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ACCURACY ANALYSIS OF MAPPING BASED ON PHOTOS AND GCPs COLLECTED FROM GOOGLE EARTH

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Abstract

The photoic maps available on Google Earth come primarily from two sources: satellites and aircraft. Google gets this imagery and other digital mapping information from sources such as TeleAtlas and EarthSat, both of which compile photos and maps into digital form for commercial applications. Because the data comes from different sources, it is provided at different resolutions, which is why some areas of the globe appear crisp even at street level while others are blurry from a great distance.

The selected test area is located in Egypt. The test area is covered by photos collected from Google Earth with an overlap and side-lap between them ranging between 15%-25%. All GCPs and CPs are collected from Google Earth, based on Universal Transverse Mercator (UTM). The minimum number of GCPs was 5 well distributed GCPs for each photo. Only two ground control points were measured from maps covering the study area on Egyptian Transverse Mercator (ETM).

After collecting the required data, the methodology procedures included: firstly, geo-referencing of each photo; secondly, generating a mosaic from the geo-referenced photos; and finally, map conversion from UTM to ETM for the produced mosaic followed by linear transformation using only 2 GCPs measured from maps.

In the present research, the accuracy test includes calculations of the discrepancies of (E, N) coordinates for 27 test points (CPs) located on the corrected mosaic. The (E, N) coordinates of check points CPs are compared with the corresponding ones derived from the existing map, which are considered as a reference in this research.

The results of this study concluded that the photos of Google Earth can be used successfully for producing maps with suitable scale in similar study area in case of lacking remotely sensed data and field observations. They also concluded that the worries of numerous countries about the level of detail available in the Google Earth must be taken into consideration.

1. Introduction

There are worries about the Google Earth program focus on national security. Officials in numerous countries have voiced concerns over the level of detail available in the Google Earth application, including Australia, Britain and the United States. The photoic maps available on Google Earth come primarily from two sources: satellites and aircraft. Google gets this imagery and other digital mapping information from sources such as TeleAtlas and EarthSat, both of which compile photos and maps into digital form for commercial applications. But the trick of Google Earth is not in compiling and storing all these images. It is in getting them to your computer quickly and efficiently. With a 56k dial-up modem, it would take 12,400 years to download a one-meter resolution image of the Earth [source: Butler]. But Google Earth makes it seem like a high-resolution picture of the entire world is right in front of you. You are not viewing the imagery in real time: according to Google, the information is no more than three-year-old and is continually updated as new data becomes available. When using Google Earth, you can zoom in, rotate, pan and tilt on an image as specific as your own front yard, view road names and local businesses and get directions from here to there. In this study, the used projection and datum are: (1) Universal Transverse Mercator (UTM); (2) Egyptian Transverse Mercator (ETM). The software package used in this study is ENVI software.

2. Test Site

The test area is Kafr az Zayat region, Egypt. The test area is covered by snapshots (photos) from Google Earth with an overlap and side-lap between them ranging between 15%-25%.

The total area = 1.5 km *1.0 km= 1.5 km^2. Figure (1) shows a snapshot of the test area which was selected for the present research. The UTM coordinates of the boundaries of the selected study area are:

UL corner = 291700, 3411900 m

LL corner = 291700, 3410450 m

UR corner = 293450, 3411900 m

LR corner = 291450, 3410450 m

Fig. 1. A snapshot of the test area which was selected for the present research.

3. Data Acquisition

The test area is covered by photos collected from Google Earth. All GCPs and CPs are collected from Google Earth, based on UTM. The minimum number of GCPs is 5 well distributed GCPs for each photo. Only two ground control points are measured from maps.

3.1. QuickBird images

The test area is Kafr az Zayat region, Egypt. The test area is covered by QuickBird, 0.599m resolution, panchromatic standard ortho-ready Level-2A date 2005-09-06. This image is partially used in this investigation for verification and visual comparison only.

