Generation of Ortho Photo and Contours by Using High Resolution Satellite Data

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Abstract— **The availability of stereo data from satellite significantly changed the way in which satellite images may be used. Presently, satellite images can be used for applications in which only aerial photographs were used previously. One of the most important applications of satellite stereo data is generation of Digital Terrain Model mission planned satellites like QB, GeoEye and Cartosat which provide the metric quality data.**

The study area is located in Dehradun. The input data used is cartosat-1 PAN (Stereo image) with resolution of 2.5 m is used in this work to generate a model, ie a 3D stereo view to generate Orthophoto and contours.

A suitable DEM must be obtained to provide a vertical datum for an Orthophoto. Some projects may allow inclusion of a DEM for the project area that was developed from other imagery. However, most large-scale ortho-photo projects require a DEM to be developed from the new imagery. This will insure and improve the accuracy of the image rectification.

The final phase of the Orthophoto process is the merger of the digital image and the DEM along with corrections in pixel intensity throughout the image. Software, used to merge the digital raster image with the DEM, makes adjustments in the horizontal location of pixels based upon their proximity to DEM points. This process removes the errors due to displacement and produces an image that is orthogonally accurate.

Contours are generated with an interval of 10 m and it is exported in the shape file so that the slope can be easily identified for future assessment. Conventional aerial triangulation is reviewed. This review encompasses various mathematical models, self-calibration technique, additional parameters, and the associated mathematical models. Mission planned satellites like IKONOS, QB and Cartosat provide the metric quality data. In this research work, it is proposed to use high resolution satellite stereo data i.e. GeoEye-1 for creating the block setup and AT.

Index Terms—**Aerial Triangulation, DEM, Orthophoto, QB, GeoEye and Cartosat, Contour**

I. INTRODUCTION

An orthophoto or orthoimage is a photograph showing images of objects in their true orthographic positions.

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Orthophotos are therefore geometrically equivalent to conventional line and symbol planimetric maps, which also show true orthographic positions of objects. The major difference between an orthoimage and a map is that an orthoimage is composed of images of features, whereas maps utilize lines and symbols plotted to scale to depict features. Because they are planimetrically correct, orthoimage can be used as maps for making corrections for making direct measurements of distances, angles, positions, and areas without making corrections for image displacements.

A. Orthorectification **:** The ortho rectification process takes the raw digital imagery and applies a DEM and triangulation results to create an image or photograph with an orthographic projection is one for which every point looks as if an observer were looking straight down at it, along a line of sight that is orthogonal (perpendicular) to the Earth. Relief displacement is corrected by taking each pixel of a DEM and finding the equivalent position in the satellite or aerial image. A brightness value is determined for this location based on resampling of the surrounding pixels. The brightness value, elevation, and exterior orientation information are used to calculate the equivalent location in the orthoimage file, Yang, X [13]. In practice, the constant scale of an Orthoimages means that the distance measured between any two points in the image can be converted to its corresponding distance on the ground by multiplying by a single scale factor. As a result, an orthorectified image can be used in a Geographic Information System (GIS) as a base map layer over which vector layers, such as road networks, can be laid. Another related advantage of the orthoimage is that many Orthoimages can be mosaic together to form a seamless image map covering large areas.

II. OBJECTIVE AND STUDY AREA

A. *Objective*

The main objective of the project is to generate
i) Create 3D-Stereovision by AT
ii) Orthophoto
iii) Contour generation

B. *Study Area*

The Study area is Dehra Dun which is the capital city of the state of Uttarakhand in the northern part of India. Located in the Kadhauli region, it lies 236 kilometers (147 mi) north of India's capital New Delhi and is one of the "Counter Magnets" of the National Capital Region (NCR) being developed as an alternative Centre of growth to help ease the migration and population explosion in the Delhi metropolitan area and creation highways to establish a smart city at Dehradun.

