Moose Tower LIDAR Scanning Project Report

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Project Team:

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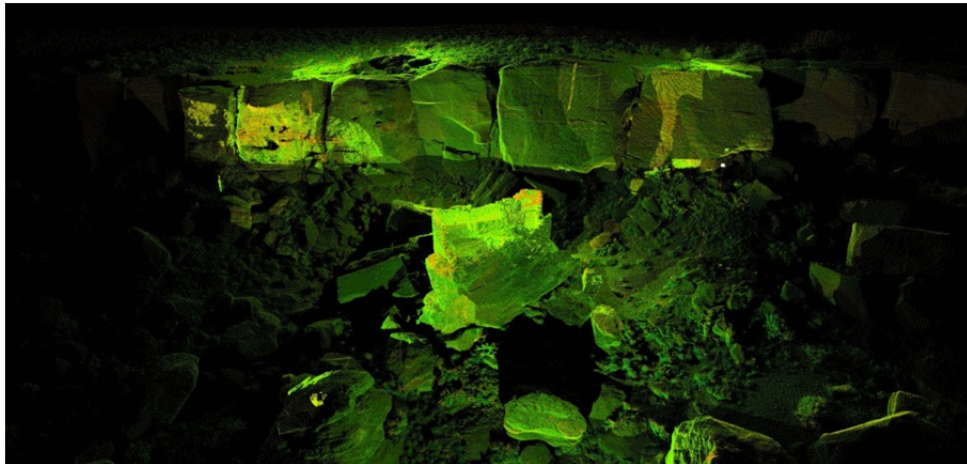Associate Professor of Architecture & Planning
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Contents:

1. Site Evaluation and Assessment:

Description of Site:

Moose Tower is an impressive free standing structure with a number of associated structures and infrastructure surrounding including several granaries and a reservoir. The tower is composed of three rooms set on top of a large boulder several meters from the cliff edge as well as another 3 story tower next to the boulder. The construction of the tower is a compound masonry with some grout still remaining.

The organic nature of the architecture makes traditional documentation methods such as hand measuring very difficult. LiDAR scanning is a powerful tool for this particular site as the tower and surounding context is so complex and non-linear.

2. Data Gathering and General Site Procedures

Onsite Description of Technical Processes:

Using LiDAR to digitally scan a site and/or structure is different for every project. Depending on the desired outcomes and deliverables expected the strategies involved can vary widely. For the most part though, the equipment we bring is similar. Besides the Leica made Scan Station 2, we use a PC laptop to control the scanner, a standard Ethernet cable to connect the two, a number of HDS targets on tripods, two large batteries to power the scanner, a tribrach, Nodal Ninja, Digital SLR camera, and a separate, heavy tripod that supports the 40 pound, fully robotic scanner. We also bring a gas-powered generator with us to most sites, as they tend to be remote. The generator powers the laptop and charges the batteries used for the scanner.

Once a thorough site inspection has been completed so that scan locations and target locations have been identified the scanner is set up in its first location. These scan locations are determined based on efficient data collection and wide coverage of the site and or structure that is being documented. Once the scanner is ready it is connected to the PC laptop via the Ethernet cable. We use a software program called Cyclone (made by Leica) to control the scanner with the laptop. After the appropriate settings are established the scanner begin operation. The scanner is equipped with a digital camera (low quality) inside and has the capability of taking a nearly 360-degree image from the perspective of the scanner. This allows us to see what the scanner sees from the laptop. We can now see what the scanner sees and can begin to select what to scan through this digital image provided to us through the Cyclone software interface.

HDS target and Leica Scan Station 2 at Moose Tower
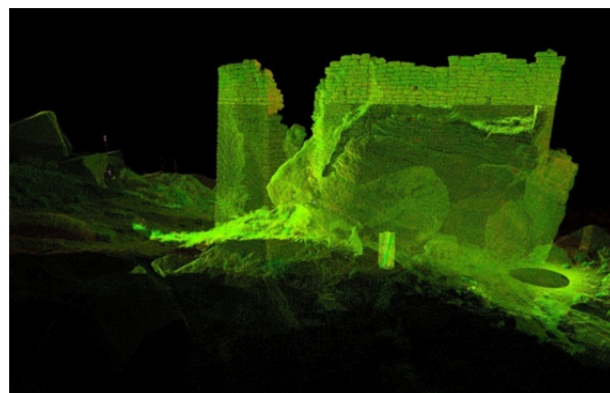
View of scan data at Moose Tower

Once we can see this preview image the scanning can begin. Depending on how much and at what point densities we are scanning a scan can take anytime between 15 minutes and several hours to complete. The scanning itself is not the only thing going on at each scan location. Within each scan we are also acquiring HDS (High Definition

Surveying) targets. These are very precise points in space that allow us to tell the scanner where it was in space in relationship to the other scan locations. This is important for post-processing efforts once data collection is complete. The process telling the computer where each scan location was in relation to the other scan locations is called registration. This is when we tie all the scans together to create a completed 3D model.