3.2 Photos

In this study, snapshots (photos) from Google Earth at elevation 250m for the selected study area are taken, each of the 9 strips (from 1 to 9) containing 10 images, taking into consideration the side-lap and over-lap between the photos. The photos data are listed below:

- Area covered by one photo = 275x125 m
- Number of strips = 9
- Number of photos per strip = 10
- Total number of photos = 90

Figure (2) shows the layout of the strips and photos. Figure (3) shows photo number 6-6.

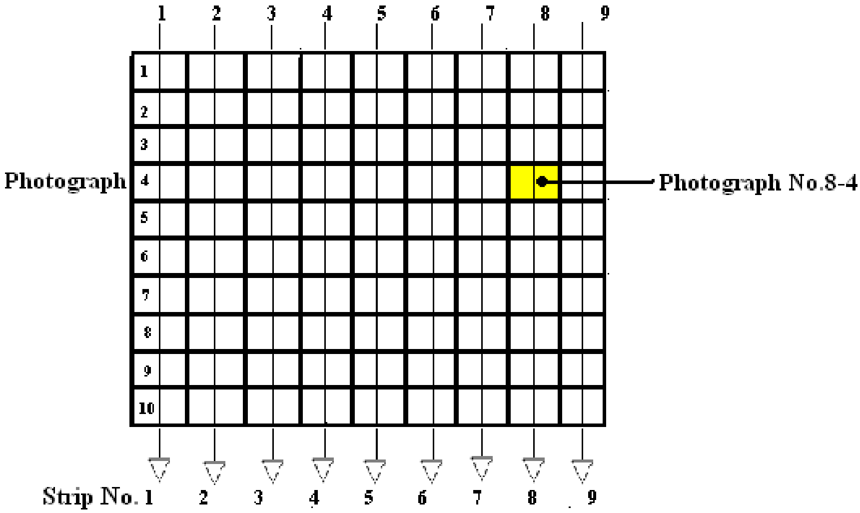

Fig.2. Layout of strips from 1 to 9 with 10 photos in each strip

Fig.3. Photo number 6-6

3.3 Ground Control Points GCPs

There are two types of ground control points used in this study:

a. GCPs collected from Google Earth

All GCPs are also collected from Google Earth, on UTM. The minimum number of ground control points for each photo is 5 points, taking into consideration that the GCPs must be well distributed over the photos and located at the corners and in the overlap area, if possible.

b. GCPs collected from available maps in scale 1/2,500

Only 2 GCPs are measured from maps in scale 1/2,500 which have been used for image transformation.

3.4 Collection of Check Points

27 well distributed sharp features were selected and identified on the geo-referenced mosaic and on the maps in scale 1/2,500. The coordinates (E, N) of these check points are measured from the maps in scale 1/2,500.

3.5 Map in scale 1/2,500

The selected study area covered with map in scale 1/2,500 was produced from aerial photos.

4. Methodology of the Practical Work

After collecting the required data, the methodology involves:

- Geo-reference of each photo based on the collected ground control points on UTM coordinate system taking into consideration the root mean square error (RMS) value for the GCPs. Approximate methods will be used to correct the images (i.e. polynomials). First order polynomial is used in this case.

- Generation of a mosaic from geo-referenced photos based on the geo-reference method in UTM coordinates system.

- Map conversion from UTM to ETM for the produced mosaic based on the transformation parameters between the two systems and using ENVI software package.

- Linear Transformation using only 2 GCPs measured from maps.

5. Results and result assessment:

5.1 Quantitative assessment of GCPs

Quantitative assessment through statistical calculations for the GCPs. Table 1 shows the residuals and the RMS for the GCPs used to correct the photos.

Table 1.Root mean square error (RMS) for the ground control points

No of GCPs	Dx (m)	Dy (m)	RMS (m)
Min 5 for each photo	Max. 0.403 Min. 0.059	Max. 0.525 Min. 0.098	Max. 0.627 Min. 0.108

5.2 UTM and ETM Mosaic

UTM mosaici from the corrected photos were created, based on the geo-reference method. Figure 4 shows the produced mosaic. Using ENVI software, the produced UTM mosaic is converted to ETM mosaic without GCPs. After that, linear transformation using only 2 GCPs measured from maps is performed to regeoreference the mossaic.

