Paper presented at the 22nd Asian Conference on Remote Sensing, 5 - 9 November 2001, Singapore.

Change Detection of River Way Using Aerial Images

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KEY WORDS: Change Detection, Digital Camera, Digital Photogrammetry.

ABSTRACT: Satellite images have been applied in detecting the changes of an overall drainage basin. However, the resolution of the image data is not high enough for studying a small flood area. This research is therefore, going to collect images by using the low altitude remote sensing approach. A balloon was used as the platform to acquire image data in this research. A video camera and a digital camera were fixed together and hanged by the balloon. Radio images were communicated and displayed on a LCD monitor arranged on the ground. Once monitor the area of interest shown on the LCD, images were taken remotely with the digital camera. The resultant images were rectified for comparison and analysis. This method can be an effective and convenient way for the relative research about large-scale mapping.

1.Introduction

Recently, several flood disasters occurred near some riverbank areas in Taiwan. Even a dredged river is hard to avoid hazard. To monitor and to detect change of river way may assist to give a portent. Satellite images have been used in detecting change, but the resolution is still not high enough to apply in small research areas. Aerial photography may have good resolution for detecting change of a small stream, but one will naturally be concerned with the involved costs and scheduling. Generally, to take a flight costs much no matter how large an area is to be photographed. Usage of existing aerial images is therefore, the main consideration of this research for detecting change of a river way.

Change detection needs multi-date data of the study area. The study area of this research has a digital aerial photography produced in 1998. To acquire the latest image of the study area in an efficient way and with moderate prices was then, the primary motivation of this research. A cheap platform was hence, designed so that a digital camera and a wireless video camera were fixed together in a box hanged by a balloon. Both images acquired from the existing digital aerial photography and taken by the digital camera were registered and became the source data of this study.

Images acquisition, change detection using write function memory insertion and change detection using post-classification comparison are described in the succeeding sections.

2. Images Acquisition

Two images of the study area were used in this research. One was digitized aerial photography taken on October 1, 1998. The other one was digital image taken by a digital camera and exposed on August 2, 2001. The former has already been ortho-rectified and has a resolution of 0.1m per pixel. The latter was acquired in a process described as below.

A video camera and a digital camera, Kodak DC280 were arranged in a durable plastic box shown in Fig. 1. The box was hanged on a balloon. The video camera was used to monitor the ground view, and its image could be telemetered remotely and displayed on a LCD monitor arranged on the ground. When taking the pictures, the balloon was tied by three ropes and controlled separately by three people on the riverside. According to the flight plan, three people drove and adjusted the position and altitude of the balloon. Once monitoring the area of interest shown on the LCD, button of the digital camera was pushed remotely and image was taken.

The digital camera has a focal length of 60mm and a frame size of 1168 rows by 1760 columns. The camera has been calibrated so that the polynomial coefficients of radial lens distortion, and the pixel size, 0.021mm were solved. More than ten images were taken, but only seven of them were adopted in order to keep that the end lap of each stereopair was greater than 55%. The average flying height above ground is 150m. Before taking pictures, 24 ground control points were arranged. Three-dimensional coordinates of these points were measured by GPS.

An ortho-rectified mosaic of the images taken by the digital camera was also produced. The mosaic has the same pixel size as the digitized aerial photography has. Digital images on two different dates were thereafter prepared for change detection and shown separately in Figs. 2 and 3.

The study area is located in the campus of National Chengchi University, and has a size of 210m by 45m. As shown in Figs. 2 and 3, a significant change could be found in river way of the study area.

