# Implementation of an Enhanced Change Detection System based on OGC Grid Coverage Specification

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**Abstract**: Change detection technology, which discovers the change information on the surface of the earth by comparing and analyzing multi-temporal satellite images, can be usefully applied to the various fields, such as environmental inspection, urban planning, forest policy, updating of geographical information and the military usage.
In this paper, we introduce a change detection system that can extract and analyze change elements from high-resolution satellite imagery as well as low- or middle-resolution satellite imagery. The developed system provides not only 7 pixel-based methods that can be used to detect change from low- or middle-resolution satellite images but also a float window concept that can be used in manual change detection from high-resolution satellite images.
This system enables fast access to the very large image, because it is constituted by OGC grid coverage components. Also new change detection algorithms can be easily added into this system if once they are made into grid coverage components.
**Keywords:** Change Detection, OGC Grid Coverage.

## 1. Introduction

Change detection technology, which discovers the change information on the surface of the earth by comparing and analyzing multi-temporal satellite images, can be usefully applied to the various fields, such as environmental inspection, urban planning, forest policy, updating of geographical information and the military usage.

To get higher-quality change detection results, we have to minimize any other noise factors by selecting multi-temporal image pairs that have similar photographing conditions, such as atmospheric conditions, variation in the solar illumination angles, and sensor calibration trends. It is, however, very difficult to maintain radiometric consistencies between images due to these different photographing conditions. Therefore, radiometric co-registration should be done to remove these noise effects between multi-temporal images [8].

For the purpose of more correct pixel-by-pixel analysis, a geometric co-registration operation is necessary to make geometric information of the images to be same. Typically, the RMS error between two images should not exceed 0.5 pixels [7].

After radiometric co-registration and geometric co-registration are accomplished, change information can be extracted from the images with various algorithms [1][4][7].

Simplest change detection algorithm is image algebra change detection method that includes band differencing, band rationing, and so on. Band differencing method is to extract change elements by calculating difference between pixel values in two images. This is very simple algorithm and quantitative analysis is allowed, but it is apt to regard spectral characteristics, such as seasonal elements and sun angle, as change elements. To complement this defect, we may use band rationing method that uses ratio between two pixel values instead. Most important factor to get good results in these methods is threshold value that defines the change pixels. Threshold value can be determined experientially or by calculating standard deviation of mean.

Write function memory insertion method, or image overlay analysis, is similar to the algebra method explained above. In this method, for example, if two images are assigned to red and green each, the changed areas are displayed in red or green color and others in yellow color, or composite color. This method has the merit that two or three images are compared and analyzed intuitively at once. But it has a shortcoming that quantitative analysis is impossible.

Post-classification comparison change detection method, most generally used change detection method for quantitative analysis, detects change information in the classified images acquired by supervised or non-supervised image classification. Classification performs objectification and minimizes the compared information.

This method is able to get from-to information with pixel based change detection matrix, but its accuracy absolutely depends on classification algorithm

The methods based on pixel-by-pixel comparison as described above are not suitable for change detection in the high-resolution satellite images because the observed contents in the high-resolution images are different from those in the middle- or low-resolution images. For instance, occlusion area, shadow of building and effect of roadside appear in the high-resolution satellite images.

One of the methods to solve these problems is to get change information by matching linear segments extracted from two images. It is less sensitive to the photographing condition such as change of illumination than pixel-by-pixel comparison method, but it needs more complex algorithm as well as errorless and sufficient number of extracted line segments to construct the object models [5].

Another method for change detection in high-resolution satellite images is head-up digitizing method that extracts the changed objects by manually comparing two images by a specialist. This method entirely depends on the operator's observation and has disadvantage that the operator becomes easily tired. In spite of these shortcomings, it is still a solitary method due to the limitation of automatic classification and analysis for high-resolution satellite imagery in the current technology.

The developed change detection system, ChangeAnalyzer, provides a user interface to detect changes with naked-eye in the high-resolution satellite imagery based on the concept of the float window as well as widely used methods such as image differencing, image rationing, PCA(Principal Component Analysis), CVA(Change Vector Analysis), image overlay, post-classification, and scene operation method. This system also can accomplish both quantitative and qualitative analysis of the detected results.

ChangeAnalyzer is implemented with IRHIS (Integrated Rs s/w for High resolution satellite ImageS) component package based on OGC Grid Coverage specification. So this system has advantages that it can be modified and added easily other new algorithms for change detection with assembling other components only.

## 2. Features of ChangeAnalyzer

ChangeAnalyzer provides the ability to detect and analyze the changes in the various satellite image as explained above. This system has the properties as follows.

