AENSI Journals
Australian Journal of Basic and Applied Sciences
ISSN:1991-8178
Journal home page: www.ajbasweb.com

Increasing the Accuracy and Eliminating the Shifting in Spatial Data Based on Remote Sensing and Field Surveying Techniques

Samih Al Rawashdeh

Associate professor at Balqa Applied University, Engineering Faculty, Department of Geomatics and Surveying. Salt(19117) Jordan

ARTICLE INFO
Article history:
Received 25 January 2014
Received in revised form 8 March 2014
Accepted 10 March 2014
Available online 2 April 2014

Keywords:
Shifting, no matching, remote sensing, GIS.

ABSTRACT
InfoGraph Company (Jordan) suffers from the problem of no matching and shifting of data coming from high resolution satellite images. The main objective of this paper is to build a methodology for resolving these types of problems to enhance the products of the company in taking a case study a part of Ikonos images and other vector layers in Amman area. An important shifting occurs; these problems were resolved in changing the method of collecting and observing the ground control points (GCPs) and the method of geometric correction. After validation in two different methods, the accuracy was increased and a good matching of layers was remarked.

To Cite This Article: Samih Al Rawashdeh., Increasing the Accuracy and Eliminating the Shifting in Spatial Data Based on Remote Sensing and Field Surveying Techniques. ***Aust. J. Basic & Appl. Sci.,*** *8(3): 1-6, 2014*

INTRODUCTION

Geographical information systems (GIS) and remote sensing are computer based system that is used to extract, analyze a very wide variety of subjects and fields dealing with: civil engineering, environment, natural science, administration, industry, and economy (Christofer, 1997; Dobson, 2003; Fisher, 2003 and Comber et al, 2004).

InfoGraph is a company fully specialized in Geographic Information System (GIS) software products, services, and applications. InfoGraph also offers consulting and project development services in a number of GIS application areas as well provides and prepare GIS digital data products, such as : (i) Urbanization (spatial planning), (ii) hydrological studies (iii) development of some models working with GIS (customizing) and (iv) other related projects. So this company concerned with high accuracy of data, as well, it suffers from the problem of no matching between the digital maps and data provided from aerial photographs and satellite images.

Resolving these problems means increasing the competency of this company to produce a correct and a high quality projects in the fields of GIS. Increasing the accuracy, the problem of no matching of spatial data coming from different sources and the degradation of spatial data quality due to the electronic processing such as the transfer from one format to another ….etc. are big challenges for all the companies working with spatial data : GIS, Global positioning system (GPS) and all other fields working or using spatial data (Al Rawashdeh, 2008). The organization dealing with the fields of planning and urbanization suffers from the problem of the inaccuracy and the problem of matching the different spatial data. For example, there are always problems of no matching between spatial data coming from spatial data of water networking, electricity's lines, telephone lines sewer network with spatial data coming from aerial photographs and satellite images even if these images are geometrically corrected. For example, it is very difficult to do a track system if there are no matching between coordinates coming from satellites and the used digital maps. The organization working in cadastral and land registration fields, they all suffer from the problem of no matching between different data and the problem of the transfer from one format to another.

The work conducted by Al Rawashdeh (2011) presents a methodology for extracting the irrigated areas in the eastern parts of Jordan using remote sensing techniques by applying a pixel by pixel data fusion method in remote sensing software, this allowed avoiding the problem of shifting. Arnot et al (2004) studied the problem of no matching due to the deformation caused by the classification of satellite images. The work conducted by Jose et al (2010) studied the problem of dataset shifting by imposing cross-information in the classifiers through matrix regularization, he proposed a novel kernel method for multitask learning in remote sensing data classification.

Corresponding Author: Samih Al Rawashdeh, Associate professor at Balqa Applied University, Engineering Faculty, Department of Geomatics and Surveying. Salt (19117) Jordan.
E-mail: rsamih@hotmail.com and samih_alrawashdeh@yahoo.com

The problem of no matching present a big challenge for the data fusion between temporal layers or images, many researchers had faced important problems in their studies about this type of problem which effect the the further processing and analysis (Saleh and Al Rawashdeh, 2007;Yang ,2002; Cheng et al, 2003; Tachizuka et al, 2003). These type of problems contaminate the database when doing data detection in using satellite images due to the no good matching of pixels between the different overlaid satellite bands.

The objective of this work consisting of (i) evaluating the produced and used digital spatial data in the company, (i) evaluating the process of working of the company team to find the suitable process to obtain high quality spatial data, (iii) detecting the sources of errors which contaminate their database, (iv) doing the atmospheric and geometric corrections in correct ways and finally (v) doing the correct transfer from one project to another to avoid the problem of shifting. This will allows increasing the accuracy of the digital spatial data on one hand, and on other hand to resolve the problem of mismatching and resolving problem of transfer from one project to another.

MATERIALS AND METHOD

A high resolution satellite images (IKONOS) was used and precise GCPs were collected using a very sophisticated total station and GPS. The Erdas imagine software was used to achieve the geometric correction. Moreover, the PCI Geomatica was used to achieve the atmospheric correction.

The first step of working consist of investigating the problems which caused the shifting of data, In the second step of work, we shall focus on how to increase the accuracy of the existing spatial data .On the third step we shall emphasize on the problem of projection and the transfer from one system of projection to another and finally on the forth step, we will focus on resolving the problem of shifting and mismatching due to the variety of resources and processing This can be achieved by:

1. Checking the available data and understanding the problem and the sources of errors which contaminate their database.
2. Doing atmospheric correction of the satellite images.
3. Doing geometric correction of the satellite images in correct manner.
4. Doing the correct transfer from one project to another to avoid the problem of shifting and mismatching.

