By Dipl.-Ing. H. Schöler

Discussion Article

Vertical-Base 3-D Analysis

By Dr. B. Shmutter*

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DR. SHMUTTER deals with the geometrical relations of photographs taken successively during a rocket flight. I am of the opinion that Dr. Shmutter's way of dealing with this subject matter might lead readers to visualize quite a new problem in such an exposure condition. My reason for believing this is that the attempt to derive directly absolute magnitudes from the photographs may seem to be strange to photogrammetrists who are familiar with modern photogrammetric techniques. However, if one separates this task conventionally into relative and absolute orientation, then one will readily see that the solution does not deviate very much from more familiar concepts.

Any terrain point P (Figure 1) is intersected above a base lying between the camera stations I and II. Generally base b has three spatial components. In this case b_x and b_y are approximately zero; Figure 1 shows the special case where $b_x = b_y = 0$.

Thus it is clear that such photographs can be plotted with conventional stereo mapping instruments. In practice the technical parameters of individual designs naturally limit the range of application. Therefore, stereo mapping instruments without a b_z setting and without any possibility of parallel alignment of the projecting beams ($b_x = 0$) are not applicable. It is in any case advantageous to have a large b_z range. Limits are also encountered in viewing of the image without optical magnification compensation.

It may be interesting to consider—with reference to the Ranger exposure system—the possibilities of plotting with conventional stereo mapping instruments. Aboard the spacecraft, among other items were two wide-angle surveying cameras having a focal length of 25 mm. and a picture format of 11×11 mm. In this instance where the camera axis coincided with the direction of flight a base of about 5,600 m would result for the flight data of Ranger VII.

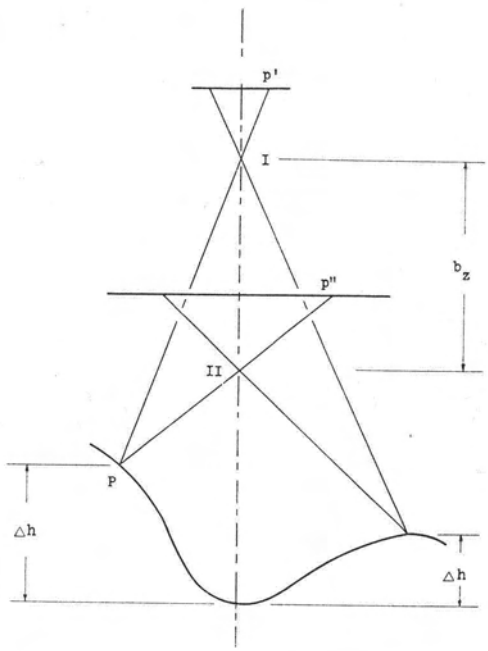

FIG. 1

Because of its magnification compensation, the stereoplanigraph is a suitable plotting instrument. The full utilization of the instrument requires an 18× magnification of the original photographs (to the picture format 18×18 cm.) and a plotting lens of 100 mm. focal length. A consequence of this is the necessary deformation of the photographic pencil of rays by the affine factor of 4; i.e., the optical model produced in the instrument is compressed in the z-direction with a factor of 4. This factor increases the b_z range in the same ratio and provides a model scale of about 1:35,000 in plan and of 1:14,000 in elevation. With a z-range which (in the case of the stereoplanigraph) can be utilized up

* *This* spelling is correct. — *Editor.*

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to 40 mm. with good image quality it would be possible to plot photographs with object distances of more than 90 km.

The usefulness of deformation of the photographic pencil of rays leads to the consideration of the possibilities of the stereotrigomat system.* The advantage of this instrument is especially applicable in those cases where the camera axis deviates from the direction of flight. (This case would necessitate approximate solutions due to decentering of the photographs in the stereoplanigraph.) However, the stereotrigomat has specifically been designed for accurate plotting with deformed pencils of rays. In its present design the projection system under equal conditions allows the plotting of a model that has a horizontal scale of 1:17,000 and a vertical scale of 1:155,000. Up to a nadir distance of about $8g^{(7.2°)}$ no modifications arise for an operator familiar with the plotting conventional photographs on stereomapping instruments. An adaptation of the viewing system, which will be necessary due to large differences in the scales of the photographs, will however not offer any very great difficulty.

Excellent conditions of the stereoscopic viewing and measurement of rocket photographs are also offered by the new interpretoscope with independent zoom systems in the paths of light of the stereo-microscope where the data obtained can be fed into a computer for further processing.

* PHOTOGRAMMETRIC ENGINEERING, Vol. XXXII, No. 5, page 896, September 1966.

SUBSEQUENT REMARKS BY DR. B. SHMUTTER

All photogrammetric problems are of the same general nature: (a) the derivation of three-dimensional quantative information requires at least two different photographs; and (b) the orientation of the photographs relative to some coordinate system must be known or solved for.

The pair of photographs either may have a base with one dominant component (for example, $bx \gg by$ and $bx \gg bz$, which occurs in common photogrammetric practice, or $bz \gg bx$ and $bz \gg by$, which is the characteristic of this vertical-base problem), or may have components of equal order of size, such as an oblique base.

If photogrammetric problems are to be examined from this point of view, the conclusion must be that all applications have one principle in common: a new point is always determined by intersection from the ends of some base. In light of this remark, the reservation of Mr. Schöler, that the vertical-base problem is not entirely different from conventional photogrammetric problems, seems acceptable.

The solution of outer orientation need not necessarily be separated into the two conventional stages. The distinction between relative and absolute orientation is necessary if the pair of photographs is set in a stereoscopic plotting instrument. An analytical approach to the orientation problem can avoid this subdivision. The article to which Mr. Schöler refers approaches the vertical-base problem analytically; hence outer orientation is treated as a whole.

Mr. Schöler suggests that vertical-base pairs be evaluated with the stereoplanigraph. It seems reasonable to evaluate such photographs mechanically or optically provided no limitations are imposed by the instrument. A plotting instrument simulates some geometric models; presumably the vertical base can be simulated as well. However, I question the application of the mechanical/optical solution in this instance. The analytic approach requires simple measuring devices, existing data processing systems can handle the measuring data quickly and reliably, and the output can consist of a list of coordinates as well as printed-out contour lines. Because the scale of vertical-base photographs is necessarily small (due to the short focal length and the high altitude), the accuracy of the graphical representation of the measured data by means of a computer should suffice.