ABSTRACT

The spatial precision of VHR data (QuickBird, IKONOS) is systematically evaluated, more specific for an urban and suburban environment using the GCP information obtained by GPS measurements. The 3D-georeferenced images are compared with ortho-rectified images in terms of their geometric accuracy.

The geometric accuracy of a DSM from VHR data is compared with the accuracy of the DSM, derived from aerial photography at scales of 1:12000 and 1:4000.

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1. EVALUATION OF THE QUALITY OF VHR-GEOREFERENCED DATA

1.1 Qualitative analysis

The QuickBird image (2002) for Ghent was orthorectified using its Rational Polynomial Coefficients, a DSM from aerial photography and GPS measured GCP. The same image was georeferenced, i.e. Only corrected in X and Y, using the same GCP. Figure 1 shows a clear example of the differences between 2D and 3D corrected images, respectively the lower and upper half in the figure. The top of the tower is not on the longitudinal axis of the church, and the axis itself is displaced according to the true position of the 3D corrected image.

Figure 1: 2D and 3D corrected QuickBird image of St. Nicholas Church, Ghent

The top of the church being displaced to the south fits the idea that a sensor viewing angle from the north results in image displacements towards the south.

1.2 Quantitative analysis

The quantitative analysis of the difference between the 2D and 3D corrected QuickBird image is done by comparing the plane coordinates of 115 checkpoints divided over the four Ghent Test Zones (TZ1, 3, 5, 6). The checkpoints are taken as well at ground as at rooftoplevel. Coordinate differences are calculated as follows: \( X_{3D} - X_{2D} = \Delta X \); \( Y_{3D} - Y_{2D} = \Delta Y \). From Figures 2 and 3 show clearly that there is a dominant direction in which the plane errors occur. This direction more or less corresponds to the Y-axis of the LambertII2-system, i.e. North.

Figure 2 illustrates that the main displacements for TZ 3, 5 and 6 are situated along the Y-axis, while there is a clear deviation for the errors in TZ1. This can only be explained by the lower quality of the ground truth control points that were used for the orthorectification of TZ1. Those GCP were not measured with GPS but were derived from a topomap: 1:10,000. If we take a look at the Table 1 that corresponds with this graph, the effect of TZ1 becomes even more clear.

Table 1: Qualitative analysis

2. MODELLING OF DISPLACEMENTS CAUSED BY TERRAIN MORPHOLOGY AND SENSOR VIEWING ANGLE

The model is based on viewsheds of the Digital Surface Models of the different test zones. Given the angles of the sun and satellite elevation and azimuth for a certain VHR image, the viewpoint results in shadow and occlusion prediction for the given image. Reclasping the hithatched surface model gives areas with value "1" (no shadow or occlusion) and value "0" (shadow or occlusion). At first the shadows and occlusions are calculated for a given area, using the azimuth and elevation angles as available from the image metadata.

The next step consists of series of simulated shadows and occlusions on the DSM, in which the azimuth and elevation angles as available from the image metadata. The occlusion area is expressed as ratio of the total area of the test zone.

Table 2: Occlusion ratio TZ6 (Ghent)

This table shows the relationship between the occlusion area (S) and the satellite elevation (\( \psi \)) for a given surface model. A more general way of expressing this relationship is the following equation:

\[ S = a \times \cot \psi \]

The value "a" is calculated from the simulation series using the Least Squares Method.

3. DEVELOPMENT OF A DSM FROM VHR STEREOSCOPIC IMAGERY

The model is based on viewsheds of the Digital Surface Models of the different test zones. Given the angles of the sun and satellite elevation and azimuth for a certain VHR image, the viewpoint results in shadow and occlusion prediction for the given image. Reclasping the hithatched surface model gives areas with value "1" (no shadow or occlusion) and value "0" (shadow or occlusion). At first the shadows and occlusions are calculated for a given area, using the azimuth and elevation angles as available from the image metadata.

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The value "a" varies per different type of urban morphology and needs to be calculated for each such area apart. It depends on the mean building height of the area, width of the streets, DSM variancy, and possible others characteristics of urban morphology.

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