REPORT ON BRIDGING BY A-6

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ABSTRACT

The Wild Autograph A-6, commonly regarded as a "non-bridging" type of stereoplotting instrument, is adequate for aerotriangulation using a simple procedure based on its design characteristics. After the diapositives have been interchanged, relative orientation of the succeeding model is accomplished by the usual adjustment of the angular components (κ, ϕ, ω). Absolute orientation consistent with the previous model requires the application of easily computed corrections to (1) the common-ϕ tilt to recover the base inclination and (2) the Z-datum to establish the base length. Flight azimuth is maintained by swinging the plotting sheet to bring passpoints into coincidence.

A single test with the A-6 has yielded a horizontal accuracy equal to that of a graphically adjusted Autograph A-5 "bridge" and a vertical accuracy within one-half a contour interval.

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THE author, in publishing these facts wishes to point out that, while believed to be theoretically sound, the method has been tested only once—glass positives from film used—and then, because of insufficient control and field checks the findings of the test are conclusive only for the claim that the plan accuracy attained was equal to a graphically corrected, A-5"bridge," at a 3× enlargement of the photographic scale and elevations, after correction, within half a contour interval. It is believed, however, that greater accuracy is attainable.

THE METHOD

Like most photogrammetrists of his acquaintance the author believed that, because of the absence of the "*by*" and "*bz*" movements in the make-up of the A-6, "bridging" with this instrument was impossible and the idea of attempting such a feat was dismissed summarily. It was only on the insistence and aid of a late colleague, J. Van Eden, that an attempt to overcome these deficiencies was made, The form of investigation pursued was based on the following established fundamentals.

bx' = The instrument base of the previous model.

ϕ_0 = Main fore and aft (tip) rotation.

ϕ_0' = Previous ϕ_0.

RB = Rotation base = The horizontal distance from the rotation axis to the perspective center of the rear camera of the stereo-pair (1060 mms. approx. if "bridging" from left to right but $1060 - bx$ mms. if from right to left.)

ω' and ω'' = Respectively, the lateral tilt movements of the left and right cameras.

κ_2' and κ_1'' = Respectively, the swing movements of the L. H. camera of the stereo-pair under consideration and the R. H. camera of the previous stereo-pair.

ϕ_2' and ϕ_1'' = As for κ_2' and κ_1'' but replace "swing movements" with "fore and aft tilts."

ω_0 = Main lateral tilt.

$\delta\phi$ = The difference between ϕ_1'' and ϕ_2'.

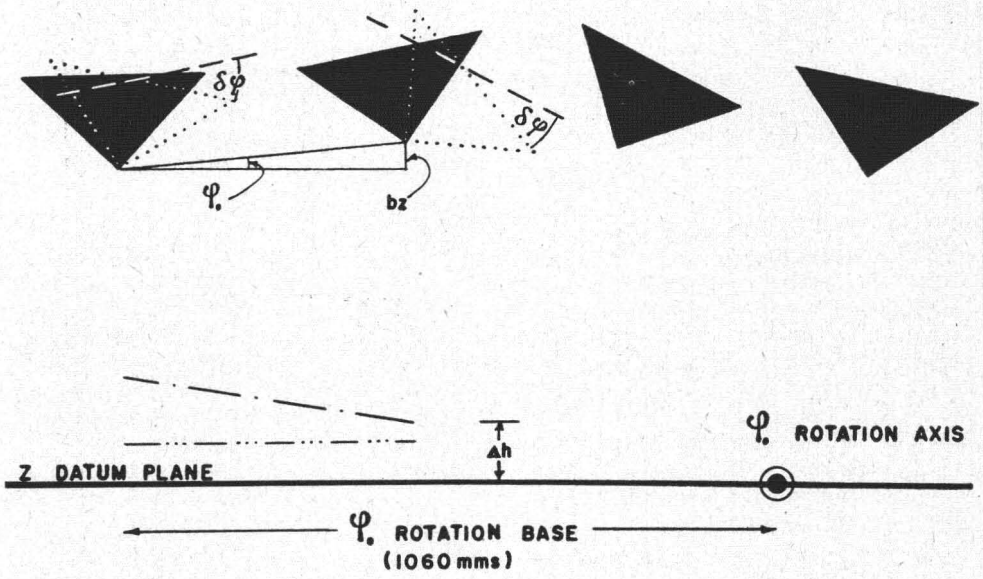

FIG. 1

Shown in Figure 1 by the solid camera positions, is the correct relationship between the planes of the Z datum and the photographs. This relationship must be re-established if "bridging" is to be carried out.

