EXAMPLES OF ANALYSIS OF AERIAL PHOTOGRAPHS AND GEOGRAPHIC INFORMATION SYSTEM FOR SURVEYING DISASTERS

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Abstract

Aerial photos which provide understanding of a subject at an arbitrary time from an arbitrary direction allow us to acquire valuable information in various surveys. In addition, processing of aerial photos into numerical (digital) data can replace relations with other geographical information data with computer operations. In particular, where prompt treatment is required, for example in case of a disaster survey, this digital processing of aerial photos is extremely effective and useful. Information obtained from morphological maps, geological maps, soil maps and others provide a valuable clue to understand its' causes and scale. Therefore, digital processing and then operational treatment of these map information with aerial photo data will bring about more reliable study/analysis.

This report focusses a disaster survey using image analysis; firstly, techniques to process aerial photos to digital data is discussed and then a new technique to process geographical information from various maps into digital data is explained and examined for its effectiveness. A case study is shown to examine the effectiveness.

1. Digital Processing of Aerial Photos

1.1 Introduction

Digital processing of aerial photos is currently dealt with in the field of analytical photogrammetry, where highly precise aerial photos are used based on a strict plan of photographing. Many disaster surveys require urgency, resulting in aerial photos with locationally low precision. However, aerial photos taken immediately after a disaster contain valuable information and thus offer important materials in conducting a fact-finding survey and planning disaster control measures.

In this paper, a technique to collect information from aerial photos taken in urgency is proposed and case studies are introduced.

1.2 Analytical Technique

Fig. 1 summarizes the analytical technique. This technique has been established with special reference to acquisition of much information from aerial photos taken without a strict photographing plan in consideration of a response to an emergent case.

(1) Aerial photos

Various types of photos including those taken by a camera for photo surveying, an ordinary small camera and others, or vertical photos and oblique photos, can be used.

(2) Scanner input

An aerial photo is set in a drum scanner. The aerial photo is divided into grids, in each of which reflexibility of light for every R (red), G (green) and B (blue) is converted to digital data and then stored as 3 band image data.

(3) Rectification (Measurement of ground control points/orthographic conversion)

Geometrical distorsion is rectified to convert to orthographic image data. This allows treatment of various images in the same condition and meaningful numerical values of distance, area and others. The rectification of aerial photos is made based on geometry of central projection (Fig. 2 and 3). That is:

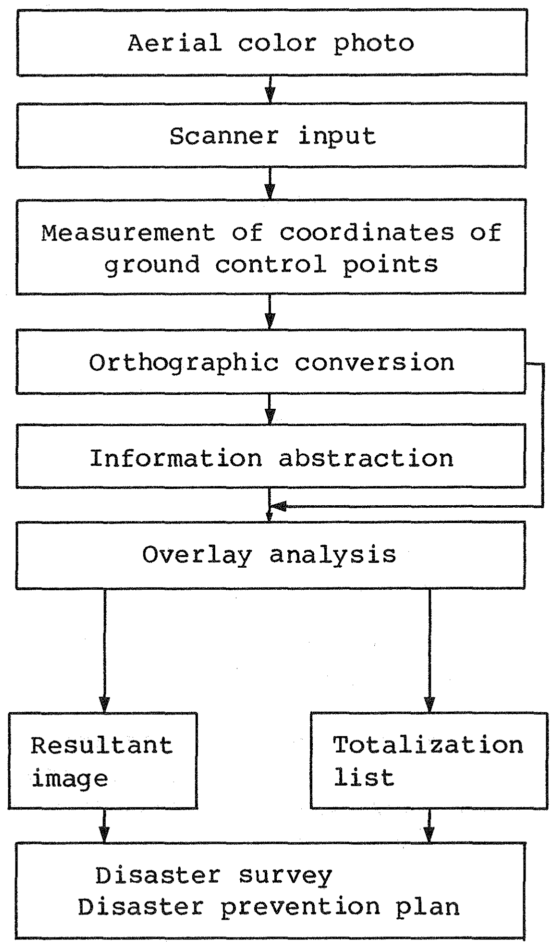

Fig. 1 A flowchart of the analysis

1 As shown in Fig. 3, points which can correspond on a map and on an oblique photo are selected as ground control points (GCP) to measure the coordinates on the both.
2 Several sets of the GCP coordinates are treated with the method of least squares to obtain the coordinates of the photographing points (X_0, Y_0, Z_0) and the photographing direction (, ,).
3 The coefficients thus given are used to re-arrange the data on the photo image at the positions corresponding to the orthographic image.

