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Planning and Cost Analysis in Orthorectification IKONOS Satellite Images*

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Abstract: In this study, cost calculations and its activities for satellite image rectification project have been completed. Planning of satellite image rectification by the use of working flow chart and Gannt diagram have been done. Image rectification is the process of making image data to conform a map projection system. Most often the image is also oriented in such a manner that the north direction corresponds with the top of the image. Images can be converted to real-world ground coordinates by referencing the image to another source that is in the desired map projection. Source information may be obtained from another image, vector coverages, or map coordinates. In order to accomplish this task, Ground Control Points (GCPs) need to be selected from both the input source and the reference source. GCPs are points that are used to depict the same location on the Earth's surface Depending on the needs of the satellite imagery in the GIS system, there are advantages and disadvantages to using either method. GCP orthorectification is a faster process and can be accomplished using existing paper maps to establish the GCPs. Using DEMs for orthorectification is a more accurate process by which to geocode digital imagery but require an existing Digital Elevation Model (DEM) or Digital Terrain Model (DTM) for processing. Once an image has been orthorectified it can be used with vector and raster data of the same coordinate system. This image can have roads, streets, buildings, etc. Spatial data can accurately measure in terms of distances and area. These data can use for more complex spatial analysis. At the same time cost of project is important criteria in this study project planning with IKONOS satellite image has been made and cost analysis investigated using 5 km*5 km Selcuk University Kampus area in Turkey. According to results cost and accuracy criteria orthorectificated satellite images have important advances for most of GIS applications.

Key words: Satellite image, orthorectification, project planning, gannt diagram, cost analysis

INTRODUCTION

IKONOS satellite which can generate image data with a spatial resolution of 82 cm and a positional accuracy of ±1 mRMS. In order to help customers in their decision making processes, IKONOS images provide products and derived information with very high detail and accuracy. Multi-band (MSI), color (PSM), black and white (PAN), Stereo and 3 dimensional IKONOS products, which are provided cost effectively with high details to be used in various applications, ensure an ideal environment to produce and update information of geographical based maps as well as combining those information (http://www.sieurasia.com/showpage.aspx?id=161,2008).

The new generation of commercial high resolution space imageries such as IKONOS have provided a considerable progress in photogrammetric mapping and map revision. One of the great

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promises of IKONOS is its potential to generate 3D spatial information products in meter accuracy and to produce large scale topographic maps such as 1.100000 scale and even larger (Valadan *et al*., 2002).

IKONOS, the world's first commercial high resolution imaging satellite, was successfully launched in September, 1999, From a 680 km sun synchronous orbit, the IKONOS satellite simultaneously collects 1 m panchromatic and 4 m multi spectral images in 4 bands with 11 bit resolution (Grodecki and Dial, 2002).

IKONOS data is produced for five different product levels and is available at different prices. A minimum order of 100 km^2 is required. The geo product, which is the most affordable but offers the lowest positioning accuracy, is not corrected for terrain distortions. It has an accuracy of 50 m with 90% level of confidence. Accuracy becomes worse in mountainous areas if the images are acquired with of nadir viewing, which is quite common for the IKONOS data (Fraser, 1999). The accuracy of ground points can reach 3 m in planimetry and 2 m in height with over 4 GCPs in spite of fact that the experimental conditions were based on a simulated study (Li *et al*., 2000).

High resolution satellite imagery on the wide area can be achieved more repeatedly and econimically compared to the aerial photos (Jeong *et al*., 2001).

As primary future users of image data from 1 m satellites, the photogrammetric mapping and GIS communities have shown considerable interest in this new technology (Fraser, 1999).

The production of topographic maps is based on the restitution of aerial photographs since many decades. During the restitution process the operator extracts semantic information and geometric information out of the images. Due to the long lasting experience it can be guaranteed, that the image interpretability as well as the mapping accuracy meets the standards for different image scales and map scales.

Though the production of topographic maps from satellite image data is basically very similar, it was ignored by the cartographic community for a long time. It is of course obvious that the use of satellite remote sensing for the production and revision of maps is only of interest if the data can be extracted with the appropriate accuracy, completeness and reliability. This however has to be examined. It is reasonable for related investigations to study the two major elements of topography, i.e., planimetric mapping and the height measurements, separately (Albertz and Wiedemann, 2003).

