

Producing Stereo Teaching Aids from Aerial Photographs

Detailed procedures are outlined for preparing stereo slides, stereograms, and stereo photographs from existing aerial photographs.

INTRODUCTION

STEREOSCOPIC TEACHING AIDS and testing materials are essential for remote sensing instruction. Several individuals have developed and used techniques for preparing stereoscopic teaching aids (Kiefer, 1977; Niedzwiedz, 1980; Ulliman, 1980). Most articles on the subject, however, relate to the construction of single stereograms (Moessner, 1956; Bernstein, 1968), which generally do not fill the need of classroom situations. Although previous authors have described stereo projection

and slide projectors is generally more satisfactory (Kiefer, 1977; Niedzwiedz, 1980). With this approach, a single lens reflex camera mounted on a copy stand is required to produce stereo projection slides from stereoscopic photographic prints. A color slide film balanced for the illumination source should be used. Proper alignment of the stereopair during the copying process is essential to avoid difficulties in aligning the projectors during projection. Alignment of the stereopair is accomplished by overlapping and registering the

ABSTRACT: Instruction in remote sensing image interpretation relies heavily on stereoscopic teaching aids. These aids can be produced efficiently from existing stereoscopic aerial photographs. Described in this paper are steps for producing 35-mm slides for stereo projection, and techniques for using a 4 by 5 in. (10.2 by 12.7 cm) format camera for producing stereograms and stereoscopic photographs.

systems for classroom use, they have not reviewed procedures for deriving stereoscopic slides from existing aerial photographs, the primary teaching aid.

In this paper, steps are described for producing stereoscopic teaching aids from existing stereoscopic aerial photographs. Included is a method for producing 35-mm slides for stereo projection, as well as techniques for using a 4 by 5 in. (10.2 by 12.7 cm) format camera for efficient production of stereograms and stereoscopic photographs.

SLIDES FOR STEREO PROJECTION

Although equipment especially designed for stereo projection is available, the use of two stan-

two photographs as closely as possible (Figure 1a). The photographs are fixed in this position by joining them with drafting tape. The covered edge of the bottom photograph (i.e., the edge of the stereo overlap area) should then be delineated on the top photograph with a grease pencil or similar erasable marker.

The taped photographs are placed on the copy stand, and the portion of the overlap area to be copied onto slides is selected through the camera viewfinder. One axis of the camera format must be kept parallel to the flightline of the aerial photography. The photographs are then taped to the copy stand, ensuring that they are as flat as possible, and any desired annotation is added (e.g., bar scale, north arrow).

The corresponding areas of the two photographs are copied in sequence. After photographing the desired area on the top photograph, that photo-

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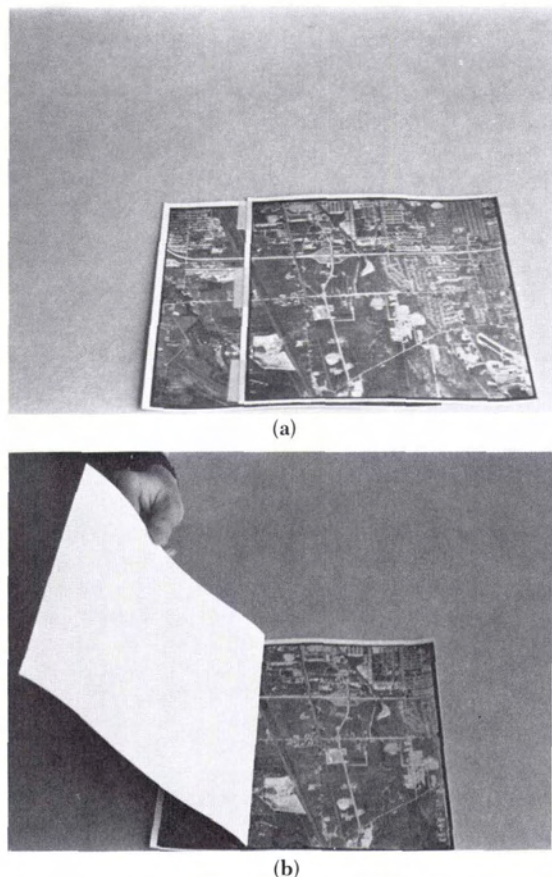


FIG. 1. In preparing stereoscopic slides, the stereopair of photographs is overlapped, registered, and taped together (a). After copying the desired area of the top photograph, the photograph is removed, and the corresponding area on the bottom photograph is copied (b).

graph is lifted away without disturbing the position of the bottom photograph (Figure 1b). The area on the bottom photograph is then copied.

