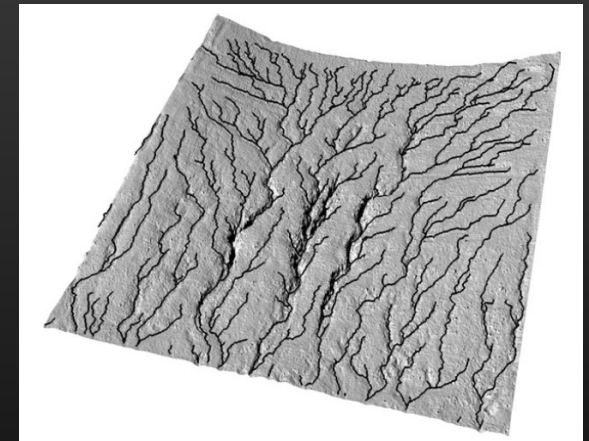


Close-Range Photogrammetric Analyses of an Active Paleontological Excavation

Dr. Maribeth H. Price
South Dakota School of Mines & Technology
April 2014

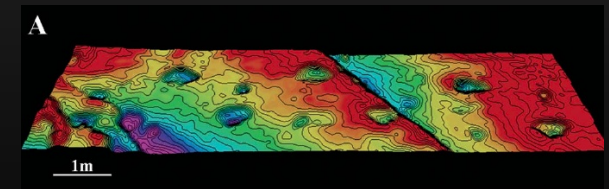
Applications of Photogrammetry

- Rieke-Zapp and Nearing (2005)
 - Detect soil surface change
 - Lab-calibrated dSLR camera
 - 3 mm pixel resolution
- Koch and Kaehler (2009)
 - Survey sculptured reliefs
 - LiDAR and CRP images
 - Measurements accurate within ± 1 mm at center, ± 3 mm at edges



Photogrammetry in Paleontology

- Breithaupt *et al.* (2001, 2004)
 - Document tracks and trackways
 - Remote sensing with calibrated cameras at different scales
 - Created DTM with 1 cm precision
- Matthews *et al.* (2006)
 - Added CRP images with 0.3-mm resolution to Breithaupt *et al.* (2001, 2004) methodology



Bates *et al.* (2008)

Created a 3D DTM of a desert landscape

The Mammoth Site of Hot Springs, SD Inc.

- Site was a sinkhole that formed from a collapsed breccia pipe
 - A minimum of 61 mammoths, both Columbian (*Mammuthus columbi*) and Woolly (*Mammuthus primigenius*), present
 - An abundance of fossil material exposed and in place
- Multiple skulls and skeletons.



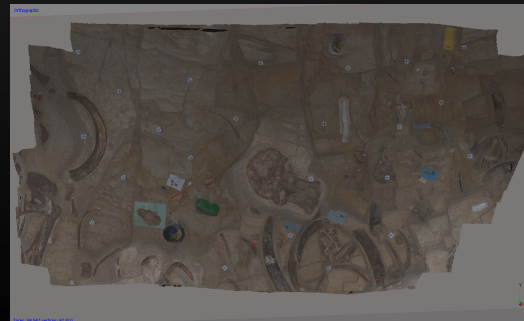
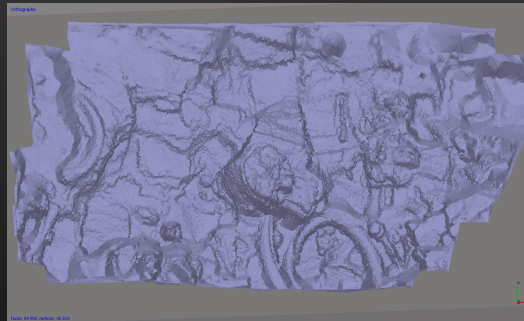
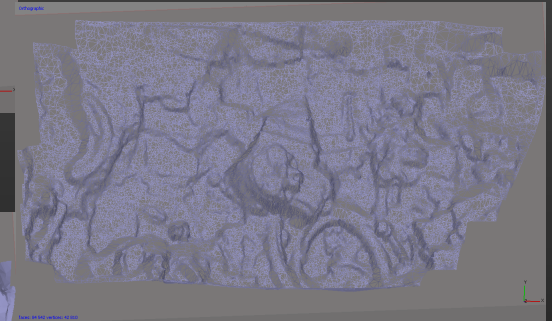
The Mammoth Site of Hot Springs, SD Inc.

