CRP has great potential as a viable alternative for documenting paleontological excavations. CRP has yet to be conducted at paleontological sites with such varied terrain. Creating 3D models will enable scientists to quantitatively analyze the morphology of specimens and their surroundings.
Bones mapped in situ with a string grid system. Strike and dip measurements taken of bed. Fossils jacketed and removed for study.
The Mammoth Site of Hot Springs, SD Inc.

• An abundance of fossil material exposed and in place
  – 61 mammoths, both Columbian (Mammuthus columbi) and Woolly (Mammuthus primigenius)
  – 81 other vertebrate, invertebrate, and microvertebrate species

• Multiple skulls and skeletons, in various orientations, to test measuring techniques and document specimen orientations
F mount, AOV 1.5 x lens focal length, 23.6 x 15.6 mm CMOS sensor, 16.9 total pixels, JPEG size: 4.3 MB. TIFF 96.5 MB; RAW size: 21 MB.
Can build a sparse point cloud or a dense point cloud – has potential to have more data points than a laser scanner.


Streamlined GUI interface with very little user control
Autocalibration feature works fairly well – no noticeable difference in models build with the autocalibrate verses ones built with lab calibrated lens.
Final portion of the Mammoth Site refer to as the Upper Bed. Rotatable on all 3 axes, can zoom in or out.
Can scale models one of two ways:
- Use GPS coordinates- either with GPS receiver on the camera or by importing at least 3 GPS coordinates for placed markers
- Create scale manually by building scale bars based on known lengths within the study area or actual scale bars. After creating scale bars, can then “Optimize” model to apply scale across scene. Results from the optimization are shown in the “View Estimated Scale Bar” window, like the box in upper right corner. It indicates the error associated with each measurement and total error across the scene.

Murray, 380 square feet, 8.9 cm error
## Scaling

<table>
<thead>
<tr>
<th>Scale Bar</th>
<th>Distance est</th>
<th>Error (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>scale 1</td>
<td>0.0149176</td>
<td>-0.002312</td>
</tr>
<tr>
<td>scale 2</td>
<td>0.004312</td>
<td>-0.000954</td>
</tr>
<tr>
<td>scale 3</td>
<td>0.00706</td>
<td>-0.000248</td>
</tr>
<tr>
<td>scale 4</td>
<td>0.004312</td>
<td>-0.000954</td>
</tr>
<tr>
<td>Total Error</td>
<td>0.004312</td>
<td>-0.000954</td>
</tr>
</tbody>
</table>

The image shows a 3D scan or model with a table of scale bar measurements and their corresponding errors.
Camera was farther away so the model has less detail when zoomed in and more error across the model area. Also issues with shadows and there is the need for oblique photos of the area to aid in texture generation for side areas (like the walls).
Preliminary Results

• Generated model statistics:
  – Bone measurement errors accurate between 0.346 mm and 50 cm
  – Ground resolution 0.000374347 m/pixel
  – Point density 1,0440.7 points per m²

• Can document bone positions in greater detail and in the same amount of time than with the string grid system
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
  - Arc/Info ASCII Grid
    - DEM generation
Output Formats

- Can export in lots of formats:
  - Agisoft Photoscan Professional Generated Report
    - Camera height
    - Photo overlap
    - Ground resolution
    - Pixel size
    - Elevation change in DEM
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 from models

• Cyclical monitoring surveys with same set-up
  – Erosion monitoring
  – Possibly include UAVs in photograph acquisition

• Transfer to lab to document field jacket preparation
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