



DSS In-FlightOrtho™ Accuracy Assessment

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Introduction

In-FlightOrtho is a new feature of the DSS RapidOrtho Software suite that produces full-resolution orthorectified imagery in the aircraft as it is captured. Images are automatically developed, corrected and orthorectified using a pre-loaded DEM and the real-time Exterior Orientation produced by the embedded POS AV system. They are displayed in thumbnail format and in a map overview to provide “air-to-ground” QC, and are ready for exploitation in the air. All DSS 500 systems include the RapidOrtho Software suite with In-FlightOrtho.

This paper presents the accuracy results of the In-FlightOrtho orthorectified imagery from a test flight conducted by Applanix and GeoPixel Air over a test range north of Toronto.

Configuration

The DSS configuration for the test was as follows:

- DSS 439 c/w 60 mm VIS lens
- Azimuth Mount
- POSTrack 410, IMU-7, Omnistar HP Corrections enabled
- In-FlightOrtho computer:
 - Lenovo Think Pad W510
 - I7 Quad Core
 - 8 BGbyte RAM
 - 500 GByte SSD
 - Windows 7 64 bit OS
- Digital Elevation Model (DEM):
 - SRTM @ 45m posting
- Aircraft: Cessna 182

Test Description

The DSS was installed into the GeoPixel Air Cessna 182 on Sept 25, 2012, and flown over the Applanix boresight range in Mount Albert, Ontario, using the standard DSS boresight calibration procedure. The system was then removed from the aircraft, and the data post-processed to establish the camera and boresight calibration parameters.

On Oct 1, 2012, six days after the boresight flight, the DSS was re-installed into the same aircraft, and the calibration parameters were entered into the POS AV and In-FlightOrtho software. The system was then flown over the boresight range during which time the In-FlightOrtho software produced real-time orthorectified imagery. A description of the flight test is given as follows:

- 5 North-South lines at 4500 ft AGL, GSD ~ 15 cm
- 2 East-West lines at 3000 ft AGL, GSD ~ 10 cm
- In-FlightOrtho Resolution: ~ 8 cm GSD (oversampled to test CPU loading)
- Total number of images: 50
- Cycle time between images: ~ 6 seconds

The In-FlightOrtho images were logged and then evaluated against the surveyed Ground Control Points using Global Mapper.

Test Results

A map view of the In-FlightOrtho orthorectified images is given in Figure 2.



Figure 2: In-FlightOrtho Images, Displayed in Global Mapper.

The average time to produce each orthorectified image in the air was 7 to 10 seconds.

A total of eight Ground Control Points were used to assess the accuracy of the In-FlightOrtho images. The GCP's were identified and measured in the images using Global Mapper and compared against the surveyed values. Two GCP's were identified in a total of 4 images, while the remainder we identified in 12 to 14 images each. In all 87 measurements were made.



A summary of the results are presented in Table 1. Detailed results may be found in the Appendix.

	X	Y	Radial
Mean (m)	-0.05	0.05	0.07
Stdev (m)	0.26	0.23	0.35
RMSE (m)	0.27	0.23	0.36
NSSDA (m)			0.62

Table 1: DSS In-FlightOrtho Accuracy against Ground Control Points, 87 measurements

The results show that the DSS In-FlightOrtho RMS accuracy against ground control for this test was **0.27 m in X and 0.23 m in Y, or approximately 2 to 3 times GSD.**

Notes:

1. The test area is relatively flat, with a maximum height variation of approximately 50 m from corner to corner (see Figure 2, Appendix). Hence the low density SRTM DEM was more than adequate to perform orthorectification with minimal contribution to the overall error. In hilly areas a more accurate DEM with higher density posting will be required to achieve similar results.
2. The OmniStar HP service in the Toronto area is quite robust and accurate. The real-time position accuracy was estimated to be 10 to 30 cm RMS (see Figure 3, Appendix). However in other regions this may not be the case and hence it will be more difficult to achieve similar results.