Production of stereo projection slides from film transparencies requires a light table and a slight modification of the method described. One edge of one photograph of a stereopair is taped to the light table, and the second photograph is registered on top of the first (Figure 2a). After aligning the photographs, one edge of the top photograph is also taped to the light table. The top photograph is then lifted away, using the tape as a hinge (Figure 2b). The bottom photograph is copied and lifted away; and the top photograph is swung back under the camera and copied. This modified procedure might also be used with contact prints.

Preparing stereo slides from transparencies which cannot be cut from a film roll is done by marking and visually transferring the edges or corners of the desired portion of the overlap area from the first transparency onto the second. In this

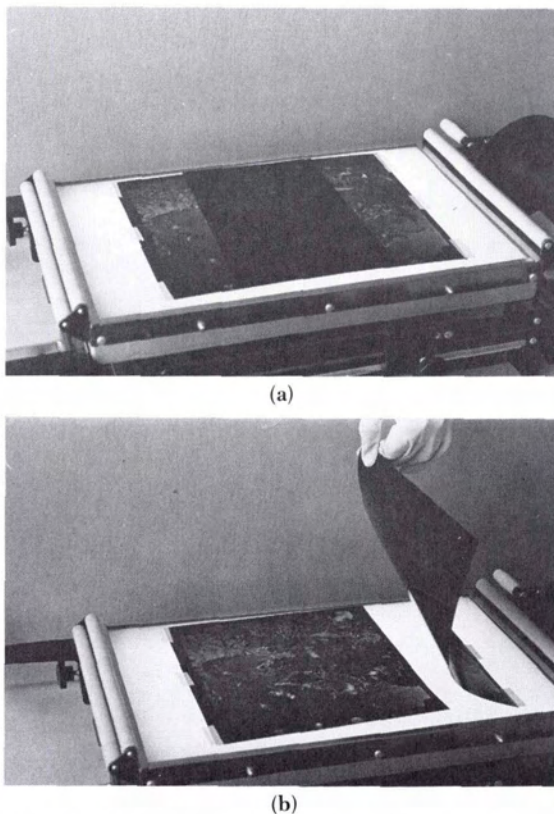


FIG. 2. In preparing stereoscopic slides from a stereopair of film transparencies, the photographs are overlapped, registered, and taped to the light table (a). The slides are made by alternately lifting away one photograph and copying the other (b).

case, "marking" can be accomplished by placing opaque material (e.g., black paper) along the outer edges, as a template or mask.

One final point of interest with regard to stereo slides concerns projection equipment. The stereo projection system described by Kiefer (1977) consists of two similar slide projectors with polarizing filters affixed to the front of their projection lenses, a silver lenticular projection screen, and polarizing stereo viewing glasses. The filters used are camera lens polarizing filters mounted in a threaded, rotatable, metal frame. The filters are attached to the projector lenses by glueing a threaded metal adapter ring onto the front of the barrel of the lens, and screwing the filter onto the adapter ring (Kiefer, 1977).

A more flexible, inexpensive alternative to the fixed mounting of polarizing filters is to insert the filters in foam cups as shown in Figure 3. The cup bottoms are carefully cut off using a razor knife. To insure that the filters fit snugly onto the cut end of the cups, the cut end should have an inside diameter slightly smaller than the outside diameter of

