GENERATING ORTHOIMAGE FROM IKONOS DATA

B.Behdinian
Iranian Remote Sensing Center
Tel: (98)-21-2064471-3 Fax: (98)-21-2064473
Email:B.Behdinan@ iran-irsc.com

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ABSTRACT
Wide availability of high-resolution Satellite imagery.Raises the demand for orthoimage products. Due to distinct characteristics of the high-resolution Satellite imagery (such as, low Satellite altitude, large cross-track and along-track pointing angles (up to +45 and -45 degree) and high-resolution of the imagery (up to 1m) the desired accuracy of the orthoimage based on photogrammetry solution like DLT method is important.
In this paper the method of DLT for Geo Corrected Ikonos data inorder to Generate Orthoimage is programmed.
With at least 6 GCP and low resolution DEM file the Orthoimage from Ikonos data is generated.

INTRODUCTION
Ikonos , the commercial Satellite with the highest publicly available resolution, was Successfully launched in September 1999. The Satellite's Sensor Can generate one-meter Panchromatic and four-meter multiband images with off-nadir viewing up to 60 degree in any azimuth for better revisit rate and stereo Capabilities. The high resolution imagery that Ikonos Provides will theoretically have "Unlimited" uses in a number of markets (including state and local government), and in various applications such as mapping, agriculture,Forestry and emergency response.
Instead of using aerial photos, highly detailed maps of whole country can be frequently and easily updated using this data. Farmers can monitor the health of their Crops status and estimate yields with greater accuracy and over shorter intervals, scientists can observe environmentally Sensitive areas and predict trends with greater Certainty. Government officials can monitor and Plan more enlightened land-use policies. City planners can further the development of new housing Communities with higher precision and attention.
Ortho rectified imagery is the only imagery which is as accurate as a map at the same scale.It is free of distortion caused by camera and local terrain Because an ortho image is "map – like" it can be used for the accurate measurement of areas and distances.
Other map layers can be precisely overlaid on top of the orthoimage and even new information can be digitized, or traced, directly from the orthoimage.
Employing this geometrical rectification, the image can be correctly georefrenced for geocoding with DLT method. It needs at least 6 GCPS, then the image coordinates are modeled as functions of the map coordinates, for each pixel on the orthoimage. Which has the same coordinate system as the map, the gray value is determined by locating the corresponding image position on the raw image followed by resamplling .(nearest neighborhood method)

DLT (Direct linear Transformation)
Direct linear Transformation for the first time in 1971 used by Abdel-Aziz and karara. In this method the space coordinate system is optional. It is useful transforming image space to ground space. DLT Equation is as follows:

$$z = 0 \rightarrow (x, y) \rightarrow (X, Y, Z)$$

$$x = \frac{a_{11}X + a_{12}Y + a_{13}Z + a_{14}}{a_{31}X + a_{32}Y + a_{33}Z + 1}$$

$$y = \frac{a_{21}X + a_{22}Y + a_{23}Z + a_{24}}{a_{31}X + a_{32}Y + a_{33}Z + 1}$$

This equation with 11 parameters transform (*x*,*y*) from image space to ground space. By omitting Z the equation convert to these equations.

$$z = 0$$

$$x = \frac{a_{11}X + a_{12}Y + a_{13}}{a_{31}X + a_{32}Y + 1}$$

$$y = \frac{a_{21}X + a_{22}Y + a_{23}}{a_{31}X + a_{32}Y + 1}$$

Where (*x*,*y*) are image coordinate and (X,Y,Z) are ground coordinate that comes from GCPS.
By Solving this equation 11 unknown parameters will be found. First of all 4 coordinate of map should be found and then each pixel on the image which has the same coordinate system as the map, the gray value is determind by DLT transformation function and locating the corresponding. image position on the raw image followed by resampling beside each needs high value that can be extracted from DEM file.

DEM (Digital Elevation Model)

Digital Elevation Models (DEMs) consist of an array of regularly spaced elevations. However, they come in many different flavors, with varying degrees of data quality.
DEMs have become an invaluable information tool in the generating of orthoimage, the Telecommunications industry for RF engineering wireless and cellular planning, in the petroleum industry for seismic surveys and exploration, and for watershed analysis in the environmental field. For this case study, the DEM file extracted from spot stereo pairs (fig 1).