Traditional orthorectification involves the use of stereo pairs from which elevation is extracted directly to be used for production of contours and DEMs in addition to orthorectification to the images. However, the cost of acquiring and processing stereo may not to be justified if the purpose is to do orthorectification only. In the case high the resolution satellites, there is also an opportunity cost for stereo acquisition: the time spent in acquiring the stereo partner is the time lost in acquiring additional primary images (Mercer, 2003).

Activities of Satellite Image Processing

In general, there are four stages at satellite image processing.

Field Work

- Determination of project area
- Obtaining of the 1/25000 and 1/100000 maps
- Reconnaissance of triangulation point and measuring of the coordinates from the maps on 1/25000 scaled maps
- Finding of the triangulation points with GPS in working area
- Construction and sketching of triangulation point
- Painting of the control points
- GPS Surveying and Coordinate Calculations
- Interview with the companies for obtaining of the IKONOS Satellite İmage of 5 km*5 km area
- Fixing day of the taking images of the satellite

Taking Image of the Satellite and to Take Delivery of Satellite Image
Office Work

- Digitization (Production of DTM)
- Orientation procedures
- Orthorectification

Reproduction

- Determination of the projection systems produce maps and legend making. Drawing of details
- Output materials

Planning of Satellite Image by the Use of Working Flow Chart and Gannt Diagram
Planning of Activities with Working Flow Chart

In the working flow chart the relationship within processing of project is presented according to computer logic. Generally, every process are written within the rectangular and the relationship between the processes are shown as arrows. If there is a decision point, it is suitable to use parallelogram. During the processing of these flow charts make sure that all the arrows, which shows the relation between the processes, are not cross each other. The flow charts are often used for the projects that needs process which is very simple and not complex. At the all stages of the project, the manager can realize easily that:

- What he has done before
- What he will do
- What he will need to do and
- What kind of precautions he can take

Planning of the Project with Gannt Diagram

In the Gannt diagram, processes are shown as the time in horizontal and the processes in the vertical axis with scale. The Gannt diagrams may be the methods which are very simple and adequate for the small projects.

Because of the simplicity of diagrams the time of processing can be seen easily. As shown at time axis they can be related with calendar and any time duration it is also adequate to measure the sources that needs at that time.

SAMPLE PROJECT

Introduction of the Project

Selcuk University Alaaddin Keykubat campus area is chosen as sample study area. As a projection UTM 6° north system have been used. Zone of working area 36° latitude (ϕ) and longitude (λ) values are:

$$(\phi) = 37°58'30'' * 38°04'00''$$
$$(\lambda) = 32°26'00'' * 32°33'00''$$

Main Activities and Their Time Estimations

In land study Magellan hand GPS and Leica GPS instrument have been used. Satellite image is obtained from IKONOS satellite. Erdas imagine software were used in orthorectification procedures. Main activities, time and total cost of sample project are presented in Table 1.

Table 1: Projects main activities, total cost and their duration

Symbol	Activities	Duration (Day)	Producer	Daily cost ($)	Total cost ($)	Final cost ($)
A1	Determination of project area	1	Concerning unit	-	-	-
A2	Obtaining of the 1/25000 and 1/100000 maps	1	1 Surveying engineer	63	63	63
A3	Reconnaissance of triangulation point and	1	1 Surveying engineer	63	63	
	measuring of the coordinates from the maps		2 Technician	42	42	105
	on 1/25000 scaled maps					
B1	Finding of the triangulation points with	1	1 Surveying engineer	63	63	
	GPS in working area		2 Technician	42	84	177
			1 Vehicle	30	30	
B2	Construction and sketching of	2	1 Surveying engineer	63	126	
	triangulation point		2 Technician	42	168	354
			1 Vehicle	30	60	
B3	Painting of the control points	1	1 Surveying engineer	63	63	
			2 Technician	42	84	177
			1 Vehicle	30	30	
B4	GPS Surveying and Coordinate Calculations	3	2 Surveying engineer	63	378	
			2 Technician	42	252	
			3 GPS receivers	86	258	1068
			2 Vehicle	30	180	
C1	İnterview with the companies for obtaining of the IKONOS Satellite İmage of 5km*5km area	5	2 Surveying engineer	63	630	630
C2	Fixing day of the taking images of the satellite	3	2 Surveying engineer	63	378	378
C3	Taking image of the satellite and take delivery	3	2 Surveying engineer	63	378	
	of satellite image		Mono satellite image	-	944	1322
D1	Digitization (Production of DTM)	5	1 Surveying engineer	63	315	
			1 Technician	42	210	525
D2	Orientation procedures	1	1 Surveying engineer	63	63	63
D3	Orthorectification	1	2 Surveying engineer	63	126	126
E1	Determination of the projection systems produce maps and legend making	1	1 Surveying engineer	63	63	63
E2	Output materials	1	1 Surveying engineer	63	63	63

