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QUANTITATIVE AND QUALITATIVE ASSESSMENT OF PLANIMETRIC INFORMATION EXTRACTION FROM QUICK BIRD IMAGES

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Abstract: *Recently, images are available from High Resolution Satellite images (Ikonos, Quick bird, etc…). These images are available in two product types. Regarding the first type, the images are processed based on satellite navigational data only, while in the second type, the images are processed based on additional local ground control points. Consequently, the main objective of this paper is to assess the accuracy of maps, produced from high resolution Quick Bird Standard Imagery Pan-Sharpened type images, on the basis of the use of additional local Ground Control Points GCPs (8 GCPs in this case), for planimetric derived coordinates. To achieve such an objective, discrepancies derived from coordinates of 49 Check points, located in the tested Quick Bird images, and direct measurements in the field using Total Station Instrument based on the very high accurate Triangulation GCPs, considered as a reference for the same area, and covering the "Borg El Arab region" in Alexandria governorate, Egypt, with a flat terrain, are evaluated. The Root Mean Square (RMS) error of positional discrepancy, in easting and northing directions, is computed. The results showed that, the accuracy of Quick Bird images, processed using local GCPs, is acceptable by the American National Map Accuracy Standard (NMAS) specifications in production and updating of maps with scale 1:2500 or less, in case of flat terrain, taking into consideration the qualitative assessment of fine features in the images, which needs more field check.*

1. Motivations behind the Present Research

Very high resolution satellite images from QuickBird are in a competition to aerial images today. The successful launch of QuickBird high- resolution satellite has narrowed the gap between satellite images and aerial photos. QuickBird is currently the satellite with the highest resolution for civilian uses. The QuickBird multispectral images (Pan Sharpened) with 0.6 meter resolution provide high quality imagery both for military applications as well as for civilian applications such as Urban Planning Mapping, and GIS applications. The overall purpose of GIS is to locate, identify and manage spatially distributed features in a comprehensive manner. Without an accurate base map, the relationships among these features cannot be determined, and the value of the information is diminished as a result. Ortho-image may be used as high quality base map. In the near future, it could even replace aerial photos with high resolution satellite images for GIS applications depending on the required accuracy. In this study, accuracy analysis will be done for base map production that will be used in GIS applications from QuickBird multispectral (Pan Sharpened) images with 0.6 meter resolution for the selected study area.

2. Objectives of the Research Work

Studying the usage of QuickBird multispectral (Pan Sharpened) images with 0.6 meter resolution, to produce large scale base map, which can be serving in building GIS layers.

3. Data Acquisition

3.1. Test Site and Data Description (Space Imageries)

The test area is surrounded by eight definite points, for Borg El Arab region in Alexandria governorate, Egypt. The test area is covered by a QuickBird imagery consists of two sets of archived data acquired at 2004 (Left & Right) with an overlap between them, with a total area of 31 km^2, and the difference in leveling is about 15 m as an average, which are displayed in Figures (1) and (2). Again, in the present research, the images used are Standard Imagery pan-sharpened type. A mosaic between the two images is performed, using the overlapped area matching method, which displayed in Figure (3) [Digital Globe, 2006].

