GCP(GROUND CONTROL POINT) FOR AUTOMATION OF THE HIGH RESOLUTION SATELLITE IMAGE REVISION

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ABSTRACT ... Today, use of high resolution satellite image with at least 1m resolution is expanding into many more areas including forest, river way, city, seashore and so forth for disaster prevention. Interest in this medium is increasing among the general public due to the roll-out to the private sector as Google earth, Virtual Earth and so forth. However, pre-processing process that revises the geometrical distortion that result at the time of photographing is required in order to use high resolution satellite image.

The purpose of this research is to search the most accurate GCP(Ground Control Point) information acquisition method that is used for the revision of high resolution satellite image's geometrical distortion through automated processing. Through this, it is possible to contribute to increasing the level of accuracy at the time of high resolution satellite image revision and to secure promptness.

KEY WORDS: High Resolution Satellite Image, GCP(Ground Control Point), pre-processing process

1. INTRODUCTION

Satellite image is a very important data for acquiring information on the location, and it is used for all types of application fields and analyses on the use of land, using qualitative information in addition to the information on the location(quantitative information). In particular, SAR image with active sensor attached is used in a full-fledged manner in addition to the existing optical image. Likewise, use of satellite image is increasing. Moreover, all types of disaster prevention and 3D development related businesses are gaining interest, and all types of researches that use satellite image are actively underway.

However, all satellite images have geometrical margin of error that results during filming, and they can be used as satellite image after the geometrical revision. For this type of geometrical revision, GCP(Ground Control Point) is used in general to subject the data on the satellite image to pre-processing, reducing geometrical distortion so that the individual picture elements can be placed at the appropriate places on the plane map.

As for the GCP(Ground Control Point) acquisition methods used to designate accurate information on the location onto the satellite image, there are the method of measuring directly using GPS and the method whereby image and Topographic Maps with the information on the location are used. Selection method based on the GPS is relatively accurate, but significant time and cost are required for acquiring GCP(Ground Control Point). The method of using the image and Topographic Maps that have the information on the location causes some problems when selecting GCP(Ground Control Point) due to the change in all types of facilities and topologies in the case of the period that is before the time when data acquired satellite image. For this reason, significant time is required for selecting GCP(Ground Control Point). Moreover, when the image revision is executed for the same region, measures for the use of GCP(Ground Control Point), which was selected in the past to eliminate repetitive work are pursued.

Existing researches conducted analysis on the automation of the geometric revision for the low resolution satellite image with the resolution of 10m and 30m, and pursued after the measures to apply high resolution image based on the findings. This research applies Affine Transformation as the method for conducting automated high resolution revision to propose the possibilities on the use of GCP(Ground Control Point) acquired in the past when it comes to the revision of high resolution satellite image.

2. RESEARCH METHOD AND DATA

QuickBird satellite image, which is high resolution image, was selected to film at the Pohang region, selected as the target region for this research between February 1, 2003 to June 3, 2004, and base data such as 1/5,000 Topographic Maps, used as the reference data for the GCP(Ground Control Point) were developed.

In the case of the satellite image which was filmed on February 1, 2003, GCP(Ground Control Point) was extracted to apply image with the geometrical revision completed through the existing normal revision onto the newly filmed image. Extracted GCP(Ground Control Point) was then applied to the image filmed on June 3, 2004 through the Affine Transformation. Image revised through the automation was subjected to the comparative analysis with the 1/5,000 Topographic maps that are provided based on the review by the National Geographic Information Institute.