Also shown—by the dotted camera outlines—are the positions of photographs no. 2 and no. 3, after no. 2 has been moved to the position of no. 1, no. 3 has replaced no. 2 and the relative orientation of nos. 2 and 3 has been accomplished in the usual A6 manner. Their true planes are shown by the pecked lines.

It will also be noted that, with respect to the Z datum plane, the true position of the perspective center of photograph no. 2 is higher than that of no. 1 and by the inter-change of positions of photographs nos. 2 and 3 just previously mentioned, four errors will be introduced into the resultant stereo-gram. These are, one, the Z datum of the stereo-model will be raised, two, this datum is tilted, three, the horizontal axes of the datum are swung with respect to the instrument axes and four, the cameras are wrongly tilted by an amount $\delta\phi$. (Note no such angular errors exist between the cameras in the lateral direction because the camera containing the no. 2 photograph may be set, prior to the relative orientation of photographs nos. 2 and 3, at the ω value it acquired in the previous stereo-model.)

The corrections for these datum and tilt errors, when investigated, proved to be surprisingly simple, They are:

(a) ϕ_0 was rotated through $\phi_1'' - \phi_2'$ (both values of which had been recorded and, as the diagram shows, their difference is $\delta\phi$) to horizontalize the datum and eliminate the tilt errors, but in doing so an additional datum error was incurred because the rotation axis of the ϕ_0 movement is to the extreme right of the instrument rather than at the perspective center of the camera containing the no. 2 photograph.

(b) This additional datum error and the previous datum error (this latter being the "bz" error) are corrected by adjusting the height counter by the amount $RB.\ \sin\delta\phi + bx'.\ \sin\phi_0'$

(c) The plotting sheet, on which the "pass-points" of photograph no. 2

had been previously plotted (the first over-lap, usually, has sufficient control to enable the absolute orientation of the first stereo-pair to be achieved and so these "pass-points" are correctly plotted by this over-lap) is swung so that they are re-oriented to their new positions as indicated by the plotting pencil. By this means the horizontal axes of the two adjacent models are made co-incident.

PROCEDURE

Briefly then, the procedure for this method of "bridging" is:

1st Stereo-pair Set and horizontalize to given ground control in the usual manner. Plot "pass-points" positions, record their heights and note the setting values.

2nd Stereo-pair Relative orientation as usual ensuring ω of photograph no. 2 is the same as in the 1st stereo-pair. (If κ_1'' and κ_2' differ sufficiently a ω_0 correction is advised to right the effect this difference may have on the lateral tilt of the model.)

Rotate ϕ_0 through $\delta\phi$.
Correct height counter for datum error.
Establish scale in usual manner by agreement of heights of pass-points.
Re-orient the plotting sheet.
Plot "pass-points," record height and setting values.

Following Stereo-pairs Repeat as for 2nd Stereo-pair.

CONCLUSIONS

There is no doubt that the A-6 may be usefully applied to certain photogrammetric problems which involve "bridging."

The method above was evolved with the purpose of producing the most accurate "bridging" procedure of which the A-6 is capable. While the achievement of this aim is not claimed, there are obvious short cuts with corresponding decreases in accuracy.

COMMENT ON "REPORT ON BRIDGING BY A-6"

Use of the Autograph A-6 for aerotriangulation is a natural outgrowth of its excellent performance characteristics as a "single-model" instrument. A slight modification of the practical procedure described by Mr. Kavanagh would exploit more fully the capabilities of the A-6.

After the absolute orientation of the initial model to ground control, the base inclination of succeeding models is recovered more accurately by the use of a right angle clinometer fitted with 30″ bubbles. The absolute tilt of a plate, recorded by clinometer in the previous model, is quickly set after interchange by bringing the levels to the horizontal with adjustment of the ω and common-ϕ tilts. This setting is independent of the ω and common-ϕ circles and is not subject to error due to the course graduations of the latter. Further refinement requires substitution for the common-ϕ circle of a circular scale fixed to the hand-wheel which drives the screw that tilts the superstructure. This scale may be graduated to give a direct reading of the vertical movement of the left perspective center. The height counter correction to "zero-in" the Z-datum may be computed by slide rule.

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