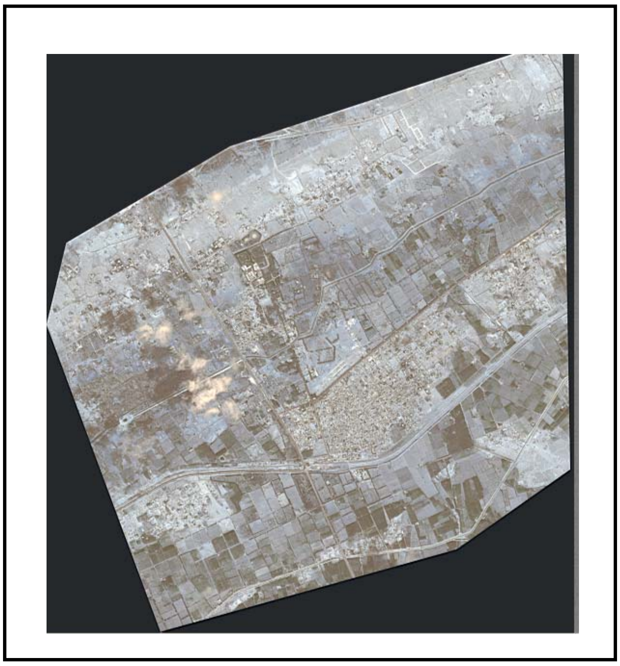

Fig. 1. *A Fragment of Left QuickBird Imagery over Borg El Arab, [16/7/2004]*

Fig. 2. *A Fragment of Right QuickBird Imagery over Borg El Arab, [28/6/200*

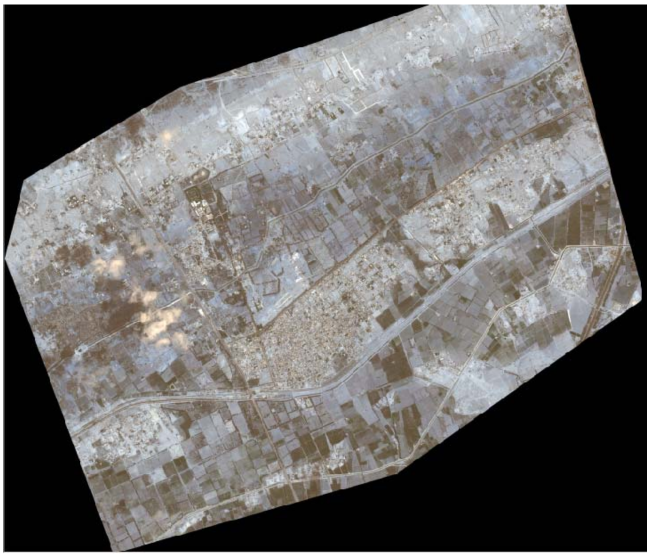

Fig. 3. *A Mosaic of Left & Right QuickBird Imageries over Borg El Arab*

3.2. Ground Control Points

A complete mission for acquisition of Ground Control Points (GCPs) as well as Check Points (CPs) is done using GPS technique. The distribution of ground control points (8 points) is well distributed over the test area. The residuals in coordinates of GCPs is displayed in **Table (1)**, based on old Egyptian datum (ETM).

Table 1. *Residuals (meters) of the Ground Coordinates for the 8 Control Points Acquired from GPS Field Mission (ETM Datum)*

No.	Residual E	Residual N
1	0.020	0.019
2	0.027	0.014
3	0.012	0.012
4	0.011	0.013
5	0.012	0.014
6	0.013	0.013
7	0.012	0.014
8	0.013	0.014
AVMR*	**0.027**	**0.019**
RMS	**0.012465**	**0.011187**
RMS_p	**0.0154**	

* AVMR = Absolute Value of Max. Error.

4. Methodology of the Practical Work

In the present research, the test includes calculations of the discrepancies, of E, N coordinates for a total group of (49) test points, located on the corrected mosaic image covering the whole test area. These point's E, N coordinates are compared with the corresponding ones derived from the ground surveying, which are considered as a reference, in this research. The software used in this operation is ERDAS Imagine, along with its modules **[ERDAS, 2001]**. The procedure applied in this test is as follows:

4.1. Mosaicking

First step is to perform the mosaic between the two data sets left and right images. Due to the fact that the time elapsed between the acquisition of the two images is about three weeks only, also, the viewing angles for the two images are almost the same, the mosaic between the two images is performed using the overlapped area matching method.

4.2. Correction of Satellite images

The satellite orbit information and calibration data (Rational Parameters) for the imageries in hand is not available, rigorous methods will not be used in the current research. This means that other alternative models should be used to solve practically this problem and calculate the imagery parameters. Therefore, these empirical approaches can be applied to determine the ground points coordinates.

The images used are Standard Imagery pan-sharpened type, which has a coarse DEM applied to it, to normalize for topographic relief with respect to the reference ellipsoid, which means that, it has terrain corrections applied, so, it is not suitable for orthorectification by the customer. Accordingly, the type of correction for this type of images will be done in planimetry only (2D). Therefore, and for the reasons mentioned before, the approximate methods will be used to correct the images (i.e. polynomials). Second order polynomial is the used one in this case. **Table (2)** shows the residuals and Root Mean Square Error (RMS) for the GCPs used to correct the image **[Pohl, 1996]**.

Table 2. *Residuals (meters) of the Ground Coordinates for the 8 Control Points after Least Squares Adjustment, Mosaicked Corrected Image*

No.	Residual E	Residual N
1	-0.015	0.002
2	0.059	-0.040
3	-0.006	0.025
4	0.007	-0.014
5	-0.076	-0.001
6	-0.005	0.044
7	-0.002	-0.036
8	0.037	0.042
AVMR*	**0.076**	**0.044**
RMS	**0.037**	**0.027**
RMS(T)	**0.046**	

* AVMR = Absolute Value of Max. Error

4.3. Collection of Check Points

Forty nine common sharp features were identified, on the digital geo-referenced QuickBird corrected image. The coordinates (E, N), of these common points are measured from the field and stored. The same features were identified, and their coordinates (E, N) are measured from the corrected image, with an estimated precision of one pixel, which equals to 0.6 m in this case. The distribution of these points over the test area is based on two ideas: some points measured nearest the ground control points and the others measured allover the image to assess the accuracy for the solution. Finally, the discrepancies in (E, N) resulted from the corrected image, with the corresponding (E, N) measured from ground surveying, for control and check points, along with their statistical parameters are calculated.

5. Results

Assessment of results follows different steps:

5.1. Quantitative assessment through calculation of statistics from the check points derived from the geo-corrected mosaic image to assess the accuracy of maps that could be produced from this kind of images, taking into consideration the accuracy of capturing GCPs from GPS.

