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Difference Detection

The blink principle, employed for difference detection of ERTS imagery, was tested using a Hinman Collator and the Gestalt Photomapper.

Introduction

In a number of applications, aerial photographs and imagery taken at different times, or at the same time using different regions of the electromagnetic spectrum (e.g., ERTS Multi-Spectral Scanner Imagery), are available. Comparison of two images of the same scene is carried out to detect temporal or spectral differences between the images. These differences indicate changes in the scene over time or, as in the case with MSS imagery, certain features based on explicit spectral differences. Applications range from the detection of forest disease to objects for military purposes.

The comparison can be carried out without special aids by examining visually two corresponding areas of the images one at a time. This is quite a tedious procedure, particularly when dealing with a large quantity of imagery. Automated methods of comparison use the densitometric values of the two images and pattern recognition techniques. The enormous amount of digital information and the possibility that images of the same object on different imagery can be quite different are serious problems encountered in such automated methods. A principle for the correlation of density values on conventional photography, whose interior and exterior orientation can be determined, is given by Masry.[1] This principle can help in relating densities of the same object on two photographs. There is, so far, no obvious answer to the large volume of digital information to be handled.

Abstract: *The "blink" principle was first used for the detection of changes in position and luminosity of stars and it is being used now in proofreading of documents by employing an instrument called a Hinman Collator. An instrument using this principle together with a television viewing system offers good potential for difference detection in imagery and photography. Tests were carried out using an instrument of this type and a Hinman Collator. Particularly good results were obtained with ERTS imagery. As a result of the tests, the features of an instrument for difference detection in imagery and photography are outlined.*

The method described here draws the attention of an interpreter to the area or areas on two corresponding images where there is a difference. It is particularly useful in the detection of small individual details which appear on only one image.

Principle of the Method

The basic principle of the method was first used with the blink comparator (sometimes referred to as the blink microscope), an instrument used in astrophysics to detect changes in position or luminosity of stars from two photographic plates taken on different dates[2]. The principle is very simple: two photographs are viewed binocularly one at a time. If in the interval between the exposures of the photographs one of the stars have moved, disappeared, or exhibited change in luminosity, it will seem literally to blink. It might be interesting to note that the "blinking" technique most likely came about after the introduction of an instrument based on the principle of the stereoscope to detect changes in star photographs. The instrument was designed by Pulfrich.[3]

The principle was used successfully by Dr. Charlton Hinman[4] in proofreading all printings of the works of Shakespeare back to the First Folios in order to detect discrepancies that had crept in. An instrument similar to that used by Dr. Hinman can still be found on the market (Figure 1). The instrument is called the Hinman Collator and is used mainly in libraries for comparing documents. The same principle found limited use in the interpretation of aerial photography and imagery. One of the reasons, perhaps, is the need for an instrument especially designed for this purpose.

A Suitable Instrument and Tests

Tests carried out indicated that an instrument for the interpretation of imagery and utilizing the above principle should incorporate some or all of the following features in its viewing system:

- ★ Adjustment of the relative magnification of the two images viewed
- ★ Common change in magnification to allow closer examination
- ★ Relative rotation of the images viewed
- ★ Variable contrast
- ★ Cycle rate for alternate viewing of about four times per second, preferably variable
- ★ Provision for reversal of one of the images to be viewed as a negative or positive (This feature is desirable for reasons explained below)

The mechanical design of the instrument should provide for

- Adjustment of the relative positions of the images in x and y direction.
- Automatic and manual movement of the stages.
- Approximate relative orientation.

The reason for the reversal provision of the viewing system requires further explanation. In the tests carried out it was found that, on the whole, light details are detected much easier than dark ones. A tone reversal of the images would, therefore, allow easier detection of dark objects.

A viewing system, suitable for the incorporation of the above features, consists of two television cameras (Figure 2) which display the images on a television monitor (Figure 3). Such a system is used in the Gestalt Photomapper, an instrument used in the automatic

FIG. 2. Comparator stages with television cameras.

FIG. 1. Hinman Collator.