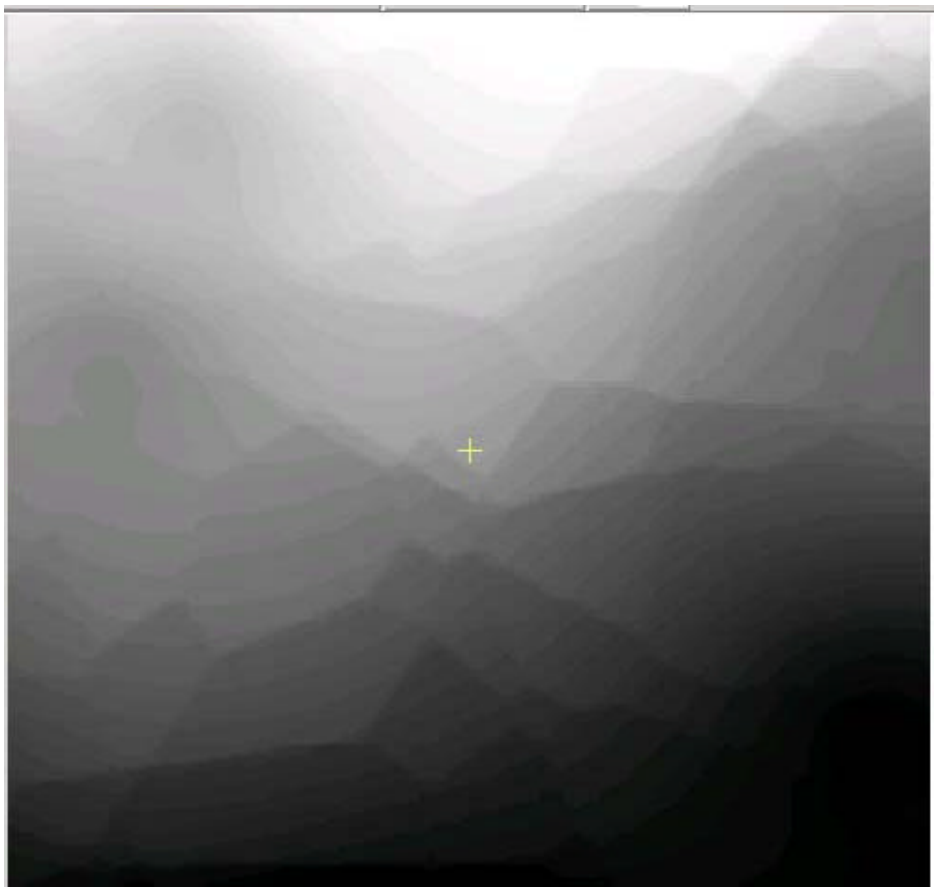

fig 1-DEM file extracted from spot stereopairs

The upper left coordinate of DEM file is E: 533902,811 , N: 3953680,726 and lower right is E: 537092,811 ,N: 3950670.726 in UTM projection. The pixel and line of the file is (319 301). The resolution of DEM file is 10 meter and for importing to the Ikonos Image (10 10) pixel have the same hieght. For extracting height from Dem file to use in program it has some processing to get the hieght value from Raw file. The DEM file that use here has Raw format and 16 bit grayvalue. For computing and importing the exact height in the program the follow simple equation should be down. As the file is 16 bit it means 2 bytes keep the height value and height could be calculated by this formula byte 2 * 256+byte 1= height

IKONOS data

Ikonos data is produced for five different product levels and is available at five different prices. Table 1 shows and example of the basic panchromatic product. Ikonos is distributed in eight-bit or 11- bit GeoTiff format with ASCII metadata file.

Product code	Accuracy
Geo	50 m
Reference	25m
Map	12m
Pro	10m
Precision	4m

Table 1

The Geo product, which is the most affordable but offers the lowest positioning accuracy, is not corrected for terrain distortions.

The precision product is the most expensive but offers the highest positioning accuracy (4m). To achieve it, the user will have to provide GCPs and a DEM to space Imaging for generating the orthoimage.