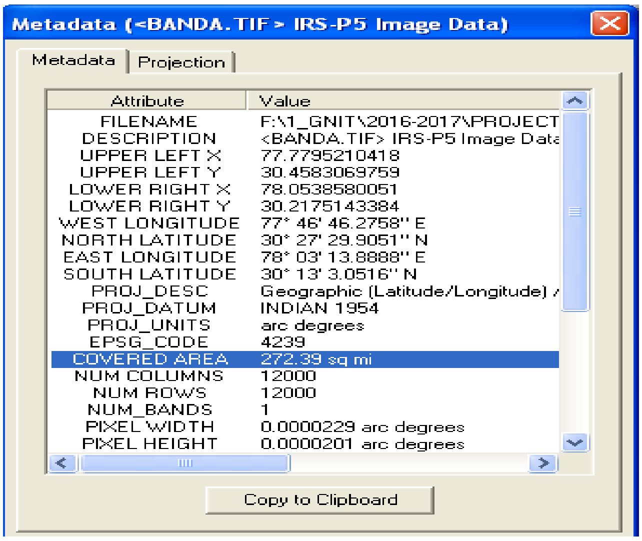

Fig-1 Meta Data

- AOI:-The extent of study area lies between longitude 77°46' to 78° 03‘ E and latitude 30°27' to 30°13‘ N.
- Area_ (AOI):- 272.39 Sq. mi

III. Methodology

Generation of DEM Contours and Ortho image from high resolution data. Once the proper selection is made the stereo pair has to be oriented/ triangulated using sensor parameters and ground control points to generate exterior orientations. In this project work Digital photogrammetric techniques has proposed to use for generation of DEM. Then the Orthoimage and Contours is generated from the DEM. A flowchart of methodology for Generation of DEM and Orthoimage is shown in the following Figure 2

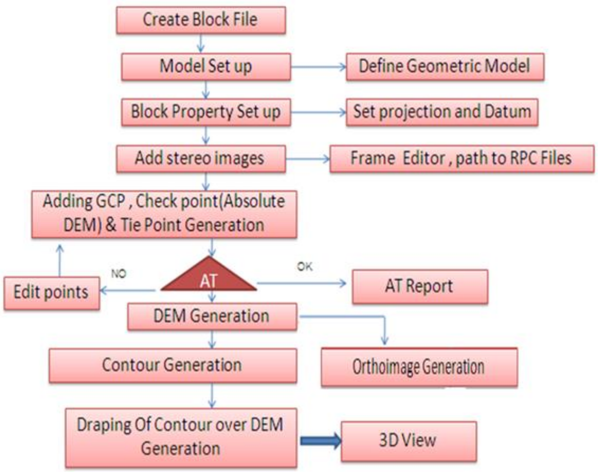

Fig-2 Flow chart

A. *Process Set up*

Block files have the .blk extension. A block file may be made up of only one image, a strip of images that are adjacent to one another, or several strips of imagery. The .blk file is a binary file. In it all the information associated with the block including imagery locations, camera information, fiducial mark measurements, GCP measurements etc are stored.

For creating a new project we click on the LPS icon pan. The LPS project manager viewer is opened. In the viewer we can access tools using toolbar. There is a Block Project tree view; we can make selections here to view them in the Project Graphic Status. We can also view Project Graphic Status Window-a display whose contents are controlled with the tools in the right side of the viewer. Now click on new file icon to create a new block file

