Change Detection using KOMPSAT EOC Images

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Abstract: Change detection is one of the common research topics in remote sensing. In general, global change detection methods using image difference method, etc, are used in low resolution images and local change detection methods using floating windows, etc, are used in high resolution images. But, these methods have disadvantages in practical use. If changed area images are automatically produced, these images will be used in public area such as regional planning, regional development managements. In this research, we developed new change detection method applicable KOMPSAT EOC images. This method automatically produces subset images in changed area.

Keywords: Change detection, global change detection, change detection, KOMPSAT EOC images,

1. Introduction

Change detection is a useful technology that can extract or highlight differences with comparison and analysis among multi-temporal spatial images [1]. The types of differences are various; construction, dismantlement, seasonal change, etc. Change detection using aerial photographs and manual visual comparison has played an important role in taxation, environmental monitoring, etc. But, manual comparison between the images is very tedious, exhausted and time-consuming, and the larger the area the harder the change detection. Also, it is practically impossible to have aerial photos over the area periodically. That is to say, periodical change detection using aerial photographs may be unreasonable.

As substitutes for aerial photos, satellite images have been adopted in change detection. Although low resolution satellite images (over 10m spatial resolution) have good temporal resolution, it is impossible to extract feature-oriented information. So change detection using satellite images has been focused in the area such as environment or forest applications. But now, because we can get many high spatial resolution images such as IKONOS and Quickbird, many change detection researches using satellite image has been done.

High and accelerating rate of urban changes, in particular in the developing countries, calls for an efficient and fast technique for mapping the changes with the required accuracy for updating the existing topographic urban geospatial databases accompanied by the objects definition needs to be considered [2].

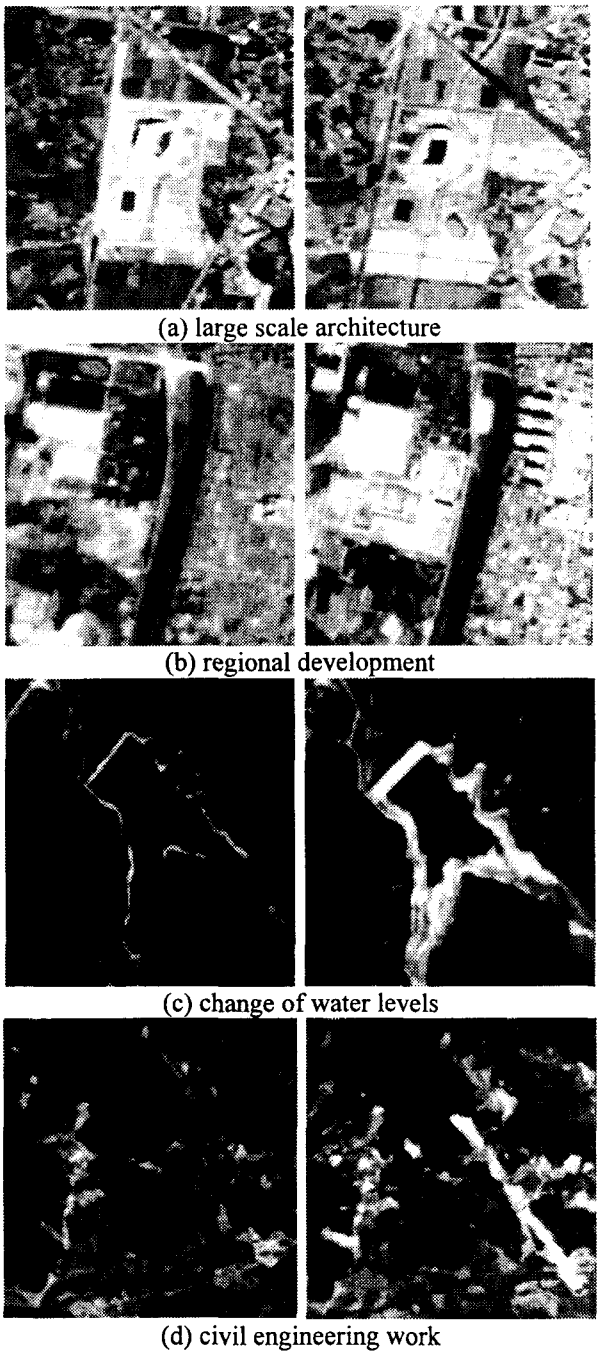
In this paper, we aim to develop a general change detection model applicable to various satellite images; low, intermediate and high spatial resolution. We use global change detection method, automatic changed area generation method and local change detection method for the low, intermediate and high resolution images, respectively. We use KOMPSAT Electro-Optical Camera (EOC) images as input images.