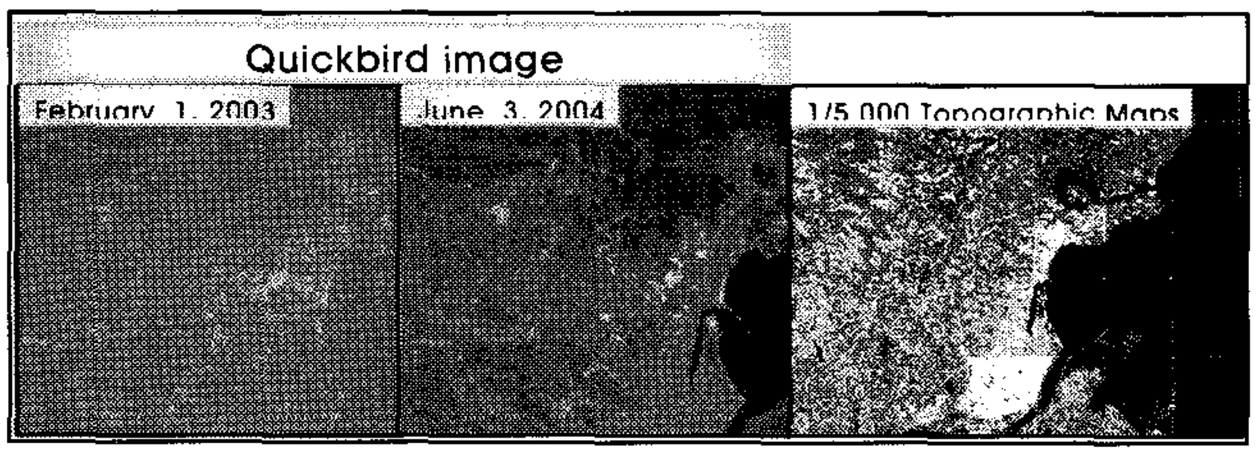

Figure 1. Research data

3. GCP(GROUND CONTROL POINT) SELECTION AND GCP(GROUND CONTROL POINT) CONFORMITY

3.1 GCP(Ground Control Point) selection

GCP(Ground Control Point) refers to the standard point used to obtain formula for the coordinate conversion between the image and map coordinates. In this research, GCP(Ground Control Point) was selected based on the intersections and bridges with the 1:5000 Topographic Maps as the basis, and tombs and roads in the mountains were used as the standard in the case of the regions where there are no clear cut facilities that can serve as the standard in the case of mountainous areas. Total of 16 GCP(Ground Control Point) were selected to conduct pre-processing of the February 1, 2003 Quickbird satellite image.

For the alignment of the GCP(Ground Control Point), initial satellite image too has coordinates. Thus, conversion formula was used to convert into UTM coordinate, and DEM based on the 1/5,000 Topographic Maps, and collection of RPC information, which is meta data were produced at the time of filming satellite image in order to collect data needed at the time of Orthometric Correction. Quickbird satellite image, filmed on February 1, 2003, was subjected to the Orthometric Correction by applying the existing pre-processing method that uses the collected RPC information and DEM. The result shows that it is possible to obtain image with accuracy level of ±0.6m.

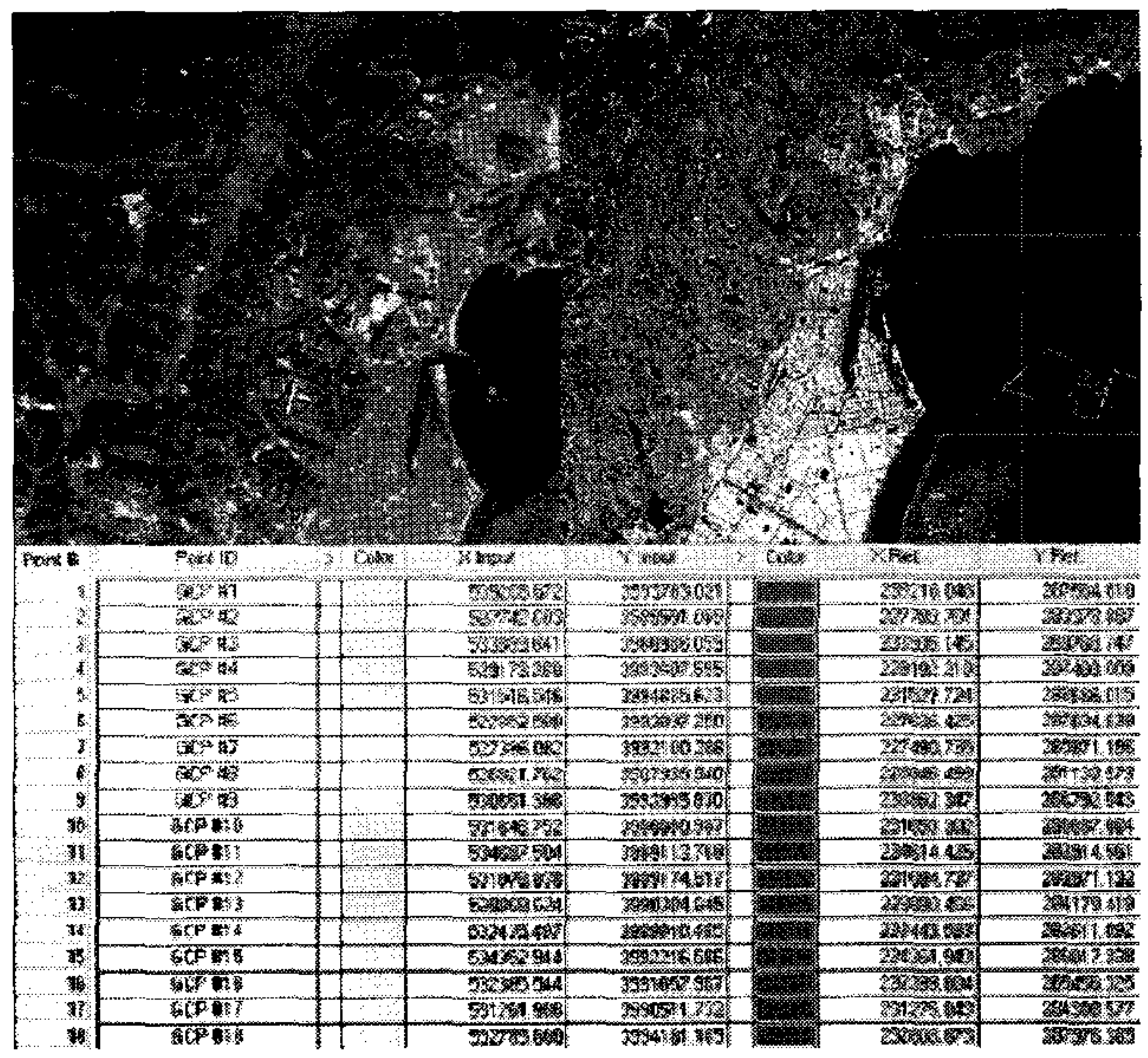
Figure 2. GCP selection for orthorectification on Quickbird image february 1, 2003