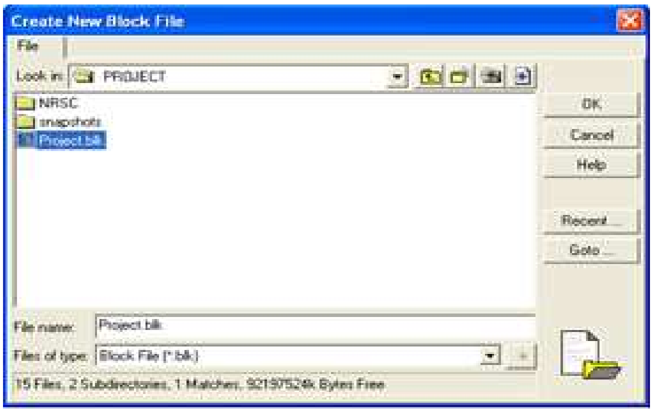

Fig-3 Block File Creation

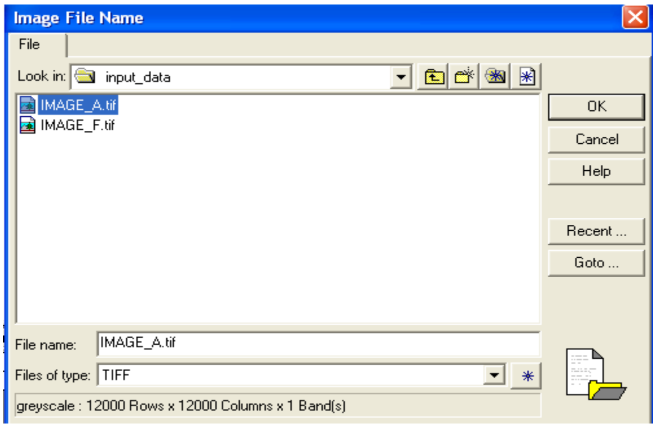

Fig-4 Adding Images

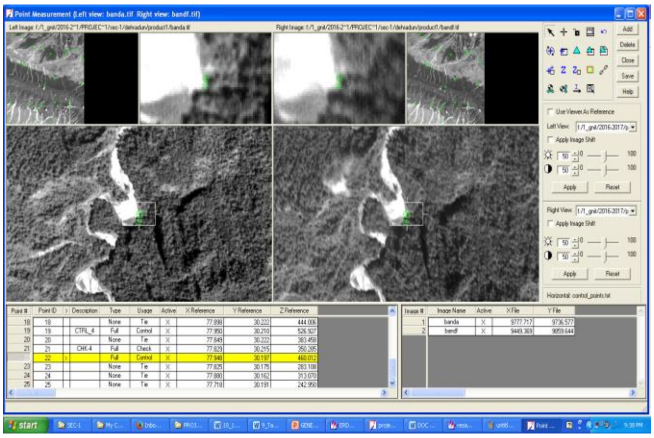

Fig-5 Point Measurement Tool

IV. Result Analysis

The results for each iteration of processing are calculated once the triangulation has been performed. This value is computed based on the image coordinate residuals for that particular iteration of processing. The computed standard error for each iteration accumulates the effect of each image coordinate residual to provide a global indicator of quality. The lower the standard error, the better the solution.

Adjustment Report With OrthoBASE

Output image units: pixels

Output ground units: degrees
Output z units: meters
Calculated ground x, y and z coordinates: degrees meters

type	pid	ground_x	ground_y	ground_z
gcp	4	77.88546671	30.38800824	508.13987063
gcp	7	77.91892648	30.36774432	509.35583407
gcp	8	77.97530786	30.35775421	503.43606469
gcp	19	77.94992623	30.20957089	526.81803473
gcp	22	77.94757521	30.19691295	459.89433347
chk	11	77.81283205	30.35213866	428.82790007
chk	15	77.87425980	30.27582123	568.38702963
chk	17	77.80785173	30.23648930	378.62011754
chk	21	77.82850637	30.21505542	349.86493470 tie
1	77.80580227	30.44817055	401.12001695	
tie	2	77.83793923	30.43454119	458.30883414
tie	3	77.86146186	30.40269807	477.75488556
tie	5	77.98347354	30.36671243	558.68505751
tie	6	78.00858004	30.36255564	595.70196734
tie	9	78.03007157	30.32601900	545.46180997
tie	10	77.80369490	30.35815085	424.02738149
tie	12	77.83653113	30.33061834	467.89986379
tie	13	77.91449055	30.29131684	479.64243782
tie	14	78.00398360	30.26056913	532.09974498
tie	16	77.73912257	30.25056059	342.54087766
tie	18	77.89823030	30.22218077	444.00080316
tie	20	77.84869302	30.22246615	383.39938755
tie	23	77.82460188	30.17455021	282.97866756
tie	24	77.88007407	30.16231895	313.01562208
tie	25	77.71752577	30.19087199	242.53185932

Control and check point residuals:degrees meters

type	pid	residual_x	residual_y	residual_z
gcp	4	-0.00000006	-0.00000005	-0.30499433
gcp	7	-0.00000006	-0.00000002	-0.21138719
gcp	8	-0.00000005	-0.00000011	-0.15199583
gcp	19	-0.00000006	0.00000051	-0.10855991
gcp	22	-0.00000008	0.00000053	-0.11733010
chk	11	0.00000003	0.00000022	-0.45435960
chk	15	-0.00000002	0.00000031	-0.20229400
chk	17	-0.00000011	0.00000028	-0.50888683
chk	21	-0.00000015	0.00000029	-0.42034030