Software:

The following software’s were used in this work:

Erdas imagine software for doing the geometric correction.

a) PciGeomatica to achieve the atmospheric correction
b) Liscad Software to process and to view the field surveying works.
c) GIS to do the overlay operations.

Data collection:

Different types of data were used for this research:

a) IKonos satellite image from Info Graph Company,
b) A large number of GCPs points collected by earliest Total Station, some of them to achieve the geometric correction, others for doing the validation and the re-correction.

For that, a satellite Image (IKONOS) was used and a suitable number of GCPs was collected using earliest total station.

The following flow chart resumes the followed method (Fig. 1).

Results and analysis:

An IKONOS image corrected geometrically presenting a part of Amman city (Fig. 2) was considered to show the shifting of layers coming from other sources of data extracted from high resolution satellite images (Fig.3). This figure shows an important shifting despite that this image was corrected geometrically. The sources of the inaccuracy were investigated, these error mainly coming from: The precision, accuracy and errors of the initial data because of systematic, blunders and random errors.

1. The bad distribution of GCPs and the insufficient number of these points.
2. The method of achieving the geometric correction using Erdas software.
3. The no correction from atmospheric correction.

So we try to resolve some types of these problems specially those coming from:

1. Atmospheric correction,
2. Geometric correction and,
3. GCPs collection.

Twelve points were observed inside the study area (the IKonos image) using a very sophisticated Total station and GPS. These points were choosing in considering the following:

1. The topography of the area

2. The distribution of these points
3. Choosing these points in features that have geometric forms such as intersection of two streets, a corner of a building etc…

These points were collected in geographic and in Cartesian coordinates.

Table 1 presents five points at UTM WGS84 Zone36 as system of projection and Table 2: presents five control points in geographic coordinates.

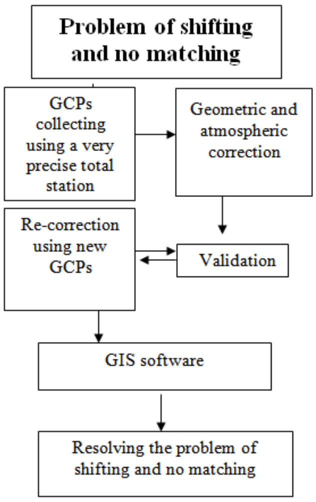

Fig. 1: The followed method.

Fig. 2: High resolution satellite image shows the shifting of data (in red colour).

Table 1: Presents five points at UTM WGS84 Zone36 as system of projection.

P1	Y: 3533495.40,	X: 780171.12,	Z: 992.03
P2	Y: 3535887.11,	X: 774622.62,	Z: 924.80
P3	Y: 3536924.16,	X: 776853.24	Z: 903.58
P4	Y: 3537248.301,	X: 775331.564,	Z: 899.071
P5	Y: 3550154.996,	X: 773676.850,	Z: 943.70

Table 2: Five ground control points defined in geographic coordinates system. (Latitude /Longitude).

point	Φ	λ
P1	31.9028322241684°	35.962467720868°
P2	31.9257360184975°	35.9045418026913°
P3	31.9345384871874°	35.9284040862973°
P4	31.9378290354923	35.9124186259731°
P5	32.0545216510988	35.8985933173852°

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Figure 4 shows some examples of these points.

First the, the image was corrected form atmospheric effects using the module of atmospheric correction in PCI Geomatica.

The geometric correction was achieved using the polynomial model in Erdas software. The shifting was minimized (Fig 3). Other ten GCPs were observed and the corrected image was re-corrected in the same manner. The vector layers coming from other sources were newly overlaid to the resultant image.

Projection: UTM WGS84 Zone 36N
Y: 3537248.301, X: 775331.564, Z: 899.071

Projection: UTM WGS84 Zone 36N
Y: 3535887.11, X: 774622.62, Z: 924.80

Fig. 3: Show a reduction of the shifting, in red we see the location after correction, in Cyan shows the location before the correction with the adopted method.

The image was resurrected using new gcps points. This image was validated using two gcps. Figure 4 shows the results.

Fig. 4: Shows the reduction and the elimination of shifting.

The database was validates using the two following methods:

1. Using two check control points as shown in Figure 4.
2. Visual validation by overlaying the vector data with the re-corrected image Fig. 5.

The two methods of validation showed an exact matching or accepted shifting between the vector data with the re-corrected image as shown in Figure 6.

Fig. 5: The data base overlaid to the re-corrected high resolution IKONOS image, we remark a good superposition of the data without shifting or with an acceptable shifting.

In observing the shifting in the database, we remarked that it is important in the zone where the topography is very difficult. To be noted that the topography in Jordan is hilly and mountainous in the active zones such as: Amman governorate, Kerak governorate, Balqa governorate, Jerash Governorate, Ajloun Governorate, Madaba Governorate, Tafila Governorate and some parts of Aqaba, Ma,an governorates. For the regions of Jordan valley we have very great problem of geometric correction because of the severe topography which causes an important distortion in case of satellite images and very important parallax in case of aerial photographs.

For the problem of electronic transfer of format we suggested that company adopt a suitable format and to avoid the successive change of format.

Conclusion:

The shifting of data is a big challenge for companies dealing with GIS and remote sensing data, the followed methodology present a solution for eliminating the shifting caused by collecting the GCPs and doing the geometric correction in classical ways. The shifting in our test area was eliminated. The shifting was remarkable in the accidental zones, so the intensification of GCPs in these types of area was imperative to minimize or eliminate the shifting.

The validation of geometric correction, visually and by GCPs, is very imperative for obtaining an accurate and reliable database to increase the competency of the company.

This work shows that the successive change of format affect the quality of spatial data. So we have to avoid this type of problem to guaranty the high quality of database.

The main conclusion consist of that the necessity of validating our results and to consider the topography in case of GCPs collection.

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