Once scanning and target acquisition is completed we use the Digital SLR camera to collect better image information than the scanner can. We take the time to collect HDR (High Dynamic Range) photography at each location. HDR allows us to capture high quality images that give us more information than standard photography. We also collect RAW images for greatest quality and color range. We collect a 365-degree sphere of images that we later stitch together and texture map onto the point cloud data for a more photo-realistic 3D model.

Once scanning and HDR photograph is complete at each location the process of moving to the next location must be completed. During the process of moving all the equipment related to the scanning process it is critical to make sure that they stay out of the way of the scans. We often are shifting around the generator, battery boxes, scanner boxes, etc. to ensure we are only capturing the site and its structures. As we move equipment around we are also being very cautious not to shift targets. These HDS targets are so accurate that even an accidental touch can shift the target out of position giving you errors in the post-processing effort. The target locations are also very specific so they can be seen from multiple scan locations. At each location the scanner is disconnected, powered down and moved with care.

Group photo from Left to Right: Julia Ausloos, Mike Nulty, Neffra Mathews Tom Noble and Vince MacMillan. With SS2 running in the background

Procedures and Scanning Effort Details:

The University of Colorado Denver scanned Moose Tower and surrounding context using a Leica Scan Station 2 Scanner from Tuesday, August 7th through August 9th 2012. Two CoPR employees, Julia Ausloos and Mike Nulty, arrived at the Moose Tower site in the mornings along with Vince MacMillan, Neffra Mathews and Tom Noble. In total, thirteen different scan locations were acquired on site, and of those locations seven consisted of 360 degree scans to acquire surrounding context of the site. The remaining scans consisted of detailed window scans of the tower and other important features. In addition to scanning, 13 panoramic images were also captured at each location to be used for photo texturing during post processing. Seven HDS targets were used throughout the site as control points that would later tie all scan locations together. Five to seven targets were acquired at each location. On average the 360 degree scan locations took about an hour and a half, while the other window scan locations took about 45 minutes (please see field notes for a more detailed scan schedule).

The On Site scanning was made more complicated by the fact that a team from the BLM's NOC was on site during the same time performing photogrammetry of the same site. The two teams came up with an initial plan on how best to stay out of each other's way and maintain an efficient schedule before meeting on site. Throughout the days there was a lot of communication to confirm where each team would be and what parts of the site they would be working on.

Both teams documented the survey control for both technologies. For photogrammetry the BLM used measuring sticks with targets and patterns. The LiDAR team used HDR targets throughout the site.

Site Photos

Leica Scan Station 2

Team overlooking cliff edge above Moose Tower

Mike Nulty scanning rooms on top of Moose Tower

Tom Noble with BLM Photogrammetry Team

3. Data Management

Initial Post-Processing:

Towards the middle of August initial post processing of the Moose Tower began. The 13 panoramic images were processed applied to each scan location making the data look more photo-realistic. All 13 scan locations were registered together using a combination of target and feature registration with a Mean Absolute Error (MAE) of only .002 m.

The data will someday be used to produce HABS drawings as part of a future agreement.
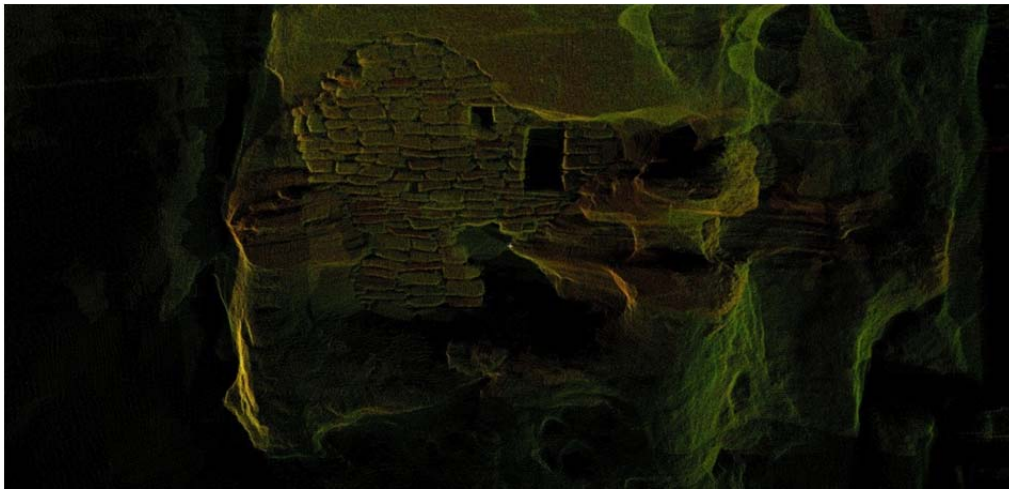
Scan Data view of Granary