- Data collected with:
 - Nikon D5100 dSLR camera
 - 35mm lens
- Over 10,000 photographs taken
 - Weekly basis
 - 750 ft² area daily for 1 week



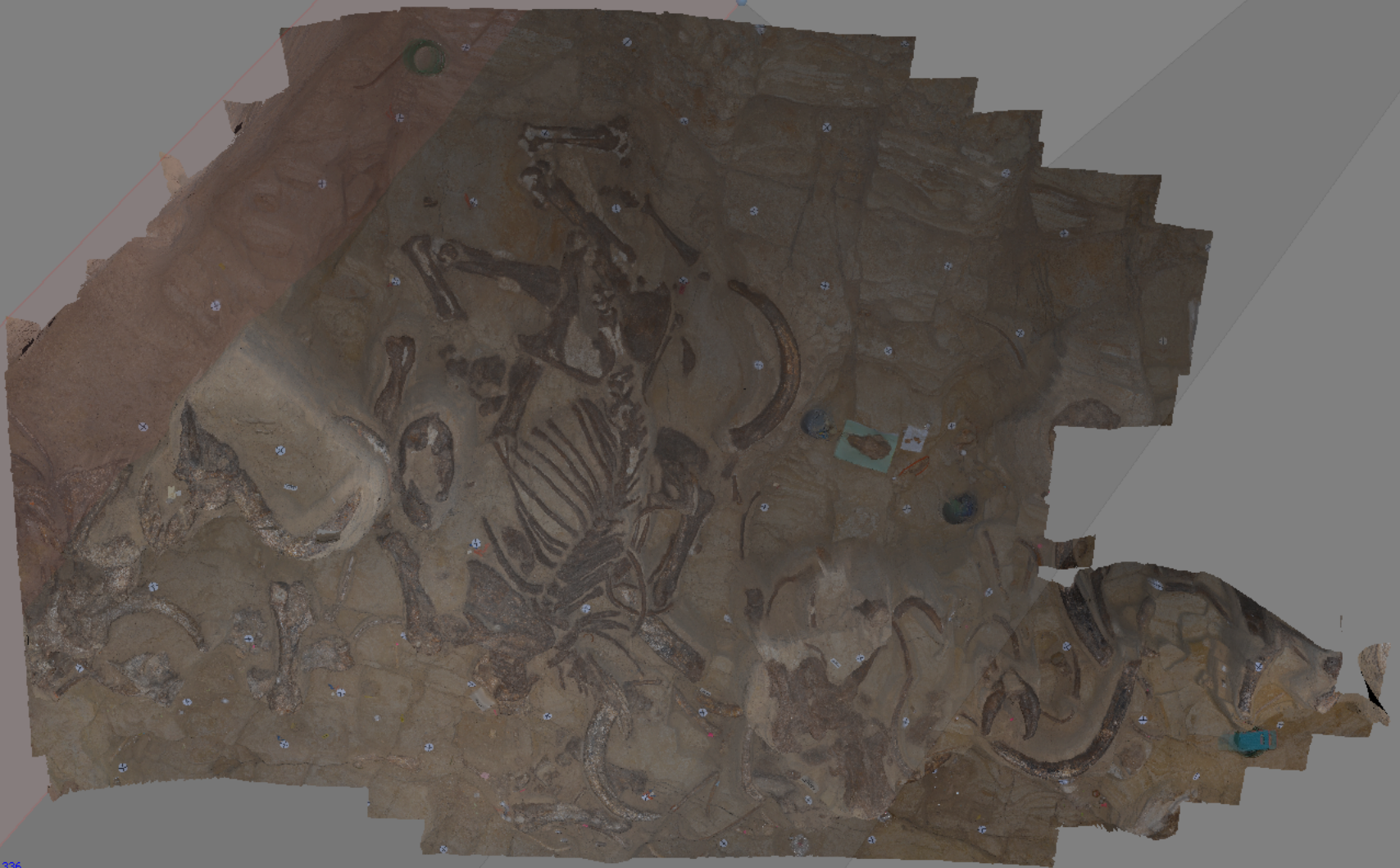
The Mammoth Site of Hot Springs, SD Inc

- Model generation in AgiSoft Photoscan Professional
 - Photos aligned based on common points
 - Planar surfaces extrapolated and given depth
 - Photographic detail draped over geometry



Preliminary Results

Perspective



faces: 93 095 vertices: 47 336

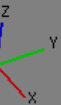


Preliminary Results

Perspective

Scale Bars	Distance (m)	Error (m)
<input checked="" type="checkbox"/> scale 1	0.279400	0.225627
<input checked="" type="checkbox"/> scale 2	0.215900	0.140471
<input checked="" type="checkbox"/> scale 3	0.084582	-0.008574
<input checked="" type="checkbox"/> scale 4	0.100000	-0.013232
<input checked="" type="checkbox"/> scale 5	0.100000	-0.013537
<input checked="" type="checkbox"/> scale 6	0.100000	-0.013112
<input checked="" type="checkbox"/> scale 7	0.084582	-0.005381
<input checked="" type="checkbox"/> scale 8	0.084582	-0.008664
<input checked="" type="checkbox"/> scale 9	0.084582	-0.006698
Total Error		0.089064

