CO-REGISTRATION OF KOMPSAT IMAGERY AND DIGITAL MAP

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ABSTRACT:

This study proposes the method to use existing digital maps as one of the technologies to exclude individual differences that occur in the process of manually determining GCP for the geometric correction of KOMPSAT images and applying it to the images and to automate the generation of ortho-images. It is known that, in case high-resolution satellite images are corrected geometrically by using RPC, first order polynomials are generally applied as the correction formula in order to obtain good results. In this study, we matched the corresponding objects between 1:25,000 digital map and a KOMPSAT image to obtain the coefficients of the zero order polynomial and showed the differences in the pixel locations obtained through the matching. We performed proximity corrections using the Boolean operation between the point data of the surface linear objects and the point data of the edge objects of the image. The surface linear objects are road, water, building from topographic map.

KEY WORDS: KOMPSAT-2, Co-registration, Digital Map, Boolean operation

1. INTRODUCTION

To geometrically register geospatial data that has two different types of ground spatial resolutions and relief displacements, it is necessary to select corresponding features that commonly exist in the topographic data and to adjust relief displacements. Corresponding features are interest points, lines, etc that are distinct from images.

Geometric correction methods, which are based on feature point information, have been applied in different ways, according to the geometric model characteristics of the sensors and the ground spatial resolutions of the images being processed. In the case of high-resolution satellite images, the RPC (rational polynomial coefficients) processing method using sensor orientation or the sensor exterior orientation estimation is employed for the geometric corrections of Level 1B images (Grodecki & Dial, 2003; Jacobsen et al., 2005; Cheng, 2006).

There are three methods of geometric correction using RPC. The first method involves correcting images by using RPC and removing the errors of the corrected images by post-processing. The second method involves renewing the initial RPC by using the correct GCPs (Ground Control Points). In the third method, an RPC is generated and adjusted using many GCPs.

When the first method is applied, acceptable accuracies can generally be obtained, even when only using constant terms, namely, offset translation, in the case of IKONOS images. For QuickBird images, it has been found through studies that fair correction results can be obtained by applying first order polynomials. In this respect, automated geometric corrections were performed in this study based on the fact that, when RPC is applied, the geometric correction errors of high-resolution images are largely dependent upon translation transformations.

We proposed a method whereby existing digital terrain maps are used as a technology to exclude individual differences that occur in the process of manually determining GCP for the geometric correction of high-resolution images (Han, etc, 2007). This method is then applied to the images in order to automate the generation of orthoimages. In this paper, we applied this method to KOMPSAT image (refer to Figure 1).

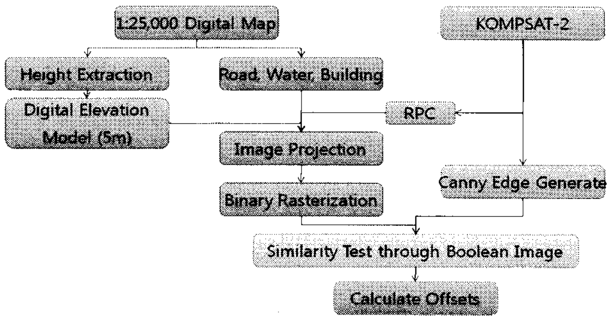


Figure 1. Flow of research.

2. CO-REGISTRATION

2.1 Geometric Transformation Model

This study modeled each resolution error of the image by using rotation and translation, adopting the block adjustment method (shown below) proposed by Grodecki and Dial (2003), which was validated by space imaging.

$$\Delta P = A_0 + AS \cdot Col + AL \cdot Line + ASL \cdot Col \cdot Line + \cdots$$
$$\Delta R = B_0 + BS \cdot Col + BL \cdot Line + BSL \cdot Col \cdot Line + \cdots \quad (1)$$

where, Col, Line = column and row of the image
A_0,AS,AL,B_0,BS = adjustment coefficients
ΔP, ΔR = adjustment errors of the column and row

The positional error of test images is modeled by RPC into the relation formula of the zero order polynomial.

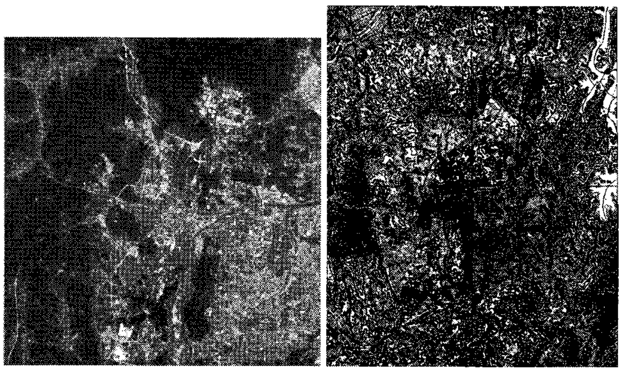
2.2 Correction by the Boolean Operation

Binary images of the surface objects can be generated by rasterizing each segment of the objects into the size of the image pixels, after transforming the 3-dimensional surface object data into satellite image spaces by using RPC. Objects that can be considered surface objects are estimated through edge extraction from satellite images.
In order to undertake a rapid search when performing adjustments, the Boolean proximity adjustment, a method to search for corresponding objects that exist in the binary image of the digital map and that of the KOMPSAT image, was divided into two in this study: the proximity adjustment and the precise adjustment. In the proximity adjustment, the Boolean operations were carried out for every five pixels in the direction of line columns, while in the precise adjustment the Boolean operations were performed for every single pixel.

