Practical Tests of the Numerical Stereo-Radial Method— A Summary

BERTIL HALLERT,
Royal Institute of Technology,
Stockholm, Sweden

IN TWO publications "A New Method for Analytical Radial Triangulation," PHOTOGRAMMETRIC ENGINEERING,* and "Das Prinzip der numerischen Korrektion und die Radialtriangulation," *Bildmessung und Luftbildwesen* 1957, Nr. 1, the basic principles of the numerical stereo-radial method have been published. The method is founded upon image coordinate measurements in approximately vertical photographs in combination with y-parallax and x-parallax measurements for the correction of systematic errors due to the deviations from the vertical.

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The method was tested in practice at the Division of Photogrammetry of the Institute of Technology in Stockholm and has proved to give excellent results. As an example of the tests the results of the measurements in one pair of photographs over the Öland test area will be demonstrated in this paper.

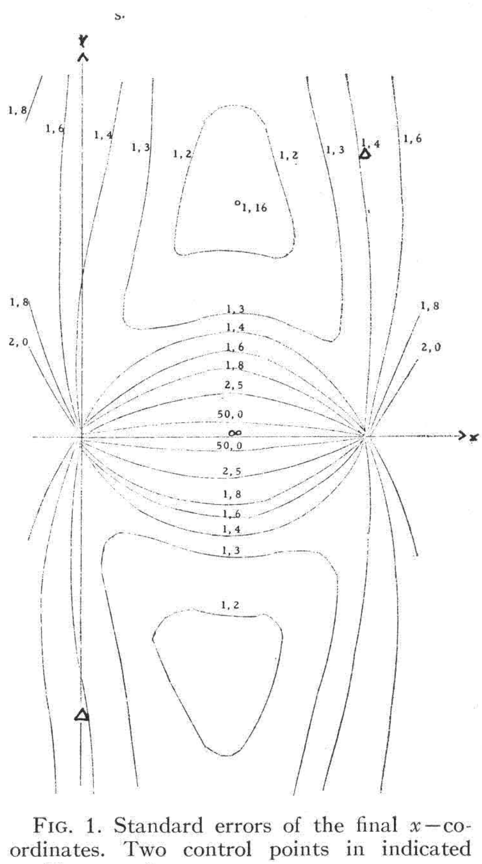

FIG. 1. Standard errors of the final x—coordinates. Two control points in indicated positions. $\mu=1$.

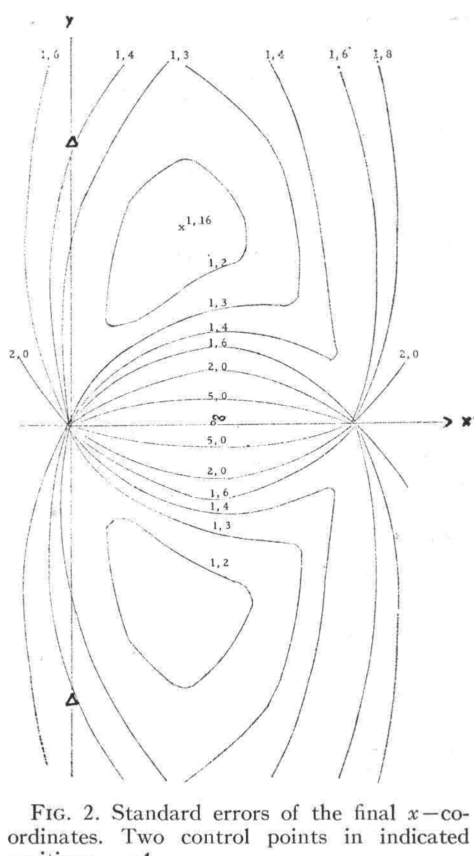

FIG. 2. Standard errors of the final x—coordinates. Two control points in indicated positions. $\mu=1$.

The photographs were taken on film with a RC-5 camera with Aviogon lens, $c=114$ mm., from an altitude of about 4,900 meters. The image scale is consequently about 1:43,500. The measurements were performed in contact glass diapositives (18×18 cm.) in a Zeiss stereocomparator. The y-parallaxes were measured in 9 symmetrical points; the x-parallaxes and the image coordinates were measured in 10 signalled control points.

The standard error of the y-parallax measurements as computed from the adjustment of the relative orientation was found to be 6 microns. From the measured x-parallaxes in the control points, preliminary elevation differences on the ground were computed. After application of the principles of the numerical corrections and absolute orientation in three elevation control points, the mean square value of the residual elevation errors was found to be 0.4 meters. The radial distortion of the photographs was earlier determined with the aid of the grid and the y-parallax methods and proved to be considerably different from the radial distortion of the lens according to the manufacturer. The theoretically derived elevation standard errors to be expected proved to agree very well with the results of the practical tests.

In planimetry, preliminary coordinates were computed from the image coordinates by the simple intersection formulae. Then the preliminary coordinates were transformed to the ground system by ordinary coordinate transformation with the aid of two control points. The mean square values of the errors in the rest of the control points were found to be about one meter in the x-and y-directions. The deviations of the photographs from the vertical were found to be so small that no corrections to the coordinates were necessary.

