

AERIAL TRIANGULATION REPORT



INDIANA STATEWIDE IMAGERY PROGRAM INDIANA OFFICE OF TECHNOLOGY TIER 2 - BLOCK 7

Woolpert Project Number: 72134
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TIER 2 - BLOCK 7

INDIANA STATEWIDE IMAGERY PROGRAM

WOOLPERT PROJECT #72134

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AERIAL TRIANGULATION REPORT

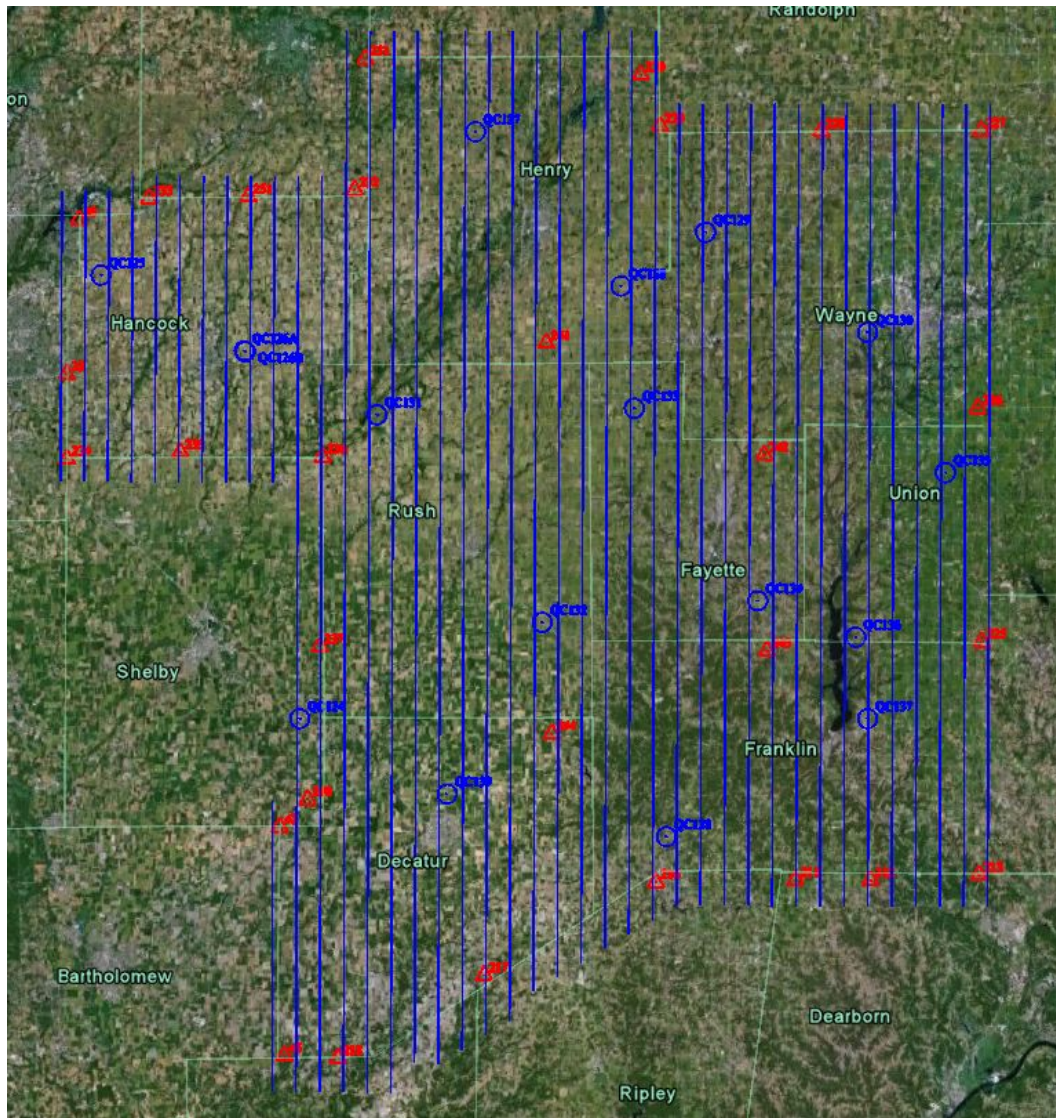
INTRODUCTION

This report contains an outline of the photogrammetric aerial triangulation (AT) process that supported the 2012 Indiana Statewide Imagery Program for Tier 2 - Block 7, under the direction of the Indiana Office of Technology.

