Automatic Change Detection Using Pair of PRISM Triplet Images

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Abstract

Geographical Survey Institute (GSI) is the national mapping organization in Japan. We are now updating 1:25,000 topographic maps, which is the largest scale base map in Japan. One of our hard task is investigation of changed area in all over Japan, since we spend much time and effort on collecting a mass of material to find changed areas.

To find changed areas without difficulty, we developed the automatic change detection method based on Pixel-change and DSM-change. We have tested our method using the PRISM triplet images observed over testfield in Tsukuba area and Saitama area, central Japan. We confirmed that Pixel-change and DSM-change make it easier finding changed areas. Also this method performs well even if two images have different brightness.

Keywords: PRISM, change detection, pixel-change, DSM-change

1. OUTLINE

Figure 1 shows a flowchart of our method. Our method requires two orthoimages and two DSMs. Then it automatically provides "change detected image", which is the integrated image with Pixel-change image and DSM-change image. Our method contains four operations (1: georeferencing error correction, 2:Pixel-change extraction, 3:DSM-change extraction, 4:image integration). Each part is described in following sections.

2. GEOREFERENCING ERROR CORRECTION

Georeferencing error correction is quite effective to obtain good result in Pixel-change extraction and DSM-change extraction since these parts are quite sensitive to georeferencing errors. In this part, a georeferencing error is detected and estimated by "roughly matching". This approach estimates the relative georeferencing error between two orthoimages by using FFT (Fast Fourier Transform) every 100 pixel square. Relative georeferencing error is corrected by the estimated georeferencing error. Also this estimated georeferencing error is applied to two DSMs.

We note that this approach can detect and estimate the relative georeferencing error, while it can not correct the absolute georeferencing error.

3. PIXEL-CHANGE EXTRACTION

Our Pixel-change extraction is based on a matching score. A matching score $Ms_k(i, j)$ using window size k at image coordinate (i, j) is computed by using the following equation:

$$Ms_k(i, j) = \frac{\vec{a}_{ijk} \cdot \vec{b}_{ijk}}{\sqrt{\left|\vec{a}_{ijk}\right| \times \left|\vec{b}_{ijk}\right|}} \tag{1}$$

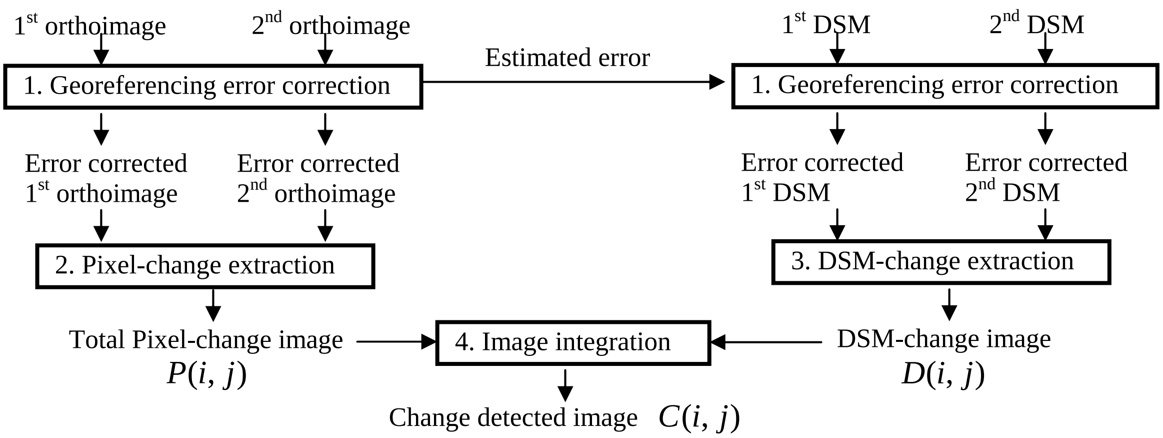

Figure 1. Flowchart of our change detection method

where

i, j : image coordinate

k : window size

$\vec{a}_{ijk}$, $\vec{b}_{ijk}$: orthoimage vectors for windows size k at image coordinate (i, j)

Pixel-change image for each window size k $P_k(i, j)$ is computed using conversion table C . $P(i, j)$ is computed as a total pixel-change image by using the following equation.

$$P_k(i, j) = C(Ms_k(i, j)) \tag{2}$$

$$P(i, j) = \sum_k P_k(i, j) \tag{3}$$

Here, we used following 4 windows, 3×3, 5×5, 9×9, 15×15. This multiple-window processing has an effect to obtain clear and sharp images.