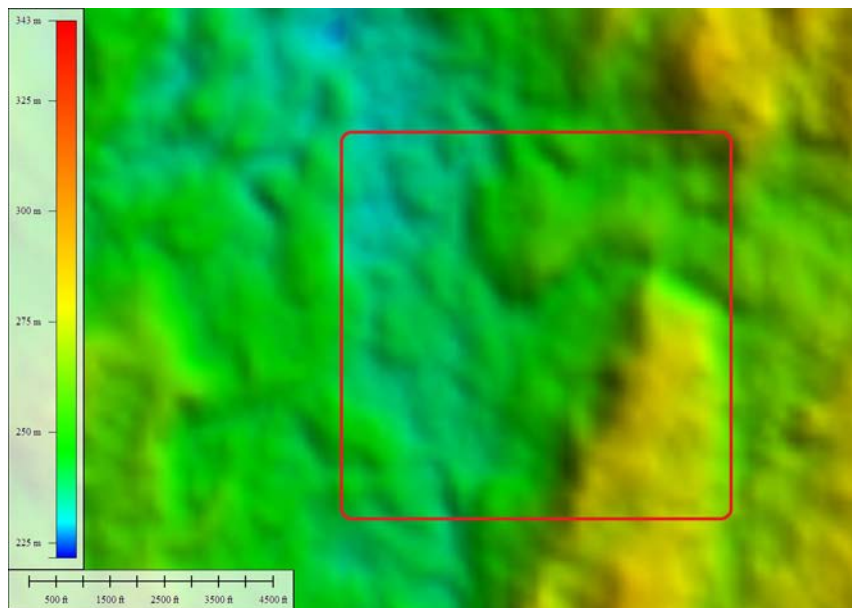
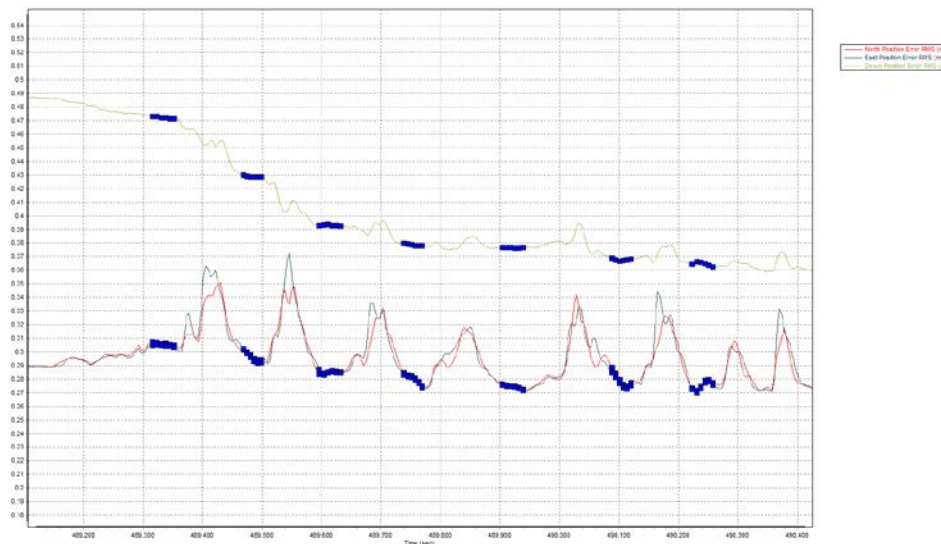
Appendix**Figure 2: SRTM DEM Used in Test Showing Flight Area****Figure 3: POS AV Estimated Position Accuracy, Real-time**