Next, we describe the characteristics of KOMPSAT EOC images in the respects of input images for change detection. And then, three change detection methods are described according to spatial resolutions. Although we use KOMPSAT EOC images as input images, any other images can be used as input images.

2. Characteristics of KOMPSAT EOC images

KOMPSAT EOC images have 6.6m spatial resolutions and swaths of them are 17km. Ground coverage is about 17km squares. In Korea, cities with 500 hundreds dwellers or so can be represented in one KOMPSAT EOC image (e.g. Jeonju city has 600 hundreds citizens and the area if that is 206㎢). On the other hand, high resolution satellite images generally has 10km swath (it is too small to represent cities) and low resolution satellite images is too coarse to detect the changes of urban areas. KOMPSAT EOC images, therefore, can be said to have appropriate spatial resolution in time series urban change detection.

By visual interpretation using KOMPSAT EOC images, it can be known that changes occurring in construction field and destruction of greenbelts are easily detected (refer Fig.1.), but changes of separate buildings are not easily detected because of its spatial resolution.



(a) large scale architecture

(b) regional development

(c) change of water levels

(d) civil engineering work

Fig. 1. Change examples of KOMPSAT EOC images

3. Developments of change detection methods

For the change detection, we classified satellite images into 3 categories (low, intermediate and high spatial resolution) and develop 3 change detection methods according to its spatial resolutions. Characteristics of each method are shown in Table. 1 and each method is described in the followings.

Table 1. Comparison of change detection methods

	low	intermediate	high
Techniques	Pixel based	Pixel based	Feature based
Area	Global	Global	Global
Development schemes	Automatic	Automatic	Manual
Output	Entire images	Subset image of changed area	Vectors

1) method for the low resolution images

Many change detection tools have been developed for the images such as image differencing, feature based subtraction, post-classification comparison, mixed-pixel analysis, principal component analysis, etc [3][4]. Image differencing is the simplest approach, and finds a change image by subtracting corresponding pixels and bands in the source images. Feature space subtraction uses a transformation to first enhance a given type of land cover such as vegetation, and then does image differencing. Typically the transformation is a band ratio, a vegetation index (such as normalized difference) and a linear combination of the bands (such as the tasseled cap transformation). Post classification comparison techniques first perform multi-spectral classification on each source image, and then compare the resulting images for differences in classification. The mixed pixel approach uses spectral mixture analysis to classify source image pixels by the fractions of each pixel that match reference spectra or "end members" of known surfaces. Principal Components Analysis (PCA) mixes spectral elements from all bands according to their statistical frequency among the image pixels.

Methods above mentioned are appropriate in the low resolution images such as LANDSAT TM and SPOT XS. Some of them are only applicable in multi-spectral images such as PCA and various vegetation indices. Because they are global change detection method, output images of them are entire images of input images.

2) method for the intermediate resolution images

For the intermediate resolution images, we use pixel based and global change detection method similar with that for the low resolution images. But difference of this method with the methods for the low resolution images is to generate automatic changed area subset images. Practically, urban planner and policy makers want to know the changed area automatically, but they will investigate the area carefully with manual image interpretation. So, we now aim to automatically generate the changed area for the interpretation. Because volume of imagery has been increasing according to

image resolution, this method is essential for the practical use. The scheme of automatic subset image generation is shown in Fig. 2.

