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ANALYTICAL AERIAL TRIANGULATION IN PRACTICE

A b s t r a c t

A technology for analytical aerial traingulation by block adjustment is applied. The photograph coordinate measurements are carried out by Zeiss-Jena Stecometer stereocomparator, and their registration - by Bulgarian-made Isot 9115/ES 9002 recording system. Calculations are done by IBM-370 computer. A package of three programs is in use, the two based on the National Research Council of Canada programs, adapted to the local requirements.

I n t r o d u c t i o n

A technology for analytical block aerotriangulation is applied at the General Administration for Geodesy, Cartography and Cadastre among the other methods for densification of the geodetic network. It is used both in making and revision of the large-scale topographic map of Bulgaria (1:5000 and 1:10 000) and in making of very large-scale urban maps (1:500 and 1:1000).

Depending on the map scale, contour interval and aerial cameras in use, as well as on other specific requirements, the scale of the photographs in the first case vary from 1:12 000 to 1:30 000, while in the second - from 1:3000 to 1:6000. Details concerning the available technical means and technology applied for mapping, as well as map accuracy requirements are explained in /1/ and /2/.

Ground control

The territory of the country is covered by a sufficiently dense traingulation network. It can serve for planimetric and height ground control of aerial traingulation for the large-scale topographic map without additional land survey work. It is necessary only to pre-mark the existing triangulation points on the terrian.

Application of aerotraingulation technology in very large-scale mapping of populated areas, however, requires further densification of the existing triangulation network by means of land survey methods.Usually the coordinates of the ground control are determined by means of precise polygons, whose lengths are measured by electro-optical distance meters, and the heights of the points - by levelling or trigonometrically. In this case, too, the ground control points have to be marked on the terrain prior to aerial photography.

Photogrammetric measurements

The photogrammetric measurements are made by Zeiss-Jena Stecometer precise stereocomparator and recorded by means of Bulgarian-made Isot 9115/ES 9002 system attached to it. The system consists of Isot 9115 device for analog-digital transformation of data and ES 9002 device for recording on magnetic tape. Zeiss-Jena Transmark and Wild PUG-4 devices are used for marking the image points on the diapositives.

Program package

The computation of block aerotraingulation is carried out by the consequential action of the following three Fortan programs:

Data Preparation,

Strip Formation,

Block Adjustment.

The Data Preparation program has the task of checking the stereocomparator measurements and preparing them for the second program. The first step is a check for completeness of

the measurements and their recording, as well as a check on other data introduced. The next step is to compare the differences between each two respective measurements with a test value, if they are made twice, and to obtain the mean values of the measurements. The mean stereocomparator coordinates and parallaxes serve to calculate the coordinates for each pair of consecutive photographs forming a model. By affine transformation these coordinates are transformed into the photograph coordinate system, defined by the fiducial marks /3/.As it is well known, the affine transformation takes into account the different rates of film shrinkage along the two coordinate axes. Next, the photograph coordinates are reduced to the principal point of the photograph, whose position may differ within a few micrometers from the origin of the photograph coordinate system according to the camera calibration certificates.

The performance of the first program terminates with the computation of the photograph coordinate differences of the point common for each two consecutive models. These differences provide a reliable criterion, both for the accuracy of stereocomparator measurements and for the correctness of calculated photograph coordinates. On account of this, the program compares the differences with a pre-set test value.

The Data Preparation program acts independently from the next two programs. Output data is recorded on magnetic disk or tape and after analysis it is decided whether to use it as input for the Strip Formation program. This offers the possibility of using a minicomputer, positioned close to the stereocomparator, for calculation by means of the Data Preparation program.

The second and the third programs,vis. the Strip Formation and Block Adjustment ones, are based on two programs of the National Research Council of Canada /4, 5/, being adapted to the local requirements.The result of the action of the second program is stored as well, and following its analysis, the computation continues by the third program.

The following example provides an idea about the speed of the prgrams when computation is carried out by IBM-370

computer. A block consisting of 120 models (7 strips) with 40 ground control points distributed in 4 bands across the strips and 170 minor control points has been computed. The number of the image points measured once is 1700 (plus 960 fiducial mark measurements).Second-degree polynomials and 8 iterations are applied for the block adjustment. The total computer time was about 17 minutes, out of which 12 - for the action of the Data Preparation and Strip Formation programs, and 5 minutes - for the Block Adjustment program. Total processor time for this computation was less than 4 minutes.