Image ID	X	Y					
GCP00	634286.072	4887825.337	Diff in X	(Diff in X)^2	Diff in Y	(Diff in Y)^2	(Diff in X)^2 + (Diff in Y)^2
27258255	634286.266	4887825.371	0.194	0.038	0.034	0.001	0.039
27258262	634286.071	4887825.555	-0.001	0.000	0.218	0.048	0.048
27258451	634285.465	4887825.458	-0.607	0.368	0.121	0.015	0.383
27258455	634285.552	4887825.371	-0.520	0.270	0.034	0.001	0.272
27258460	634285.811	4887825.382	-0.261	0.068	0.045	0.002	0.070
27258464	634286.060	4887825.561	-0.012	0.000	0.224	0.050	0.050
27257348	634286.082	4887825.214	0.010	0.000	-0.123	0.015	0.015
27257355	634286.591	4887825.810	0.519	0.269	0.473	0.224	0.493
27257504	634286.169	4887825.701	0.097	0.009	0.364	0.132	0.142
27257510	634286.310	4887825.406	0.238	0.057	0.069	0.005	0.061
27257621	634285.803	4887825.068	-0.269	0.072	-0.269	0.072	0.145
27257629	634286.479	4887825.166	0.407	0.166	-0.171	0.029	0.195
27258125	634286.296	4887825.560	0.224	0.050	0.223	0.050	0.100
27258132	634286.056	4887825.166	-0.016	0.000	-0.171	0.029	0.029
Image ID	X	Y					
GCP04	634303.360	4888454.039	Diff in X	(Diff in X)^2	Diff in Y	(Diff in Y)^2	(Diff in X)^2 + (Diff in Y)^2
27258262	634303.370	4888453.780	0.010	0.000	-0.259	0.067	0.067
27258269	634303.363	4888453.935	0.003	0.000	-0.104	0.011	0.011
27257355	634302.919	4888453.907	-0.441	0.194	-0.132	0.017	0.212
27257370	634303.398	4888454.449	0.038	0.001	0.410	0.168	0.170
27257492	634303.264	4888454.491	-0.096	0.009	0.452	0.204	0.214
27257498	634303.454	4888454.209	0.094	0.009	0.170	0.029	0.038
27257636	634303.433	4888453.864	0.073	0.005	-0.175	0.031	0.036
27257643	634303.504	4888454.012	0.144	0.021	-0.027	0.001	0.021
27257650	634303.405	4888454.153	0.045	0.002	0.114	0.013	0.015
27257763	634303.426	4888454.428	0.066	0.004	0.389	0.151	0.156
27257769	634303.581	4888454.167	0.221	0.049	0.128	0.016	0.065
27258113	634303.483	4888454.322	0.123	0.015	0.283	0.080	0.095
27258119	634303.447	4888454.146	0.087	0.008	0.107	0.011	0.019
Image ID	X	Y					
GCP07	634576.545	4888788.707	Diff in X	(Diff in X)^2	Diff in Y	(Diff in Y)^2	(Diff in X)^2 + (Diff in Y)^2
27258269	634576.341	4888788.240	-0.204	0.042	-0.467	0.218	0.260
27257486	634575.957	4888788.720	-0.588	0.346	0.013	0.000	0.346



27257492	634576.284	4888788.547	-0.261	0.068	-0.160	0.026	0.094
27257498	634576.495	4888788.317	-0.050	0.003	-0.390	0.152	0.155
27257643	634576.284	4888788.394	-0.261	0.068	-0.313	0.098	0.166
27257650	634576.207	4888788.682	-0.338	0.114	-0.025	0.001	0.115
27257757	634576.438	4888789.066	-0.107	0.011	0.359	0.129	0.140
27257763	634576.591	4888788.740	0.046	0.002	0.033	0.001	0.003
27257950	634576.841	4888788.490	0.296	0.088	-0.217	0.047	0.135
27257957	634576.822	4888788.759	0.277	0.077	0.052	0.003	0.079
27258106	634576.092	4888789.009	-0.453	0.205	0.302	0.091	0.296
27258113	634576.284	4888788.644	-0.261	0.068	-0.063	0.004	0.072
Image ID	X	Y					
GCP09	635117.864	4888896.186	Diff in X	(Diff in X)^2	Diff in Y	(Diff in Y)^2	(Diff in X)^2 + (Diff in Y)^2
27257763	635117.371	4888896.072	-0.493	0.243	-0.114	0.013	0.256
27257769	635117.678	4888895.726	-0.186	0.035	-0.460	0.212	0.246
27257950	635117.525	4888896.053	-0.339	0.115	-0.133	0.018	0.133
27257957	635117.505	4888896.303	-0.359	0.129	0.117	0.014	0.143
Image ID	X	Y					
GCP01	634289.511	4887818.891	Diff in X	(Diff in X)^2	Diff in Y	(Diff in Y)^2	(Diff in X)^2 + (Diff in Y)^2
27258255	634289.783	4887818.986	0.272	0.074	0.095	0.009	0.083
27258262	634289.545	4887819.235	0.034	0.001	0.344	0.118	0.119
27258451	634288.939	4887819.083	-0.572	0.327	0.192	0.037	0.364
27258455	634289.037	4887818.997	-0.474	0.225	0.106	0.011	0.236
27258460	634289.275	4887818.986	-0.236	0.056	0.095	0.009	0.065
27258464	634289.567	4887819.208	0.056	0.003	0.317	0.100	0.104
27257348	634289.524	4887818.818	0.013	0.000	-0.073	0.005	0.005
27257355	634290.108	4887819.446	0.597	0.356	0.555	0.308	0.664
27257504	634289.689	4887819.336	0.178	0.032	0.445	0.198	0.230
27257510	634289.901	4887819.026	0.390	0.152	0.135	0.018	0.170
27257621	634289.281	4887818.660	-0.230	0.053	-0.231	0.053	0.106
27257629	634289.999	4887818.787	0.488	0.238	-0.104	0.011	0.249
27258125	634289.844	4887819.224	0.333	0.111	0.333	0.111	0.222
27258132	634289.591	4887818.872	0.080	0.006	-0.019	0.000	0.007
Image ID	X	Y					
GCP05	634302.261	4888453.930	Diff in X	(Diff in X)^2	Diff in Y	(Diff in Y)^2	(Diff in X)^2 + (Diff in Y)^2
27258262	634302.222	4888453.674	-0.039	0.002	-0.256	0.066	0.067



