

PRECISION INCREASE IN CLOSE - RANGE PHOTOGRAMMETRY
BY USING GEODETIC DATA

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ABSTRACT

In close range applications the accuracy of obtained coordinates depends at a great extent to the number of pass-points and camera configuration. The aim of this study is to check the precision increase by using geodetic data with different number of pass points. The used data is derived from a precise test-field, which was established with the use of girder plates of a photogrammetric plotting instrument.

INTRODUCTION

The main task of photogrammetric measuring techniques is to reconstruct the spatial geometry of objects by means of photographs. The three dimensional coordinate determination is a part of this task, other than the determination of the continuous forms of the objects, such as contour lines, profiles or cross sections. Then the last properties can also be determined in some way from the three dimensional coordinates of the object. Therefore, like the geodetic point determination, photogrammetric point determination plays an important role in all applications.

In this context, digital techniques have been used in photogrammetry since the 1960's, starting with aerial triangulation. With the use of computer techniques and combined with data acquisition, the application field of photogrammetric methods is not limited to map production. The use of analytical photogrammetry in engineering has become widespread, so that one can very easily speak of an engineering photogrammetry, a discipline whose tasks become more and more important.

During all these years the geometrical concept which is at the basis of photogrammetric has changed considerably : the photogrammetric stereo model is replaced by the photogrammetric bundle. The object points are registered simultaneously by the bundle of spatial directions from camera stations. The accuracy of a single ray of a camera depends in the first place on the principle distance c of the camera and on the accuracy of the image points coordinates.

The aim of this study is to test the accuracy increase by means of some geodetic data specially in close range applications.

TEST FIELD

A test-field which was constructed for a different study /2/ gives a good possibility to gain suitable data for this study, too. The test field was constructed with two girder plates. As known, each of the plates has in intersection of horizontal and vertical lines 100 points, whose coordinates were determined with an accuracy of $\pm 0.5 \mu\text{m}$, absolutely

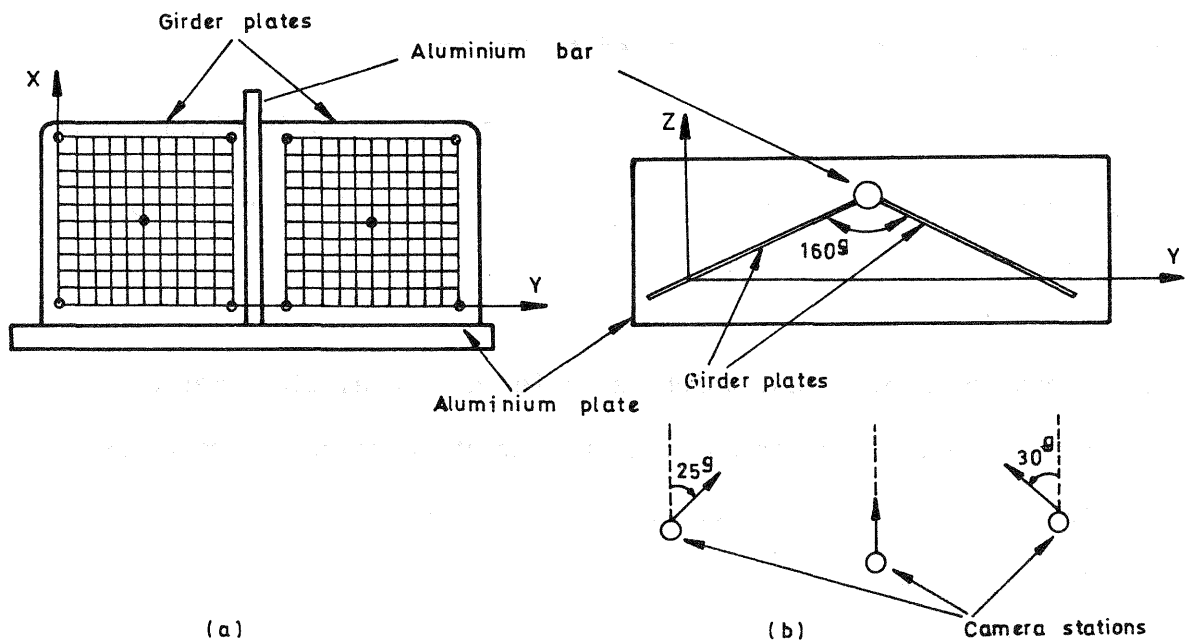


Figure 1- Design of the test field with camera stations and exposure directions, (a) view, (b) plane

As the photographic record of photogrammetric bundles are very easy (free stationing), any camera station may be chosen in the field (picture n-tupel). The bundles are only tied together by common object points. As for the orientation of the bundles no restrictions are made, and the pictures are taken sometimes freehand.

Depending on the problem the bundle block adjustment is either carried out as a free adjustment or if the coordinates are known for some object points - as an adjustment with control points.

