MAP UPDATION AND TERRAIN MODELLING

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KEY WORDS : Map, Updation, Terrain, Modelling, Sterteo, Imageries

ABSTRACT :

The advent of satellite stereo-imageries have revolutionised the photogrammetric techniques. The development in hardware and software techonology has enabled the production of sophisticated digital photogrammetric systems which facilitate setting up of spot stereo-imagery.

Stereo-imageries, unlike photographs, are acquired by satellite born sensors in a dynamic and time dependent mode. The advanced version of digital photogrammetic workstations support setting up of the SPOT-stereo models and make it possible to establish the co-relation between the 3-dimentional model, created by the stereo-imagery, and the ground truth within fair accuracy limits. The existing digital files, of the area of interest and the additional data, the cultural details natural features and topography can be extracted by stereo-digitization through analytical operations. The data thus generated can be merged with the existng data to get an updated version of cartographic product. This makes the satellite stereo data an important source of GIS information. The authors have carried out elaborate studies by selecting a few test areas and attempted solution of a few SPOT stereo models for updating the existing cartographic products. The outputs have been varified broadly with respect to the ground truth and analysed statistically. The statistical analysis has revealed encouraging results. This paper briefly describes the equipment used, the technique adopted and the conclusion drawn after the analysis.

1. INTRODUCTION

The advent of computers has revolutionised the map making techniques and enabled transition from conventional mapping to digital mapping. This transition was highly warranted to meet the demands of map users, which have been changing at an appreciable pace, mainly because of the application of maps in planning, execution and monitoring of developmental projects / activities. The users' requirements have been becoming more and more demanding due to the availability of digital cartographic data bases. The cartographic data bases need to be updated by a process which should be speedy and at the same time cost-effective. It is here that sereo imageries may offer a promissing solution for updation of the existing maps / cartographic data bases, if used carefully. With this aim in mind a project was taken up in Digital Mapping Centre, Survey Of India, Dehradun to workout the feasibility of updating 1:50,000 scale maps by using setreo-imageries in combination with aerial photography.

2. AIM

The aim of the project was :

a) To idetify the limit upto which stereo-imageries could be used for change detection and subsequent updation of the existing maps on 1: 50,000 scale.

b) To find out if reference to aerial photography (and not setting up on photogrammetric workstation) will facilitate further interpretation of additional features / details.

c) To collect DEM data and generate contours at a suitable contour interval for evaluation of DEM

d) To analyse the results.

3. HARDWARE / SOFTWARE CONFIGURATION USED

a) Inter Map Analytic Photogrammetric workstation

b) IMA SPOT software

c) Digital Terrain Modelling software

d) IGDS software

4. DATA USED

Data Set A

i) Stereo-imageries	Left	Right
No.	11733 - 055028	11365 - 052654
View angle	+ 19.96	- 18.44
Date of pass	20.11.1990	17.11.1990

ii) Scale of aerial photography 1: 25,000

Data Set B

i) Stereo-imageries	Left	Right
No.	11114 - 055630	11115 - 053711
View angle	+ 15.16	- 18.16
Date of pass	11.03.1989	12.03.1989

5. METHOD

5.1 Data capture for updation :

Control points were selected at the planning stage and it was ensured that the control points used for setting up the stereo spot - imageries were selected in such a way that their identification was beyond doubt on maps and stereo-imageries. In case of Data set A , the points were also identified on aerial photographs. The coordinates of control points were readout from 1:50,000 scale maps. A number of well spread out check points were selected for the subsequent analysis.

The SPOT stereo-imageries were setup on Inter Map Analytic Photogrammetric Workstation and were processed for the full solution. A few control points configuration were tried till the solution converged and was accepted for each data set. The models were then evaluated by making a through comparision between the map and the 3-D model of the stereo-imagery.

Deliberate comparision was made between the existing maps and the stereo-imageries and the details, not appearing in the map, but which appeared in the stereo model, were stereo digitized as per the pre-determined data structure.

5.2 Terrain Modelling :

The stereo SPOT model was used for collecting DEM data. The sampling pattern was chosen keeping in view the type of terrain. Basically there are two methods in which DEM data is collected : uniformly spaced points and non-uniformly spaced points with X, Y, Z triplets. Generally non-uniformaly spaced points have more adaptive ability of the terrain. Keeping all the factors in view such as type of terrain, purpose of DEM, equipement available, processing and storage facilities ; the DEM data was collected by

progressive sampling with the grid interval of 250 metres.

In the progressive sampling method the measuring mark is driven within a defined boundary from one sampling point to another sampling point and an initial sampling patch of nine points is created. If one of the second differeces in height is equal to or greater than the threshold value, second differences are calculated and similarly the values collected in the second run determine the need for the third run. After a maximum of three runs a sampling data of adequate density which may match the undulations of the terrain is generated. Keeping the hilly characterstics of the data set in view the data set was further upgraded by incorporating the significant relief features like ridges, drains and break lines.