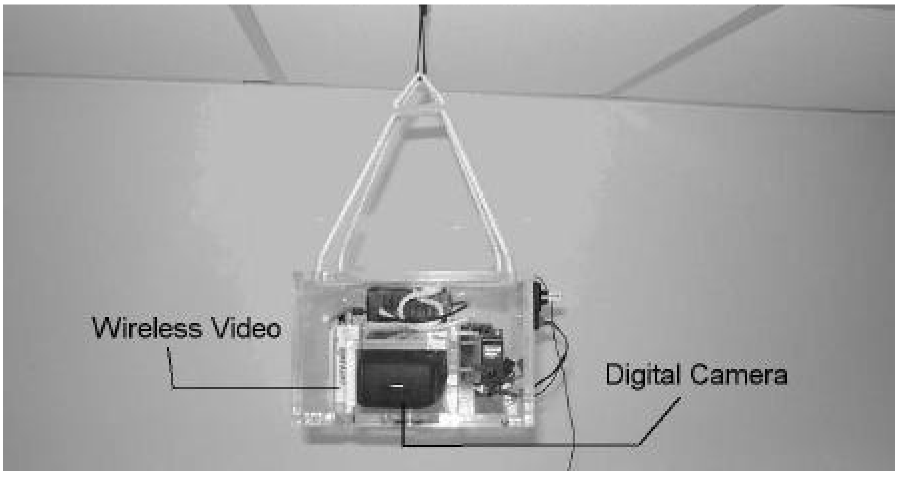

Figure 1 Remotely sensed unit of two cameras

3.Change Detection Using Write Function Memory Insertion

Write function memory insertion method was firstly used to detect change of source images. Because of this technique is an easy way to visually identify change in the imagery. Generally, in this approach, individual bands of the images are inserted into specific write function memory banks (red, green, or blue) in a digital image processing system (Jensen, 1996). As shown in Figs. 2 and 3, the tones of two images are quite different. For reducing this effect, instead of RGB bands of two rectified images, intensity bands of the images were used to generate a new image shown in Fig. 4. The intensity band of the 2001 image, the intensity band of the 1998 image, and no image were placed in the red, green, and blue image planes of the new image respectively.

Numerous changes can be seen in Fig. 4, including new concrete bank in red, new stair in red, sand in green, and changes in water surface between dates in red and green. Fig. 4 has allowed visual discrimination of change in the dredged river way by year. However, the method cannot provide quantitative information changing from one land-cover category to another.

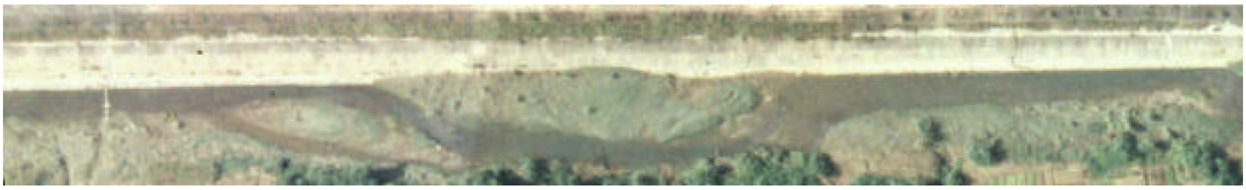

Figure 2 Ortho-rectified aerial image produced from October 1, 1998.

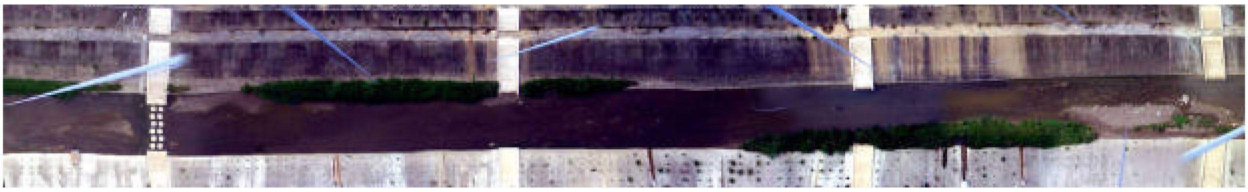

Figure 3 Ortho-rectified aerial image produced from August 2, 2001.