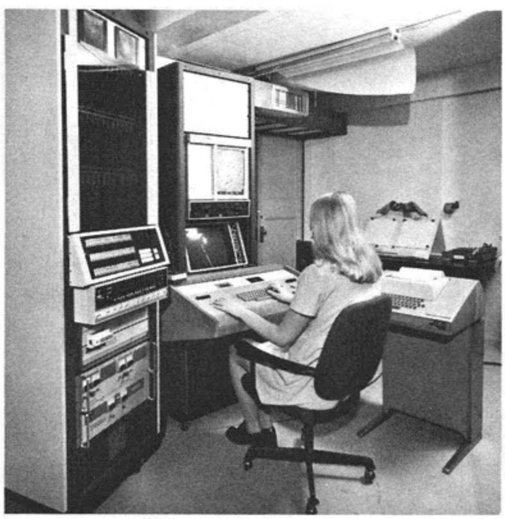

FIG. 3. Gestalt Photomapper.

production of orthophotographs and contours from stereo aerial photographs. The instrument incorporates additional features to those given above for that purpose.

A number of tests were carried out by using a Hinman Collator and the Gestalt Photomapper. Aerial photography and ERTS imagery were used in the tests. Figure 4 shows sample ERTS imagery with some of the details indicated which were readily detected. The tests showed that the method is quite suitable with imagery such as ERTS in which the two images examined are of the same area with differences in spectral signatures.

Vertical aerial photography taken from a light aircraft with a 35-mm camera was used to detect the turnover of parked cars in parking lots and along downtown streets. Here, photographs taken at a 15-minute interval on successive flights were sufficiently close in scale and orientation to provide a satisfactory comparison on the Hinman Collator.[5]

Further tests using drawings and artificial images indicated that the technique works well for colour changes as well as minute changes of detail.

In the case of photography taken from different positions and/or with different altitudes, the adjustment in the relative position of the images to bring them into registration consumed some time. An approximate relative orientation at the beginning partly solves this problem.

Conclusions

A method for the detection of differences between images has been described. Better results can be obtained with a flexible television viewing system. The tests carried out show good potential for the method and particularly with imagery such as ERTS.

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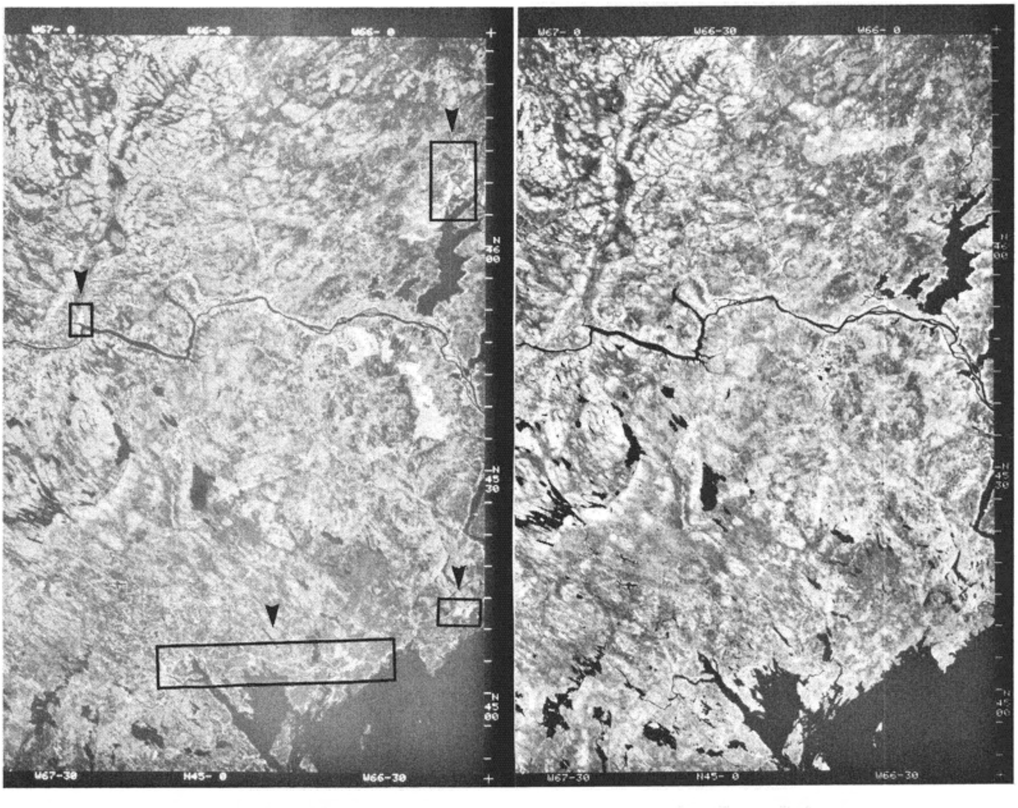

(a) Channel 5 (b) Channel 7

FIG. 4. ERTS MSS imagery of the St. John valley, New Brunswick.

instrument. Thanks are also due for the tests carried out by Mr. R. Craigs.

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