- Specifying and verifying a bundle of input images. : Change Analyzer can specify a bundle(or pair) of input images(reference image and target image) to be compared at once and examine if the specified images are available for change detection.
- Image Preparation for change detection: The input image pair for change detection must be consistent geometrically to minimize errors in change detection. And their radiometric characteristics caused by the different photographing conditions should be corresponded with each other. ChangeAnalyzer can prepare an image pair to detect changes without other tools because it provides the geometric and radiometric co-registration operations in itself.
- Conformance to OGC Grid Coverage specification: It can managed the history of process as well as information about input and output images, because all processing operation is implemented in grid coverage components conforming OGC Grid Coverage specification, which enables real-time process of huge size of satellite imagery and easy maintenance by adding or replacing the appropriate components when change detection functions need to be extended or updated.
- Provide various change detection methods: ChangeAnalyzer has various extended pixel-based methods for change detection on the low- or middle-resolution satellite images. And it can support to make the change map from the high-resolution satellite images with various user interfaces helpful in operator's inspection.

Fig. 1. is the appearance of the developed system and Fig. 2. shows the change detection process with that. After two multi-temporal satellite images to get change information are acquired, verification of 2 input images is performed at first. If either of 2 images is not suitable

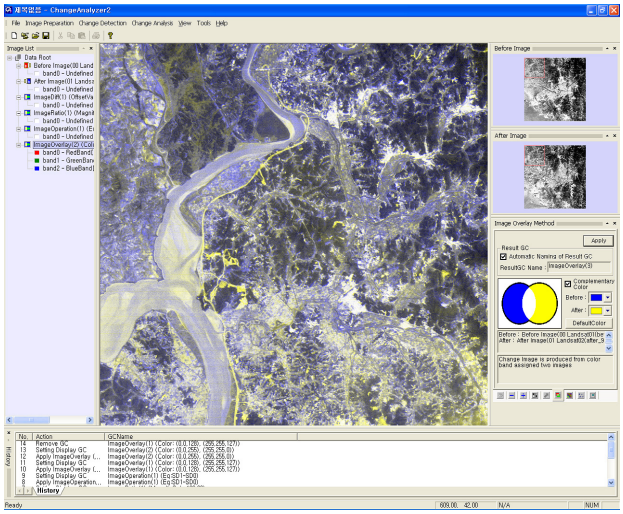

**Fig. 1. The appearance of ChangeAnalyzer**

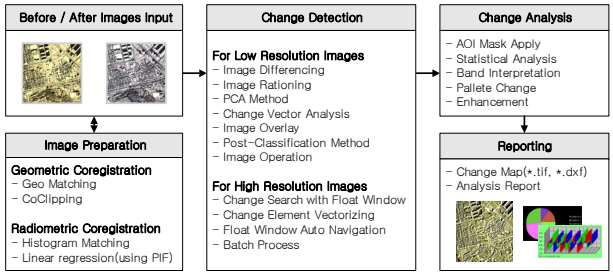


**Fig. 2. The change detection process with ChangeAnalyzer**

as an input image for change detection, image preparation operation accomplishes geometric and radiometric co-registration. The change elements between two processed images can be detected with various change detection methods. Also the developed system can analyze the extracted change elements and make the reports helpful for decision-making in various fields.

## 3. Conclusions

Using IRHIS, satellite image processing component packages, complied with OGC Grid Coverage Standard, we developed a general purpose change detection system, so-called ChangeAnalyzer, which can be applied to detect the change in various fields.

This system provides a variety of functions for analyzing the element of the change, as well as, functions for specifying the images suitable to detect the change, for examining the propriety of the input image to be utilized, for detecting the change with pixel-based method on low-resolution images, and for detecting the change with a float window method on a high-resolution images. This system can rapidly handle the a huge size of satellite images and can be easily expanded or ameliorated by assembling the components, because it is developed with IRHIS(Integrated Rs s/w for High resolution satellite ImageS) components complied with OGC Grid Coverage standard. Furthermore, it could make a group of experts possible to cooperate with each other to detect and analyze the changes, if we use the characteristics of IRHIS that can easily manipulate the large amount of satellite images on the distributive environment.

The concept of this system can be applied to a variety of fields, such as environmental monitoring, city planning, forest conservancy, geographical information renewal, and military purpose. Especially, it could be useful to the fields of detecting changes on the high-resolution satellite images, such as the monitoring of illegal structure, the renewal of a small-scale map, and the damage analysis of a disaster, which are hard to analyze with the existing change detection methods using the low-resolution satellite images.

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