THE DEVELOPMENT OF CHANGE DETECTION SOFTWARE FOR PUBLIC SERVICES

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ABSTRACT Change detection is a core function of remote sensing. It can be widely used in public services such as land monitoring, damage assessment from disaster, analysis of city growth, etc. However, it seems that the change detection using satellite imagery has not been fully used in public services. For the person who is in charge of public services, it seems not to be ease to implement the change detection because various functions are combined into it. So, to promote the use of the change detection in public services, the standard, the process and the method for the change detection in public services should be established. And the software which supports that will be very useful.
This study aims to promote the use of satellite imagery in public services by building up the change detection process which are suitable for general public services and developing the change detection software to support the process. The software has been developed using ETRI Components for Satellite Image Processing to support the interoperability with other GIS software.

KEY WORDS: Change Detection, Satellite Imagery, Public Services

1. INTRODUCTION

In 1999, IKONOS-2 satellite succeeded in its launch by Space Imaging, USA, which had 1 meter high resolution camera. In the same year, Korea also succeeded in the launching of KOMPSAT-1 which had 6.6meter resolution panchromatic camera. In the next year, both satellites started to provide high resolution satellite imagery of high quality in Korea. As the satellite imagery was rapidly distributed, the applications of satellite imagery were widely recognized and have been increased in various fields.

In the application of satellite imagery, various functions are related with the operations to manage, process and manipulate it. To operate the functions, software of high price and experts in remote sensing are required. In reality, because of the lack of experts and the software tools, the applications of satellite imagery have not been able to keep pace with the increasing supply of the imagery. As the result, the applications of satellite imagery usually have been carried out with limits by experts in research or academic institute as research services and the applications for public services as well as daily life have been insufficient.

Because of National Geographic Information System of Korea which has been performed during the last decade, GIS has been widely used in policy making, planning, and administration of public service in Korea. Also, the demands for satellite imagery in GIS are increasing now, because the satellite imagery affords not only visual effects but also reliable qualitative and quantitative analysis in GIS.

Change detection is one of the most important functions of remote sensing. It can be used effectively in public services such as land monitoring, damage assessment from disaster, analysis of city growth, etc. As the matter of fact, however, the change detection using satellite imagery is not practically used in the fields of public services. Though many researches have been concentrated on the automation of processes in remote sensing during a few decades, change detection using satellite imagery still requires technical knowledge of operator. Therefore, it is not easy for the person who is in charge of public services to operate the change detection using satellite imagery with his own option and decision.

In this paper, we investigated on the state of the art of change detection technology and analyzed the procedures and related functions. Then, we developed computer software to support the operation of change detection using satellite imagery in the field of public services. Consequently, we intended to promote the application of satellite imagery in the field of public services by developing a convenient tool for the change detection using satellite imagery in public services.

2. FUNTIONS OF CHANGE DETECTION USING SATELLITE IMAGERY

2.1 Change Detection using Satellite Imagery

The change detection using satellite imagery have been widely used in such fields as environmental monitoring, city planning, forestry management, update of GIS database, military information etc. In most cases it uses multi-temporal satellite images.

The general procedure of change detection using satellite imagery is consist of several steps; data acquisition and pre-processing, geometric and radiometric corrections, data normalization, change detection analysis, accuracy assessment, final product generation to make report (Lunetta and Elvidge, 1998). Figure 1 shows the procedure.

Although the procedure illustrated in figure 1 can be regarded as general steps of change detection, the functions that can be included in each step seem to be hard to be generalized because there are so many options to select or combine the functions in each step according to the characteristics of satellite images to be applied, the purpose of change detection, the environment of the object field, etc.

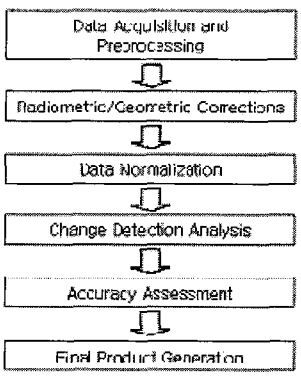

Figure 1. Procedures of change detection using satellite imagery

2.2 Analysis of Existing Software

The change detection with satellite imagery has been performed mainly using commercial satellite image processing software of high price. In the existing commercial satellite image processing software, numerous functions are arranged. Properly combining these functions, experts in remote sensing can deduce a method for purpose. Change detection also can be implemented by combining various functions in the commercial software according to the types of satellite imagery, object of change detection, required accuracy, etc. But, it would be hard for the people in common to undertake this kind of work. Only experts in satellite image processing would be able to perform it with his knowledge and experience.