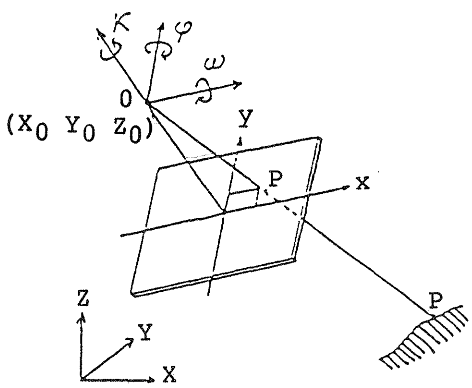

Fig. 2 Geometry of center projection

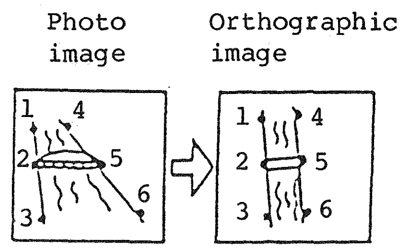

Fig. 3 Orthographic conversion

(4) Image abstraction

Effective information are abstracted from the orthographic image of the aerial photo to know the actual state of the disaster.

Information which can be abstracted from the image data are, for instance:

1 Flood range: the color of turbid water due to earth and sand is used as a clue to know a flood range.
2 Degraded land: The clear color difference between a vegetated area such as forest and a degraded area with exposed soil makes understanding of degraded land very easy.

(5) Overlay analysis

The result thus sampled is overlayed on the original image to show the result clearly. The locational relation of the disaster site becomes clear and distance measurement becomes possible. More than one sampled results are overlayed to obtain differences among data with operation. This offers a very effective mean to know a change with time.

(6) Totalling

Totallization of distance and area which are digital data can be done very easily. The area and distance of the sampled points can be made.

1.3 A Case Study of Disaster Surveying Based on Aerial Photos

In this section, case studies in which the technique explained in 1.2 was actually applied are introduced. The application was made to disasters shown below.

(1) Hilly land disaster

A big scale landslide took place along a road constructed in a hilly district. Aerial vertical photos taken before and after the disaster were input and overlayed after rectification to understand a locational relation of the damaged site with the road before the disaster on the images.

(2) River disaster (Photo 2)

A bank of a river flowing down through a plain failed during a localized torrential rain. Next day, oblique aerial photos taken at the site as the earliest information were processed to an image, which was then subjected to orthographic conversion to define the flood area.

As shown in these cases, processing of photos taken immediately after a disaster allows us to understand more accurately the site condition. This will provide valuable information in cause investigation, relief work, planning future preventive measures and others.

