Detecting The Environmental Changes Area Of Satellite Image

Nang Mya Mya Nwe and Myint Myint Sein
Mandalay Technological University and University of Computer Science, Yangon
nangmyamyanwe@gmail.com, chuchu0218@gmail.com

Abstract

Remote sensing images are frequently used for a variety of tasks such as image fusion, temporal change detection and integration of multi-source data in Geographical Information System (GIS). The basis of all these tasks is accurate image registration, though the requirement of registration accuracy may vary from one task to the other. For example, it has been reported that a registration accuracy of less than one-fifth of a pixel is required to achieve a change detection error within 10%.

The goal of this paper is detecting the environmental changes from satellite image that could affect the globe in the future conditions like pollution, global climate change, natural resource management, urban growth, and much more and trend across large geographic areas from a subset of a Landsat Thematic Mapper (TM) multispectral image to use in GIS. This paper also aims to present a review of recent image registration methods for detecting the environmental changes. The reviewed approaches are classified according to their nature (areabased and feature-based) and according to four basic steps of image registration procedure: feature detection, feature matching, mapping function design, and image transformation and resampling. The intended result is to detect the damage area and to recover the lost data after the Tsunami effect from the satellite image by using image registration method.

Keywords: analyzing, image registration, feature detection, feature matching, mapping function, resampling.

1. Introduction

Satellite data has been successfully used since the 1970's. The principal applications have been for weather prediction, to monitor global environment conditions, and geographical and geological applications. Climate changes and population growth cause increasing pressure around the world's highlands. The results of the pressure are manifold: urban growth, intensified agriculture, decrease of forested areas, loss of biodiversity, accelerated land degradation and soil erosion. The consequences introduce great demands on land use planning. Remote sensing data and techniques, and geographic information systems (GIS), provide efficient methods for analysis of land use and tools for modeling and planning [4]. Image registration is required in remote sensing (multispectral classification, environmental monitoring, change detection, image mosaicing, weather forecasting, creating super-resolution images, integrating information into geographic information systems (GIS)), in medicine (combining computer tomography (CT) and NMR data to obtain more complete information about the patient, monitoring tumor growth, treatment verification, comparison of the patient's data with anatomical atlases), in cartography (map updating), and in computer vision (target localization, automatic quality control), to name a few.

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 objection and minimizes the compared information. Another method of change detection system based on visual interpretation of high-resolution satellite imagery also has limitation in the case of two images which differ in color, resolution, and captured image over time changes. It is less accuracy to predict the change percentage. [3]

Environmental Changes detection is useful technology that can get temporal change information with comparison and analysis among multi-temporal satellite images. Especially change detection in high-resolution satellite imagery can be used to extract helpful change information for many purposes, such as the environmental inspection, the circumstantial analysis of disaster damage, the inspection of illegal building and the military use, that can not be achieved in low-or middle- resolution satellite imagery.

The main purpose of this paper is to detect the damage area and to recover the lost data after the Tsunami effect from the satellite image with registration method.

2. Processing Satellite Imagery

Since resolution is such an important and vital element of spatial digital data for use in geographic system, it is important to know how to assess its quality, accuracy and level of precision. In this paper, registration algorithm is applied for the images that took at different times and different viewpoints. Deblurring algorithm is applied for the blur or noisy image to get a good resolution. Wavelet-packet is suitable since it offer a good resolution in frequency and a decomposition in “wavelets style” coefficients which ensures an coefficient denoising [7]. Both the deblurred image and the good or high resolution satellite image, image registration or resizing is done to get higher-quality change detection results.

Image is classified as RGB model because it has wide range of colors enable to search the changes in the image. Then the information is extracted by comparing two or more images of an area that were acquired at different time by subtracting the digital numbers(DN) of one image from theose of an image acquired earlier or later. The resulting values for each pixel will be positive, negative, or zero; the latter indicates no change. The next step is to plot these values as an image in which a neutral gray tone represents zero. Black and white tones represent the maximum negative and positive differences respectively.

