Photogrammetric Brief

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Height Difference Measurement Errors

THE BASIC EQUATION for determining height differences from parallax measurements on vertical photographs is:

$$\Delta h = H \cdot \Delta p/(P + \Delta p) \quad (1)$$

where H = height of aircraft above the ground, P = absolute stereoscopic parallax at the base of the object being measured, and Δp = differential parallax

However, where it has been possible to establish parallax measurement repeatability values for individual sterocomparator operators, this equation has also proven useful in estimating the magnitude of height difference measurement errors attributable to the operator. Furthermore, as will be shown, the higher the precision attained by stereocomparator operators for parallax measurements, the more feasible height difference measurements become at small base-height ratios.

In an effort to ascertain individual capabilities, four stereocomparator operators were asked to perform five rounds of pointings to a series of images of different sizes, shapes, and contrasts appearing on selected sets of stereopairs of 1:4,000 and 1:16,000 scale. Base-height ratios ranged from .025 to 0.30 and all photographs were obtained with a 6-inch focal length camera. The results of this test are listed in Table 1.

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Two interesting observations were noted from this limited test:

1. Base-height ratio and scale did not seem to affect differential parallax measurement repeatability.
2. Operators could be assigned a numerical level of repeatability. For example, representative *repeatability values* (RV) for operators 1 to 4 were taken as 8, 4, 6, 2 micrometers respectively.

Using the known base-height ratios, repeatability values and Equation 1, estimates of height difference errors likely to result from parallax measurements at the top and bottom of an object were obtained. This was accomplished by first determining the error in millimeters (*hem*) likely to result from two independent measurements.

$$\text{hem} = \sqrt{(RV)^2 + (RV)^2]} \quad (2)$$

Next a slightly modified height difference equation was used to give the height difference error in feet.

$$\Delta\,\text{heft} = \frac{H\,\text{hem}}{B} \text{ where } B = \text{base in millimeters} \quad (3)$$

If desired, the height difference error in feet can be expressed in terms of parts per thousand of the flying height and plotted against base-height ratio to provide an index of the operator's height difference measurement capabilities (Figure 1). Obviously, an operator capable of fine precision can produce acceptable height difference measurements at quite

TABLE 1. BASE-HEIGHT RATIOS AND STANDARD DEVIATIONS OF PARALLAX READINGS (μm)

Operator	*.025*	*.05*	*.10*	*.10*	*.18*	*.20*	*.30 B/H*
*1	9	3	7	13	6	6	9
2	5	3	2	3	4	3	5
3	6	5	8	6	5	8	—
**4	3	2	2	2	4	2	2

* Operator 1 was relatively inexperienced, accounting for the rather wide range of standard deviations.
** The ability of Operator 4 to measure parallaxes was apparently limited by the capabilities of the instrument.

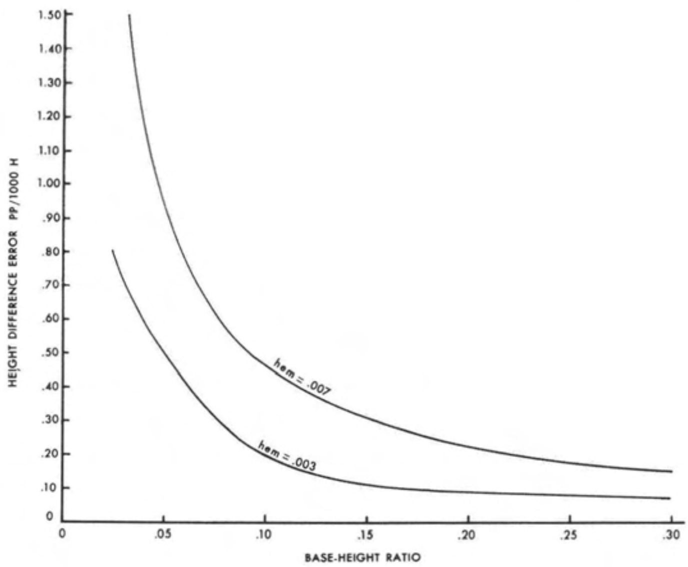

FIG. 1. The height difference error can be expressed in terms of the flying height and plotted against base-height ratio to provide an index of the operator's height difference measurement capabilities.

small base-height ratios, thus minimizing the geometric constraints.

REFERENCES

1. Harpe, Ralph W. (1965) "Experiments with Minimum to Optimum Base-Height Ratios," Presented to the Semi-Annual Convention, American Society of Photogrammetry, Dayton, Ohio, September 22–24.
2. ITC Textbook (1964) *Binocular Vision,* Chapter IV.2.

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