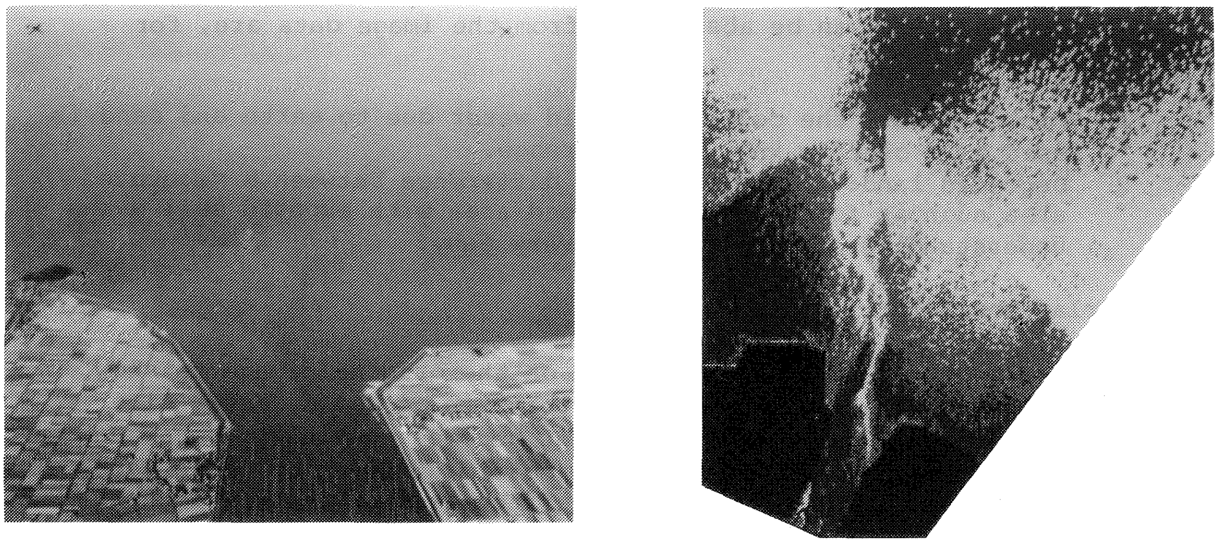

Photo 1 Example of water polution

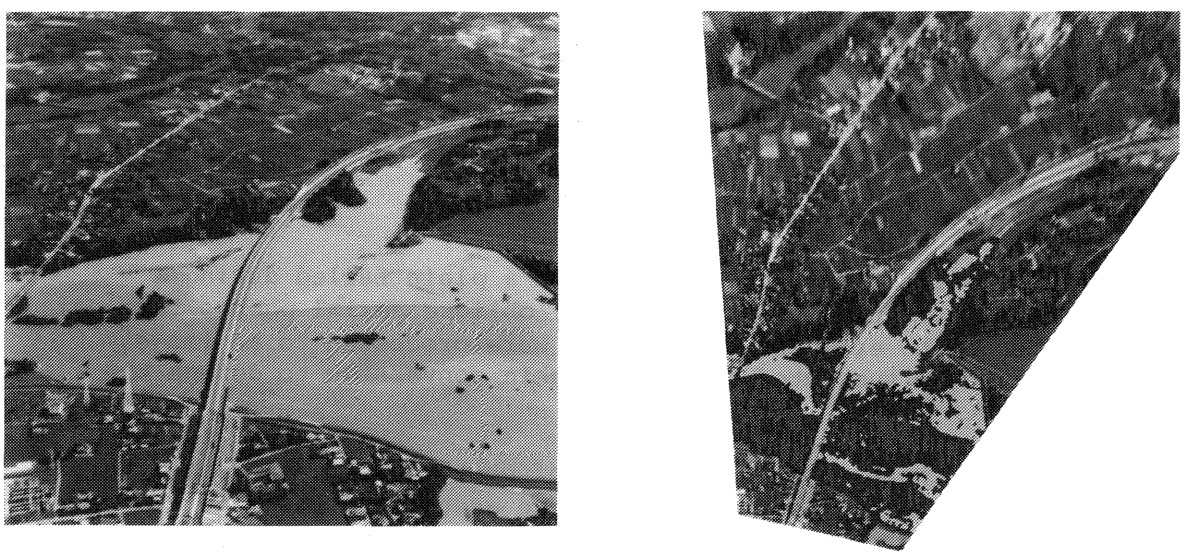

Photo 2 Example of river disaster

2. Processing of Geographical Information to Digital Data

2.1 Introduction

Various geographical information obtained from morphological maps, geological maps and soil maps are closely associated with the causes and scale of a disaster. Processing of these geographical information to digital data allows operations such as overlaying with aerial photo data, resulting in higher reliability in a disaster survey based on the images. Processing of map information to digital data is mostly made by mannual input by the use of a digitizer. However, this processing which requires a lot of time and labour is not useful in a disaster survey which has to be done urgently. Here, a processing method based on color distinction is proposed as a technique for processing of map information to digital data, and its effectiveness is examined.