Image point residuals:

imgid	pid	residual_x	residual_y
1	4	-0.0280	-0.0133
1	7	0.0186	-0.0060
1	8	-0.1004	-0.0128
1	19	-0.0524	-0.0249
1	22	0.0642	0.0123
1	11	0.0340	-0.0019
1	15	-0.0320	0.0057
1	17	-0.0211	-0.0054
1	21	-0.1489	-0.0096
1	1	-0.0004	0.0032
1	2	-0.0154	0.0021
1	3	-0.0031	0.0023
1	5	0.0512	0.0062
1	6	0.1076	0.0221
1	9	-0.0776	-0.0030
1	10	0.0548	0.0061
1	12	0.0101	0.0032
1	13	-0.0640	-0.0009
1	14	0.0376	0.0045
1	16	-0.0332	0.0019
1	18	0.0375	0.0046
1	20	0.0209	0.0045
1	23	0.0307	0.0060
1	24	-0.0605	0.0026
1	25	0.0028	0.0061

Ax=-0.0067 Ay=0.0006 Mx=0.0564 My=0.0091

2	4	0.0254	0.0496
2	7	-0.0145	0.0275
2	8	0.0907	0.0187
2	19	0.0488	0.0334
2	22	-0.0483	0.0255
2	11	-0.0353	0.0852
2	15	0.0351	0.0464
2	17	0.0254	0.1006
2	21	0.1433	0.0871
2	1	0.0007	-0.0224
2	2	0.0143	-0.0182
2	3	0.0026	-0.0175
2	5	-0.0467	-0.0170
2	6	-0.0935	-0.0191
2	9	0.0684	-0.0093
2	10	-0.0487	-0.0247
2	12	-0.0089	-0.0190
2	13	0.0566	-0.0131
2	14	-0.0345	-0.0171
2	16	0.0298	-0.0234
2	18	-0.0345	-0.0227
2	20	-0.0196	-0.0253
2	23	-0.0316	-0.0252
2	24	0.0435	-0.0167
2	25	0.0008	-0.0318

Ax=0.0068 Ay=0.0061 Mx=0.0512 My=0.0397

Total unit weight RMSE = 0.0864

Image accuracy for control and check points for each scene:

image id 1:

pid	type	image_x	image_y	residual_x	residual_y
4	gcp	5159.1724	2104.4785	-0.0280	-0.0133
7	gcp	6769.5415	2695.9768	0.0186	-0.0060
8	gcp	9228.1533	2663.8481	-0.1004	-0.0128
19	gcp	9741.9434	9176.3350	-0.0524	-0.0249
22	gcp	9777.7168	9736.5771	0.0642	0.0123
11	chk	2508.4194	4222.1221	0.0340	-0.0019
15	chk	5878.2148	6969.1387	-0.0320	0.0057
17	chk	3521.0359	9188.4111	-0.0211	-0.0054
21	chk	4610.4287	9934.7842	-0.1489	-0.0096

RMS Errors for 5 GCPs:
x: 0.0601
y: 0.0152
Total: 0.0620

RMS Errors for 4 CHKs:
x: 0.0787
y: 0.0063
Total: 0.0790

image id 2:

pid	type	image_x	image_y	residual_x	residual_y
4	gcp	5337.9189	2190.0251	0.0254	0.0496
7	gcp	6771.3242	2797.9797	-0.0145	0.0275
8	gcp	8959.3545	2787.2021	0.0907	0.0187
19	gcp	9417.3057	9315.5537	0.0488	0.0334

22	gcp	9449.3691	9859.6436	-0.0483	0.0255
11	chk	2978.8950	4262.4331	-0.0353	0.0852
15	chk	5978.2598	7081.0698	0.0351	0.0464
17	chk	3880.3840	9230.5889	0.0254	0.1006
21	chk	4849.8120	9981.2480	0.1433	0.0871

RMS Errors for 5 GCPs:
x: 0.0525
y: 0.0327
Total: 0.0619

RMS Errors for 4 CHKs:
x: 0.0769
y: 0.0824
Total: 0.1127

Summary RMSE for GCPs and CHKs (number of observations in parenthesis):

	Control	Check
Ground X:	0.0000001 (5)	0.0000001 (4)
Ground Y:	0.0000003 (5)	0.0000003 (4)
Ground Z:	0.1930598 (5)	0.4132243 (4)
Image X:	0.0564577 (10)	0.0778304 (8)
Image Y:	0.0254621 (10)	0.0584017 (8)