Fig.4. The produced mosaic (UTM coordinates)

5.2.1 Quantitative assessment of ETM mosaic direct conversion

Table 2 shows the total RMS of the CPs' direct conversion without GCPs. The discrepancies in the selected check points (E, N), from the geo-referenced mosaic and from the existing map in scale 1/2,500 have been calculated.

Table 2. Total root mean square error (RMS) of the check points' (CPs) direct conversion

No of CPs	Dx (m)	Dy (m)	RMS (m)
27	Max. 7.643 Min. 3.013	Max. 3.926 Min. 0.111	Max. 1.253 Min. 1.214

5.2.2 Quantitative assessment of ETM mosaic using 2 GCPs

Table 3 shows the RMS of the CPs using 2 GCPs. The discrepancies in the selected check points (E, N) from the geo-referenced mosaic and from the existing map in scale 1/2,500 have been calculated**.** Table 3 shows the RMS of the CPs using 2 GCPs.

Table 3. Root mean square error (RMS) of the check points (CPs) using 2 GCPs

No of CPs	Dx (m)	Dy (m)	RMS (m)
27	Max. 2.827 Min. 0.250	Max. 2.656 Min. 0.161	Max. 1.280 Min. 0.960

RMS_t = 1.600 m

5. Conclusions

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

- It can be stated that the accuracy of mapping from photos and GCPs collected from Google Earth and using only two GCPs from the map in scale 1/2,500 for a relatively flat terrain area gives an RMS value of 1.600 m planimetry, which satisfies theoretical large scale mapping in scale 1:3,500 and practical large scale mapping in scale 1:5,000 or less.

- The worries of numerous countries about the level of detail available in the Google Earth which can be used by terrorists must be taken into consideration.

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АНАЛИЗ НА ТОЧНОСТТА НА КАРТОГРАФИРАНЕ НА БАЗАТА НА СНИМКИ И НАЗЕМНИ КОНТРОЛНИ ТОЧКИ, ВЗЕТИ ОТ GOOGLE EARTH

Рамзи Ахмед

Резюме

Фотографските карти, налични в *Google Earth*, изхождат предимно от два източника – спътници и самолети satellites and aircraft. Google получава тези изображения и друга цифрова картографска информация от източници, като TeleAtlas и EarthSat, които събират снимки и карти в цифров вид с търговска цел. Тъй като данните

произхождат от различни източници, те притежават различна разделителна способност, поради което някои части от земното кълбо се виждат отчетливо дори на ниво улица, докато други са неясни дори от голямо разстояние.

Избраният тестови участък се намира в Египет. Тестовият участък е отразен в снимки, взети от *Google Earth*, чието припокриване и странично застъпване варира в границите 15%-25%. Всички наземни контролни точки и контролни точки са взети от Google Earth в Универсална трансверзална меркаторова система (UTM). Минималният брой на наземните контролни точки беше 5, добре разпределени за всяка снимка. Само две наземни контролни точки бяха измерени от карти, покриващи изследваната област в Египетска трансверзална меркаторова система (ETM).

След събиране на необходимите данни методологичните процедури включваха: първо, геопривързване на всяка снимка; второ, създаване на мозайка от геопривързаните снимки; и накрая, преобразуване на картата от UTM в ETM за създадените мозайки, последвано от линейно преобразуване с помощта на само 2 наземни контролни точки, измерени по карти.

В това проучване, проверката за точност включва изчисляване на несъответствията в координатите (E, N) за 27 контролни точки, разположени върху коригираната мозайка. Координатите (E, N) на контролните точки се сравняват със съответните координати, получени от наличната карта, която е приета за еталон в проучването.

Резултатите от това проучване показват, че снимките от Google Earth могат да се използват успешно за създаването на карти в подходящ мащаб в подобни области на изследване при липса на дистанционни данни и полеви измервания. Те показват още, че тревогата на голям брой страни за нивото на подробности в *Google Earth* са основателни.