3. EXPERIMENT

We performed an automated correction of the KOMPSAT panchromatic image, without any field survey, based on the 1:25,00 digital terrain map in order to obtain a control point or any input of control point by naked-eye readings. The input data was: the four 1:25,000 digital maps, the digital map layers that can be used as the control surface objects, the satellite image and header information (refer to Figure 2). Table 1 shows the specifications of KOMPSAT-2 image.

Part of Daejeon, Korea, was selected as the study site. The study area is 15km by 15km. This area includes forests and rivers, as well as the downtown area. The output data was the transformation polynomial information. The study process can be automatically conducted through Mathworks' Matlab.



(a) KOMPSAT Image (b) 1:25,000 Map

Figure 2. Input Data.

The binary control object data from the building, road, water layer and the binary edge point data from the image were extracted (refer to Figure 4).

Table 1. The specification of KOMPSAT-2 image

Product Level	Row GSD	Column GSD	Samples	Lines	Satellite Incidence
L1R	0.981m	0.994m	15000	15500	87.79°

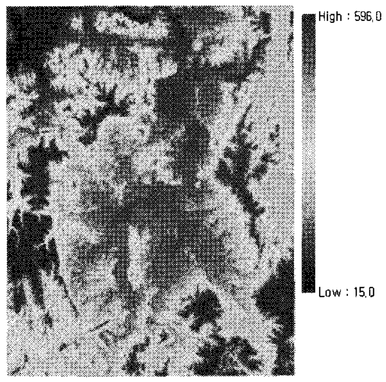
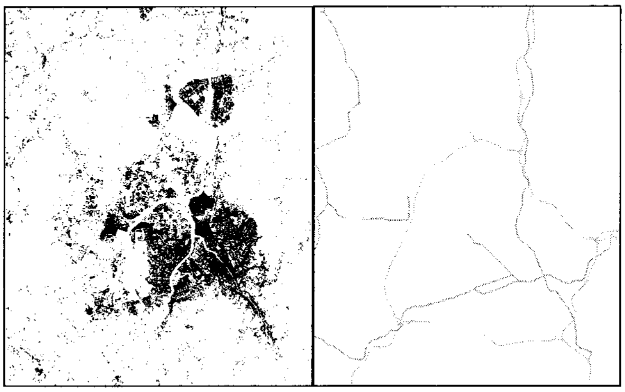
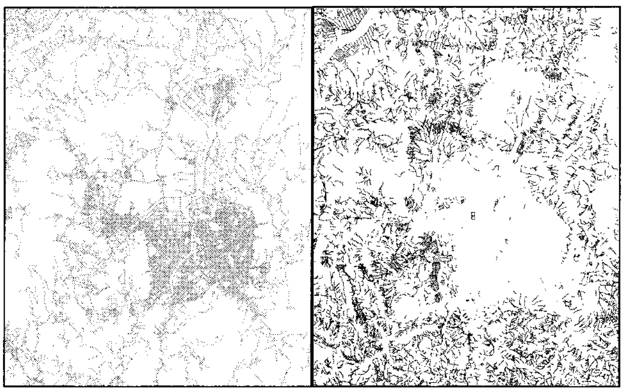


Figure 3. DTM generated by the contour lines and the height point layers of the digital map.



(a) Building(non-house) (b) Freeway



(c) Local road (d) Water

Figure 4. Binary control object data.

We calculated the proximity movement offsets from the Boolean operation between the control object point data and the binary edge point data. The optimal locations in the section -100~+100 pixels using the building layer as control object data - are the column and row displacements +40, -11 (refer to Figure 5).

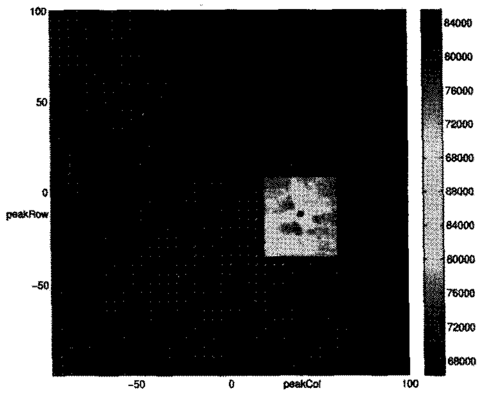


Figure 5. Two stage registration of Boolean operation matching metrics in case of building layer.

Figure 6. Overlay of the digital binary image and the edge image, after a registration.

After identifying all edges from KOMPSAT image through connected component labelling, small sized edges with a maximum of 100 points were deleted for the comparison in estimation of geometric transformation. Table 2 shows the final coefficients of the zero order polynomial transformation. The average column and row displacements are 40, -13. The offset didn't differ significantly between four control object data.

Table 2. Estimated parameters for the zero order polynomial transformation

	Offset	Building	Freeway	Local Road	Water
All Edge	Row	-11	-13	-13	-13
	Column	40	42	40	39
Partial Edge†	Row	-11	-14	-13	-13
	Column	40	42	39	39

† Edge more than 100 pixel.

4. CONCLUSION

In this study, we matched the corresponding objects between 1:25,000 digital map and a KOMPSAT image to obtain the coefficients of the zero order polynomial. The average column and row displacements of the KOMPSAT image are 40, -13. The proposed method is an automated method, utilizing the surface objects and the height information of the digital terrain map. The authors are planning to conduct geometric accuracy assessment using GCP obtained from 1:5,000 digital map.

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ACKNOWLEDGEMENTS

This work was supported by the Korea Aerospace Research Institute through a grant from the KOMPSAT-3 system development project. We thank R & G World for providing the KOMPSAT image.