A SYSTEM FOR THE ORIENTATION OF NON-METRIC CAMERA IMAGE PLANE

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ABSTRACT

In this study, a system is designed and produced to overcome the problems related to camera position, camera-object distance and the orientation of the non-metric camera image plane.

This system is designed to take photographs in the normal case of photogrammetry. In this system, there is a single camera carrier which can be slid on two parallel X-bars. The X-bar base length is variable from 1 to 400 millimetres. This system can also be supported on the WILD C40 tripod.

In addition to this, the possibilities of obtaining a drawing output in the stereoplotter's plotting table using stereo-photographs which are taken with this orientation system, are investigated.

In order to present the practical applicability of the proposed system and method, two samples of drawing outputs are given.

INTRODUCTION

In recent years, due to the improved non-metric camera calibration techniques and with the use of analytical techniques, metric as well as non-metric cameras are used as photographic data acquisition systems in close range photogrammetry.

There are three main problems to be resolved in both metric and non-metric cameras. These are respectively camera position, camera-object distance, and the orientation of the camera image plane.

In this study, a system is designed and produced to overcome these problems. Accuracy of the orientation of photographs taken is also tested using an analytical method. In addition to this study, the possibilities of obtaining a drawing output in the stereoplotter's plotting table using stereo-photographs taken with the orientation system are investigated. In order to illustrate the practicability of the proposed system, two sample drawing outputs are given.

STRUCTURE OF THE ORIENTATION SYSTEM

If a stereoplotter is used to form an optical model of the object space, and if the photographs taken are of the normal case, then only the direction parallel to the direction of the camera axes will be subject to affine deformation. If the photographs are not at the normal case, then the affine deformation will occur in the three directions. Therefore, the proposed system is designed to take photographs in the normal case of photogrammetry.

In the analogue method of data reduction, this deformation should be corrected during plotting, by a proportion equal to the ratio of the principal distance introduced in the instrument and the actual principal distance.

In the semi-analytical method of data reduction, a numerical adjustment will be required before the final results are obtained.

The orientation system incorporates a camera carrier, two parallel steel bars (X-bars) and a level bubble (Fig.1). The camera carrier can be slid along the base, enabling the base length to be varied between 1 and 400 millimetres. This system can also be supported on the WILD C40 tripod tribrach. One of the non-metric cameras can be rigidly attached to the camera carrier. The respective tilting and rotations of the photograph are adjusted approximately at zero by means of a level bubble and tripod foot-screws.

When the system carrier slides on X-bars the optical axes of the stereo pairs remain parallel to each other and perpendicular to the base. In order to obtain stereo pairs in the normal case, only one non-metric camera is needed if this system is used. This enables photograph taking at different bases. The system also has a steel rule at the back and the base length can readily be measured.

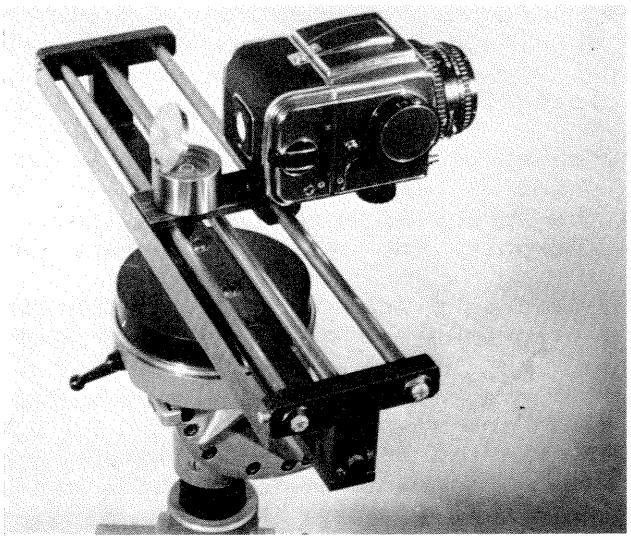

Figure 1. The Orientation System

ANALOGUE AND SEMI-ANALYTICAL PLOTTING FROM THE ORIENTED NON-METRIC STEREO IMAGES AT THE TIME OF EXPOSURE

The photogrammetric model of the photographed object is formed in the stereoplotter by utilizing the principle of the intersection of conjugate rays from two differently located non-metric photographs which are taken by the proposed system.

The interior and the exterior orientation elements of the camera can be determined by using the NLECC [Nonlinear Least-Squares Estimation Colinearity Condition] method, an on the job calibration method which was developed by Muftuoglu (1980-1982) and which has been used in this study. An example is given in Table 1, where the accuracy of the orientation system is also demonstrated.