Because most of images are acquired at off-nadir viewing the accuracy of GCPs should be with in one meter accuracy and the DEM should be within five meter accuracy. Sub-pixel accuracy (which may be obtained with satellites such as spot and landsat) will not be achievable for Ikonos, even for flat terrain. Unlike other commercial satellite , Ikonos does not provide detailed orbital information.
In addition, supplying GCPs and a DEM to space Imaging in order to obtain precise ortho products could represent a delay in using the product. Finally, prices of precision ortho products are very high in comparison to the Geo product. However, it is possible for users to purchase the Geo product (about 5.5 times cheaper than the precision product) and to geo- correct the data themselves.
The Ikonos data used for this project has the following identification. Subimage from Tehran the capital city of Iran in (3137,2897) pixel and line.
For reading the image by C program, the file should be change the format to “tiff or jpg” (fig 2).


fig 2-uncorrect Ikonos from Tehran 1999

For geocoding about 35 GCPs collected from “1:2000” map,that some of this point use for check the data .(fig 3)

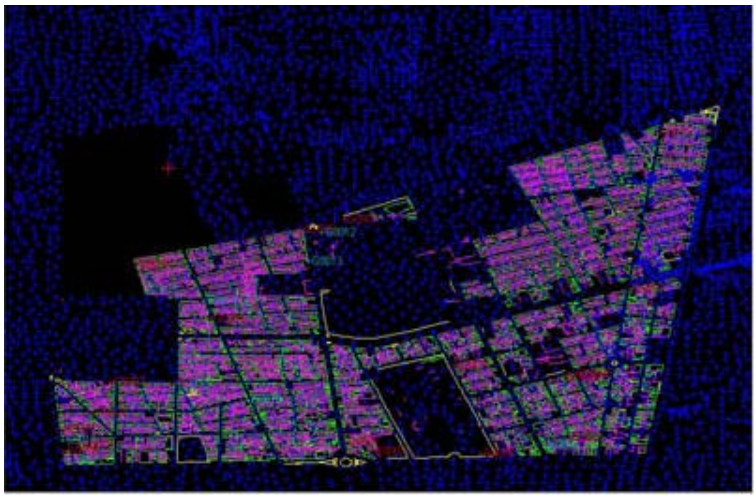
fig 3-(1:2000) map of Tehran

Program, Result and Analysis

This program is written in Borland C language, and get the tiff or jpg raw Ikonos data and DEM file from opening menu of file (fig 4).