The DEM data set was then processed by DTM software wherein the data was converted to POINT file. It was subsequently changed to a TIN file, which contains the data of the vertices of slope triangles as X, Y, Z triplets. Finally from the TIN file profiles were extracted by converting to a POINT file (GRID file). The GRID file data was finally converted to graphics.

The DTM surface (mesh of horizontal and vertical profiles) was then evaluated as given in the subsequent pragraphs.

6. EVALUATION AND ANALYSIS

6.1 In case of data set A, the large scale photography was used to exploit the change in the contrast in the imagery for interpretation of the details from the stereo model setup in the photogrammetric workstation. The data captured in respect of this data set was evaluated by comparing with ground truth. The plot of this data is enclosed as Annexure I About 90% of the details agreed on evaluation. Details are brought out in para (7) under findings.

In case of data set B, the output as indicated in Annexure II was not subject to ground truth.

6.2 The DEM generated was evaluated by comparing the DEM with the heights of some prominent points as inpretted from the existing map. The analysis is given in Annexure - II.

7. FINDINGS

7.1 The data in respect of the following features could br stereo-digitized with convenience by using stereo-SPOT imageries in isolation :

i) Roads

ii) Forests limits

iii) River courses

iv) Cultivation

v) Village limits (Blocks)

7.2 Reference to the photography helped in interpretation of the following details to a great extent :

i) Cluster of isolated huts

ii) Type of roads

iii) Orchards

iv) Depiction of roads in built up area

7.3 RMSE value in height is about 11 meters. Keeping in view the sensitivity of the floating mark in stereo-imagery environment, it is recommended that the DEM be used to generate contours at 50 meters vertical interval.

8. CONCLUSION

In the present environment of " data explosion ", possesion of latest spatial information by the scientists, planners and the administrators has become highly relevant for their day-to-day research, execution and monitoring of developmental projects / activities. It is in this context that updation of the existing maps has become necessary and meaningful. It is seen that stereo-imageries, in combination with aerial photography, may provide a way out for speedy updation which at the same time is cost-effective. Data capture in respect of roads, village limits, change in river courses etc. can be done with ease from satellite stereo-imageries and reference to aerial photography may facilitate interpretation of more details which otherwise cannot be interpreted if stereo-imageries are used in isolation. DEM generated from stereo-imageries may be an asset for micro-level planning.

Please regard the colour pages at the end of the volume

Annexure - III
(Data set A)

	LEFT	RIGHT
IMAGERY NO.	11733	11365
VIEW ANGLE	+ 19.96	- 18.44
DATE OF PASS	20 NOV 90	17 NOV 89

Sl No.	RESIDUALS X	Y	XY	Z	REMARK
1	0	0	0	+15	
2	0	0	0	+ 2	
3	0	0	0	0	
4	+10	0	10	+ 5	
5	0	0	0	+21	
6	0	0	0	+11	
7	0	0	0	+ 8	
8	+ 3	+12	12.4	- 3	
9	-15	+ 5	15.8	0	
10	-15	+10	18	+ 6	
11	+ 5	-15	15.8	- 3	
12	0	0	0	+ 4	
13	+15	-20	25	+16	
14	0	- 5	5	0	
15	+35	+15	38.1	+18	
16	+20	-15	25	0	
17	-10	-15	18	+21	
18	-20	-10	22.4	+10	

RMSE in Position (XY) : 16.04 m
RMSE in Elevation (Z) : 10.73 m

Annexure IV
(Data set B)

	LEFT	RIGHT
IMAGERY NO.	11114	11115
VIEW ANGLE	+ 15.16	- 18.16
DATE OF PASS	11 MAR 89	12 MAR 89

Sl No.	RESIDUALS X	Y	XY	Z	REMARK
1	- 4	+ 9	9.8	6	
2	- 5	-10	11.2	-13	
3	0	0	0	- 3	
4	+16	+10	18.9	-20	
5	- 4	0	4	-16	
6	- 2	+18	18.1	-17	
7	+20	+17	26.2	+ 2	
8	-24	-10	26	-20	
9	+ 2	-15	15.1	- 5	
10	+16	+ 2	16.1	- 6	
11	+10	+15	18	+ 5	
12	+10	-10	14.1	0	
13	- 1	+12	12	0	
14	-15	+10	18	+10	
15	-20	+25	32	-28	
16	+10	+ 5	11.2	+ 4	
17	-11	-16	19.4	+ 4	
18	+12	- 3	12.4	+10	
19	+14	-14	19.8	+10	
20	0	+10	10	+ 8	

RMSE in Position (XY) : 17.2 m
RMSE in Elevation (Z) : 11.9 m