Section 5. Case study: Close-Range Photogrammetry for Architecture at Ostia Antica, Italy#

5.1 About the Project#

Ostia Antica, once a port and military outpost for the Roman Republic, is today a superb example of typical Roman urbanism. The people that once populated this ancient city came from many different walks of life and covered the entire social spectrum. It was because of this local diversity that a two semester honors colloquium called "Visualizing the Roman City" was created at the University of Arkansas using Ostia as its test case. This multidisciplinary course is aimed toward students studying in Architecture, Geosciences, Anthropology, Archaeology, and Classical Studies. Students in this class are not limited to learning through lecture alone, are able to visually reunite Roman sculptures and paintings with their architectural contexts in a way that can be navigated in three dimensions by creating digital reconstructions.

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5.2 Data Collection and Documentation#

In the spring of 2007, a crew of researchers from the Center for Advanced Spatial Technologies visited the site of Ostia Antica with the goal of collecting three-dimensional spatial information. One of these types of spatial information was collected in the form of high-quality photographs. In order to extract three-dimensional models of various structures at the site, photogrammetric quality photographs were collected using a high-end digital SLR handheld camera, and taken anywhere from one to 20 meters off the ground. In an effort to capture the social diversity of Ostia, data collection was focused on three main structures, each belonging to a different step of the social ladder.

Data collection consisted of digital images captured with a 50mm (fixed) Nikkor lens on a Nikon D200 DSLR camera, and positional data recorded with a Trimble 5600 total station. Calibration images were taken on site with the Nikon D200 and 50mm lens and a printed 36" x 36" calibration target from the software package PhotoModeler. Before any images were taken, the camera and lens settings were fixed so that each image was taken with the same focus (set to infinity in this case).

A total of 43 digital images were captured for the project, averaging 14 images per structure. Eight to ten total station control points were collected for each structure, allowing for the absolute orientation of the photogrammetric model.

Throughout the data collection process, the position and orientation of each image were indicated on a hand drawn sketch of the structure and surrounding area. Additional photos were taken for each control point to clearly indicate their exact position.

5.3 Metadata#

Example metadata for each step of the close-range photogrammetry workflow can be found below.

Project Metadata	Sample entry
Title	Close-range photogrammetry at Ostia Antica, Italy
Description	Collection of digital images and external control for photogrammetric survey of three structures.

Subject	Terme Marittime (III,VIII,2), within Insula VIII, within Regio III, Ostia Antica
Coverage	Ostia Antica, Italy. Within the official park walls and near the western end (see field sketch map). Lon 12.283779680728912, Lat 41.751278373666516
Creators	Adam Barnes, Center for Advanced Spatial Technologies (CAST), University of Arkansas
Identifiers	CASTUID_PRJ000862
Dates	March 16-21, 2007 (field work), April 2007 (lab work)
Intended accuracy or scale of the survey	1-2 centimeter for image block. 0.5-1 meter absolute positioning from external control.
Description of reference information used	Various plan views from http://www.ostia-antica.org.
Additional project notes	Some elevated images taken from a 20 meter boom lift.

Camera Metadata	Sample entry
For each Camera:	
Date of calibration	March 16, 2007
Camera calibration file name	070316_NikonD200_50mm_cal.txt
Camera specifics	Nikon D200 DSLR camera body with Nikkor 50mm f/1.4 fixed lens
Array dimensions in pixels	3872 x 2592
Array dimensions in mm	23.6 x 15.8
Focal length and principal point	49.828543 mm Xp Value 11.202745 mm Deviation 0.006 mm Yp Value 7.649016 mm Deviation 0.009 mm
Lens distortions (K1, K2, P1 and P2 parameters)	K1 Value 8.346e-006 Deviation 6.0e-007 K2 Value -9.988e-009 Deviation 7.1e-010 P1 Value -7.413e-006 Deviation 1.3e-006 P2 Value 5.713e-006 Deviation 2.0e-006
Affine distortions	NA
Calibration Quality Values	Overall RMS: 0.287 pixels, Maximum residual: 0.8756, Photo coverage: 96%
Calibration adjustment report	070316_NikonD200_50mm_calreport.txt
Number of images used	18
Calibration target description	36? x 36? planar target printed from .pdf file included with PhotoModeler software. Contains an array of 100 black dots on a white background. Four of the 100 targets have unique patterns for automatic detection by the software calibration tool.
For each calibration image:	
Image file name	DSC_0282.dng

Image Metadata	Sample entry
For each group of images	
Project name	Close-range photogrammetry at Ostia Antica, Italy
Number of images	15

File name for planimetric sketch or map	Attached as jpeg 070321_OstiaAntica_CRP_sketch.jpg
Camera calibration file	070316_NikonD200_50mm.txt
Additional notes	DSC_0301.dng and DSC_0310.dng contain plumb line and scale measurement. Images DSC_0300.dng and DSC_308.dng contain color checker/gray card.
For each image	
Image file name	DSC_302.dng
Textural description of location and orientation	South side, view to northeast
Format conversions (if any)	Uncompressed Nikor RAW NEF converted to Adobe DNG archival format using Adobe DNG converter.

Reference/datum Metadata	Sample entry
For each control point:	
Point ID	001
Source and datum (total station, GPS, etc. and WGS84, UTM, LRF)	Trimble 5600 total station. All positional data is referenced to the World Geodetic System of 1984 (WGS84).
xyz coordinates	X 12.283969, Y 41.751179, Z 6.42103
xyz covariance matrix	NA
Textual description of location	SW Corner of Terme Marittime and as seen in image of control point 1.
Image with control point location indicated	070316_OstiaAntica_control_001.jpg
Geometric constraints on reference features or control	NA
Coordinate System	WGS84 (EGM96)

Model Metadata	Sample entry
Name and version of the software	EOS Systems PhotoModeler version 5
RMSE values	Overall RMS: 0.426 pixels, Control point RMS: 0.389
Constraints on object points	Found in text file, 070408_OstiaAntica_CRP_BlockReport.txt
For each point:	
Point type	Found in text file, 070408_OstiaAntica_CRP_BlockReport.txt
XYZ priori and a priori	Found in text file, 070408_OstiaAntica_CRP_BlockReport.txt
Covariance matrix a priori	Found in text file, 070408_OstiaAntica_CRP_BlockReport.txt
Image coordinates and residuals	Found in text file, 070408_OstiaAntica_CRP_BlockReport.txt
For each image:	
Exterior orientation	Found in text file, 070408_OstiaAntica_CRP_BlockReport.txt