In this study, we analyzed the functions related with change detection which were provided by worldwide famous software packages such as ER-Mapper®, ERDAS IMAGINE® and PCI Geomatics®, and by Korean software package called iCube® (old version of PG-STREAMER®).

As mentioned previously, the software packages we analyzed usually provided restricted functions for simple change detection. Moreover, functions required in whole process as illustrated in figure 1 were distributed across the whole packages. So, it won't be easy for people in common to find proper functions in the packages for change detection using satellite imagery.

3. DESIGN OF SOFTWARE

3.1 User Requirements

The user requirements should be induced in advance of software design through analysis of change detection works in public service and its characteristics. However we could not find any public institute in Korea which operates change detection works as a regular job. So, we visited Korea Institute of Water and Environment and made an interview with a staff at KIWE to induce user requirements. Although KIWE do not perform the change detection using satellite imagery as a practical job, it has made the good use of satellite imagery and aerial photos in their business. The result of the interview could be summarized as follows,

- o Integrated environment is required that includes pre-processing and post-processing for change detection.
- o Change analysis function that enables to deal with classified images would be very useful in practical works.
- o Geometric correction and radiometric correction are necessary to change detection.
- o In case of high resolution imagery, visual interpretation and manual operation are inevitably required in change detection.

From the analysis of the user requirements induced from the interview at KIWE, the investigation of functions on existing commercial software and the research of the literature on change detection, we grouped all functions required in change detection procedure shown in figure 1. Table 1 shows the grouping of the functions according to each step of change detection.

Table 1. Required functions in the procedures of change detection using satellite imagery

Step	Required functions
data acquisition and pre-processing	- image I/O - Co-clipping
geometric and radiometric corrections	- geometric correction - radiometric correction - image enhancement
data normalization	- data conversion - band operation
change detection analysis	- change detection algorithms (image differencing, image rationing, image overlaying, change analysis with classified images, image operation)
accuracy assessment	- accuracy assessment - band operation - AOI setting
final product generation	- threshold setting - image enhancement - palette change

3.2 Software Design

Based on the above user requirements, we designed the software for change detection using satellite imagery to be used in public services. Figure 2 shows the design. As illustrated in figure 2, all steps in figure 1 are reduced to 3 steps; pre-processing, change detection, and result analysis and 2 utilities; image viewer and image checkup. Data were processed based on image files system.

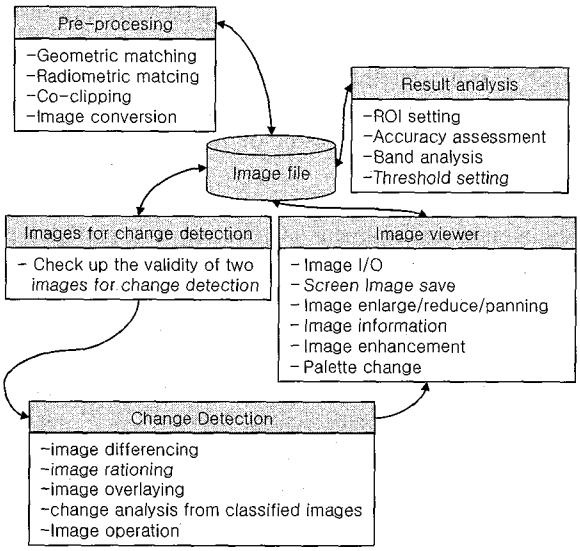

Figure 2. Design of the software for change detection

Image viewer is closely linked with image files and displays them on the screen. Band selection and RGB channel allocation are options of the image viewer. Image enhancement and palette change are also performed on the image viewer. Image viewer shows the information of displayed image. Displayed images can be stored as an image file.