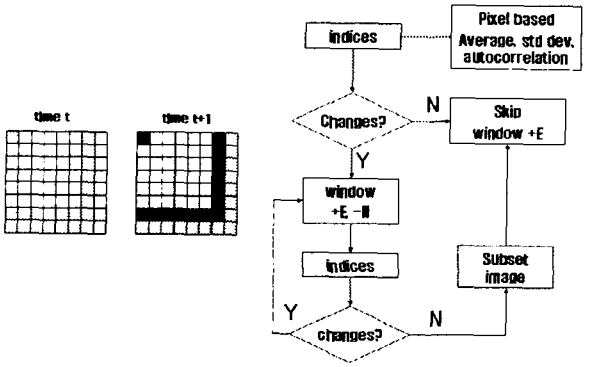


Fig. 2. Automatic Subset image generation.

3) method for the high resolution images

The conventional pixel-by-pixel comparison methods for change detection cannot be applied to high-resolution imagery at all, because the observed contents and spectral characteristics of the high-resolution imagery are different from those of the intermediate or low resolution images. Although a number of researches for the automatic change detection of high resolution images have been done, robust methods do not exists. The main reasons of it may be image matching and universal edge detector. So, practically change detection methods for the high resolution images are manual digitizing methods which overlay master and slave images (before and after images). In manual digitizing methods, output file of change detection will be vector format file.

4. Preliminary outputs of change detection methods

In the followings, we show preliminary output of change detection methods. For the low resolution images, we developed some techniques for single band images. For the intermediate and high resolution images, we are developing the techniques.

1) method for the low resolution images

Output files of change detection for the low resolution images are of same dimension with input images. In Fig. 3, some results are shown. In Fig. 3, boxed regions are easily detected. Image overlay method, we display before image with red band and after image with green band. And then, changed area is displayed in red or green and unchanged area is displayed yellowish in the results image (overlay image).

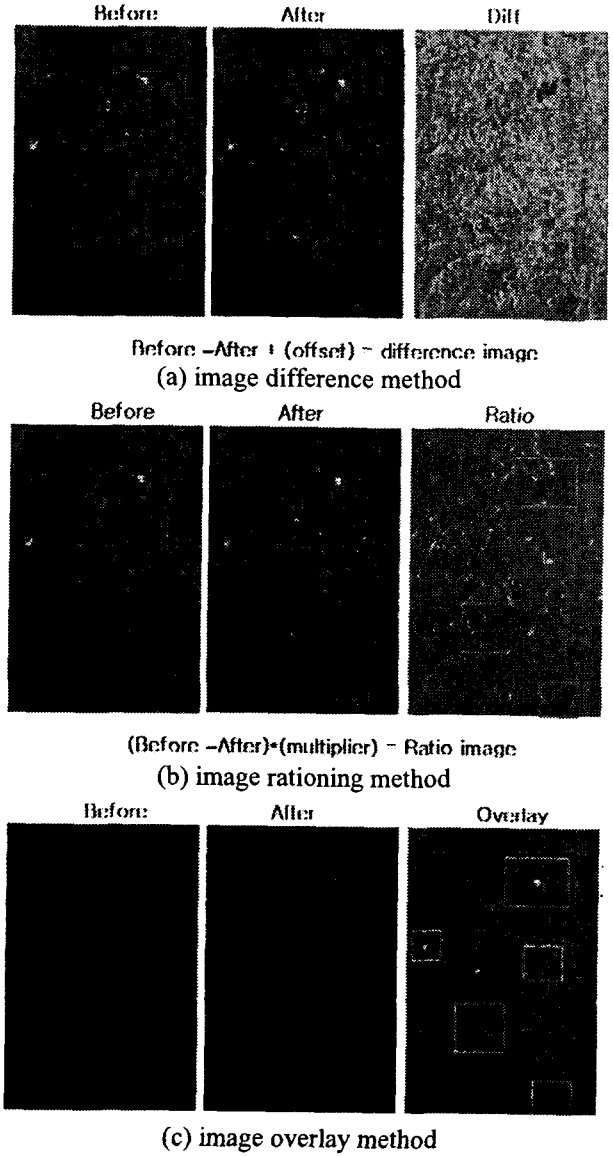
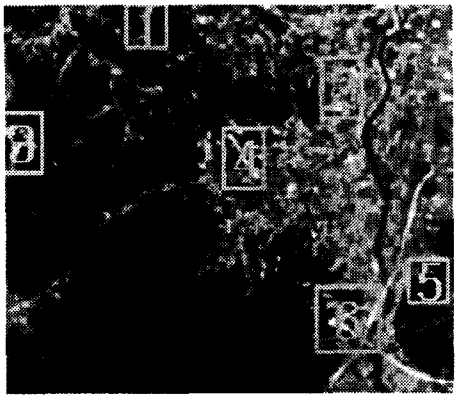


