RADIOMETRIC AND GEOMETRIC CHARACTERISTICS OF PLEIADES IMAGES

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ABSTRACT:

Pleiades images are distributed with 50cm ground sampling distance (GSD) even if the physical resolution for nadir images is just 70cm. This should influence the effective GSD determined by means of point spread function at image edges. Nevertheless by edge enhancement the effective GSD can be improved, but this should cause enlarged image noise. Again image noise can be reduced by image restoration. Finally even optimized image restoration cannot improve the ground resolution from 70cm to 50cm without loss of details in the images, requiring a comparison of Pleiades image details with other very high resolution space images.
The image noise has been determined by analysis of the whole images for any sub-area with 5 pixels times 5 pixels. Based on the noise values of the small sub-areas the image noise is determined by frequency analysis. This leads to realistic results, checked by test targets. On the other hand the visual determination of image noise based on apparently homogenous sub-areas results in too high values because the human eye is not able to identify small grey value differences – it is limited to just approximately 40 grey value steps over the available gray value range, so small difference in grey values cannot be seen, enlarging the manual noise determination.
A tri-stereo combination of Pleiades 1A in a mountainous, but partially urban, area has been analyzed. The image restoration is very good, so the effective image resolution resulted in a factor 1.0, meaning that the effective resolution corresponds to the nominal resolution of 50cm. This does not correspond to the physical resolution of 70cm, but by edge enhancement the steepness of the grey value profile across the edge can be enlarged, reducing the width of the point spread function. Without additional filtering edge enhancement enlarges the image noise, but the average image noise of approximately 1.0 grey values related to 8bit images is very small, not indicating the down sampling of the GSD from 70cm to 50cm. So the direct comparison with WorldView images has to give the answer if the image quality of Pleiades images is on similar level as corresponding to the nominal resolution.
With 154 ground control points (GCP), determined by relative GPS-positioning, root mean square differences as average for X and Y of 61cm has been reached. In relation to the physical ground resolution of 70cm this corresponds to 0.87 GSD which is satisfying for the GCPs mainly defined by edges and not by symmetric positions. But even in relation to 50cm GSD this result would be acceptable as adjustments with WorldView show. Sub-pixel accuracy usually only can be reached if the point definition in the images is optimal. Discrepancies at neighboured ground control points up to a distance of 1.3km are just correlated by 0.1 and in the following distance group no more correlation exist, meaning that there are no significant systematic errors in the Pleiades scenes.
In general the results achieved with Pleiades images would be acceptable also if the physical GSD would be 50cm instead of 70cm.