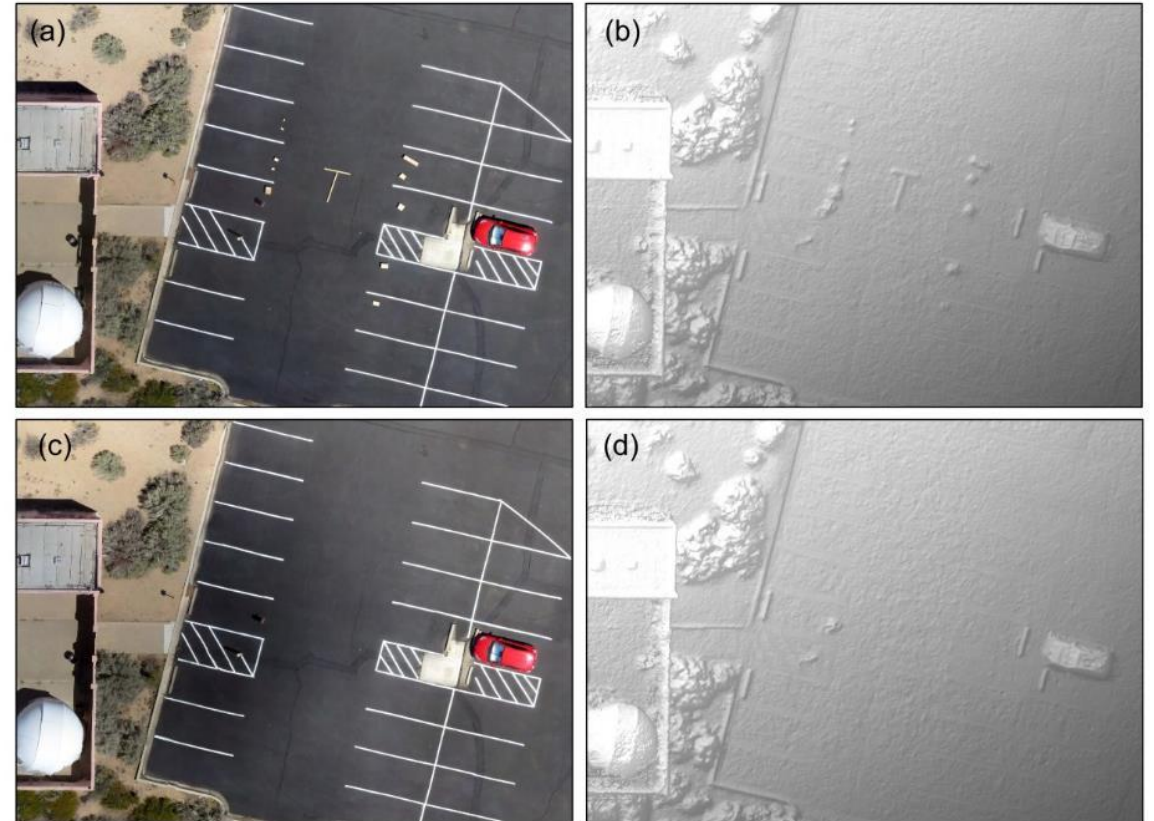


Orthophoto

DSM

Co-Registered Outputs

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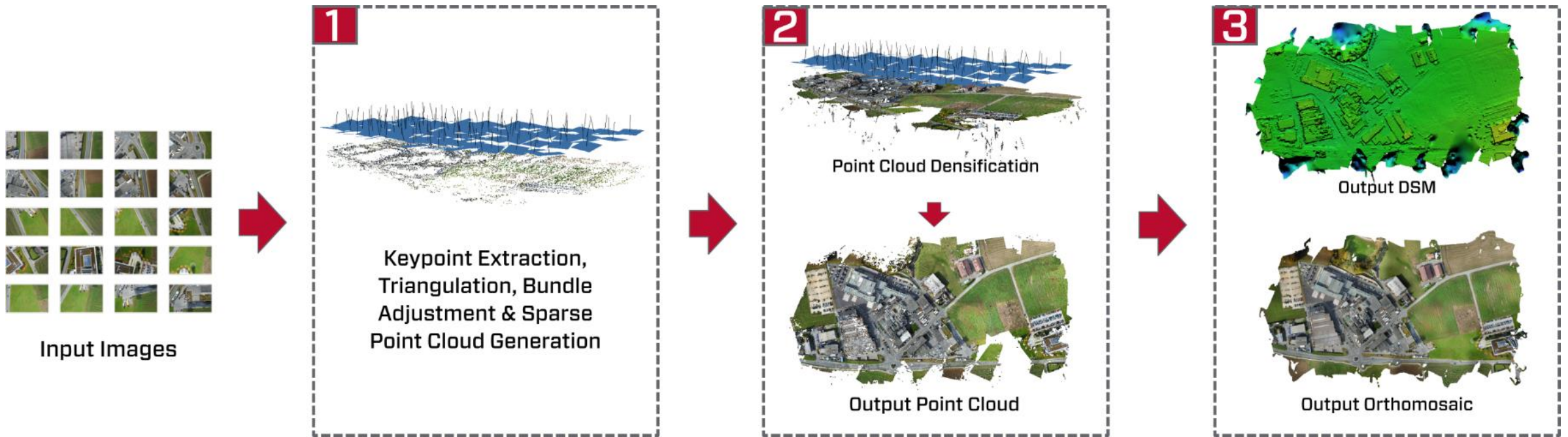