2.2 Processing Technique

The processing technique is shown in Fig. 4.

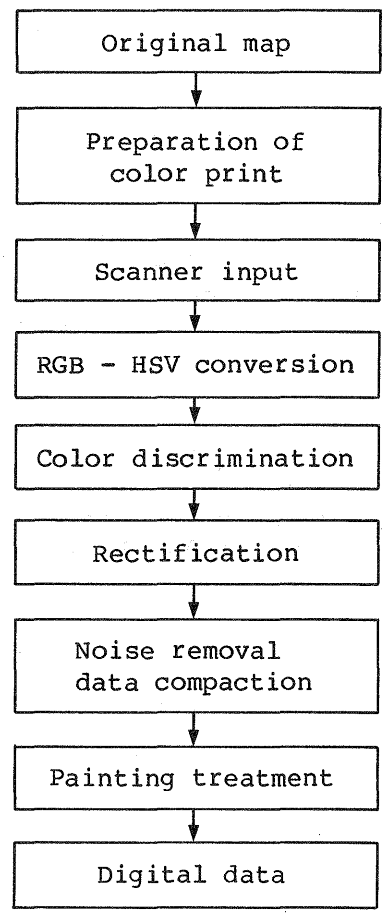

Fig. 4 A flowchart of the processing

(1) Preparation of original map/painted paper

An original map has a variety of colored signs and symbols in accordance with legends, on which notes are written. A painted paper is a chart made by picking out only necessary information of them and coloring with different colors for different categories. In order to reduce the time required for the preparation and to prevent misunderstanding due to color irregularity, only the circumference of a closed region is colored and painted for computer processing.

(2) Scanner input

The painted paper is set on a drum scanner and input as digital data for every three colors of R, G and B.

(3) RGB - HSV conversion

A software exclusively for this purpose is used to convert the RGB 3 band data to 3 band data of H (hue), S (chroma) and V (brightness).

(4) Color discrimination

The HSV conversion results in approximate H values for a same color family. Therefore, level slice processing of the H values provides distinction of category. In accordance with the distinction result, the H values are converted to a single attribute value to code the image data.

(5) Rectification

Rectification is made to maintain coherency with image data such as aerial photos. In accordance with previously defined coordinates, the image data are arranged.

(6) Noise removal

Misjudgements in the color distinction are removed. This process is divided into automatic correction and manual correction with eyes.

(7) Painting treatment

In the color print in which only the circumference of a region is colored, only the data processed up to this point have attributes. The inside of the region is painted to make perfect geographical information data.

2.3 An Example of Prepared Geographical Information Data

Photo 3 shows an example of geographical information data prepared with this technique. Each map shows a chart and data in the process shown below:

Photo 3(1): A painted paper prepared from the original map and then put in the scanner.
Photo 3(2): Subjected to color discrimination/rectification and displayed by different colors for each attribute.
Photo 3(3): Geographical information data completed with the painting treatment.

2.4 A Comparison of Digital Data Processing Techniques

This technique is compared with the traditional input technique using a digitizer, as shown in Table 1.

Table 1 Comparison of input techniques

Item to be compared		Digitizer input	Color distinction processing
Processing	Pretreatment	Original map with no processing	Preparation of a painted paper (2 hours)
	Input medium	Digitizer	Drum scanner
	Input method	Manual input (5 hours)	Manual input (5 minutes)
	Processing after input	Polygon raster conversion (1 hour)	Color distinction processing (1 hour)
Precision of data	Areal information	High	High
	Linear information	High	Low
Suitable usage		Input of linear information	Input of complicated areal information

* Figures in the parentheses mean a required time.

