

HERITAGE DATA AND THE NATIONAL TRUST FOR SCOTLAND

July 24, 2015 Stefan Sagrott Buildings, Digital Archaeology, Explore Posts, Photography, Post Medieval, Public Archaeology, Survey Data, Heritage, management, NTS, photogrammetry, Scotland, SfM

I am the Archaeological Data Officer for the [National Trust for Scotland](#). We are a conservation charity who own and care for almost 80,000ha of land, making us the third largest landowner in Scotland. Across our land we have over 11,000 heritage sites of which 101 are designated as Scheduled Monuments and 271 are Listed Buildings, we also have the dual World Heritage Site of the St. Kilda Archipelago.

The majority of my workload revolves around our heritage data management, databases and GIS; over the last two years I have polygonised all our heritage sites, and these have associated records linked with the [RCAHMS Canmore database](#). Our GIS also pulls in Ordnance Survey data, including historic maps, survey data created by ourselves or contractors, historic estate plans from our archives, condition monitoring data and so on, all of which helps us to efficiently, and effectively manage the heritage *for everyone*.

Aside from the data management work, I also have a number of different projects on the go which should enhance the understanding and visibility of the heritage sites to our staff, our members and the public. These range from carrying out detailed surveys of our Scheduled Monuments and other archaeological sites, to developing a system for aiding the monitoring of the condition of our heritage sites, to acquiring and processing LiDAR survey data. One area that I'm increasingly working in is the visualisation of heritage sites, artefacts and architectural details through techniques such as close-range photogrammetry.

Close-range photogrammetry, also known as Structure from Motion (SfM) works by matching features within a series of overlapping photographs to create a digital model. The more photographs that are used in the processing which are taken at a variety of positions and angles, the greater the accuracy of the pixel-matching and therefore the entire model.

Developed in the 1990s by computer scientists, the technique has undergone a huge growth in the last 5 years due to the availability of high resolution digital cameras, the increase & affordability of computer processing power and the availability & affordability of SfM software such as Bundler, Photoscan and VisualFSM.

The process of alignment automatically matches and triangulates pixel patterns within the photographs allowing the software to calculate the camera positions and reconstruct the object geometry. EXIF data contained within each photograph provides information such as focal length and allows the software to correct lens distortion.

Algorithms and triangulation of the matched pixels produce, in the first instance, a 3D point cloud in a virtual space. The result of this is a representation of the object captured in the original photographs. Due to the lack of ground-control points (GCPs) initially the point cloud is at an arbitrary scale and location within the virtual world, although the point cloud can be correctly scaled and if required re-located using captured survey data.

The point cloud can then be meshed to form a 3D model and a texture for the model can be generated from the original photographs.

I've been using SfM to record a number of different sites, monuments and artefacts in the care of the National Trust for Scotland from standing stones, to stone carvings, graveslabs and prehistoric quern stones.

NEW LIGHT ON OLD STONE: 3D RECORDING & VISUALISATION OF THE FALKLAND PALACE ROUNDELS

Conservation work on a series of 'roundels' at [Falkland Palace](#) in Fife provided an opportunity to photograph them with a level of coverage suitable for SfM. The Roundels are located some 7m up on the south Range of the Palace and form part of the alterations to the Palace completed by James V in 1541. There are 10 roundels on the south range, of a quality comparable to contemporary sculpture in France and Italy. They were probably carved by the French master mason Nicholas Roy, who was brought over by James V who wished to recreate the splendour of the French court. They form part of the most advanced Renaissance architectural programme in Britain of their time.



Fig 1: South range of Falkland Palace, the roundels can be seen either side of each of the main windows

Two sites visits across a number of weeks by myself and a colleague allowed the capture of the 10 roundels at an average of 40 images per roundel.

The images were then aligned using Agisoft Photoscan, which produced the camera positions and a sparse point cloud for each roundel. Further processing produced the dense point clouds, with each of the points coloured according the photograph. The point clouds were then tidied up in Photoscan to remove both extraneous points and the surrounding stonework.

