AERIAL TRIANGULATION REPORT

2006 DIGITAL ORTHOIMAGERY PROJECT

ASHLAND COUNTY, OHIO
WOOLPERT PROJECT #65339

August 2006

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TABLE OF CONTENTS

Introduction

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

Project Area

The project area encompasses approximately ±424 square miles of Ashland 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 six (6) missions were completed for the entire project area as follows:

Julian Day	Imagery Flights	Date
086	01-03	March 27, 2006
088	18-22	March 29 2006
089	03-16	March 30, 2006
094	09-15	April 4, 2006
099	16-18, 22 (patch flights)	April 9, 2006
107	19 (patch flight)	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 0.06-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

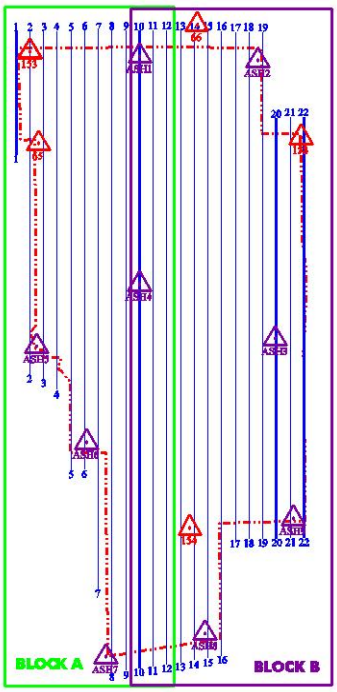
Processing Software

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 two (2) 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

The ground control used in the triangulation process is shown within the table below. The ground control was held at a weight of 0.1 meters or 0.33 feet.

Ohio State Plane, North Zone			
Point Names	**X (Meters)**	**Y (Meters)**	**Z (Meters) Ellipsoidal**
ASH_1	616462.198	154850.001	287.110
ASH_2	627496.691	154431.271	305.360
ASH_3	629115.841	128214.318	324.843
ASH_4	616431.687	133363.620	281.515
ASH_5	606844.634	127472.710	279.582
ASH_6	611497.035	118463.576	270.346
ASH_7	613306.660	98215.450	325.234
ASH_8	622562.819	100439.578	355.924
ASH_9	630799.633	111274.682	253.693
65	606984.424	146627.536	310.999
66	621786.144	157808.939	271.455
153	606202.422	155300.197	264.830
154	621131.842	110386.186	260.476
158	631510.798	147197.575	316.565

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**
ASH_4	0.026	-0.115	0.508
65	0.368	0.130	-0.318

Block B

Quality Control Points			
Point ID	**X ft**	**Y ft**	**Z ft**
ASH_3	0.096	0.020	0.130
154	0.517	0.149	0.135

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**
ASH_1	-0.539	0.122	0.090
ASH_4	-0.261	-0.124	0.534
ASH_5	0.317	-0.064	-0.537
ASH_6	0.041	-0.147	0.359
ASH_7	0.027	-0.084	0.420
65	0.336	0.169	-0.726
153	0.079	0.129	0.179

Block B

Control Point Residuals			
Point ID	**X ft**	**Y ft**	**Z ft**
ASH_1	0.309	-0.140	-0.076
ASH_2	-0.568	0.004	-0.690
ASH_3	-0.003	-0.022	0.012
ASH_4	0.168	-0.113	0.234
ASH_8	0.231	-0.179	0.018
ASH_9	-0.213	-0.129	0.081
66	-0.309	0.140	0.076
154	0.375	0.100	0.046
158	0.011	0.338	-0.033

Summary

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

	X	**Y**	**Z**
RMS	0.292	0.144	0.353
RMSP	0.326		

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-feet RMSE vertical accuracy.