Faces: 93 095 vertices: 47 336



Preliminary Results

Perspective

Scale Bars		Distance est	Error (m)
<input checked="" type="checkbox"/>	scale 1	0.096093	-0.003907
<input checked="" type="checkbox"/>	scale 2	0.086488	0.001829
<input checked="" type="checkbox"/>	scale 3	0.086706	0.002048
<input checked="" type="checkbox"/>	scale 4	0.084312	-0.000346
Total Error			0.002394



Preliminary Results

Perspective



Scale Bars	Distance est	Error (m)
<input checked="" type="checkbox"/> scale 1	0.268875	-0.010525
<input checked="" type="checkbox"/> scale 2	0.224696	0.008796
<input checked="" type="checkbox"/> scale 4	0.083658	0.083658
<input checked="" type="checkbox"/> scale 5	1.162792	1.162792
<input checked="" type="checkbox"/> scale 6	0.476670	0.476670
<input checked="" type="checkbox"/> scale 7	0.575593	0.575593
Total Error		0.565360

Faces: 84 393 vertices: 42 782

Preliminary Results

Perspective

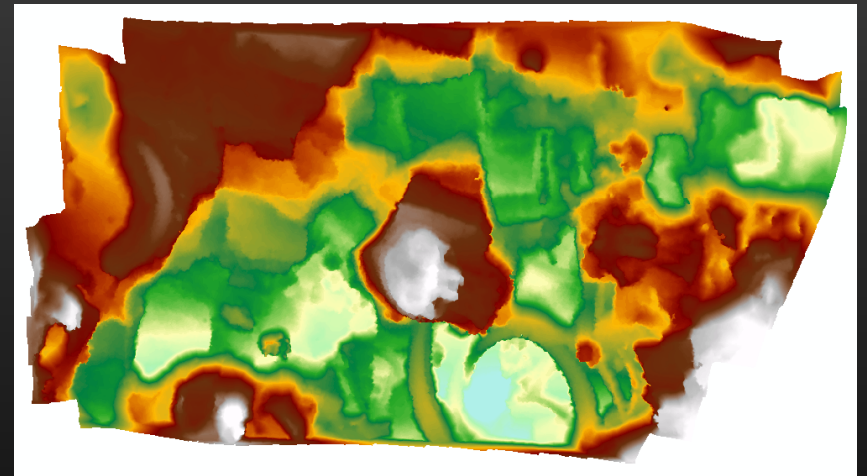


Scale Bars /	Distance est	Error (m)
<input checked="" type="checkbox"/> scale 1	1.005270	0.005270
<input checked="" type="checkbox"/> scale 2	1.014658	0.014658
<input checked="" type="checkbox"/> scale 3	0.997261	-0.002739
<input checked="" type="checkbox"/> scale 4	0.084058	-0.000592
<input checked="" type="checkbox"/> scale 5	0.276614	-0.002786
Total Error		0.007187



Output Formats

- Can export in lots of formats:
 - Adobe PDF
 - Rotatable image
 - Google Earth KMZ
 - XYZ point cloud
 - ASPRS LAS file
 - Orthophotos
 - JPEG, GeoTIFF, PNG
 - Huge amount of detail in the models
 - Arc/Info ASCII Grid



AGISoft-Generated Report

- First Page
- Image of model
- Similar to model image

Agisoft PhotoScan

Processing Report

17 April 2014



Generated Report

- Second Page
- Figure 1 shows the number of images taken to cover given area of model and estimated central position of each image

Statistics

Survey Data

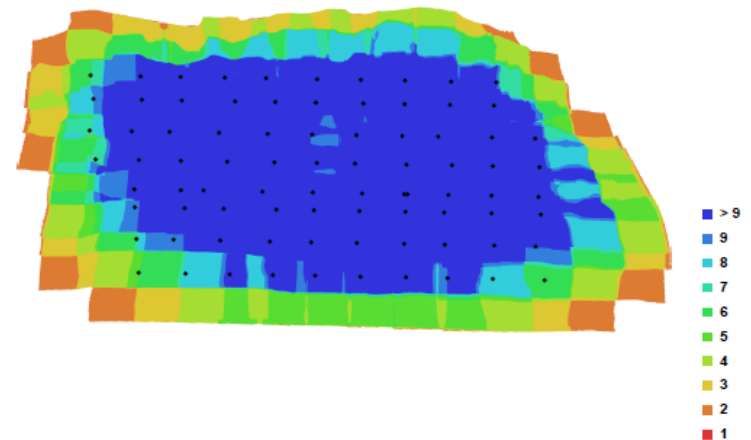


Fig. 1. Camera locations and image overlap.

