Orthorectification Method Using Regular Grid

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Nowadays, real-time ("on the fly") methods of processing satellite and aerial imagery are becoming more and more popular. Amongthe majoradvantagesofthesemethodsistheabilityto monitortheresultsonthescreen, aswellastocanc eloradjusttheprocessingparameters. Thelattera llowstoenhanceperformanceduetothereducedti meneededto save and reload the results, these actions being common when using traditional processing methods. Oneofthemodernreal-timeimageryprocessingmethodsis "onthefly" orthorectification.

One of the ways to orthorectify an image "on the fly" is to automatically replace the currently displayed fragment of the initial image with its rectified version. Such an algorithm is implemented in ArcGIS, and all the calculations are performed in real-time during panning around or zooming in and out of the displayed area.

Another way of "on the fly" orthorectification is to use regular grid which defines the connection between the coordinates in object space and the image (pixel coordinates) space. Thus, precalculated regular geographical grid corresponding to some pixel coordinates of the image is provided by default for some remote sensing data, e.g. ASTER, MODIS, RADARSAT-1, RADARSAT-2, etc.). This grid can be used as a geometry model for the subsequent reprojection of the initial image.

Unlike traditional digital imagery processing methods, using regular grid "on the fly" transformation doesn't result in creating new raster matrix of interpolated pixel values. Instead, the initial photometric values are preserved, which is crucial for automatic imagery interpretation.

If the geometry model for an image is described using external and internal orientation elements, coordinates of the grid nodes are calculated directly by means of reconstructing the bundle of projective beams along and across the scanning direction using a defined step. The same direct method is used if the geometry model is described using an inverse rational function model (RFM), which includes RPC to calculate object coordinates at a defined elevation.

However in practice, especially for high-resolution imagery the orientation elements are not provided to the end user and the image geometry model is described by a forward RFM, whose coefficients allow calculatingthe image coordinates based on the real object coordinates and elevation.

This work proposes a method of calculating the regular transformation grid using RFM coefficients and DEM. A detailed research was conducted to define the accuracy of the proposed method for various acquisition conditions, grid step values, and inclination angles. The optimum grid step was experimentally defined, depending on the DEM nodes density. Furthermore, a comparison of calculations performance was conducted for the proposed and traditional orthorectification methods.

Five multi-temporal QuickBird-2 images were used during the experiment, featuring incidence off-nadir angles from 2 to 35 degrees. Research was conducted on a 100 sq. km filed in the premises of Avignon (France), and 33 instrumentally measured ground control points were acquired. Seven DEMs of various density and accuracy were also used for the experiment.

A pixel-by-pixel comparison of the plane coordinates was conducted for the orthophotoplans received using the proposed (with various grid step values) and traditional methods to define accuracy.

As a result, it was found that the proposed orthorectification method gives highly accurate outputs when the transformation grid step is less or approximately equal to the distance between DEM nodes used for the calculations. It was shown that the greatest coordinates discrepancy coincided with occluded areas and areas with incidence angles exceeding 30 degrees.

Performance comparison showed that the proposed method was 4 – 28 times faster (depending on the DEM density) than the traditional one.

Themethoddescribedabove is now being implemented in ScanEx Image Processor and is planned to appear on the market in one of the next releases.