EVALUATION OF THE POTENTIAL OF THE HIGH RESOLUTION SATELLITE IMAGERIES (IKONOS) FOR LARGE SCALE MAP REVISION

[a]Farhad Samadzadegan, [a]Ali Azizi, [b]Mohammad Sarpoulaki, [c]Ahmad Talebzadeh

[a] Departmen of Geomatics Engineering, Faculty of engineering, Tehran University,
[b] National Cartographic Center
[c] Iranian remote Sensing Center
e-mail addresses: [1]samadz@chamran.ut.ac.ir , [1]aazizi@ut.ac.ir, [2]sarpulki@ncc.neda.net.ir

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ABSTRACT:

High and accelerating rates of the urban changes and the urban area growth especially in developing countries like Iran with more than 1000 cities calls for efficient and fast techniques for map production and revision with the required accuracy. The availability of the new generation of the commercial one-meter resolution satellite imageries have opened a new era heralding a promising future for producing and updating large scale digital maps. Although several investigations have already began in this area, still the subject demands more comprehensive tests for the determination of the suitability of such high resolution images for large scale map revisions. In this study the mapping potentials of the IKONOS images have been thoroughly examined in a test site in Iran. The test is conducted based on the following three-stage experimentation.

The first stage is concerned with the 2D and 3D geometric accuracy assessment of the IKONOS images over the test site. A wide range of mathematical models for geo-referencing is adapted and implemented. For the 2D geometric evaluation these were multi quadratic functions, projective and polynomial transformations. 3D geometric accuracy assessment is also investigated using Direct Linear Transformation, as well as rational and rigorous functional models. Since the stereo images for the IKONOS data and the corresponding orbital parameters were not available, a large scale DTM of the test area was used to compensate for the relief displacements. In order to make the geometric evaluation as reliable as possible, a test site (city of Rasht, in Iran) was selected for which 200 ground control points was available. The coordinates of these points were measured with differential GPS with an accuracy in the order of 10 to 15 cm. These control points were well distributed over the test area with an overall distribution density of 2 to 3 ground control points in each square km. Moreover, photogrammetricaly generated 1:1000 and 1:10000 scales digital maps (acquired from 1:5000 and 1:40000 scale aerial photographs respectively) and the 3D city model and the corresponding DTM covering nearly 80 squares km was also available. The geometric accuracy assessments were made based on the residual errors calculated for ground control points as well as uniformly spaced checkpoints. The test results

indicate that the multi quadratic function offers a better image distortion modeling for flat areas provided that large number and well-distributed ground control points are available. One of the drawbacks of the multi quadratic functions was the fact that accuracy assessment could not be studied on ground control points and hence existence of checkpoints was inevitable. The rational functions on the other hand indicated a better performance for non- flat areas. The rational functions also demonstrated more flexibility in terms of the number and distribution of the ground control points.

In the second stage of the project the information content and the sharpness of the features of the image in comparison with the standard aerial photographs were evaluated by visual inspection. This visual inspection was quantified using frequency domain analysis approach. In this context the possibility of improving the quality of radiometric information using image restoration techniques such as de-blurring operations were also investigated. To perform this stage, it was necessary to estimate the imaging system's point spread function (psf). This was evaluated using the smallest detectable symmetric feature with a uniform grey scale background that could be found in the image. The 2-sigma of the psf was evaluated assuming a Gaussian model for it. The pictorial restoration operations were then performed by modified inverse and Wiener filters respectively. The test results indicated a limited marginal radiometric improvement.

In the third stage the feature tracing and pointing capabilities of IKONOS image was compared with the feature tracing and pointing potentials of standard aerial photographs for the same test area. For further assessment of the feature tracing potentials of IKONOS images some linear features such as non-occluded road and building edges were traced and digitized on geo-referenced images and the result was compared with the same features extracted from 1:1000 and 1:10000 scale digital maps and the corresponding city model. In the final stage of this study, based on the preceding metric and pictorial evaluations, the suitability of the images for large scale map revision were assessed. Based on the overall evaluation of this study it may be concluded that map revision for the scale of 1:10000 is feasible with IKONOS images.