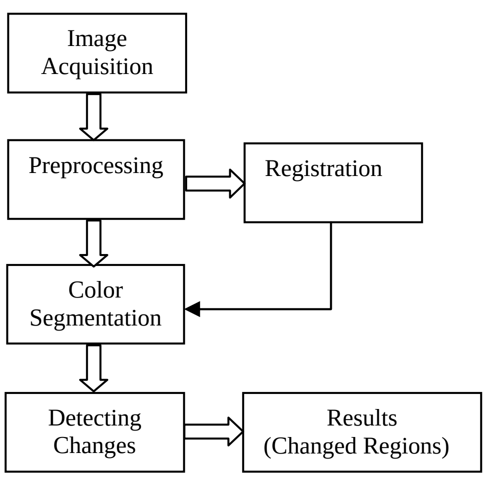


Figure 1. Block Diagram of proposed system

As follows, there are general processes to process the satellite image to detect the environmental changing. [4]

1. Data Acquisition and Preprocessing
2. Radiometric/Geometric Co- registration
3. Change Detection Analysis
4. Accuracy Assessment
5. Final Product Generation

As a general definition, automatic image registration of satellite image data is the process that aligns one image to a second image of the same scene that was acquired at the same or at different times by different or identical sensors. One set of data is taken as the *reference data*, and all other data, called *input data (or sensed data)*, is matched relative to the reference data. The general process of image registration includes three main steps:

- Extraction of features to be used in the matching process.
- Feature matching strategy and metrics.
- Data re-sampling based on the computed deformation (sometimes replaced by indexing or fusion.

Many choices are available for each of the previous steps [1,2].

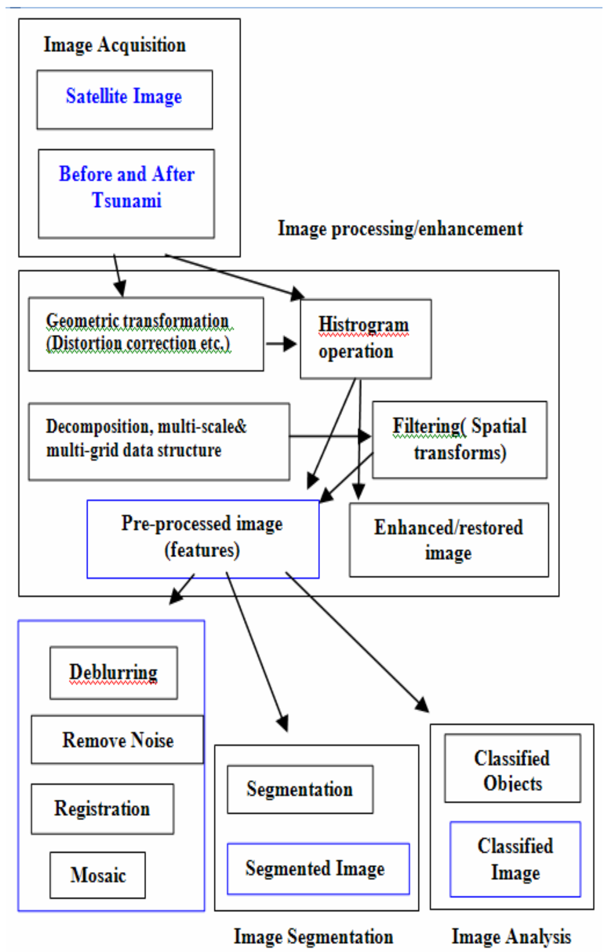


Figure 2. Schematic of hierarchies and sequences of image-processing tasks

3. Image Registration Approach

Digital image registration is very important in many applications, such as medical imagery, robotics, visual inspection, and remotely sensed data processing. The analysis of such data requires integration, therefore, accurate registration of these data. Image registration is defined as the process that determines the most accurate relative orientation between two or more images, acquired at the same or different times by different or identical sensors. Registration can also provide the orientation between a remotely sensed image of the Earth and a map.

