

AERIAL TRIANGULATION REPORT



2006 DIGITAL ORTHOIMAGERY PROJECT

**OTTAWA COUNTY, OHIO
WOOLPERT PROJECT #65343**

December 2006

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Introduction

This report contains an outline of the photogrammetric aerial triangulation (AT) process that supported the Ottawa County, Ohio, 2006 Digital Orthoimagery Project.

Project Area

The project area encompasses approximately ± 266 square miles of Ottawa County, Ohio.

Purpose of Aerial Triangulation

Aerial triangulation is a method of ground control extension or densification performed mathematically and in conjunction with a limited number of ground control points, Airborne GPS data, and inertial measurement data to control aerial imagery such that it may be utilized to measure 3D information about features on or above the ground.

Dates of Image Acquisition

Aerial imagery was acquired using the Leica ADS40 digital sensor. A total of five (5) missions were completed for the entire project area as follows:

Julian Day	Imagery Flights	Date
100	01	April 10, 2006
100	31-35	April 10, 2006
100	40-48	April 10, 2006
101	01-04	April 11, 2006
103	04-16	April 13, 2006
105	15-30	April 15, 2006
105	36-40	April 15, 2006
105	49-50	April 15, 2006
107	14, 19, 36	April 17, 2006

Sensor Description

All data was acquired using the Leica ADS40 digital sensor, serial number 30027. Both the FCIR and RGB bands were acquired simultaneously. The maximum acquisition ground sampling distance was 0.52-foot with the final deliverable pixels being produced at 0.5-foot. The band configuration is outlined below:

BLUE NADIR	GREENF16	PANB14
GREEN NADIR	REDF14	PANF28
RED NADIR	NIRF18	

Calibration Date of Sensor: September 21, 2004

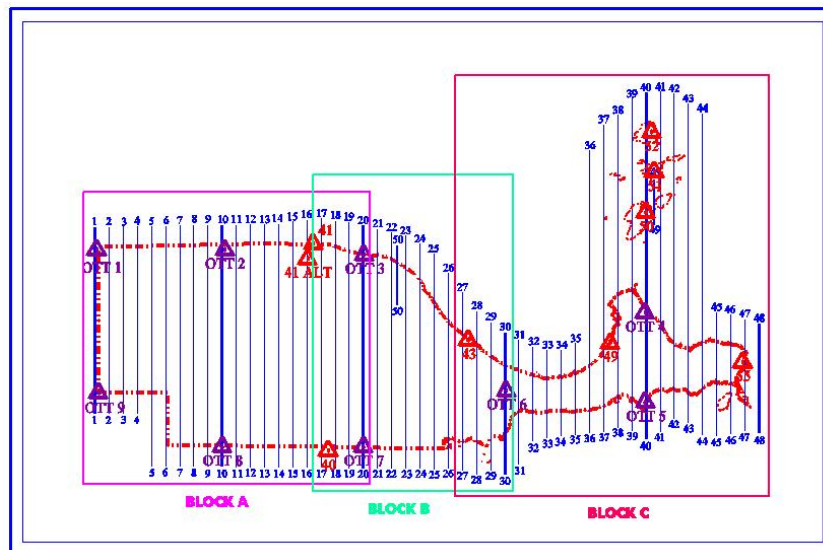
Processing Software

The software utilized for the digital image processing and aerial triangulation, developed by Leica GeoSystems, was: LPS 9.0, ORIMA 9.0a, CAP-A 7.12 and GPro 3.1.

Processing Methodology

The project area was divided up into three (3) aerial triangulation blocks (see Diagram “A” shown below). Each block was created using Leica’s GPro software and is based on project specifications, control point locations and a suitable number of lines for our blocks. Each block had a good distribution of control points within its boundaries.

Diagram “A”



Every band for the required flight lines is added to the project applying the processed position and orientation data. This creates metadata files and an orientation data file for each band giving the imagery its raw position and orientation.