In stage of pre-processing, geometric matching, radiometric matching, co-clipping, image conversion are performed based on the image file I/O. Temporary images are displayed on the dialog box of each pre-processing function to identify the state of processing. Result of each function is saved when the operation completed.

Two images for change detection should be suitable for the functions of change detection (Jensen, 1996). In our design, two images are checked up on the validity for change detection in advance of it. If two images are not suitable for change detection, software informs the reasons and measures to user. Then, user will go back to the pre-processing stage to operate correct pre-processing for change detection.

In change detection, 5 algorithms are supported. Once two images are input, algorithms can be selected and executed with input of required parameter. The output of each algorithm is directly displayed on the image viewer. User can identify the result immediately and store it using the save function of image viewer.

On the result analysis stage, ROI(region of interest) setting, accuracy assessment, band analysis and threshold setting are operated using the output file from change detection stage. The output is saved as file and can be displayed on the image viewer if user wants to visually check it.

4. SOFTWARE DEVELOPMENT

4.1 Environments for Software Development

We used Visual C++ 6.0® included in Visual Studio 6.0® of Microsoft® as a development tool and Pentium PC with WindowsXP®SP2 as a development platform. Pentium PC is readily available at public service area in Korea.

To secure the interoperatabilities with other GIS software that are commonly used in public services, we adopted GIS specifications released by the OGC (Open GIS Consortium) that are now adapted as worldwide standards (Open GIS Consortium, 2001).

The GridCoverage Specification of the OGC is closely related with satellite image processing and we conformed to the specification in our development.

It is very advantageous to use existing software components because it makes possible to reduce the development period and to secure the stability of the software. So, we made the best use of existing software components developed by ETRI (Electronics and Telecommunications Research Institute) at Korea in the implementation of image viewer and image I/O(ETRI, 2004).

ETRI Components for Satellite Image Processing had been developed according to the OGC GridCoverage Specification. So, it provides not only interoperatabilities with other GIS software, but also high level of image I/O with high speed for satellite imagery of huge size.

4.2 Developed Software

The user interface of the software developed in this paper for the applications in public services is presented in figure 3. As we run the software, a simple toolbar looks like upper part of figure 3 is displayed on the computer screen. Then, by clicking each button, corresponding window or menu is popped up.

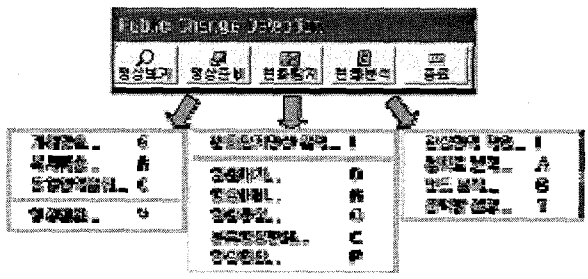

Figure 3. User interface

Clicking first button from left side on the toolbar of figure 3, image viewer looks like figure 4 is popped up on the screen. User can display several image viewers by

clicking the button several times as far as memory is enough.

Fig 4. Image Viewer

Image viewer provides not only simple image display but also simple image processing and storing displayed image. So, it is interactive with almost all functions to show outputs effectively along the entire software.

The picture on figure 4 shows an output of change detection from satellite imagery using the software developed in this research.

4.3 Discussion

The software developed in this research aims to be applied to change detection in public services. Users are supposed to be the person who is in charge of public services and they would not be accustomed to the satellite imagery. So, the software is designed to be easily operated focused on change detection of large area.

At present, the software has not been practically tested because we have not been able to find any public institute in Korea which operates change detection works as a regular job. However, compared with existing commercial software packages, the software would be more efficient in change detection for public services because it is specialized software for change detection of public services.

The software developed in this paper could contribute to satisfaction to demands for technology to apply satellite imagery in public services in Korea by promoting and maximizing the application of satellite imagery.

5. CONCLUSIONS

In this paper, we investigated the technology and user requirements for change detection in public services and developed computer software for change detection using satellite imagery to promote the application of satellite imagery in public services.

According to the general steps of change detection procedure, we arranged the required functions at each step and implemented it to develop change detection software for public services.

The software developed in this study will be tuned after practical application in the future, then, it will be able to contribute to the enhancement of application of satellite imagery in public services.

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