DIGITAL ELEVATION MODEL COMPUTATION WITH SPOT 5 PANCHROMATIC AND MULTISPECTRAL IMAGES USING LOW STEREOSCOPIC ANGLE AND GEOMETRIC MODEL REFINEMENT

MAY Stéphane, LATRY Christophe

CNES DCT/SI
18, Av. Edouard Belin,
31401 Toulouse Cedex 9, France

1. INTRODUCTION

This paper presents the algorithm used to compute Digital Elevation Model (DEM) with a couple of Spot 5 images. The little shift between Panchromatic (P) and multispectral (XS) detectors creates a stereoscopic parallax in the column direction. This low stereoscopic angle (B/H ratio) effect is exploited in order to extract DEM directly from the images with correlation algorithms. Low B/H ratio ensures higher correspondences between images (little move of clouds, shadows, background of valleys seen on both images), but this method is also highly sensitive to correlation errors and geometric modelling errors. Direct computation of disparity map with a couple of images integrates both effects of the elevation model impact and geometric errors: satellite position, satellite attitude (roll, pitch and yaw). Effects are difficult to separate. The originality of the method consists in firstly refining the geometric model after computation of homologous points, and secondly computing the dense disparity map. Using the Shuttle Radar Topography Mission (SRTM), the absolute position of the computed DEM is modified. Geometric model is updated. This paper presents the different steps of this method, the obtained results and the foreseen evolutions for this algorithm.

2. PRESENTATION OF THE METHOD

First step consists in preparing input data. The panchromatic image is dezoomed to the XS resolution (10 m). A linear combination of B1 (green) and B2 (red) radiances is performed to synthesise a pan-like image since correlation requires high radiometric resemblance between the 2 images.

Secondly a sparse correlation is done in order to select homologous points well distributed over the grid. They are used for the spatio-triangulation: roll, pitch and yaw linear drift slopes are evaluated to refine the geometric model. The shift is due to attitude evolution between P and XS acquisition time (2.25 s). A sampling grid between XS and P is computed.

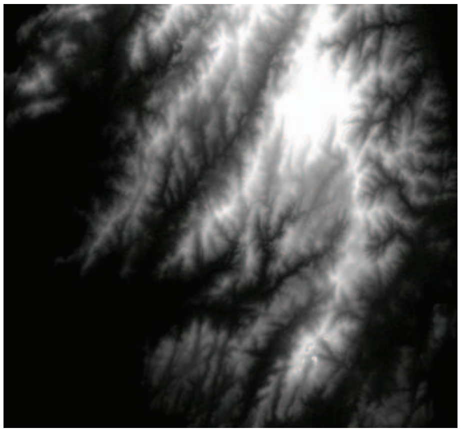
The dense correlation is then performed. A low-pass filter is applied on both images before correlation in order to reduce aliasing and so improves the correlation accuracy. The use of refined model and sampling grid reduces the search window, and fasten computation time. Missing values or low correlation points in the disparity map are filtered. The preliminary Digital Elevation Model is available.

The last original step of this algorithm consists in using the SRTM to perform an absolute geometric refinement. The SRTM is resampled in the Pan geometry (and so DEM geometry). The correlation map between DEM and SRTM is computed. Selection of homologous points is used for the last spatio-triangulation: attitude errors are reduced. The SPOT 5 location accuracy is as accurate as the SRTM one.

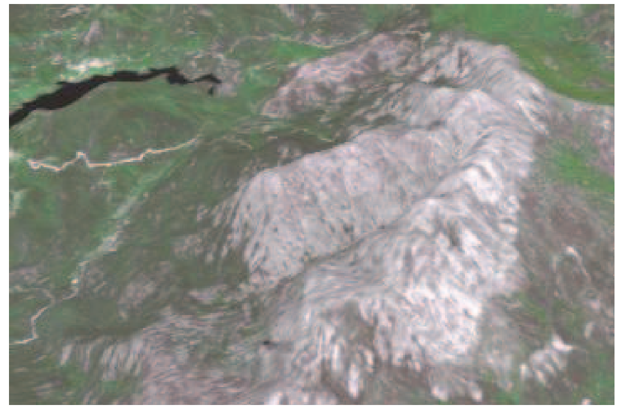
Finally, DEM abnormal values are corrected: presence of clouds on the Spot 5 images is detected, and final DEM is filled with SRTM data. Mean altitude for each line is adjusted to be equal to the SRTM one.

3. RESULTS AND CONCLUSION

Comparisons with SRTM have shown that some sharp relief were not present in the SRTM model, but well detected with this method. Use of SRTM to fill areas with low correlation values or clouds increases the quality of results. Moreover absolute location of the computed DEM is very good thanks to the refinement with SRTM. Evaluation of the method has underlined problems with some landscapes (textured areas with low contrast) where the correlation method is not sufficiently precise considering the low B/H ratio sensitivity effect. Filtering techniques and complementary disparity map computation method will be used in the future to improve quality of the computed DEM.



(a) DEM on South of Corse



(b) 3D view of SPOT 5 image with DEM

Fig. 1. Example of DEM results with Spot 5 P+XS images

4. REFERENCES

[1] H. Vadon ”3D navigation over merged panchromatic-multispectral high resolution Spot 5 images,” *International Workshop on Visualization and Animation of reality based 3D models. ISPRS,* Feb. 2003.