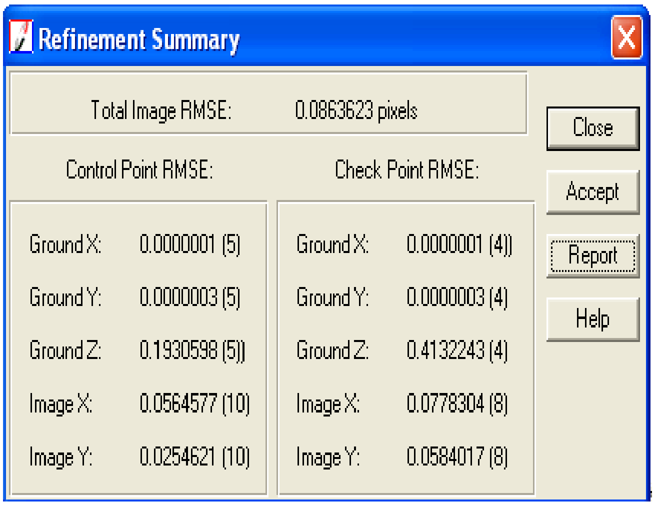

Fig-6 AT Summary Report

A. 3D View Stereo Vision

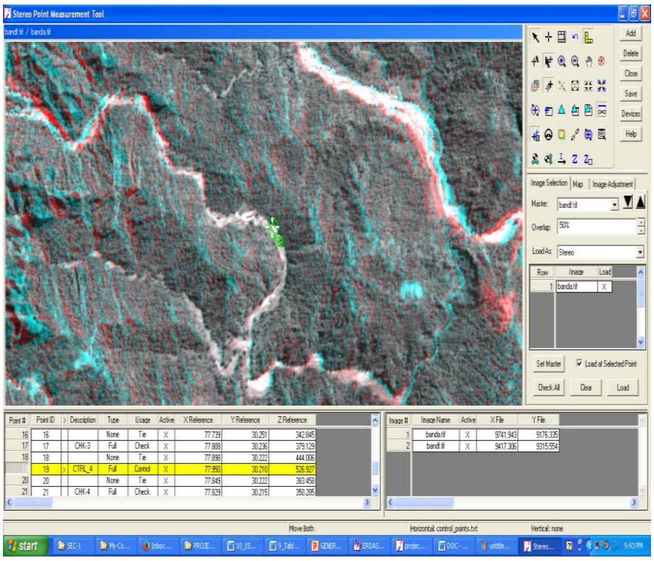

Fig-7 Created 3D-Stereovision by AT

B. Ortho Resampling

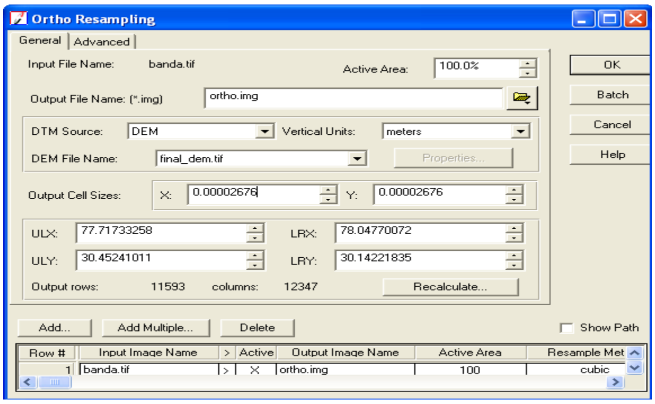

Fig-8 Ortho Resampling Setup

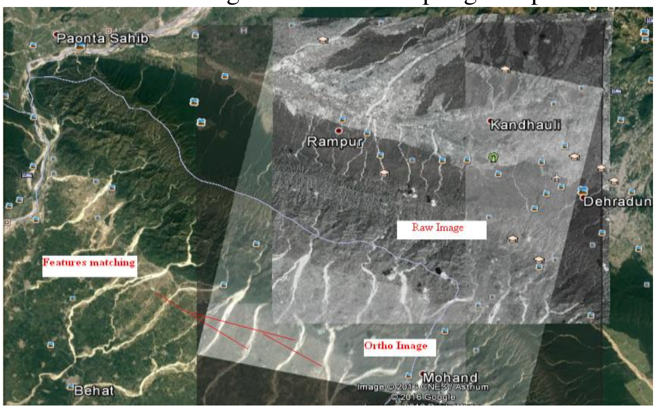

Fig-9 Cross check wrt Google earth for Features matching

C. Contour Generation

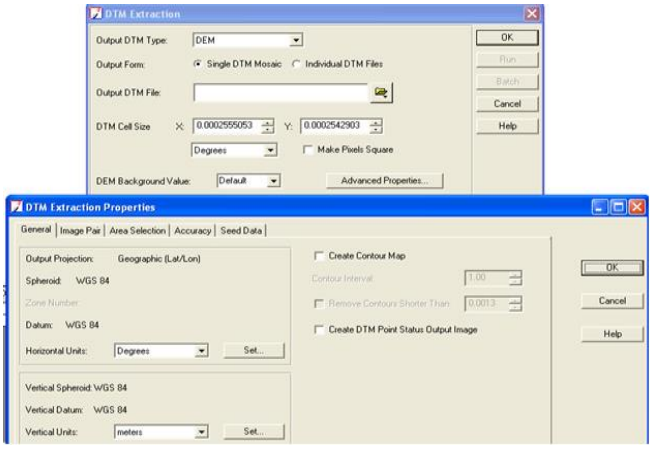

Fig-10 Contour Generation Setup

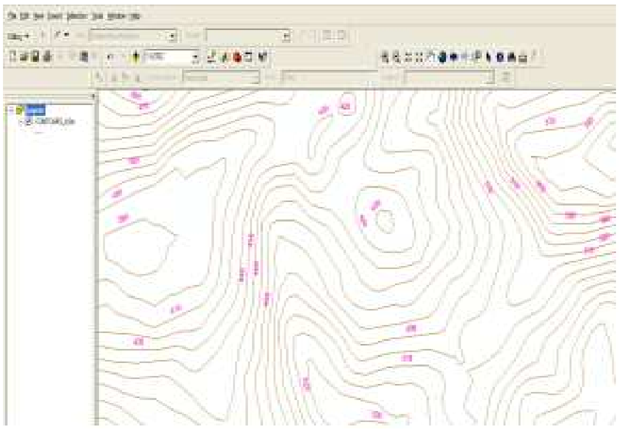

Fig-11 Contour Output

V. CONCLUSION

In this project work the suitability and the capability of Cartosat-1 data has been studied for the generation of Aerial Triangulation & Digital Elevation Model (DEM)

- Orthophoto: - Aerial photographs are not planimetric map, because they have geometric errors, those errors comes from tilt and relief displacement and when we correct the photos from those problems the result is orthophoto which is useful for 2D digitization.
- commonly used in Geographic Information Systems (GIS) as a "map accurate" background image
- The latest technique generating a contours is fast and less cost when comparing with manual surveying.

REFERENCES

[1] Wolf, P.R. and Dewitt, B.A., 2000. Elements of Photogrammetry with Applications in GIS. 3rd Ed. McGraw-Hill.
[2] Fritsch, D., 1995. "Introduction into digital aerial triangulation". Photogrammetric week '95, Wichmann Verlag, pp. 165-171.