0 5 10 20
Meters

Orthophoto

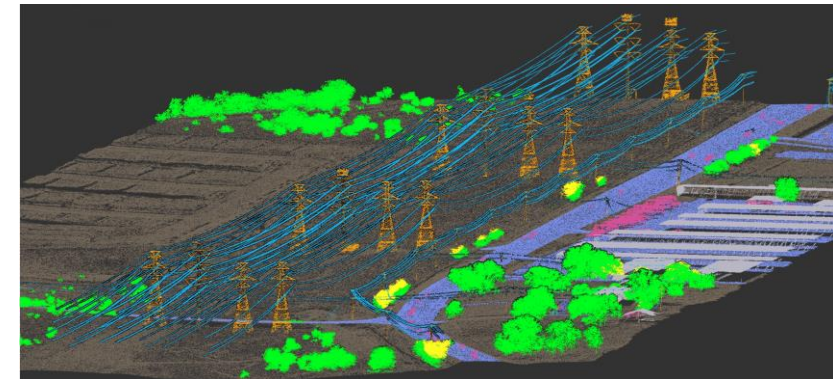
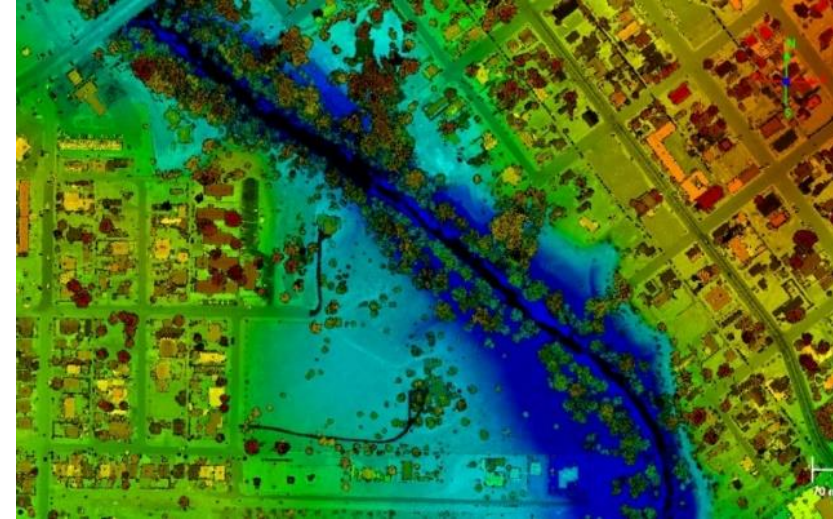
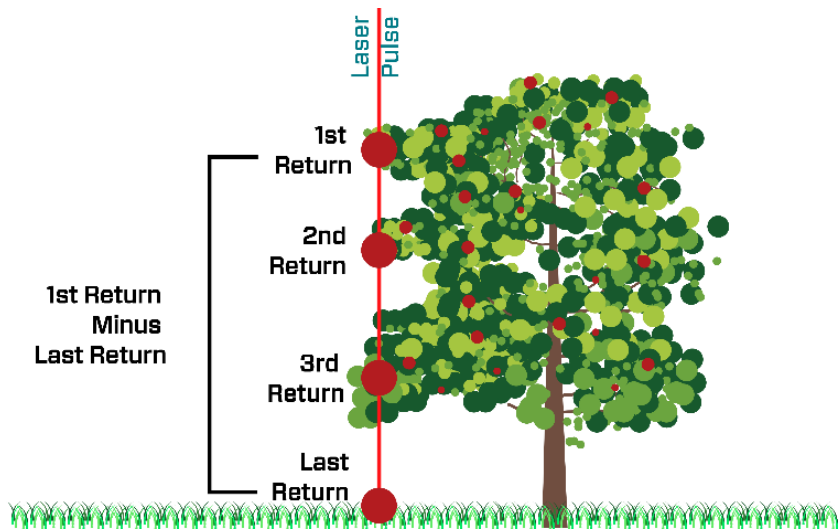
DSM