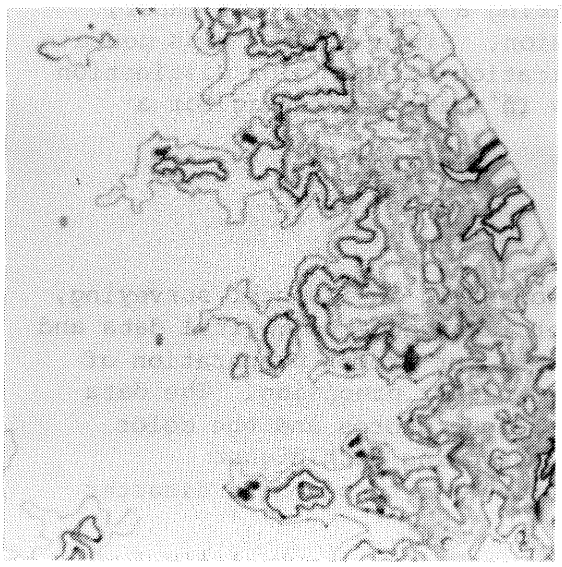

Photo 3(1) Painted paper prepared by drum scanner

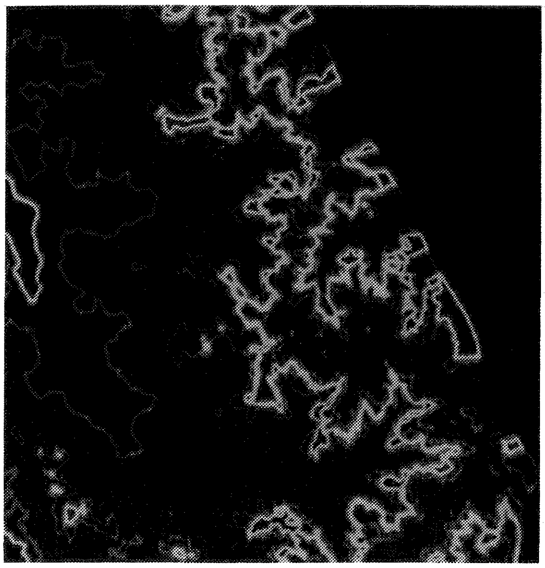

Photo 3(2) Code data processed from painted paper

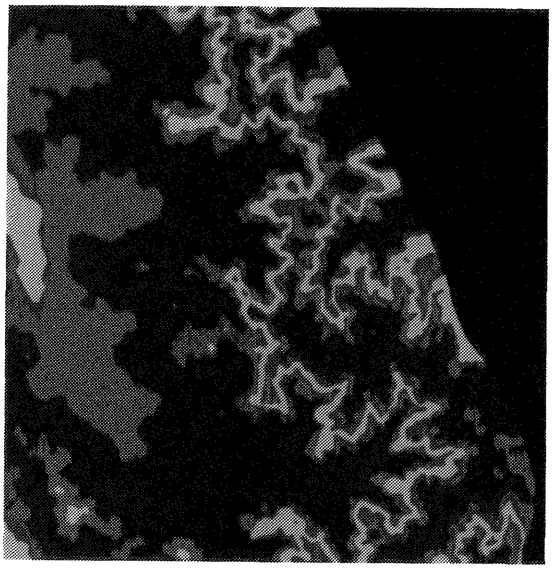

Photo 3(3) Geographical information data (Resultant Image)

This comparison suggests that it is more advantageous to adopt the color distinction method for areal information, which can provide high precision, than the digitizer input requiring a huge amount of labor, although providing a similar level precision. Since general maps contain very complicated areal information, application of the color distinction method can provide much higher efficiency in image processing for a disaster survey.

3. Summary

This study focussed promptness of data processing in disaster surveying, examined processing of aereal photos taken in urgence to digital data and its application, and discussed the technique for prompt preparation of available geographical information data in higher precision. The data preparation using digital processing of oblique photos and the color distinction treatment provides real time surveying with higher reliability, which will make a great contribution to planning disaster prevention measures.