[3] Grodecki, J., Dial, G., 2003. "Block adjustment of high-resolution satellite images described by rational polynomials". Photogrammetric Engineering and remote sensing 69, pp.59-68.
[4] Jensen, J. R.1996. Introductory digital image processing: A remote sensing perspective. 2nd ed. Upper Saddle River, N.J.: Simon and Schuster.
[5] Krzystek P., Heuchel T., Hirt U., Petran, 1996. "An integral approach to automatic aerial triangulation and automatic DEM generaton", International archives of photogrammtery and remote sensing. Vol 31, part B3. Vienna 1996, 405-414.
[6] Morgan, M., K. Kim, S. Jeong, and A. Habib, 2004. Indirect Epipolar Resampling of Scenes Using Parallel Projection Modeling of Linear Array Scanners, XXth Congress of ISPRS, 12-23 July, 2004.
[7] Pablo d'Angelo, Manfred Lehner, Thomas Krauss, Daniella Hoja and Peter Reinartz, 2005. "Towards automated DEM generation from high resolution stereo satellite images", From web
[8] Toni Schenk, 1996. "Digital aerial triangulation", International archives of photogrammetry and remote sensing. Vol 31, part B3. Vienna 1996, 735-742.
[9] Tsingas, V. "Operational use and empirical results of automatic aerial triangulation." Paper presented at the 45th Photogrammetric Week, WichmannVerlag, Karlsruhe, September 1995, 207-214.
[10] Yang, X., and D. Williams. "The Effect of DEM Data Uncertainty on the Quality of Orthoimage Generation." Paper presented at Geographic Information Systems/Land Information Systems (GIS/LIAS) '97, Cincinnati, Ohio, October 1997, 365-371

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