Simplified Process



Airborne LiDAR

- Airborne LiDAR
 - Uses light in the form of a pulsed laser to measure distance
 - Accurate elevation data



S-UAS Laboratory

- **S-UAS Laboratory**
 - **Spatial informatics research and education**
 - **S-UAS research**
 - **Sensors**
 - **Applications**
 - **S-UAS services**
 - **Aerial imagery collection**
 - **Data analytics**
 - **Aerial and ground survey**



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malvernanalytical.com



aerosci.info



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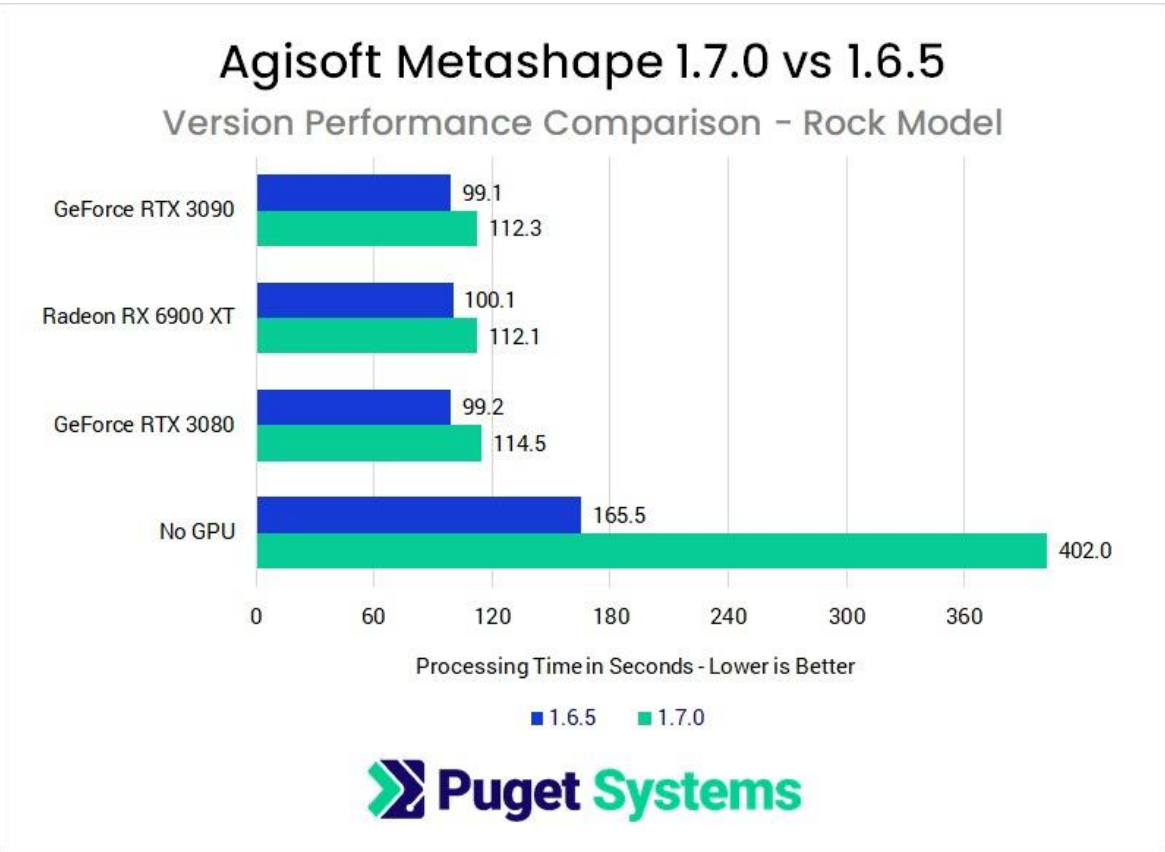
S-UAS Laboratory

- Image processing and visualization



Image Processing Benchmark

- Benchmark



Metashape Preferences

General GPU Network Appearance Navigation Advanced

GPU devices:

<input checked="" type="checkbox"/>	GeForce GTX 1060 (10 compute units @ 1670 MHz, 6144 MB)	CUDA
<input type="checkbox"/>	Intel(R) UHD Graphics 630 (24 compute units @ 1100 MHz, 6502 MB)	OpenCL
<input checked="" type="checkbox"/>	Radeon RX Vega (gfx900) (56 compute units @ 1590 MHz, 8176 MB)	OpenCL

Note: GPU acceleration is supported for image matching, depth maps generation, mesh generation based on depth maps and mesh refinement.

Warning: When using dedicated GPUs please turn off integrated GPUs and CPU for optimal performance.

Use CPU when performing GPU accelerated processing

OK Cancel Apply