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FINAL ESTIMATE OF PARAMETERS:
B( 1) =          1.45533        X COORDINATE OF THE PRINCIPAL POINT
B( 2) =        80.871407        CAMERA PRINCIPAL DISTANCE
B( 3) =     0.569778130-02      PHI ROTATION
B( 4) =    -0.136844510-01      OMEGA ROTATION
B( 5) =    -0.161222970-02      KAPPA ROTATION
B( 6) =        11683.752        X COORDINATE OF THE CAMERA PERSPECTIVE CENTER
B( 7) =        8104.3353        Y COORDINATE OF THE CAMERA PERSPECTIVE CENTER
B( 8) =        10037.447        Z COORDINATE OF THE CAMERA PERSPECTIVE CENTER
B( 9) =          1.48990        Z COORDINATE OF THE PRINCIPAL POINT

STANDARD ERROR OF ESTIMATE =  0.156153840-01
MULTIPLE CORRELATION COEFFICIENT =  0.99999888
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Table 1. Accuracy of the Orientation System

The non-metric photographs can be only approximately centered in the stereo plotter. A good solution to relative orientation depends on a good intersection of at least five pairs of rays from overlapping photographs. To perform the photogrammetric plotting an absolute orientation is necessary in the stereoscopic model on the plotter. This absolute orientation requires a minimum of two points of horizontal control and three points of vertical control on the model being plotted.

One of the purposes of this present study is to obtain a drawing output, using a non-metric stereo-pair which has been taken with the proposed orientation system. In order to use this stereo-pair the following steps should be applied:

1. The object is placed in front of the test field. The photographs are taken in the proper depth of field.
2. The photographs are placed and centered approximately in the stereoplotter.
3. The coordinates of points are measured on the left negative transparency using a stereoplotter as a monocomparator.
4. The orientation elements are determined by using the NLECC solution.

5. Correct centering of the negatives is done by means of horizontal and vertical centering screws in the stereoplotter.

After this absolute orientation can be accomplished by using conventional methods. Consequently, graphical output can be produced directly in the desired output scale on the plotting table. Two samples of drawing output are given in Fig.2 and Fig.3.

Fig.2. Countermap of Human Body Produced by Using Non-metric Images.

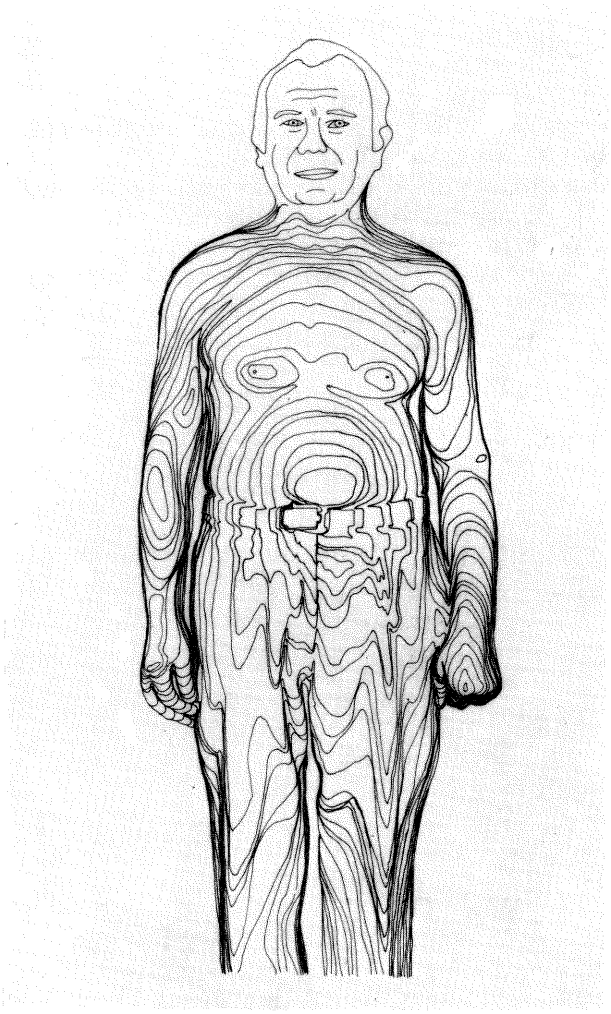

Figure 3. Countermap of Human Body Produced by Using Non-metric Images.

CONCLUSION

The advantage of the orientation system is fixed relative orientation with a close approximation between the two positions of the camera.

A bubble level on the camera carrier is used to level the system. Thus, one of the disadvantages of non-metric cameras is eliminated.

REFERENCES

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