Figure 3. Quickbird ortho image February 1, 2003

3.2 GCP(Ground Control Point) alignment

Because the Quickbird image filmed on February 1, 2003 obtained sufficient level of accuracy as an image thanks to the Orthometric Correction, GCP(Ground Control Point) selected for the Quickbird satellite image filmed on June 3, 2004 was applied. Using the selected GCP(Ground Control Point) as the basis, Quickbird satellite image of June 3, 2004 was used to select three GCP(Ground Control Point), and triangular shape with each of the three GCP(Ground Control Point) are the vertex was generated. Moreover, variable on the change in the triangular shape was extracted through the reverse conversion of the Affine Forward Mapping Function. Relationship of coordinate with the image dated June 3, 2004 was defined, and Affine Transformation technique was applied to align the remaining 15 GCP(Ground Control Point). The formula for conversion used for the GCP(Ground Control Point) alignment is as follows.

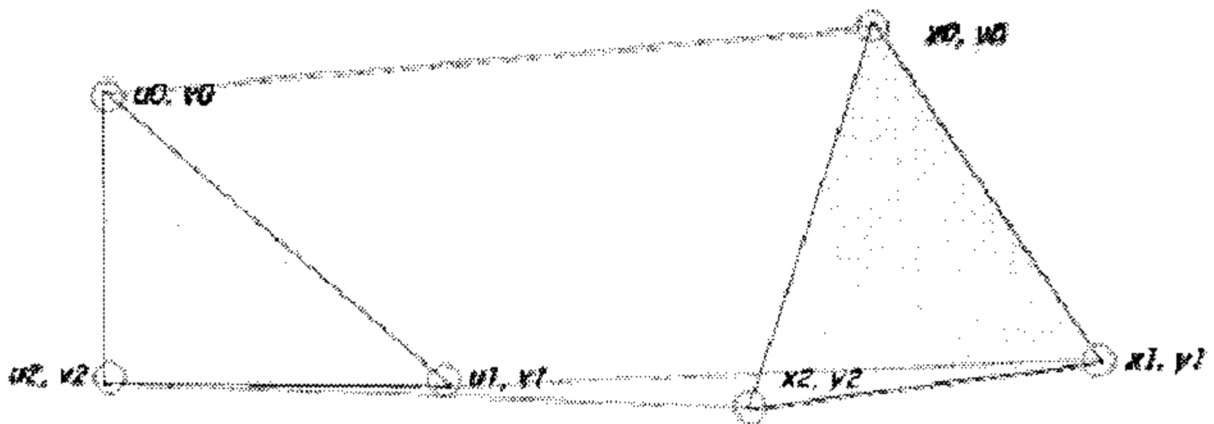

Figure 4. GCP conformity by triangle

$$x = a_{11}u + a_{21}v + a_{31}$$
$$y = a_{12}u + a_{22}v + a_{32}$$

Matrix

$$\begin{bmatrix} x_0 & y_0 & 1 \\ x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \end{bmatrix} = \begin{bmatrix} u_0 & v_0 & 1 \\ u_1 & v_1 & 1 \\ u_2 & v_2 & 1 \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & 1 \end{bmatrix}$$

GCP(Ground Control Point) obtained by using the formula for the conversion of the Affine Transformation can be applied to the image filmed on June 3, 2004, and the results of the GCP(Ground Control Point) alignment and value of transformed coordinate value are as shown on <Table 1> and <Figure 5>.