The theoretically derived standard

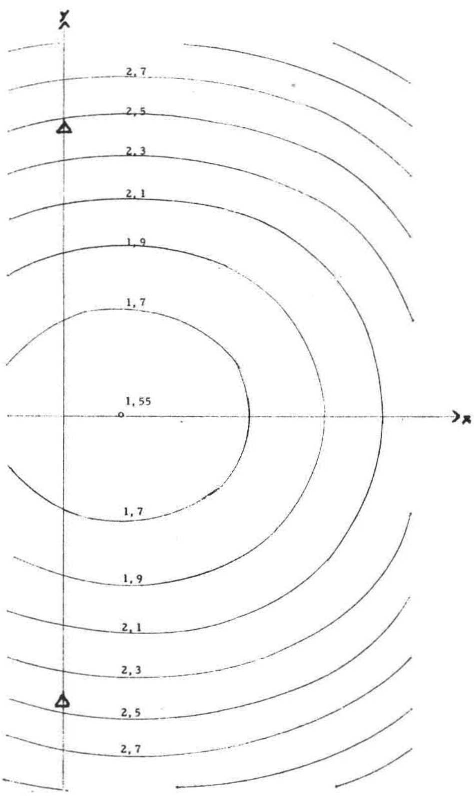

FIG. 3. Standard errors of the final $y-$coordinates. Two control points in indicated positions. $\mu=1$.

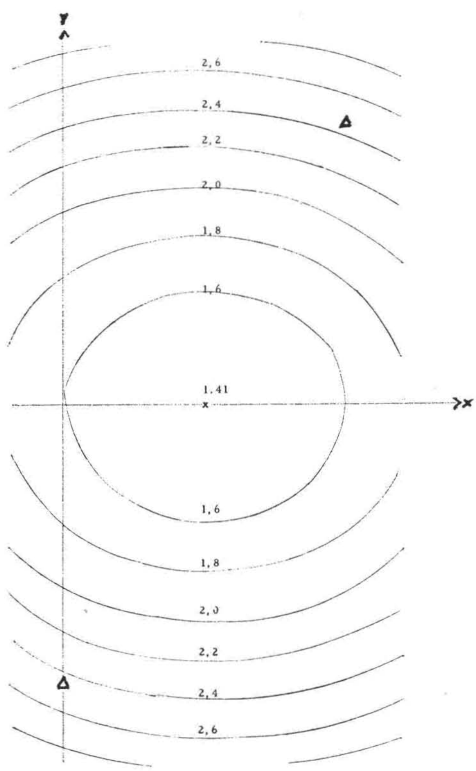

FIG. 4. Standard errors of the final $y-$coordinates. Two control points in indicated positions. $\mu=1$.

errors in planimetry proved to agree very well with the practical results.

In summary, the results of the tests are very promising, and it seems desirable that the method be tested under varying circumstances, also with such simple instruments as mirror stereoscopes and single image comparators (coordinatographs etc.)

Some examples of the theoretical distribution of the standard errors of the final x-and y-coordinates are demonstrated in the accompanying diagrams.

The error propagation formulae were derived in accordance with the well known laws of the method of least squares and for two different cases of the control point location.

In particular, the principles of the numerical corrections and of compensation in the control points were applied. In a similar way the error distribution in a triangulation strip can be derived and demonstrated.

Two Sketching Devices for Oblique Aerial Photographs

MIRIAM HERZOG, *Engineer in Training*,
assisted by GIFFORD M. MAST, *President*,
and W. K. GANNETT, *Director of Engineering*,
Mast Development Company, Inc.

ABSTRACT: *The Mechanical Oblique Sketcher and the Optical Oblique Sketcher are two novel answers to the problem of rectifying aerial photos. The Mechanical Oblique Sketcher is a mechanization of a point by point geometric rectification procedure. The Oblique Photo Sketcher is a projection device for diapositives which utilizes an intense point source of light focused on a small aperture, simple lens to produce an unusual depth of field, permitting imaging the diapositive on a grossly tilted surface.*

AERIAL photographs, taken at an oblique angle to the earth, provide useful photogrammetric information only if the normal, vertical view can be reproduced. Rectification of aerial photos is a complicated procedure since it involves the translation of a perspective view into orthographic projection. Rectification is generally accomplished by either special drafting instruments or by rectifying projection machines. Two characteristics of these devices have been:

1. the rectifying projectors were too bulky to be conveniently transported;
2. the drafting machines required tedious, eye-straining plotting.

In view of these objections, one can see that there existed a need for a simple, reasonably accurate, transportable rectification device. One use for such a device would be the prompt bringing up-to-date of maps and charts from daily reconnaissance information. The need for a devise was expressed by the Photo Reconnaissance Laboratory, Wright-Patterson Air Force Base. In answer thereto Mast Development Company, Inc., Davenport, Iowa, designed two such instruments—first the Mechanical Oblique Sketcher and second, the Optical Oblique Sketcher.

THEORY UNDERLYING THE MECHANICAL OBLIQUE SKETCHER (M.O.S.)

The Mechanical Oblique Sketcher is based on an application of Synthetic Projective Geometry suggested by Prof. A. C. Bendixen of Ohio State University Research Foundation. His suggestion applies a characteristic of homologous quadrangles namely, homologous figures are projections of the same plane figure on different planes.

In Figure 1, $ABCD$ and $A'B'C'D'$ are