A Study on Decision Support System for Change Detection

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Abstract: Change detection using aerial and satellite images is one of the important research topics in photogrammetry and image interpretation. It is of particular importance especially in the fields of military, political and administrative affairs. When there is a need to detect changes in multi-temporal images, the most efficient methods for change detection and thresholds of change/no change area need to be chosen. Also, the images obtained from the various methods need to be analyzed. To do so, we need a system that can support our decision making process. Therefore, in this paper, we propose the Decision Support System for Change Detection. This system is composed of Data Base, Model Base and Graphic User Interface(GUI). Data base is a compilation of previous change detection results, and Model Base comprise of numerous operations. The data can be input and have the results of change detection analyzed by using GUI. In this paper, we will explain the entire operation of the system and demonstrate the level of its effectiveness.

Keywords: change detection, decision support system

1. Introduction

In change detection, the changes of land cover are analyzed by using multi-temporal satellite images or aerial photos. Through this method, wide land cover and various land use can be easily monitored periodically, and thus is extensively utilized in fields of military, political and administrative affairs.

In order to detect changes of images, we need to choose the most efficient methods of change detection and threshold of change/no change area. In addition, these images obtained from different methods need to be analyzed. To do so, we need a system that can support our decision making process.

So far CEOs have relied on decision support system for making their decisions. Recently we have developed decision support system that can help us select methods of classification and plan urban & transportation policies.

In this paper, therefore, we propose the Decision Support System that will help in decision making in relation to detecting changes in multi-temporal images.

2. Change Detection

1) General Process of Change Detection

Fig.1. shows a general process for detecting change. To detect changes, pre-processing is essential and after which, it would be possible to detect change of multi temporal images.

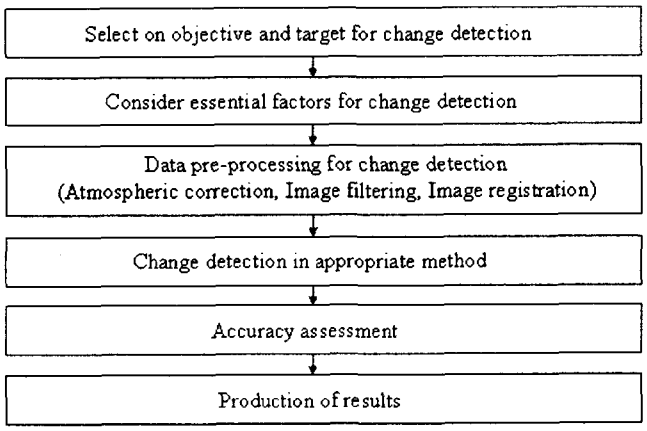

Fig.1. General Process of Change Detection

2) Change Detection Techniques

Change detection techniques can be largely divided into pre-classification comparison and post-classification comparison. Pre-classification comparison detects changes without classifying rectified images, whereas, post-classification comparison compares images after classifying rectified images.

1. Pre-Classification Comparison

Image Differencing(ratio)
Compute the difference of pixel's value in same coordinates
PCA(Principal Component Analysis) Differencing
Using principal component analysis, we produce PCA images, and detect difference in the PCA images.
CVA(Change Vector Analysis)
Using the magnitude of change vector and direction of change vector, we can analyze changes of multi-temporal images.
Vegetation Index Differencing
After computing vegetation index of images, we analyze change using the difference of vegetation index.
Image Regression
After expressing the linear functions, we detect changes applying definite thresholds.

2. Post Classification Comparison

MDC(Minimum Distance Classifier)
Using the relationship of average location of spectral classes, we classify pixels to the nearest class
MLC(Maximum Likelihood Classifier)
Compute statistical probability of a given value being a member of a particular land cover class
Mahalanobis Classifier
Algorithm that classify pixels not in accordance with the concept of probability but distance
K-means Classifier
Algorithm that classifies pixels based on minimizing the sum of distances' squares.

3) Matters to be decided in change detection

In detecting changes, first, we need to decide on the methods of change detection. And we need to choose the thresholds of change/no change area. As, in general, those thresholds are decided empirically, it would be more efficient to refer to previous results of change detection for similar environment.