Total days = 30, Total = 5114 $, %25 Company profit and other expenses = 1278,50 $, Total cost = 6392,50 $

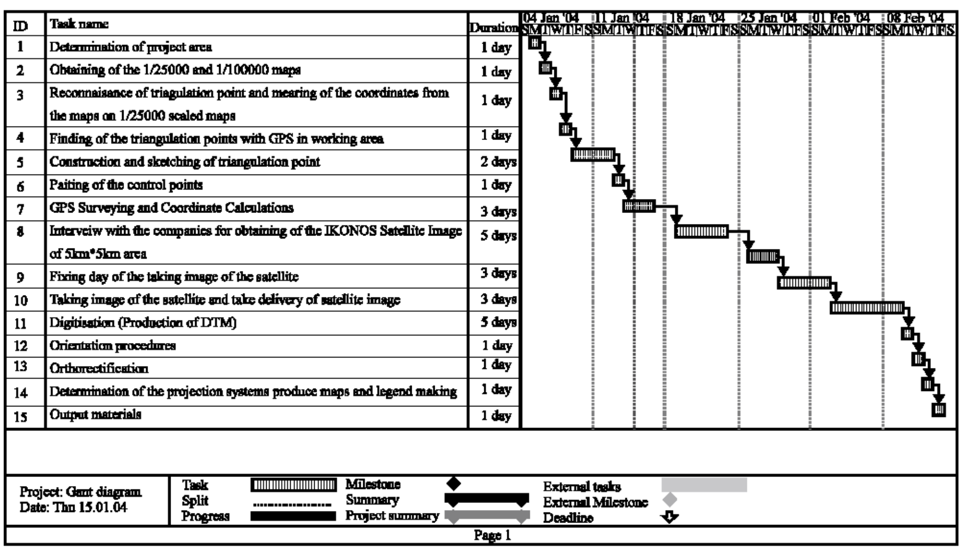

Fig. 1: Gannt diagram

Drawing of Gannt Diagram

Gannt diagram has been drawn with Microsoft Project 2002 is shown in Fig. 1.

Total Cost Calculations for Project and its Activities

Total cost of the activities were calculated with respect to the unit prices defined by the Turkish Chamber of Surveying Engineers for the first half of 2007 and given in Table 1.

The price of a GPS set with three receiver on work for 1 h:

The price of a GPS set of three receivers and their assessors (A)		:	39,000 $
Annual working time	: 960 h,		
Time of Amortization	: 5 years,		
Cost of Amortization	: 20/960×1/100*A = 0.00020833A	:	8,12487 $
Instalment and service tax	: 14.4(%)		
	: 14.4/960×1/100×A = 0.00015A	:	5,85 $
Service and maintenance	: 1/960×1/100×A = 0.0000104A	:	0,4056 $
Total		:	14,38047 $
The price of the same GPS set on work for1 day (6 h)		:	86,28282 $

According to the unit prices of the first half of 2007 for the maps and plans subject to registration and endorsement determined by the Chamber of Surveying Engineers.

According to the classical method, cost of 2500 ha mapping is 75,553 $. (1 ha = 30,22 $) and project time is 60 days.

CONCLUSION

By a project planning it is aimed that the project is finished with an optimum time and cost in the shortest time with an exist capacity. In this concept, it is only possible to complete a project that is undertaken by breaking the bottom price of the project in governmental entrusts and even thinking to have profit still, if it is known how to complete the project in minimum cost and time. So, Gannt Diagram method suits project planning desires well providing that it shows free times and allows planning steps in detail for cost analysis.

According to the GANNT Diagram, orthorectification cost of IKONOS Satellite Images is 6392,50 $ and calculated durations is 30 days. Same project cost is 75,553 $ and duration 60 days with geodetic surveys. Therefore, by the use of orthorectification 12 time cheaper than classical map production method and 50% in the time can be saved. It was recognized that the use of orthorectification is more economical in terms of cost and time rather than the use of classical process. When we considerate time, cost and accuracy criteria orthorectificated satellite images have important advances for most of GIS applications. That is, According to obtained data orthorectification is a good data capture methods for GIS users.

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