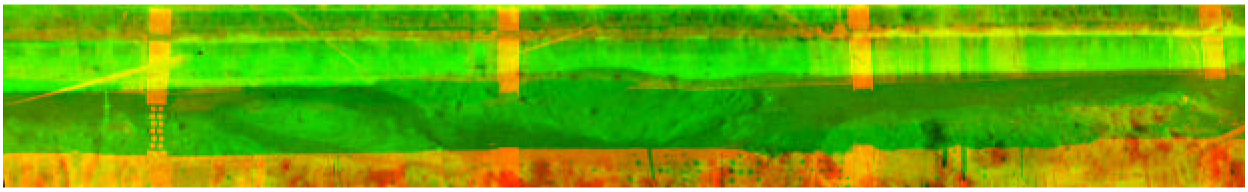

Figure 4 Change detection using Write Function Memory insertion using two dates of aerial images.

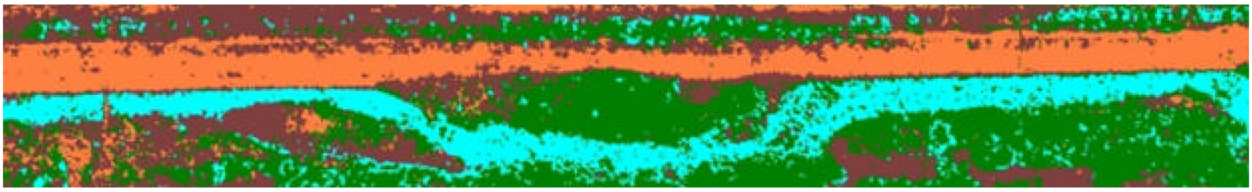

Figure 5 Classification map of the study area produced from October 1, 1998.

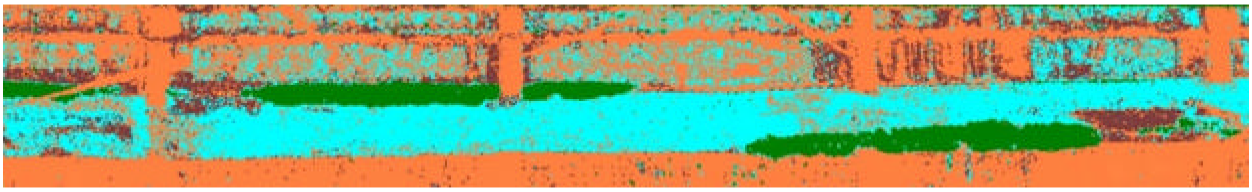

Figure 6 Classification map of the study area produced from August 2, 2001.

4. Change Detection Using Post-Classification Comparison

For extracting the detailed quantitative from-to information, post-classification comparison method was then, employed. This method requires rectification and classification of each image. The multi-date images have been ortho-rectified as mentioned above. Classification and change detection of the two images were conducted as the following way.

Supervised classification of each image was used. Four main cover types, water, concrete, plants, and sand were chosen to classify the river way. The classified images from Fig.2 and Fig.3 are shown in Fig.5 and Fig.6, respectively.

After training and classifying, the pixels in each image were assigned to the class of which it has the highest likelihood of being a member. So, the number of pixels assigned to which class could be filled up the change detection matrix shown in Table 1. The matrix offered a quantitative assessment for change between two images.

Table 1 Change Detection Matrix

1998 \ 2001	water	concrete	plants	sand	total
water	56873	44378	10970	8199	120420
concrete	33028	82757	5150	24446	145381
plants	73277	143023	2343222	20788	2580310
sand	50473	118863	9867	24446	203649
total	213651	389021	2369209	77879	3049760

As listed in Table 1, the areas of water and concrete have increased, and the parts of plants and sand have decreased. It showed that hydraulic engineering effectively reduced the deposition of sand, and the water apparently gathered in middle of the river way.

5.Summary

As mentioned above, the balloon platform could be used for obtaining the digital aerial images in a flexible way. Besides that, the flight cost is much less than that using an airplane platform. The aerial images taken by this low altitude remote sensing approach indeed reduced scheduling and cost problems.

Two ortho-rectified images have been proven to be well-matched when superimposing one image on another. On the whole, it was really a useful and efficient method of taking large-scale images for a small research area.

In order to realize the change, the images of the study area will be acquired continuously in a period of time. In addition, collection of the rainfall records, and study of the relationship between the rainfall data and the river way will be the later part of this research.

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