Various change detection techniques produce different results of change detection images. Therefore, we need to compare these results visually and statistically. We can also apply weights of different results based on previous cases of change detection.

3. Decision Support System for Change Detection

1) Decision Support System

Decision Support System (DSS) is a computer based system which support user's decision making by offering models and analysis data.

It should be noted that DSS only supports decision making. The users are ultimately the one making the decision. That is, users make decision based their insights and the information obtained from DSS.

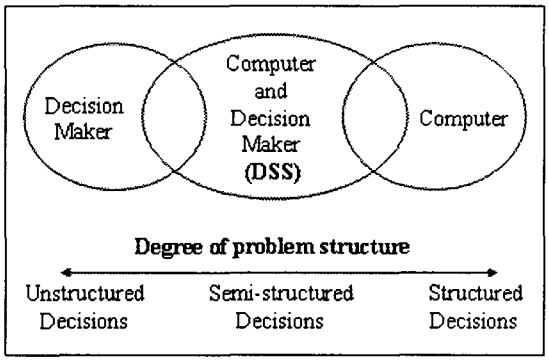

Fig.2. Decision Support System

2) Decision Support System for Change Detection (DSSCD)

In this study, in order to support a user's decision making process, we propose the Decision Support System for Change Detection(DSSCD). It offers data from the Data Base which is a compilation of previous cases. The data are provided via the GUI(Graphic User Interface).

3) Outline of the DSSCD

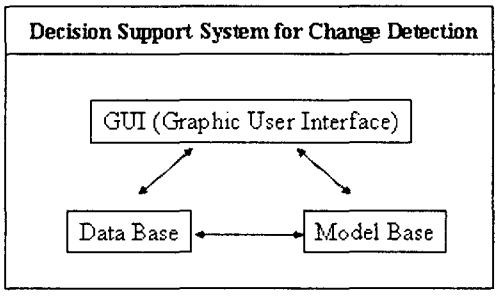

Fig.3. DSSCD

As a whole, DSSCD is composed of three parts which are systemically connected with one another. They are Data Base, Model Base and GUI(Graphic User Interface). Data Base is composed of many previous cases related to change detection. We can input data through GUI and analyze results by GUI visually and statistically. Using case data from the Data Base and input data from GUI, the Model Base can operate numerous functions.

Using the basic model, we can apply it to change detection. This illustrated in Fig.4

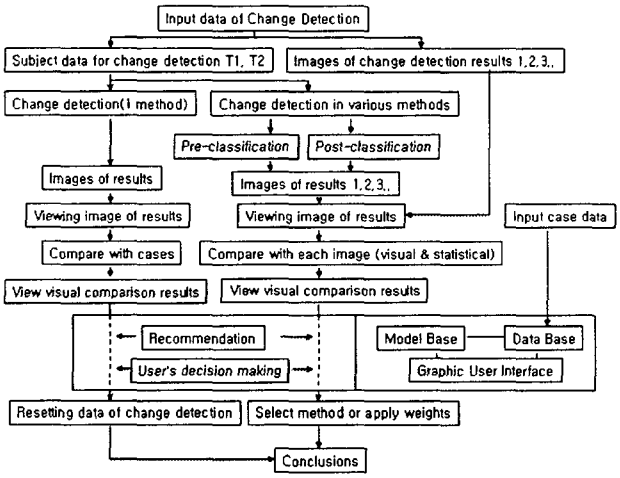

Fig.4. Flowchart of the DSSCD

4) Functions of the DSSCD

DSSCD has several functions. Using cases from the Data Base, DSSCD retrieves cases which are similar to subject data. Then, it offers information of cases and weights between them. In addition, it recommends suitable change detection techniques.

The functions of the DSSCD are as follow.

1. Retrieves and offer case data
2. Recommends change detection techniques (offering ranking of techniques)
3. Offers weights of change detection techniques (Offering weights of pixels of different techniques' results)
4. Offers threshold information
5. Compares different techniques' results visually and statistically
6. Resets data of change detection(thresholds, weights of pixels) and
7. Inputs case data of change detection and builds Data Base

5) Data Base

Data Base is mainly composed of previous cases. Users directly input case data through GUI into DSSCD. Components of Data Base are follows.

