

NEW METHODS OF TILT DETERMINATION IN VERTICAL AIR PHOTOGRAPHS

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In this report new methods of tilt determination are shown which are so simple that no considerable work is caused. Different ways are existing for the solution of this problem: Tilt determination by use of

- 1). maps
- 2). fixed points on the ground
- 3). neighbouring photographs overlapping more than 50%.

In all these cases angles or distances may form the base for tilt determination.

Tilt determination by use of maps.

The square limitation of air photograph (size $d' \times d'$) has to be drawn according to the situation in the map. The opposite sides of the quadrilateral figure in the map are no longer parallel, but they form the small angles ϑ_I and ϑ_{II} . The inquired elements of tilt result from:

$$\operatorname{tg} \alpha' = \frac{\vartheta_{II}}{\vartheta_I} \quad \gamma = \frac{f}{\alpha'} \cdot \sqrt{\vartheta_I^2 + \vartheta_{II}^2}$$

Hereby γ determines the nadir distance and α' the principal line relating to the direction of the sides of the angle ϑ_I .

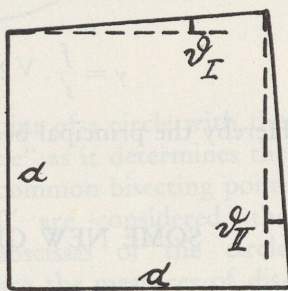


Fig. 1

Tilt determination by use of fixed points on the ground.

For rectifying fixed points are necessary. Four of these points are sufficient. By connecting two fixed points in the way that the lines intersect, four distances are formed in photograph and map. For two distances lying in a straight line g_I results:

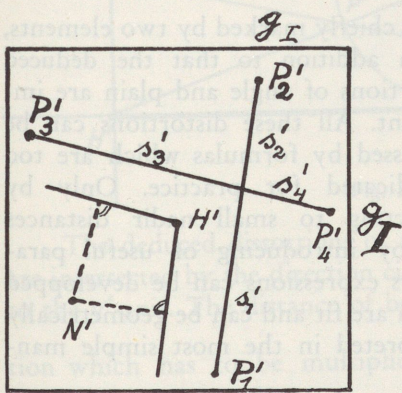


Fig. 2

$$c'_I = f^2 \cdot \frac{\frac{s_2}{s'_2} - \frac{s_1}{s'_1}}{s_2 + s_1}$$

If these terms c' are measured in direction of this straight line to which they belong, the point of intersection of the perpendiculars is the plumb point N' . In such a manner the nadir distance and the principal line are known.

Tilt determination by use of neighbouring photographs.

This method is free of fixed points. The inquired elements of tilt can be determined much more accurately by measuring of distance parallaxes.

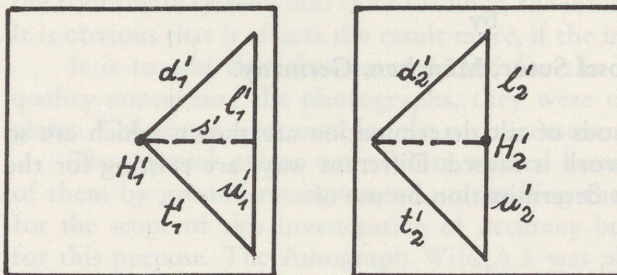


Fig. 3

In order to get simple relations the distances should be chosen as follows:

- 1) The perpendiculars l' and u' in H_2' to $H_1'H_2'$. The size shall be approximately equal to $H_1'H_2' = s'$.
- 2) The distance d' and t' starting from H_1' and pointing towards the ends of the perpendiculars l' and u' .

Measuring the distance parallaxes $\Delta d'$, $\Delta t'$, $\Delta l'$ and $\Delta u'$, the elements of tilt of the *second* photograph are resulting as follows:

$$\operatorname{tg} (d \pm 45^\circ) = \frac{\frac{\Delta u'}{u'} - \frac{\Delta t'}{t'}}{\frac{\Delta l'}{l'} - \frac{\Delta d'}{d'}}$$

$$\gamma = \frac{f}{s'} \cdot \sqrt{2} \cdot \sqrt{\left(\frac{\Delta u'}{u'} - \frac{\Delta t'}{t'}\right)^2 + \left(\frac{\Delta l'}{l'} - \frac{\Delta d'}{d'}\right)^2}$$

Hereby the principal bearing a' relates to the line $H_2'H_1'$.

SOME NEW GEOMETRIC KNOWLEDGE ON VERTICAL PHOTOGRAPHS

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The distortion of a vertical photograph is chiefly marked by two elements, distortions of direction and of distance. In addition to that the deduced

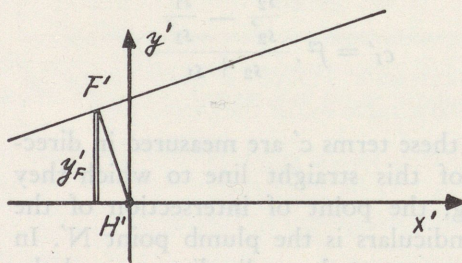


Fig. 1

distortions of angle and plain are important. All these distortions can be expressed by formulas which are too complicated for practice. Only by restricting to small nadir distances and by introducing of useful parameters expressions can be developed which are fit and can be geometrically interpreted in the most simple manner.

We suppose that the origin of