The aerial triangulation process uses only the Level 0 panchromatic imagery bands PANB14, PANF28, and GRNN00 which are created by GPro. The aerial triangulation process is similar to conventional operations, where the Level 0 panchromatic imagery is passed through Automatic Point Measurement, the resulting tie points and ground control is adjusted using CAP-A and ORIMA software. Blunders are removed and the block is analyzed for weak network areas, and if required, manual points are added. The final adjustment output consists of precise orientation data files for each band, calibration parameters and metadata. The imagery can now be rectified to a DEM which removes any relief displacement which may be present. During this processing stage, we can set the required ground sampling distance (GSD), 8 bit or 16 bit imagery, and apply a tonal curve. The ortho-rectified imagery is commonly referred to as Level 2 imagery.

Ground Control used in Triangulation

Ohio State Plane, North Zone			
Point Names	X (Meters)	Y (Meters)	Z (Meters) Ellipsoidal
OTT_1	523492.539	217003.931	148.800
OTT_2	535098.296	217001.809	140.754
OTT_3	547730.223	216536.968	139.754
OTT_4	573170.636	211283.700	139.960
OTT_5	573223.897	203168.556	140.169
OTT_6	560605.622	204238.468	140.693
OTT_7	547660.109	199127.642	142.174
OTT_8	534862.857	199123.278	152.979
OTT_9	523635.187	204012.323	157.688
40	544464.666	198737.712	144.591
41	543134.443	217511.872	140.497
41_ALT	542621.487	216199.498	140.246
43	557155.050	208795.794	140.052
49	570020.294	208559.085	140.859
50	573231.745	220387.694	143.332
51	574004.016	224038.641	141.010
52	573748.166	227666.251	143.872
55	582020.556	206790.584	143.996

Quality Control Checks

The points indicated below were withheld from the adjustment for quality control checking purposes, and all points (including these quality control points) were used in the **final** adjustment.

Block A

Quality Control Points			
Point ID	X ft	Y ft	Z ft
40	-0.047	-0.196	-0.622
41_ALT	0.230	-0.042	-0.135

Block B

Quality Control Points			
Point ID	X ft	Y ft	Z ft
OTT_7	0.254	-0.229	0.298

Block C

Quality Control Points			
Point ID	X ft	Y ft	Z ft
OTT_4	-0.309	-0.126	-0.209

Ground Control Withheld

No ground control points were withheld for this project.

AT Block Statistical Summaries

Block A

Control Point Residuals			
Point ID	X ft	Y ft	Z ft
OTT_1	0.397	0.100	0.031
OTT_2	-0.257	-0.525	0.063
OTT_3	0.046	0.545	0.068
OTT_7	-0.143	0.236	0.107
OTT_8	-0.148	-0.446	0.205
OTT_9	0.120	-0.035	0.071
40	-0.065	-0.149	-0.359
41	-0.117	0.287	-0.311
41_ALT	0.169	-0.012	0.006

Block B

Control Point Residuals			
Point ID	X ft	Y ft	Z ft
OTT_3	-0.061	0.445	-0.030
OTT_6	-0.294	0.025	0.010
OTT_7	0.189	-0.131	0.068
40	-0.065	-0.388	-0.050
41	0.439	-0.188	-0.143
43	-0.207	0.237	0.145

Block C

Control Point Residuals			
Point ID	X ft	Y ft	Z ft
OTT_4	-0.185	-0.077	-0.042
OTT_5	-0.073	-0.156	0.112
OTT_6	-0.078	0.188	-0.070
43	0.380	0.007	0.245
49	0.344	0.124	-0.248
50	0.066	0.050	-0.176
51	0.014	-0.131	0.082
52	-0.091	0.026	0.179
55	-0.377	-0.030	-0.084

Summary

The final RMSE (Root Mean Square Error) residuals on the ground control points are as follows:

	X	Y	Z
RMS XYZ	0.220'	0.250'	0.153'
RMS P	0.333'		

The RMSE values fall well within the MTS/NMAS requirements for DOI mapping at 1"=200' scale and DTM/contours at 0.3-foot RMSE vertical accuracy or the RMSE P values fall well within the industry and National Map Accuracy Standards for DOI mapping at 1"=100' scale and DTM/contours at a 0.46-foot RMSE vertical accuracy.