FORUM

Discussion Paper

SIMULTANEOUS THREE-DIMENSIONAL TRANSFORMATION

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WE HAVE RECENTLY been testing the A.I.M. technique (Aerotriangulation by Independent Models). This technique was the subject of a paper by V. A. Williams and myself at the Symposium at Delft last August. The test was made on a strip of photography flown over a well-controlled area in Great Britain. After levelling the strip, we applied the normal separation of planimetric and height adjustments, A second-degree conformal formula being used for planimetry and empiric formula for height of the type

$$H = a + bx + cy + dz + ex^2 + fxy.$$

Control consisted of eight planimetric points and seven pairs (doublets) of height control. One height point was found to be in error and discarded. The scale of the photography was 1/6,000, the strip included 13 overlaps, and an excellent result was obtained, as follows:

Plan vector error	Mean 0.20 meter	Maximum 0.32 meter
Height error	0.11	0.24

Dr. Mikhail's article has been read and it was decided to use his Equations 15 to compare results. From the solution already achieved, it was possible to obtain reasonable height values at the planimetric points and to coordinate the 13 height points. These coordinates were then obtained in geographical and height coordinates, and converted to three-dimensional geocentric coordinates with the Z-axis passing through the mean latitude and longitude of the area. There were 16 X-Y observation equations and 13 Z observation equations to fix the 10 parameters of Equations 15. After adjustment the results were reconverted to E, N, h-values and a direct comparison made with the control.

The result was not unforeseen and is as follows:

> The planimetric work was almost identical with the previous answer, the maximum being 5 centimeters in one coordinate, which could be due largely to computational "noise."
>
> In height the solution failed to remove the "twist" of the strip, residuals remained at certain points in the order of 1 meter.

Since this experiment was started I have had contact with Professor Baetsle of Belgium who has produced an article for PHOTOGRAMMETRIC ENGINEERING deriving your formulas from a consideration of the general transformation (conformal) in three dimensions. From his work it is fairly evident that it is possible to simulate a scale-change and swing of a strip by these means but virtually impossible to simulate the twist of a strip, and our results confirm this.

It is possible, of course, if the mapping occasion demands, to do a further small adjustment to the residuals obtained by adding a term Kxy to the adjustment of Z, but this detracts somewhat from the elegance of the method.

In the past, we have attempted to obtain a pure three-dimensional transformation between photogrammetric x, y, z and survey geocentric coordinates X, Y, Z. For mapping accuracy (assuming the map scale is not more than five times the photo scale) this is generally possible with a bridge of not more than five models. Thereafter the z-twist vitiates the result.

It would seem, therefore, that our mathematical models are not sufficiently sophisticated to reproduce the type of three-dimen-