Fig. 3. Change detection methods in low resolution images

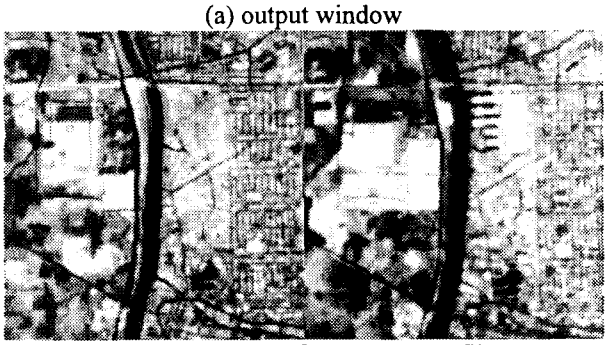
2) method for the intermediate resolution images

For the intermediate resolution images, we now are developing automatic subset image generation algorithm. We aim to generate two output files as shown in Fig. 4.

One of them is images depicting overall changed area with boxes for the input regions. Users can use this information in visual image interpretation. The other of them is subset image containing before and after image and vector overlay. This can be used on-site investigations. These outputs will be of use in practical use.



(a) output window



(b) one example of output image files

Fig. 4. Change detection methods in intermediate resolution images

3) method for the high resolution images

Output file of change detection for the high resolution images is vector file. For the making the vector file, vector editing window should be used. We are developing editing window which can display before and after image simultaneously as shown in Fig. 5. In Fig. 5, after image is displayed in boxed area and before image is displayed as background image.

Fig. 5. Change detection methods in high resolution images

5. Conclusions and further Studies

In this research, we are developing 3 change detection methods. For the low resolution images, we use the global changed methods and for the high resolution image we use on-screen digitizing method which navigates master and slave images. Especially, for the intermediate resolution images, automatic subset images of the changed area will be generated. Some of them are developed and some of them are developing.

Our research is focused in practical use. For the more practical use, many researches and development should be done in image preprocessing such as image co-registration, radiometric correction containing histogram matching and atmospheric effects. Furthermore, for the robustness, change detection method using automatic image registration with satellite orbital information should be developed.

References

[1] Young Jae Lim, Hong Gab Kim and Soo Jeong, 2003, A DESIGN OF CHANGE DETECTION SYSTEM BASED ON VISUAL INTERPRETATION OF HIGH RESOLUTION SATELLITE IMAGERY, ISPRS 2003.

[2] F. Samadzadegan, R. A. Abbaspour and M. Hahn, 2003, AUTOMATIC CHANGE DETECTION OF GEOSPATIAL DATABASES BASED ON A DECISION-LEVEL FUSION TECHNIQUE, ISPRS 2004.

[3] **URL:** Software techniques for Automating Multispectral Change Detection, Available at: http://ltpwww.gsfc.nasa.gov/ISSSR-95/software.htm.

[4] John R. Jensen, 1996, Introductory Digital Image Processing, Prentice Hall, pp. 257-280.