DEVELOPMENT OF A MAN-MACHINE INTERACTIVE SYSTEM TO DETECT LAND USE CHANGES BY USING REMOTE SENSING DATA

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ABSTRACT

A man-machine interactive system to detect land use changes by using remote sensing data has been developed. This system has been developed initially for house taxation. For house taxation purpose, digitized 1:5,000 color aerial photographs and digitized 1:2,500 maps are utilized.

The process of this system consists of two steps. The first step is the rough detection step that land use changed sites are roughly detected by digital image processing. And the second step is the precise examination step that detected sites at the first step are examined interactively by human interpretation through image display.

Combination of digital image processing techniques and human photo-interpretation makes higher precision and lower cost.

INTRODUCTION

Recently some Japanese municipal authorities begin to use color aerial photographs in order to detect land use changes for the assessment of the fixed assets. Since land use change detection using color aerial photographs is made by human photo-interpretation with use of enlarged color prints, large volume of manpower is necessary and efficiency of change detection is not so high.

On the other hand, an ideal system to detect land use changes is considered the fully automated system. However digital image processing techniques, especially pattern recognition techniques are not enough in cost and precision at present.

So the authors has developed a man-machine interactive system to detect land use changes. Combination of digital image

processing techniques and human photo-interpretation makes higher precision and lower cost in this system.

The process of this system consists of two steps. The first step is the rough detection step that land use changed sites are roughly detected by digital image processing. And the second step is the precise examination step that detected sites at the first step are examined interactively by human interpretation through image display.

This system has been developed initially for house taxation. For house taxation purpose, digitized 1:5,000 color aerial photographs and digitized 1:2,500 maps are utilized. At present another kinds of remote sensing data, such as LANDSAT MSS, TM, SPOT and MOS-1 MESSR, are available in this system.

The host computer of this system is a super mini-computer and now the authors are developing the new smaller and cheaper system using a personal computer as a host computer.

FLOW OF PROCESSING

Flow of the standard processing of this system is shown in Figure 1.

1) Data acquisition

Color aerial photographs are digitized through the A/D converter. At present color prints are digitized through the drum scanner. In future color negative roll films will be directly digitized through the CCD line Scanner. Pixel size of digitized photographs is from 25 cm by 25 cm to 100 cm by 100 cm on the ground.

If necessary map information is obtained from maps and/or existing GIS. Map information makes human interpretation easier, and brings higher precision and lower cost.

2) Geometric and radiometric registration

Digitized photographs are geometrically corrected to match existing maps. At present ground control points for geometric correction are selected manually. In future ground control points will be selected through automatic image matching.

Brightness and color tone of digitized photograph is corrected so that the difference of photographs taken at different dates can be less and two photographs can be compared easily.

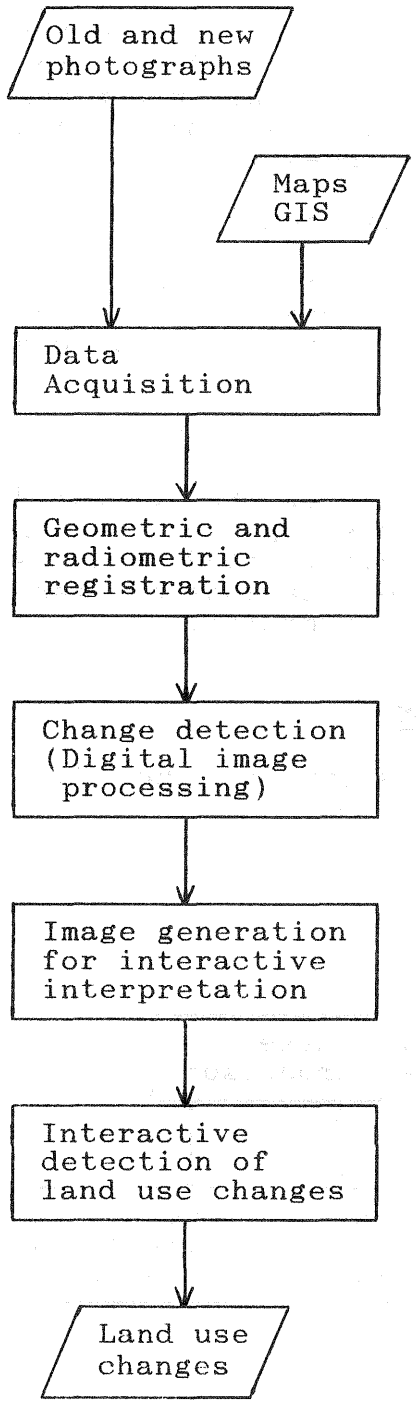
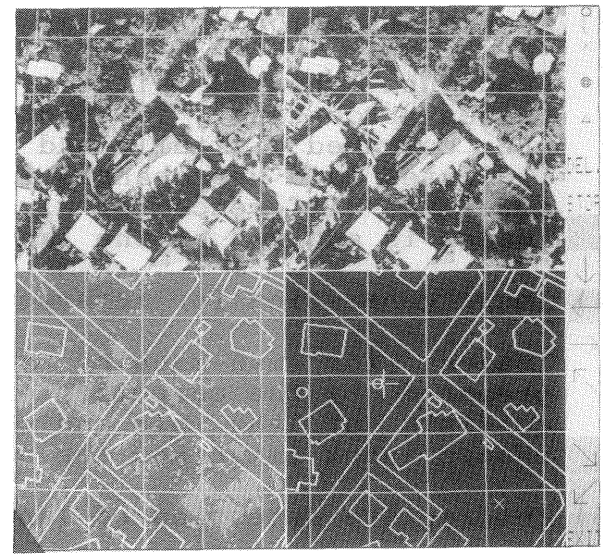