Scan Data view from above

4. Data Archiving:

Archiving strategies used for Moose Tower:

For Moose Tower full copies of raw and processed data will exist in several places and media. UCD will have a copy of the data backed up on an external hard drive as well as on a local computer. A copy of the data will eventually be housed on DVDs located in a different geographic location from the hard drives as extra protection against loss. The data will also be delivered to the BLM for their records. UCD is not contracted to store or backup the data for any amount of time.

5. Data Representation:

Representation for Moose Tower:

The end goal of this project is to collect the data in such a way that it can be used later to produce HABS drawings. Main elevations, context and plan information was gathered so that traditional, 2D line drawings may be produced in the future. One of the strengths of this technology is that it can be mined for additional visualizations and data for research purposes as well.

The University of Colorado Denver, College of Architecture and Planning, Center of Preservation Research

Digital Documentation Field Record

PROJECT NAME: Moose Toufie

DATE: 8.7.2012

Handwritten notes (red): 90°, sunny, calm breeze ⇐

→ Z is guestimate, downing to reflector at white circle

Station:	Comments / Notes:	Pano Folder Name:	Scanner ID: (m):	Scanner Height	Scan Resolution (Xmm @ Xm):	Target IDs:	Target Types:	Target Heights (m):	Total Station or GPS Station:	GPS Height:
SS01	window scan of granary (2 min) " " of scarlet marble(2min)	MST 01	—	—	5mm @ 14m / 5mm @ 17 m / 5cm @ 80m	1,2,3,4,5,6,7	HDS			
SS02	window scan of floor side (10 min) " " of granary (8 min)	MST 02			5mm@30m / 1mm@40m	BLM: ③ ④	"			
SS03	window scan of western side (10min)	MST 03			5cm @ 80m	BLM: 1,3,4,7 / BLM: ②	"			
SS04	360° window scan of west wall w/ HDS	MST 04			5cm @ 80m	BLM ② → SCANNER CRASH				
05	360° ~30min +15 min window scan of west wall (2 min) window scan of Petroglyph (1 min)	MST 04			5cm @ 80m	1,2,3,4,5,6,7	"			
06	window scan of west wall (5 min)	MST 05			5mm@10m BLM	1,2,3,5,7	"			
07	Interior scan Room 1 (40 min)	MST 06			5mm@5m / 2mm@30m	3,5,1 (feature w/ granary)	"			
08	Interior scan Room 4 (20mm)	MST 07			5mm@10m	1,2,3,4,5,6	"			
09	Interior scan Room 3 (20 min) Window of Petroglyph (1 min)	MST 08			5mm@5m / 1mm@2m	1,2,3,5,6	"			

5MT8162
Detail of Site Core

Key

R   Room
⌐   Masonry wall
—   Inferred wall alignment
‥   Rock of above

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Digital Documentation Field Record

PROJECT NAME: Moose Tavern

DATE: August 8, 2012

95°, sunny, windy

Station:	Comments / Notes:	Pano Folder Name:	Scanner ID: (m)	Scanner Height	Scan Resolution (X5mm @ Xm):	Target IDs:	Target Types:	Target Heights (m):	Total Station or GPS Station:	GPS Height
SS01	360° w Scan (top of cliff edge) w/ window of tower (2 min)	MST 09			Scan @ 80m 5cm@24m tower	5,6, feature	HDS			
SS02	360° in scan (top of cliff edge)	MST 10			Scan @ 80m	3,4,5,6 BLM: (2)				
SS03	360° - 30min (top of cliff Edge)	MST 11			90m @ 80m	5,6 — Vertex off BLM: (2)	"			
SS04	360° w 30min contact scan Window spanning, extended west wall	MST 12			6min→ scan @ 80m 7min→ 1min@ 80m	5, feature w/ grass & West wall				
SS05	360° w 30min contact scan window spanning, wiped west wall	MST 13			5cm@ 80m 1m@ 50m 1m@ 50m	5, feature w/ grass & west wall				

5MT8162
Detail of Site Core

Key

R   Room

Masonry wall

Masonry wall alignment

Inferred wall location

Back of alcove