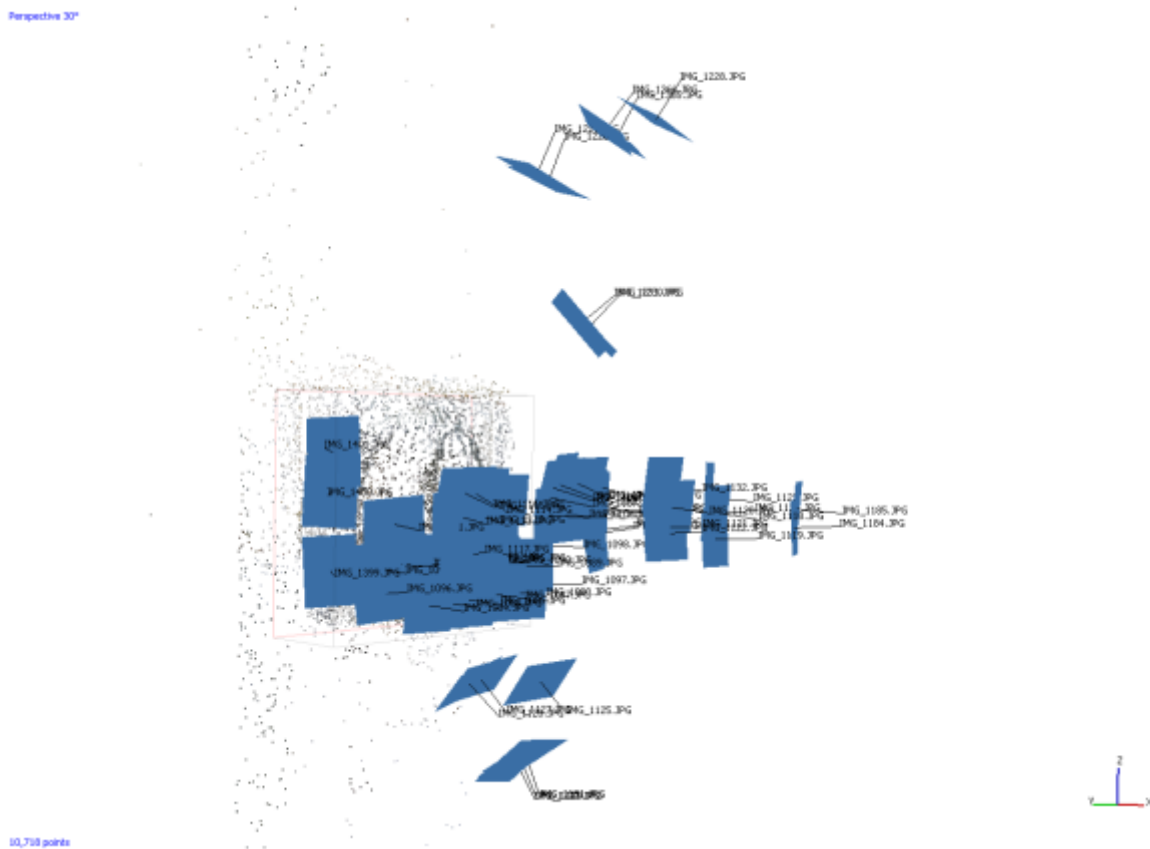


Fig 2: Sparse point cloud and camera positions following image alignment

Following the tidying up of the point clouds, they were then meshed into 3D models and then textured using the original images.

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Fig 3: Roundel 1 as a dense point cloud, coloured based on the photographs

The models provide an accurate representation of the roundels which are located some 7m up on the outer wall of Falkland Palace, and will allow visitors to see the roundels in a way which would not have been possible previously. You can interact with one of the meshes through

<http://sketchfab.com/nts-archaeology> .

Falkland Palace Roundel 1

by **NTS Archaeology**

on **Sketchfab**

The meshes have also been imported into the Meshlab software, as this has allowed us to move a virtual light source around each roundel which has helped us see detail of the roundels which was not previously possible. There is also a plugin for Meshlab called Radiance Scaling which “adjusts reflected light intensities in a way dependent on both surface curvature and material characteristics”. This technique when using the ‘dual lit sphere’ option has greatly enhanced the detail visible on each roundel model, highlighting elements of the carving which have, in recent years, been hard to see.



Fig 4: Roundel 1 mesh lit using 'dual lit sphere' technique; note the level of detail, especially of the armour breast-plate and the laurel wreath now visible

One of my colleagues is now undertaking research into the identity of the figures in each roundel which is not an easy task, and they are finding that having the 3D models to hand is an incredibly useful tool when wanting to study each figure in depth. The models created can be saved as a 3D PDF allowing them to be viewed on any computer without specialist software and they have also been uploaded to [Sketchfab](#) allowing anyone with an internet connection to view and interact with the models.

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