PROJECT AREA

The project area is defined within this report as Indiana Statewide Tier 2 - Block 7, and visually shown below:

INDIANA STATEWIDE TIER 2 - BLOCK 7



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 ADS52 digital sensor. A total of four (4) missions were completed for the entire project Tier as follows:

Julian Day	Imagery Flights	Sensor(s)	Date
58	38-41	110	February 27, 2012
66	23-37	110	March 6, 2012
69	16-22	110	March 9, 2012
70	1-15	110	March 10, 2012

SENSOR DESCRIPTION

All data was acquired using the Leica ADS52 digital sensor, serial number 110. Both the FCIR and RGB bands were acquired simultaneously. The maximum acquisition ground sampling distance was 0.98-foot with the final deliverable pixels being produced at 1.0 -foot.

The band configurations are as outlined:

Sensor #110		
Calibration Date: September 17, 2007		
BLUE NADIR	NIR NADIR	PANF02
GREEN NADIR	PANB14	RED B16
RED NADIR	PANF27	GREEN B16
BLUE B16	NIR B16	

PROCESSING SOFTWARE

The software utilized for the digital image processing and aerial triangulation, developed by Leica GeoSystems, was XPro version 5.0.

PROCESSING METHODOLOGY

Indiana Statewide Tier 2 - Block 7 was created using Leica's XPro software and is based on project specifications, control point locations and a suitable number of lines for the block. Indiana Statewide Tier 2 - Block 7 contains a good distribution of control points within its boundaries.

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, PANF27, and PANF02 which are created by XPro. 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

Ground Control Used in Triangulation			
Point ID	X ft	Y ft	Z ft
211	503105.4	1476374	960.92
212	529115.4	1476412	1013.04
213	566794.6	1478339	893.58
216	454567.3	1475352	966.28
217	394674.3	1443094	896.64
218	343540.9	1414250	758.1
225	567644	1558324	969.33
226	565941.9	1638410	1139.37
227	566733.7	1733560	1194.42
228	511098.6	1733261	1216.75
229	455105.4	1735078	1155.03
230	448203.8	1752739	1094.62
231	351994.7	1758265	918.47
232	348546.9	1713026	999.48
233	276272.2	1710057	853.91
234	247880.4	1620313	808.4
235	287810	1622600	839.61
236	337658.9	1621147	928.75
237	336994.9	1555790	907.05
240	332817.3	1503275	843.29
241	415772.9	1660445	1042.64
242	491829.8	1622128	967.33
243	493054.1	1554971	923.14

Ground Control Used in Triangulation			
Point ID	X ft	Y ft	Z ft
244	418166.4	1526284	1063.98
251	311225.2	1710715	903.33
30	251605.4	1702679	814.101
33	247664.6	1649528	843.776
42	323037.4	1493668	818.702
45	324734.3	1414927	734.243