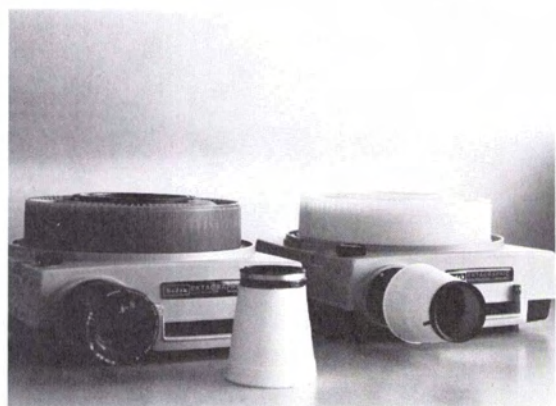


FIG. 3. Stereoscopic slide projection equipment, including polarizing filters which are mounted in foam cups.

the filter threads. The filters can then be "threaded" into the cut end of the cups, and the cups pushed firmly over the ends of the projector lenses. Modifications may be required for particular lenses (e.g., circular cardboard templates may be fitted around the end of non-circular projection lens barrels).

STEREOGRAMS AND STEREO PHOTOGRAPHS

The use of a 4 by 5 in. (10.2 by 12.7 cm) format camera for copying stereoscopic aerial photographs lends itself to the efficient production of stereograms and stereoscopic photographs. For black-and-white reproduction, Kodak Professional Copy film No. 4125 or its equivalent is suitable, while color reproduction could be performed with several color films.

STEREOGRAMS

Stereograms are useful for testing and for illustrating single features. When mounted on stiff cardboard, they provide a convenient means for stereoviewing during planned field trips. To prepare stereograms with a 4 by 5 in. format camera, the desired portion of the overlap area of the stereoscopic aerial photographs is first selected. The shape of the area to be copied must be rectangular with proportions of 5 to 8, the shorter side being parallel to the flightline (Figure 4a).

Using an erasable marker, mark the corners of the rectangular area on each photograph. A stereoscope is useful for transferring the marks from one photograph to the other. (Parallax between the photographs will distort the transferred rectangle; however, this will not appreciably affect stereogram alignment.) In order that the two rectangles may be photographed simultaneously onto the same 4 by 5 inch negative, the rectangles must be placed side by side, as shown in Figure 4b. If neither of the rectangles borders on the in-

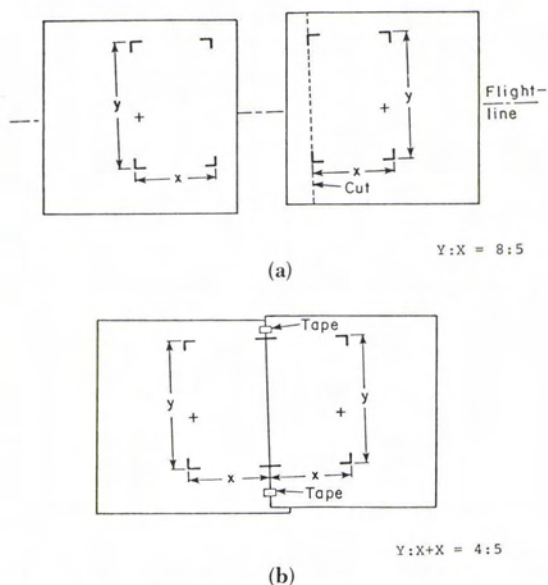


FIG. 4. Preparation of stereograms with a 4 by 5 in. (10.2 by 12.7 cm) format camera involves selecting and marking the corners of corresponding rectangles, proportioned 8 by 5, on each photograph of a stereopair (a). To copy the two rectangles side by side onto a single 4 by 5 in. negative, the photographs are aligned with the flight-line and overlapped (b). The cutting of one photograph edge may be required.

side margin of its respective photograph, one of the photographs will have to be cut.

The two photographs should be joined with drafting tape, such that the corner marks form a single rectangle (Figure 4b). This combined rectangle will have proportions of 4 to 5, the same as the negative format. A quick check of stereoscopic alignment can be made by measuring the distances between several corresponding points of approximately equal elevation within the stereogram. The distances from points on one photograph to the corresponding points on the other photograph should be approximately equal.

The photographs are then positioned on the copy stand. The camera should be adjusted such that the center line of the focusing screen is collinear with the edge between the photographs while obtaining a "best fit" for the outer corner marks in the corners of the focusing screen. (The alignment of the outer corner marks will not be rectangular due to relief distortion.) Once this orientation is achieved, the photographs are taped flat to the stand, the corner marks are erased, and any desired annotation is added. A piece of optical quality glass may be used to keep the photographs flat.

