COMMISSION IV

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PRESENTED PAPER

Inger Persson

Kerstin Viklander

Ann-Charlotte Wirlée

Department of Photogrammetry
Royal Institute of Technology
Stockholm, Sweden

TRANSFER OF TARGETS BETWEEN AERIAL PHOTOGRAPHS

ABSTRACT

This is an investigation of how to obtain control points in
already existing aerial photographs.
An area with geodetically measured points with targets is photo-
graphed from a low altitude with a measuring camera. The targets
in the new photographs are then transferred to the old ones.

Two different methods have been used for the transfer. One method
is optical, where the photographs are compared, and the targets
are being located in the old photograph by using surrounding
details as references.

The second method is a mathematical transformation. Correspon-
ding details in both photographs are measured and computations
using the double ratio between two planes are performed. All
measurements for the transfer are done in a stereocomparator.

TRANSFER OF TARGETS BETWEEN AERIAL PHOTOGRAPHS

The paper is a part of a graduate thesis done at the Department of Photogrammetry at the Royal Institute of Technology in Stockholm.

The National Land Survey of Sweden is photographing the country regularly. The pictures are taken at high altitude (4 600 meters giving the scale 1:30 000). No targeting is performed in advance.

If the aerial photographs are used in mapping, they have to contain control points. This investigation tried to find a more accurate method to obtain the points in these photographs. Our method was to photograph geodetically measured points with targets from a low altitude with a measuring camera (giving the scale 1:10 000). The targets in the new photographs are then transferred to the old photographs taken at 4 600 meters. The transferring measurements were performed in a stereocomparator. Because of the different scales in the new and old pictures, we had to use the enlargement ratio 20 to 6 in the stereocomparator.

The size of the investigation area was 15 x 15 kilometers. We used 11 geodetically measured points with targets (0.6 x 0.6 meters). The points were located after the principle of the block triangulation. For the low altitude photographing, we used the measuring camera Hasselblad MK70. The camera had an automatic filmfeed, with one picture taken every other second. The aeroplane was a private sports plane (Cessna) with a special constructed door. The camera suspension setup uses the gravity to keep the camera vertical and to eliminate the vibrations of the aeroplane. We adjusted our flying altitude to the different scales of the pictures and to the enlargement ratio in the stereocomparator - the altitude was therefore about 600 meters.

We used two different methods for transferring the targets between the photographs, one optical and one mathematical.

OPTICAL METHOD

We placed one new and one old picture in the stereocomparator. Unfortunately we were never able to get a stereomodel, because of the different qualities of the pictures. Instead we had to transfer the targets to the old photograph by using the surrounding details as references.

MATHEMATICAL METHOD

In the mathematical transformation we used the double ratio between two planes. This projective relation is

$$x = \frac{a_1' \cdot x' + b_1' \cdot y' + d_1'}{a_4' \cdot x' + b_4' \cdot y' + 1}$$

$$y = \frac{a_2' \cdot x' + b_2' \cdot y' + d_2'}{a_4' \cdot x' + b_4' \cdot y' + 1}$$

where   x y are co-ordinates in the old pictures

        x' y' are co-ordinates in the new pictures

        and the others are transformation parameters.

As many corresponding details as possible in about the same plane were measured in both pictures. Compared to the optical method this measurement was easier. Computations using the double ratio were performed to obtain the co-ordinates of the targets. We also computed the root mean square error for the corresponding details.

CONCLUSION

We had no possibility to test the accuracy of the transferred targets. This can only be done after a block triangulation. To get some information of the quality in the optical method three persons made independent measurements, and the different root mean square errors were studied. The errors varied depending on how each person interpreted the picture, especially in deep forest or where the distinct details were few. We also calculated the root mean square errors for the mathematical method. The errors from both methods are compared in table 1.

Table 1

Root mean square errors in the co-ordinates of the targets after the optical and the mathematical transfer (mm in picture scale).

Station	Picture	Optical	Mathematical
1	10019	0.0435	0.0223
1	10020	0.0692	0.0299
2	10022	0.0518	0.0220
2	10023	0.0339	0.0283
3	10023	0.0573	0.0304
3	10024	0.0458	0.0329
3	10025	0.0617	0.0240
4	10025	0.1151	0.0275
4	10003	0.1142	0.0263
4	10004	0.0660	0.0094

According to the table the mathematical method gives the best results.

Our experience tells us that it is very important that the old and the new photographs are as similar as possible. For example it is positive if the shadows are the same.