AT BLOCK STATISTICAL DATA

Control Point Residuals			
Point ID	X ft	Y ft	Z ft
211	0.001	0.0019	0.0006
212	-0.0012	-0.0001	0.0007
213	0.0056	0.0052	-0.0004
216	0.0007	-0.0006	0.0011
217	0.0003	0	0.0001
218	0.0012	0.002	-0.0002
225	-0.0032	-0.0025	0.001
226	-0.0028	-0.0099	-0.003
227	0.0053	0.0044	0.0007
228	0.0013	0.0008	0.0004
229	0.0032	-0.0041	0.0006
230	-0.0037	0.002	-0.0006
231	-0.0026	0.0016	0.001
232	0.0005	-0.0029	0.0002
233	-0.0002	-0.001	-0.0007
234	0.0008	0.0007	0.0007
235	0.0002	0.0009	0.0002
236	0.004	0.0016	-0.0004
237	-0.0022	-0.0019	-0.0002
240	-0.0027	-0.0005	0.003
241	-0.0009	0.0019	-0.0001
242	-0.002	0.0011	0.0009
243	-0.0014	-0.001	-0.0015
244	0.0014	0.0003	-0.0003
251	0.0006	-0.0015	-0.0005
30	-0.0006	0.0011	0
33	-0.0022	-0.0009	-0.0006
42	-0.0003	0.0014	-0.001
45	0.0001	-0.0001	-0.0017

SUMMARY

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

	X	Y	Z
RMS	0.0018	0.001859	0.000772
RMS P	0.002587		

The RMSE P values fall well within the industry and National Map Accuracy Standards for DOI mapping at 1"=200' scale.

QC RESULTS

The Indiana Statewide Tier 2 - Block 7 QC Point Horizontal Accuracy Static Worksheet listed below shows quality-controlled point checks and analysis.

Point number	Point description	x (Survey)	x (AT)	diff in x	(diff in x) ²	y (Survey)	y (AT)	diff in y	(diff in y) ²	(diff in x) ² + (diff in y) ²
"QC121"	target	270852.98	270852.98	0.000	0.000	1589506.8	1589506.801	-0.001	0.000	0.000
"QC122"	target	322638.65	322638.65	0.000	0.000	1585127.47	1585127.471	-0.001	0.000	0.000
"QC123"	target	264065.05	264065.05	0.000	0.000	1513143.88	1513143.881	-0.001	0.000	0.000
"QC124"	target	330011.41	330011.3233	0.087	0.008	1531065.24	1531065.217	0.023	0.001	0.008
"QC125"	target	259507.97	259507.949	0.021	0.000	1683620.78	1683620.975	-0.195	0.038	0.039
"QC126A"	target	310128.7	310128.751	-0.051	0.003	1657584.28	1657584.446	-0.166	0.027	0.030
"QC126B"	target	310454.55	310454.4511	0.099	0.010	1657287.17	1657287.334	-0.164	0.027	0.037
"QC127"	target	390687.27	390687.2825	-0.012	0.000	1733076.87	1733076.825	0.045	0.002	0.002
"QC128"	target	441727.15	441727.2594	-0.109	0.012	1680085.21	1680085.042	0.168	0.028	0.040
"QC129"	target	471095.04	471095.1906	-0.151	0.023	1698619.18	1698618.946	0.234	0.055	0.078
"QC130"	target	527539.94	527539.7327	0.207	0.043	1664247.12	1664247.067	0.053	0.003	0.046
"QC131"	target	356689.93	356689.9355	-0.006	0.000	1635650.51	1635650.428	0.082	0.007	0.007
"QC132"	target	414727.59	414727.4609	0.129	0.017	1564442.47	1564442.386	0.084	0.007	0.024
"QC133"	target	446613.01	446613.0872	-0.077	0.006	1638064.57	1638064.507	0.063	0.004	0.010
"QC134"	target	489766.58	489766.5938	-0.014	0.000	1572099.65	1572099.562	0.088	0.008	0.008
"QC135"	target	554790.16	554790.3022	-0.142	0.020	1616280.61	1616280.659	-0.049	0.002	0.023
"QC136"	target	523827.68	523827.6342	0.046	0.002	1559735.81	1559735.799	0.011	0.000	0.002
"QC137"	target	528013.87	528013.7932	0.077	0.006	1531787.39	1531787.377	0.013	0.000	0.006
"QC138"	target	458183.13	458183.3778	-0.248	0.061	1490986.86	1490986.959	-0.099	0.010	0.071
"QC139"	target	381628.96	381628.9859	-0.026	0.001	1505298.17	1505298.151	0.019	0.000	0.001
									sum	0.431
									average	0.022
									RMSE	0.147
									NSSDA	0.254