4. DSM-CHANGE EXTRACTION

The 1st DSM and the 2nd DSM are generated by using stereo matching technique. Here, we used four image pairs (backward-nadir and forward-nadir for both the 1st images and the 2nd one) to generate each DSM. Two DSMs were given at the same grid points. Therefore DSM-change image $D(i, j)$ could be realized by a calculation of the vertical difference between them at the same coordinate.

We note that the DSM resolution in planimetry should be interpolated to the same resolution of the ortho images for the following image integration section.

5. IMAGE INTEGRATION

Change detected image $C(i, j)$ is computed from the total pixel-change image $P(i, j)$ and the DSM-change image $D(i, j)$. We assign G-channel to $P(i, j)$, R-channel to positive value of $D(i, j)$ and B-channel to negative value of $D(i, j)$.

6. RESULT AND CONCLUSIONS

We have tested using two testfields, Tsukuba area and Saitama area. These two areas are located northern part of Greater Tokyo area. Table 1 shows the main parameters of the PRISM dataset acquired over the two areas.

Table 1. Main parameters of the PRISM dataset

	Tsukuba	Saitama
1st acquisition date	Mar. 27, 2006	Apr. 30, 2006
2nd acquisition date	Nov. 29, 2006	Nov. 30, 2006
Viewing angles	-23.8° , 0° , 23.8°	
No. of GCPs (1st/2nd)	10 / 15	8 / 8
No. of tie points (1st/2nd)	none	
Reference DEM	yes	

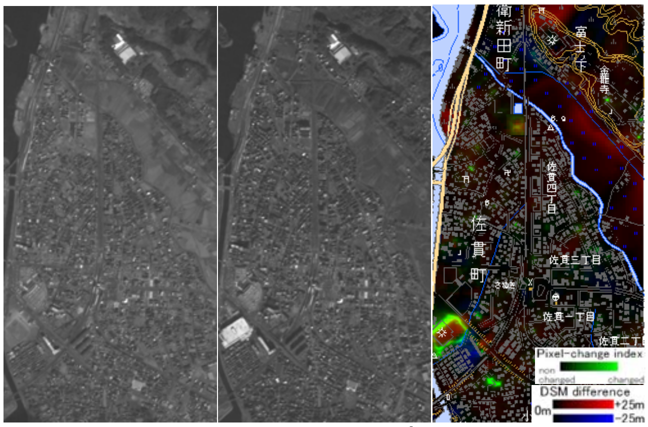

Figure 2. 1st orthoimage, 2nd orthoimage and change detected image of Tsukuba area

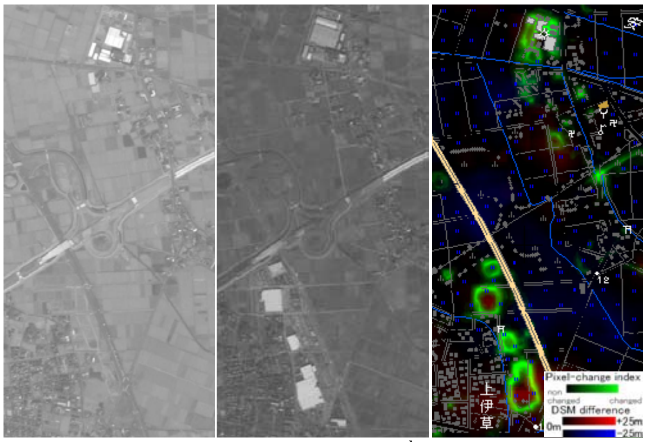

Figure 3. 1st orthoimage, 2nd orthoimage and change detected image of Saitama area

An accuracy of orbital and attitudinal data wasn't inadequate for the 1st images in both testfield since these were quite early PRISM images. Therefore we used only GCPs for georeferencing of all images and generated orthoimages and DSMs.

Figure 2 and Figure 3 shows the result of change detected images overlayed with map data. In both change detected images, new constructed buildings or reconstructed buildings are detected even if two images has different brightness.

We believe that these change detected images helps us finding many changed areas at once in wide area.

ACKNOWLEDGEMENTS

The author would like to thank JAXA, Japan for providing the image data and acknowledge their continuous support throughout this study.

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