Table 1. GCP selection by Affine Transformation on Quickbird image june 3, 2004

GCP #	변환 전		변환 후	
	u	v	x	y
1	535208.671751502	3993763.020997580	535257.177047745	3993778.851479320
2	527742.003433435	3989591.088890560	527804.242821664	3989599.842454950
3	533899.641202538	3986988.058917290	533951.524537681	3987002.386229920
4	529173.267719093	3993607.554819650	529232.934332901	3993617.799695210
5	531516.545708355	3994885.623399370	531571.430254646	3994898.088867470
6	527852.580225178	3993837.250320160	527914.590615017	3993846.284330800
7	527396.081688614	3992100.287506650	527459.574111335	3992108.825210000
8	528821.761574189	3987338.940453800	528884.393474818	3987348.592038400
9	530851.368488220	3992995.829922550	530908.175362153	3993007.599659930
10	531646.752047430	3986890.987045420	531704.354496160	3986903.230563720
11	534607.504321939	3989113.767924720	534658.839702802	3989128.843210280
12	531078.838441790	3989174.517409310	531136.640566939	3989186.333781810
13	529869.624003189	3990384.645381860	529929.202226781	3990395.395901180
14	533435.497072117	3989810.484919570	533488.730046851	3989824.506760020
15	534352.943956712	3992216.585523720	534403.599689109	3992231.558371670
16	532385.543751118	3991657.967420220	532440.024174826	3991671.097900070
17	531261.985573154	3990511.731882810	531318.956232362	3990523.774790730
18	532785.659851739	3994181.184521710	532838.471081037	3994194.792859340

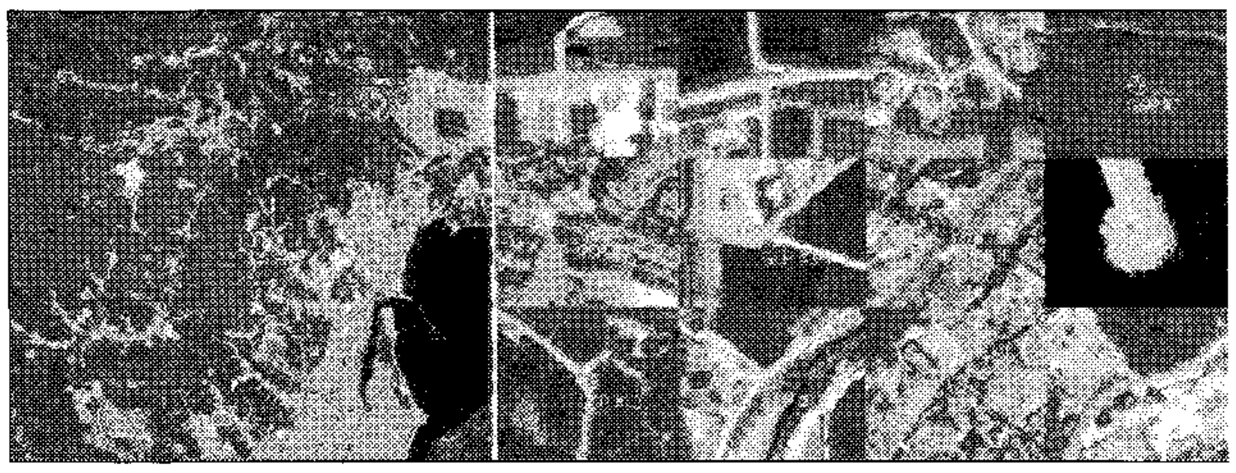
Figure 5. Result of GCP conformity on Quickbird image june 3, 2004

4. RESEARCH RESULTS AND KEY QUESTIONS GOING FORTH

This research used the Quickbird satellite images filmed on February 1, 2003 and June 3, 2004 to conduct research on the ways of using GCP(Ground Control Point) for the automation of the high resolution satellite image revision.

The results of the research show that the margin of error is relatively high with ±5m, which makes application to the Quickbird satellite image rather questionable. This is the result that came about because the variables pertaining to the entire image was not factored into the triangular shape generated by using three GCP(Ground Control Point). Although the results did not reach the scope needed to apply to the image alignment of the GCP(Ground Control Point), it is possible to identify the problems of the Affine Forward Mapping Function using triangular shape. However, GCP(Ground Control Point) alignment for the medium resolution satellite image such as IRS with the resolution of 5m or less is possible.

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