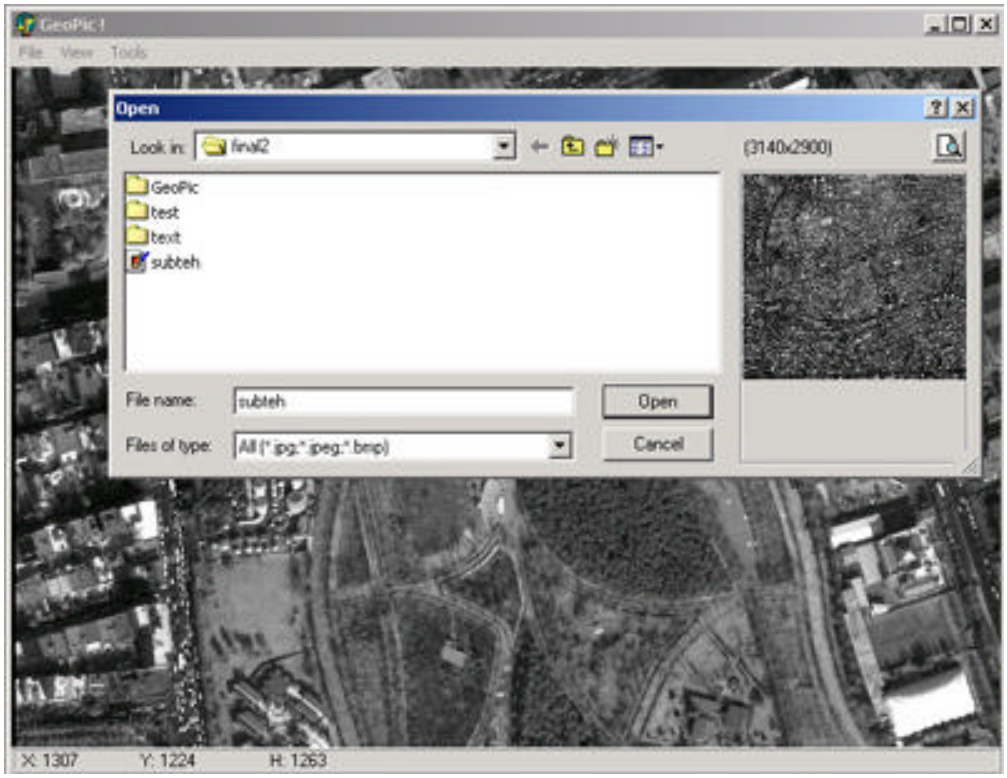

fig-4 open raw image and extract height from DEM file

By selecting tools menu and parameters. The table that it gets GCPs appear. You can collect the GCPs by manually or from a text file.(fig 5)

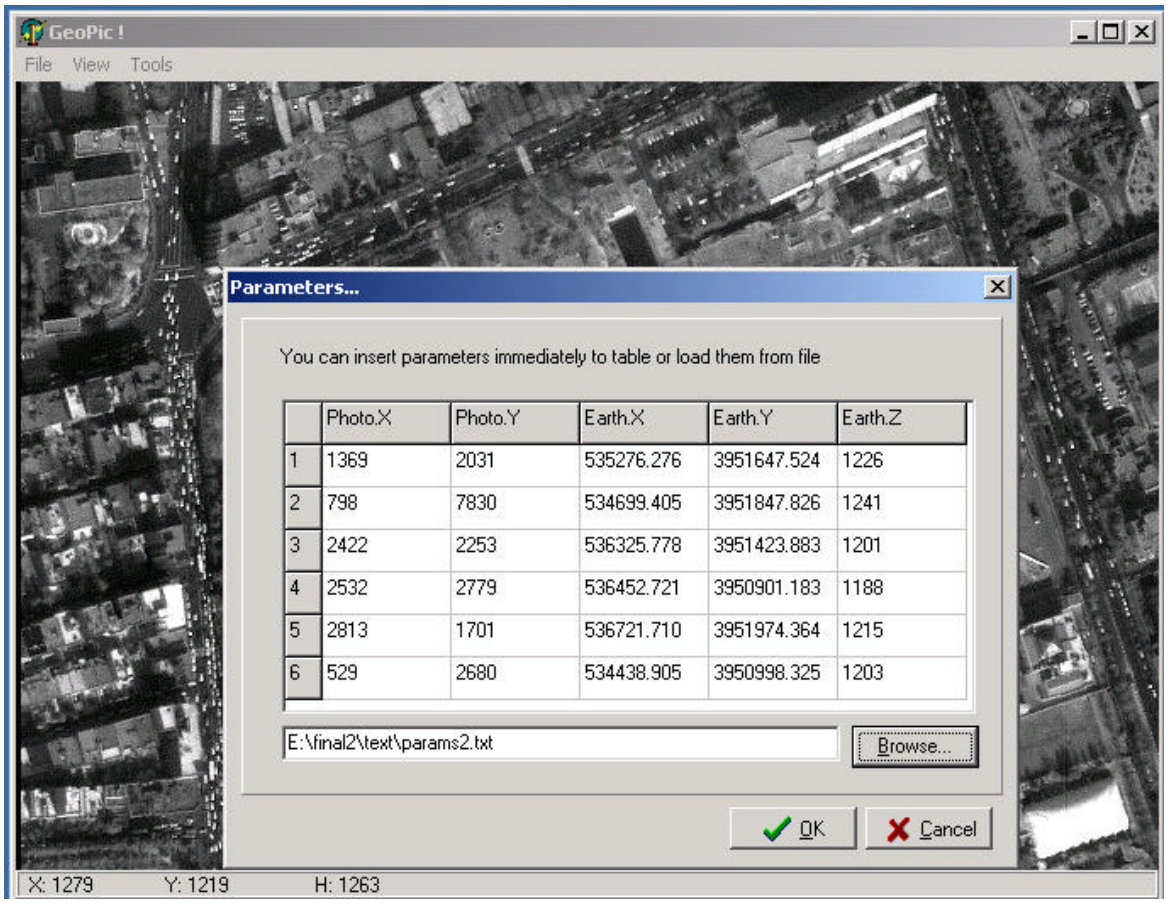

fig 5-view parameters table

The geometric correction is carried out in a two step process:

1- Transformation of pixel coordinates: Each pixel in the target (georeferanced) image is transformed according to the DLT method, in order to determine a sampling location in the input (uncorrected) image.