27258269	634302.152	4888453.801	-0.109	0.012	-0.129	0.017	0.029
27257355	634301.694	4888453.702	-0.567	0.321	-0.228	0.052	0.373
27257370	634302.314	4888454.322	0.053	0.003	0.392	0.154	0.156
27257492	634302.081	4888454.273	-0.180	0.032	0.343	0.118	0.150
27257498	634302.286	4888454.055	0.025	0.001	0.125	0.016	0.016
27257636	634302.342	4888453.639	0.081	0.007	-0.291	0.085	0.091
27257643	634302.370	4888453.801	0.109	0.012	-0.129	0.017	0.029
27257650	634302.173	4888453.949	-0.088	0.008	0.019	0.000	0.008
27257763	634302.229	4888454.259	-0.032	0.001	0.329	0.108	0.109
27257769	634302.448	4888453.984	0.187	0.035	0.054	0.003	0.038
27258113	634302.384	4888454.118	0.123	0.015	0.188	0.035	0.050
27258119	634302.272	4888453.984	0.011	0.000	0.054	0.003	0.003
Image ID	X	Y					
GCP08	634566.559	4888802.928	Diff in X	(Diff in X)^2	Diff in Y	(Diff in Y)^2	(Diff in X)^2 + (Diff in Y)^2
27258269	634566.427	4888802.593	-0.132	0.017	-0.335	0.112	0.130
27257486	634566.139	4888803.035	-0.420	0.176	0.107	0.011	0.188
27257492	634566.312	4888802.996	-0.247	0.061	0.068	0.005	0.066
27257498	634566.619	4888802.958	0.060	0.004	0.030	0.001	0.004
27257643	634566.446	4888802.746	-0.113	0.013	-0.182	0.033	0.046
27257650	634566.139	4888802.977	-0.420	0.176	0.049	0.002	0.179
27257757	634566.485	4888802.996	-0.074	0.005	0.068	0.005	0.010
27257763	634566.542	4888802.939	-0.017	0.000	0.011	0.000	0.000
27257950	634566.639	4888802.708	0.080	0.006	-0.220	0.048	0.055
27257957	634566.831	4888803.015	0.272	0.074	0.087	0.008	0.082
27258106	634566.139	4888803.304	-0.420	0.176	0.376	0.141	0.318
27258113	634566.331	4888803.111	-0.228	0.052	0.183	0.033	0.085
Image ID	X	Y					
GCP10	635114.746	4888893.473	Diff in X	(Diff in X)^2	Diff in Y	(Diff in Y)^2	(Diff in X)^2 + (Diff in Y)^2
27257763	635114.470	4888893.613	-0.276	0.076	0.140	0.020	0.096
27257769	635114.892	4888893.555	0.146	0.021	0.082	0.007	0.028
27257950	635114.566	4888893.517	-0.180	0.032	0.044	0.002	0.034
27257957	635114.700	4888893.863	-0.046	0.002	0.390	0.152	0.154
		sum	-4.423	6.277	4.520	4.742	11.019
		Mean	-0.051	0.072	0.052	0.055	0.127
		Stdev	0.264		0.228		
		RMSE		0.269		0.233	0.356
		NSSDA					0.616



			X	Y	Radial		
		Mean	-0.051	0.052	0.073		
		Stdev	0.264	0.228	0.348		
		RMSE	0.269	0.233	0.356		

Table 2: Detailed Accuracy Assessment Results, In-FlightOrtho, Oct 1, 2012