Figure 1 Flow of processing



Date 1 (Old) Digitized photograph image	Date 2 (New) Digitized photograph image
Land use change index image on digitized map	Detected land use change sites on digitized map

Figure 2 Image for interactive interpretation

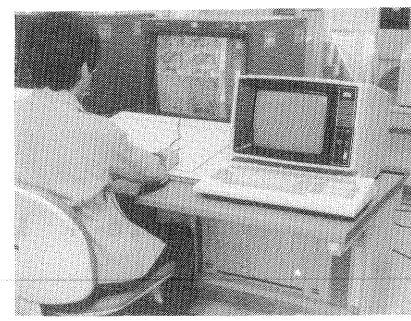


Figure 3 Man-machine interactive interpretation

3) Change detection by digital image processing

Land use changed sites are roughly detected by digital images processing. Two photographs taken at different dates are compared digitally and the land use change index which indicates land use changes is calculated. In this paper the absolute difference of digital values of two photograph images is adopted as the land use change index.

4) Image generation for interactive interpretation

Images for man-machine interactive interpretation are prepared by the computer. Figure 2 shows one example that consists of the old and new photograph image, land use change index image and the digitized map.

5) Interactive detection of land use changes

Land use changes are interactively detected on the prepared image through the color image display by human interpretation. Land use change sites are pointed out by using joy-stick, mouse or track-ball and locations of land use change sites are recorded in the host computer.

HARDWARE CONFIGURATION

Hardware configuration of this system is shown in Figure 4.

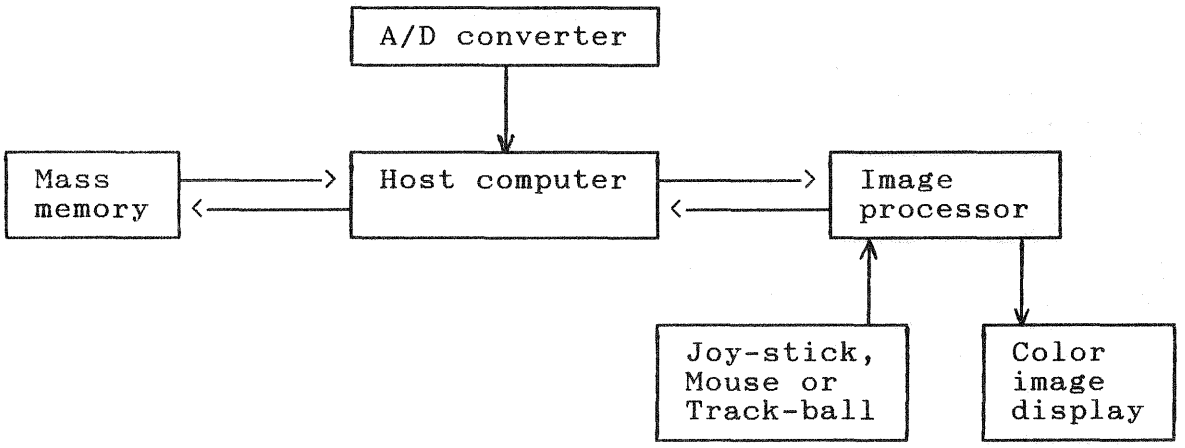


Figure 4 Hardware configuration

1) Host computer
Mini computer or personal computer.

2) A/D converter
Drum scanner or CCD line scanner.

To digitize photographs.

3) Mass storage
Magnetic disk or optical disk.
To store images.

4) Image processor
To control communication between man and machine.

5) Color Image Display
To display images for interactive interpretation.

6) Joy-stick, Mouse or Track-ball
To move a cursor over an image on the display to land use change sites and point out.

DISCUSSIONS

Through the development of the system, we have faced some problems as follows:

1) Optimum resolution of photographs

The smaller digitized pixel size is, the finer digitized image and the higher precision is. On the other hand, halving pixel size makes four times of computation time. We can conclude that the optimum pixel size is from 30 cm by 30cm to 50 cm by 50cm in the urban area of Japan.

2) Land use change index

There can be many kinds of indexes which indicate land use changes. The question what kinds of indexes are the best land use change index to indicate land use changes is very difficult.

In this paper we propose the absolute difference image of multi-date photographs as the change index image. The absolute difference image is made through a simple operation.

3) Images for interactive interpretation

In this paper we propose the image for interactive interpretation as shown in Figure 2. This image consists of four parts. The upper parts are the old and new photograph images, the lower left is the change index image on digitized map and the lower right is the image on which the detected and recorded land use change sites are displayed.

There can be a great variety of images for interactive interpretation. It is very difficult to answer the questions what kinds of images are the best for man-machine interactive interpretation.