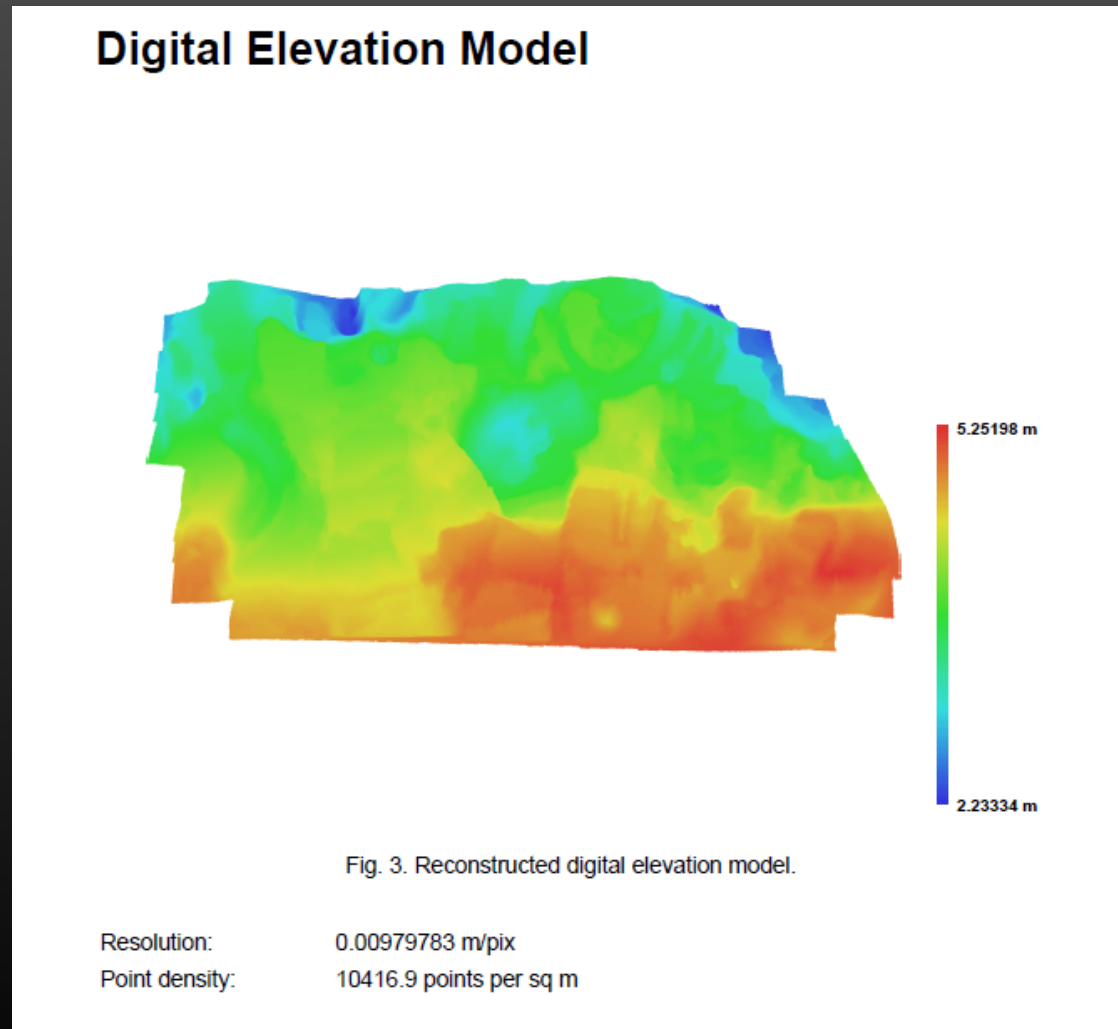
Number of images:	83	Camera stations:	83
Flying altitude:	4.24259 m	Tie-points:	327670
Ground resolution:	0.000500926 m/pix	Projections:	1186030
Coverage area:	3.8771e-005 sq km	Error:	0.653754 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
NIKON D5100 (35 mm)	4928 x 3264	35 mm	4.92678 x 4.92678 um	No

Table. 1. Cameras.

Generated Report

- Third Page
- Gives scale and resolution of generated DEM
- Without appropriate GCS, unsure how accurate the resolution is here



Elevation change

Future Work

- Comparison of data collected from CRP models to that traditionally collected
 - Statistical analysis of measurements made by hand and from models
 - Collect and analyze images collected at outdoor excavation
- Conduct a taphonomic study of specimens at an excavation from CRP models
 - Measuring specimen orientations
 - Document sediment changes across excavation site

Questions?