2- Resampling : Resampling is used to determind the pixel values to be filled in the georeferenced (output) image from the uncorrected (input) image.(fig 6)

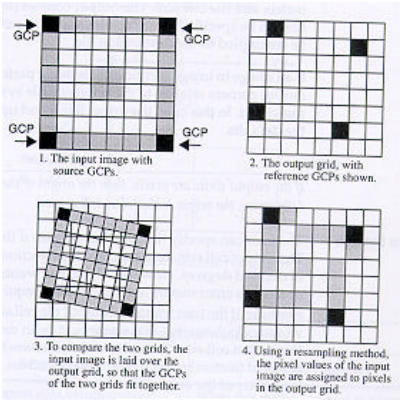

fig 6-Resampling the image by nearest neibourhood method

After processing the final image is generated (fig 7)

fig 7-Orthoimage that correct by DLT method with geopic software

The Rate of reduce error with increasing GCPs. The overal accuracy is about +4 pixel in X and =14 pixel in Y direction.To show the coincidence of the result with real world an overlay of 1:2000 map on the geocorrected image is given in the fig 8.

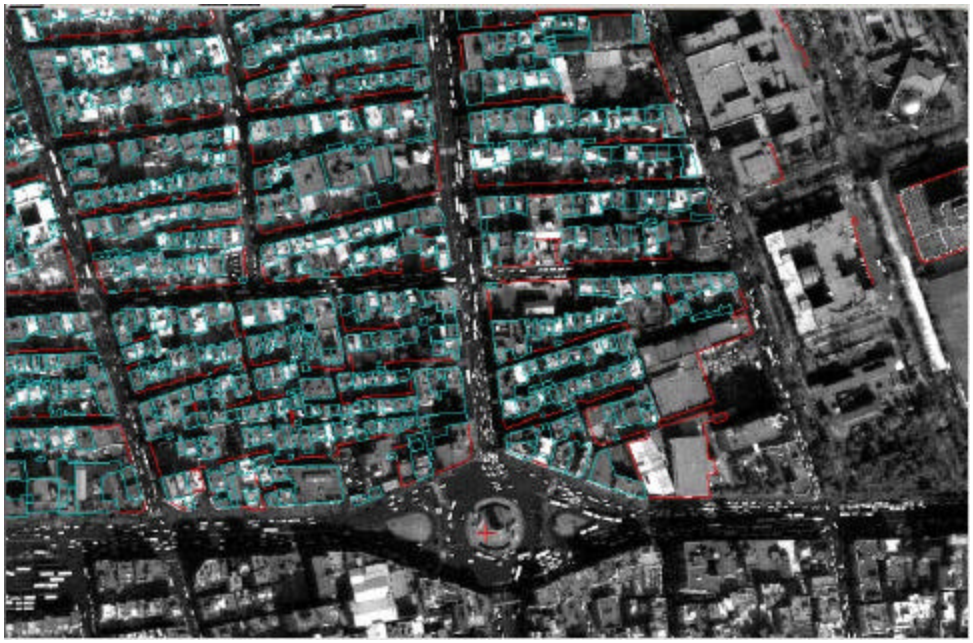

fig-8 Corrected image ,subimage covering with the map

Conclusion

We live in exciting times with 1-meter Satellite imagery becoming commercially available for global mapping.

By this program Ikonos user can correct the low- cost Geo products with at least 6 GCPs. When accurate ground data is available, users may produce consistent orthoimages which are as precise as the expensive precision products. Therefore, this program should promote the acquisition and the use of this new source of data for many applications.

Evaluation is still going on at IRSC using other Ikonos Images with low resolution DEM.

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