5.2. Qualitative assessment of the different features in the produced geometrically corrected image.

The results of the above steps can be outlined as follows

Forty nine sharp and well distributed check points are chosen on both the reference (Ground Surveying) and the resulted geo-corrected image (Mosaicked QuickBird image). Forty three points from them ware measured around and closest to the ground control points and the other (six points) are measured allover the image. Then, their coordinates ware measured from both systems. Finally, discrepancies of those points are calculated. **Table (3)** shows these discrepancies for the two groups of check points.

Table 3. *Discrepancies of the Ground Coordinates for the 49 Check Points (meters), QuickBird Corrected Image.*

No.	Δ E	Δ N	No.	Δ E	Δ N
1	1.25	-1.16	**26**	0.14	-0.66
2	0.98	-1.02	**27**	0.02	0.002
3	-0.92	-1.22	**28**	0.14	0.07
4	-1.43	-0.18	**29**	0.41	-0.19
5	0.3	0.02	**30**	0.25	-0.39
6	-1.29	-0.01	**31**	0.83	-0.50
7	0.68	-0.03	**32**	-1.37	0.31
8	-1.19	0.29	**33**	-0.46	-0.79
9	-0.63	0.05	**34**	-1.50	-0.46
10	-0.31	-0.17	**35**	-1.98	-0.66
11	0.02	-0.26	**36**	-1.41	-0.63
12	0.55	0.22	**37**	-0.42	-0.25
13	-0.24	-0.25	**38**	-0.72	-0.60
14	-0.28	0.37	**39**	-0.33	-0.74
15	-0.12	0.13	**40**	0.019	-0.29
16	0.31	0.13	**41**	-0.58	-0.54
17	-0.13	-0.46	**42**	1.001	-0.46
18	0.36	0.21	**43**	1.39	0.041
19	-0.15	-0.39	**44**	0	-0.001
20	-0.19	-0.59	**45**	0.008	0
21	0.22	-0.31	**46**	0.134	-0.29
22	-0.45	-0.68	**47**	0.104	-0.76
23	-0.22	-0.26	**48**	0.035	-0.047
24	0.31	-0.58	**49**	0.26	0.018
25	0.28	-0.63			
AVMR*				**1.98**	**1.22**
RMS				**0.739**	**0.488**
RMS_p				**0.886**	

* AVMR = Absolute Value of Max. Error

From the research findings, it is obvious that non-rigorous orientation and triangulation models can be used successfully in most cases for 2D rectification without needing a camera model or the satellite ephemeris data. In addition, accuracy up to the sub-pixel level in plane can be achieved with a modest number of GCPs.

For the second item of assessment, which is the qualitative accuracy assessment for the different features in the produced image, the check is done by experts in mapping from aerial photographs, as well as the field team of reviewing maps. The procedure of qualitative assessment is based on the recognition check for different features appeared in the corrected image against the same features appeared in the field. The land use patterns are categorized in three items, namely: urban areas (streets, buildings, trees …etc), agricultural areas (green areas, crops, canals, small streets inside villages …etc), and finally, desert areas (wadies, drainage pattern, paved and unpaved roads….etc). **Table (4)** summaries the results obtained in the qualitative check test.

Table 4. *Description of Qualitative Information Appeared in the Corrected Pan-Sharpened QuickBird Image*

Land Use	Item / Description	Land Use	Item / Description	Land Use	Item / Description
Urban	Buildings/E+	**Agriculture**	Buildings/E+	**Desert**	Roads/E
	Streets/E		Streets/ E		Railway/N
	Railway/N		Railway/ N		Drainage Patterns/E
	Green Areas/E		Green Areas/ E		Cultivated Areas
	Wet Areas/D		Crops/ D		------
	-----		Canals/ D		------

E+ = Easily Detectable + Shadow Effect, E = Easily Detectable,
M = Medium, D = Difficult, N = No appearance, C = Confused.

6. Conclusions

Regarding the assessment of obtained results, the following conclusions can be outlined:

6.1. Regarding the geometry of the Pan-Sharpened Quick Bird images, and based on the adopted Map Standards Accuracy NMAS **[Anderson and Mikhail, 1998]**, for geometric accuracy with confidence region 90%, and from the results showed in **Table (3)**, it can be stated that the accuracy of mapping from geo-corrected Pan-sharpened QuickBird images, corrected using GCPs derived from ground surveying, for a relatively flat terrain, gives an RMS value of 0.886 m in planimetry, which satisfies theoretical and practical large scale mapping of 1:2500 and smaller, taking into consideration the limitations in qualitative check and the fewer number of check points distributed allover the image.

6.2. Regarding the qualitative assessment, and from **Table (4)**, it is obvious that there is an increasing description or detectability for the different land use features, in the corrected image compared to the field check. For example, the appearance of buildings in land use category, gained more sharpness and has a shadow effect. The same results are true for the drainage patterns and green areas, within the desert category. Also, the rail way tracks are completely undefined.

7. Recommendations

7.1. Re-calculating the results using different GCPs combinations captured from ground surveying.
7.2. Using more numbers of check points that well distributed allover the image.
7.3. The same for items (1) and (2) but for images that covers hilly terrain.

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