References

/1/ National report on the development and application of photogrammetry in the People's Republic of Bulgaria during the 1972-1976 period. ISP XIII Congress, Helsinki, 1976.

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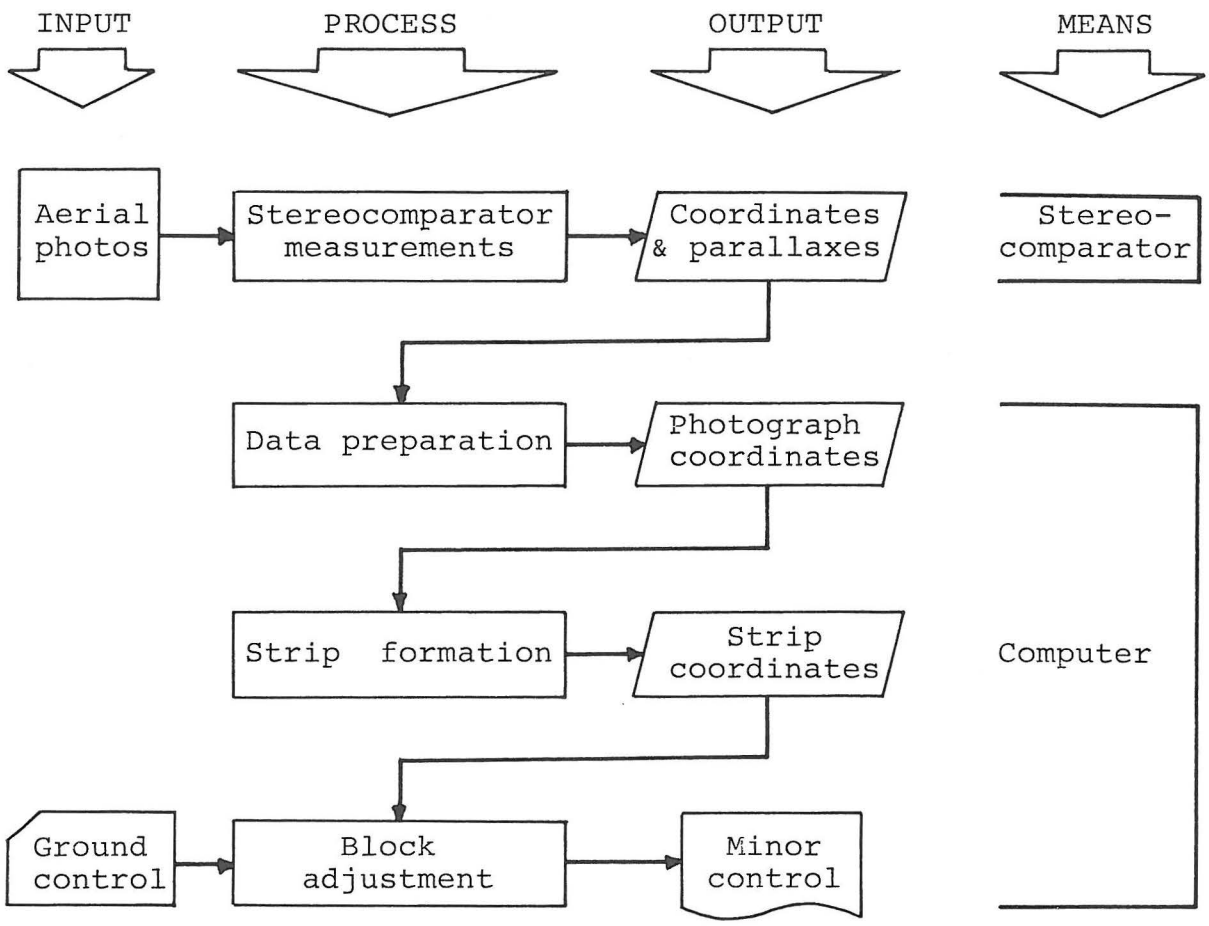
/3/ Katzarsky, I.: Transformation of photogrammetric models (Bulg.). Bulletin of the General Administration for Geodesy, Cartography and Cadastre, 1, 1971.

/4/ Schut, G.H.: An introduction to analytical strip triangulation with a Fortran program. National Research Council of Canada, 1973.

/5/ Schut, G.H.: A Fortran program for the adjustment of strips and blocks by polynomial transformations. National Research Council of Canada, 1968.

See diagram overleaf.



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