1. Dataset and resolution
   NOAA, EOS, Landsat, SPOT, Quickbird, Envisat, Kompsat, IRS, JERS, ERS, Radarsat
2. Continent
   Continent is used for detecting changes. There is an own ID value on continents.
3. Nation
   After choosing a continent, automatically we can select the nation. There is an own ID value on nations.
4. Climate
   Climate is considered as a factor which could affect change detection. We can choose climate.
5. Change detection technique
   Input change detection technique which was used
6. Target of change detection
   If main target of change detection exists, we can input it in text form.
7. Overall accuracy of Change Detection
   Input accuracy by figures form (%).
8. Thresholds
   We can input thresholds by standard deviation form. It can also have a null value.
9. Threshold Information
   If it is difficult to express threshold by direct figures, we can write the threshold information to support user's decision making.
10. Error matrix
    We can input error matrix in text form
11. References
    There may be other information that can aid change detection. We can input the information in this form.

6) Model Base

1. Case retrieval
   The process proceeds in the following order: Dataset (Resolution)→ Location (Continent, Nation)→ Change detection technique→ target of change detection.
2. Change detection
   We can detect changes in several different techniques in this part.
3. Viewing visual data
   This part has to do with viewing images of results or subject images
4. Viewing statistical data
   This part shows the total number and percentage of change/no change pixels by graphs and tables
5. Visual Comparison

We can visually compare different results' images using basic spatial operation in this part. There is an emphasis on common change/no change area.

6. Statistical Comparison
   We can statistically compare different results' images by graphs and tables of each image.
7. Recommendation
   This part offers weights and ranking of change detection techniques. It also offers weights of the pixels of the various change detection results. Weights and ranking are based on the overall accuracy in similar cases from the Data Base.

7) Graphic User Interface(GUI)

We can approach DSSCD through GUI. GUI is largely divided into input case data part and subject data part. In addition, there are also some parts for visual & statistical analysis.

1. Input case data of change detection
2. Input subject data of change detection
3. Input data of change detection results
4. Change detection and view images
5. Reset data of change detection

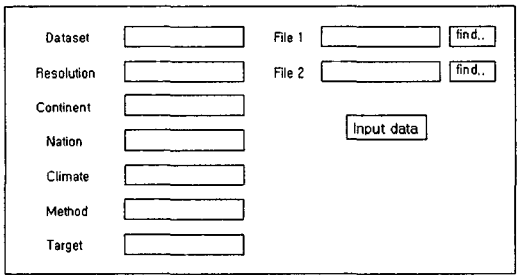

Fig.5. Example of subject data's form of change detection(GUI)

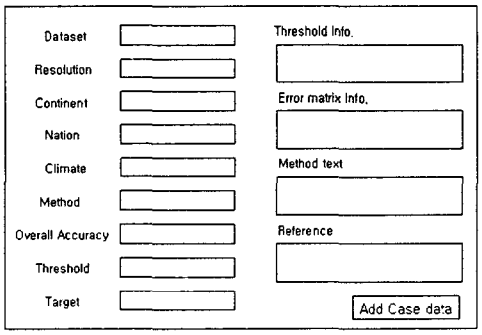

Fig.6. Example of case data's form of change detection(GUI)

4. Conclusions

In this study, we proposed the Decision Support System for Change Detection. This system is composed of Data Base, Model Base and GUI. Data base is composed of previous results of change detection, and Model Base is composed of several operations. The data can be input and produce the results on change detection analyzed by using GUI.

The suggested system offers information of thresholds, overall accuracy, and weights between methods. The information are from well-structured Data Base. Various change detection techniques produce different results of change detection. We can compare these results visually and statistically. In addition, we can choose the change detection method by using system's recommendation, and obtain new results using the recommended weights of pixels. DSSCD is worthy of notice, as it offers more useful information for change detection and support decision making.

A more structured Data Base would be able to offer more information to users. Thus, we need to continuously input more cases of change detection to Data Base. As it is difficult to input all cases into the Data Base in the same form, it is necessary that we improve this part in future work.

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