The resultant 4 by 5 inch negative is a stereogram with a separation of 2.25 to 2.50 in. (5.72 to 6.35 cm); the exact distance depends on several

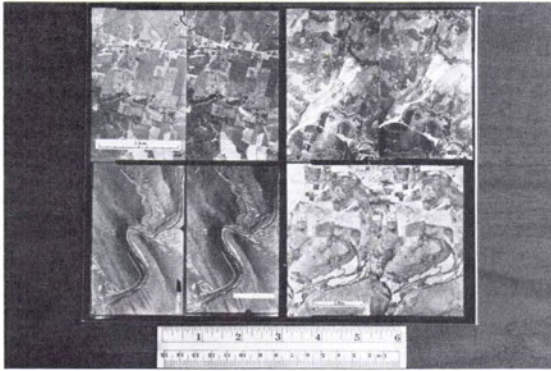


FIG. 5. Four 4 by 5 in. (10.2 by 12.7 cm) stereogram negatives can be contact printed onto a single 8 by 10 in. (20.3 by 25.4 cm) sheet of photographic paper.

factors, including the equipment used. This separation is acceptable to the average photo analyst. Consequently, for classroom instruction, multiple copies of the same stereogram can be conveniently produced through contact printing. Moreover, taping together four stereogram negatives with small pieces of transparent tape allows contact printing of four different stereograms on a single sheet of 8 by 10 in. (20.3 by 25.4 cm) photographic paper (Figure 5).

STEREO PHOTOGRAPHS

The exclusive use of stereograms is not recommended for classroom instruction because students do not gain experience in adjusting stereomodels, and because stereograms offer limited stereo coverage with fixed stereo separation. As an alternative, a 4 by 5 inch camera can be used to prepare inexpensive, multiple sets of stereo photographs which preserve detail, provide stereo coverage of larger areas, and permit individual adjustment of the separation between photographs of a stereopair.

The photographs to be copied are aligned and photographed using the procedures described for production of stereo slides, except that a 4 by 5 inch format camera with Kodak Professional Copy film No. 4125, or the equivalent, is substituted for the single lens reflex camera with color slide film. The resultant negatives provide a 4 by 5 inch stereomodel which can be duplicated by contact printing. For economy and ease of stereo viewing, four different stereopairs may be contact printed on two 8 by 10 inch sheets of photographic paper. With the arrangement shown in Figure 6, the left and right photographs of each stereopair will be printed on the opposite portions of the 8 by 10 inch sheets.

Using this method, a 4 by 5 inch area covers approximately 40 percent of the overlap portion of two 9 by 9 in. (23 by 23 cm) photographs, assuming

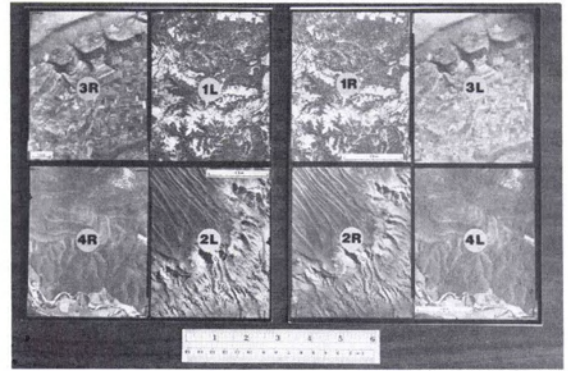


FIG. 6. Eight 4 by 5 in. (10.2 by 12.7 cm) negatives of four stereomodels can be contact printed as shown onto two 8 by 10 in. (20.3 by 25.4 cm) sheets of photographic paper. Stereoscopic viewing is obtained by matching photographs from either side of the two sheets.

a 60 percent overlap. Copying a larger area of the stereopair will provide stereo photographs which may be more effective for some photo interpretation exercises, but at smaller scales than the original photographs.

CONCLUSION

In conclusion, it is noted that the techniques described in this report can be implemented with minimal resources. It is also emphasized that proper clearances must be obtained before copying photographs which are not in the public domain.

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