Image registration is the process of overlaying two or more images of the same scene taken at different times, from different viewpoints, and/or by different sensors. It geometrically aligns two images—the reference and sensed images. The present differences between images are introduced due to different imaging conditions. Image registration is a crucial step in all image analysis tasks in which the final information is gained from the combination of various data sources like in image fusion, change detection, and multichannel image restoration.

The accurate transformation matrix is the key of the registration approach. At least three matching pairs are needed to guess the initial transformation matrix. Let us consider the registration between two parts of an object. The first part is supposed to be a main part or destination part, and the second part is supposed to be a current part or transformed part. Let *P'* and *P* denote the points on the main part and current part of an object and their relation can be expressed as:

$$P' = \Omega P + D\,, \qquad (1)$$

where D is the translation parameter and Ω contains the scaling and rotation parameters.
In 2D Case, Ω and D can be defined as:

$$\Omega = a\begin{bmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{bmatrix}$$

And $D = [d_1 \quad d_2]^T$,

where a , θ and d_1 , d_2 are the scaling, rotation and translation parameters, respectively. The initial transform matrix 0 $\boldsymbol{T}$ can be detected for both cases from above relations. The accurate transformation matrix is computed iteratively to minimize the distance between the points of the two parts expressed in the following equation.

$$D_i^k = \sum_i distance\,(\boldsymbol{T_i}\,\boldsymbol{P_i}\,, \boldsymbol{P}'_i\,) \qquad (2)$$

where $\boldsymbol{T_i} = \boldsymbol{T}o\boldsymbol{T}$. The difference δ_i from the $(k-1)^{th}$ to the k^{th} iteration is defined as $\delta_i = \frac{1}{N}(D^k - D^{k-1})$, where $|\delta_i| \leq \varepsilon_i$ and N is the number of control points on the curve. This process is continued until the difference $|\delta_i|$ becomes less than a threshold value ε_i (> 0).

4. The Detection System

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. Especially, change detection methods with high-resolution satellite imagery are very useful for the missions of inspecting on the earth such as environmental monitoring, circumstantial analysis of disaster damage, inspection of illegal buildings, the military use and so on, which cannot be achieved by low- or middle-resolution satellite imagery.

As follows, there are general change detection processes to detect change between multi-temporal images [5].

- Data Acquisition and Preprocessing
- Radiometric/Geometric Co-registration
- Change Detection Analysis
- Accuracy Assessment
- Final Product Generation

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 [6].

In this paper, detection system is proposed 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. It is planned the process including_

1. Input the blur or noisy image and High-resolution Image
2. Image registration, resizing, deblurring
3. Color Segmentation to search changes

4. Extracting for the Changing regions
6. Calculate the Percentage of changes
7. Result the Changed Area

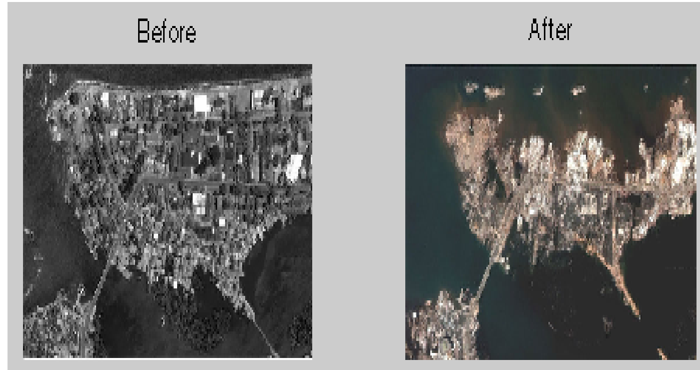
5. Experiments and Results

The tsunami satellite images got from the website of international community foundation and online donation are applied in experiment. Firstly, the images are processed for the blur, noisy before detecting the changes region. Figure 3(a&b) are Banda Aceh Shore (Indonesia) of before and after Tsunami showing the detecting of changes region with no registration processing. With image registration, the change region is get better. Processing for image registration is shown in figure 4. After the registration, the result of detecting changes region get more accurate and better. This is shown in figure 5.

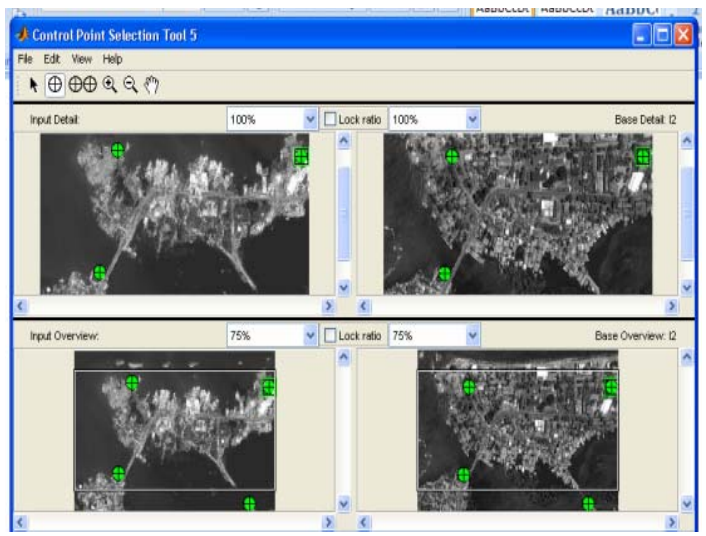
(a) Before Tsunami

(b) After Tsunami

Figure 3: Changed Detection Region (Gleebruk Village, Indonesia)



(a) Processing for registration



(b) Selecting Control Points

(c) Registered Image

Figure 4. Registration the Tsunami Image

Figure 5. Detecting the changes

6. Conclusions

The accuracy for the detecting the changes region is increased from 39.876 to 45.223% after registering image that is about 6% accuracy increased. Results of this work could be help scientists to look and study environmental changes that could affect the globe in the future conditions like pollution, global climate change, natural resource management, urban growth, and much more and trend across large geographic areas.

Reference:

[1]. A. Goshtasby, J. Le Moigne, “Special Issue Image Registration,” *Pattern Recognition,* V.32, N.1, 1999.

[2]. L. Brown, “A Survey of Image Registration Techniques,” *ACM Computing Surveys*, vol. 24, no.4, 1992.

[3]. Hua-mei Chen & Manoj K. Arora and Pramod K. Varshney1, “Mutual information based image registration for remote sensing data” , Department of Computer Science and Engineering, University of Texas at Arlington, Arlington, TX 76019, USA. & Department of Electrical Engineering and Computer Science , Syracuse University, Syracuse, NY 13244, USA.

[4]. P.K.E. Pellikka, B.J.F. Clark, T. Sirviö and K. Masalin “Environmental change monitoring applying satellite and airborne remote sensing data in the Taita Hills, Kenya” , Department of Geography, University of Helsinki, P.O. Box 64, 00014 Helsinki, Finland.

[5]. Ross S. Lunetta, et al., 1998. *Remote Sensing Change Detection, Ann Arbor Press*, USA, pp. 1~19.

[6]. Yong Du, et al., 2002. Radiometric normalization of multitemporal high-resolution satellite images with quality control for land cover change detection. *Remote Sensing of Environment*, 82, pp.123~134.

[7]. Pierre Dh´er´et´e THALES **,** Sylvain Durand LAMFA & CMLA, Ecole Normale Sup´erieure de Cachan , “A BestWavelet Packet Basis for Joint Image Deblurring-denoising and Compression”, Information Systems ,105 av. du G. Eisenhower, BP 1228, 31037 Toulouse cedex, France, Universit´e de Picardie Jules Vernes 33 rue Saint Leu, 80039 Amiens cedex 1, France, 61 av. du P. Wilson, 94235 Cachan cedex, France.

[8]. Nang MyaMyaNwe & Myint Myint Sein, “Extracting the Environmental Changes from Satellite Image”, 6th ISEIS2007, Bankok,Thailand. Pp. 17.