Besides the spatial directions of the bundles and rays, other measurements and information can be included in the bundle block adjustment /1/ :

- distances (e.g. levelling rod fixed to the object.)
- absolute spot height or spot height differences (e.g. levelled points).
- shape conditions (such as several points on perpendicular line or in a horizontal plane).

All of these possibilities, which was offered by analytical methods enlarges the application areas of photogrammetric methods. Meanwhile sophisticated software has been developed for bundle block adjustments. But there isn't any detailed accuracy and reliability models besides some attempts. (Altan 1984).

Specially there exist any theoretical or experimental study for an accuracy model in the field of precision increase by means of geodetic measurements which can be included to the mathematical model of photogrammetric data acquisition.

to a point and axes system in the surface plane of each plane. (Fig.1). As the girder plates are mounted on an aluminium plate forming an angle of 160° between, the points form a three dimensional test field. All coordinates of the test-field points are determined with an accuracy of $\pm 12 \mu\text{m}$. These about 200 points allows us now to determine some geodetic information and to investigate the gain in accuracy by using them.

PHOTOGRAMMETRIC SURVEY and GEODETIC DATA

This test field is photographed from three different camera stations, with a mean object distance of about 60 cm. The image coordinates of the girder points are measured in a Zeiss Stereocomparator. The geodetic information is obtained from the geodetic coordinates of two points and for the calculations, four types of geodetic observation is considered (see. Fig.2.)

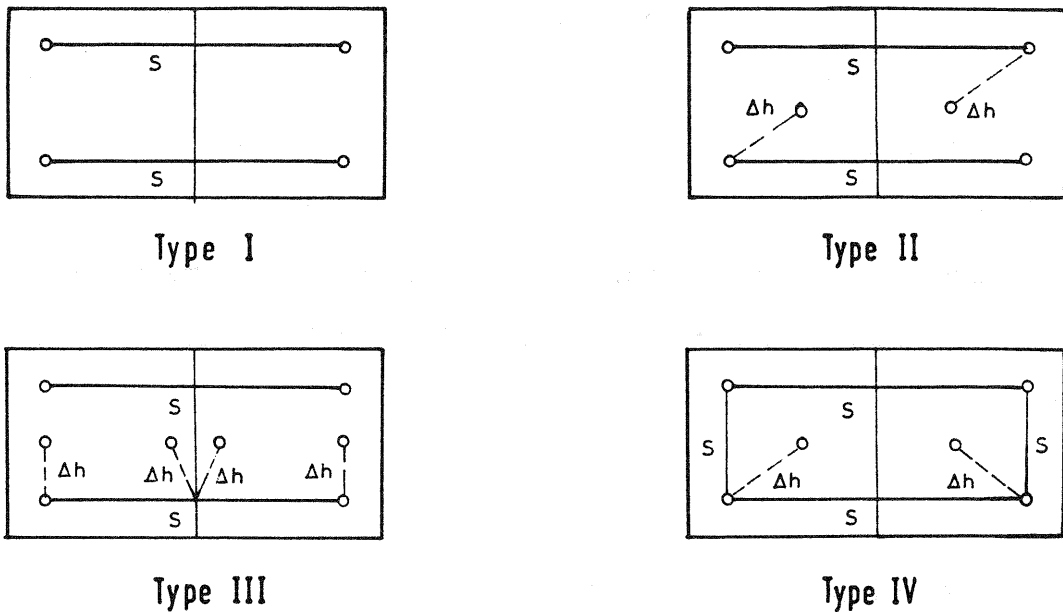


Figure 2. Different types of geodetic data combination.

Type I, two distances ; Type II, two distances and two elevation differences ; Type III, two distances and four elevation differences ; Type IV four distances and two elevation differences.

For the computations a computer program for a rigid bundle solution was used, which permits to add the geodetic measurements into the calculations.

The base for further investigations are the 3- dimensional coordinates of all test-field points, which result on one hand from the rigid bundle solution and on the other hand the coordinates of these points achieved by means of geodetic measurements. For the presentation of the results, the differences of the coordinates of all points, which are represented by the mean values, are considered.

$$\text{MDX} = \frac{1}{n} |DX|$$

$$\text{MDY} = \frac{1}{n} |DY|$$

$$\text{MDZ} = \frac{1}{n} |DZ|$$

with DX, DY, DZ differences of the coordinates
and n number of points in the comparison.

For a better representation of results, the calculated values of MDX, MDY and the ratio of MDZ to a mean object distance about 60 cm in per mile are given as drawings in Fig. 3. These results are computed for two different ratios of mean object distance to the depth of pass points as two different versions. The first version is computed for the maximum of control point depth (6.2 cm) and the ratio of these value to the mean object distance (60 cm) is 9.7 . The other version is computed for a depth of 5 cm. The four types of geodetic observation are compared with the results of photogrammetric data without geodetic data and as the first two types doesn't bring any convenient change in the results, only the combinations type III and type IV are shown in the drawings. The MDX, MDY and %oE values are given for different number of pass points, beginning from 3 pass points.

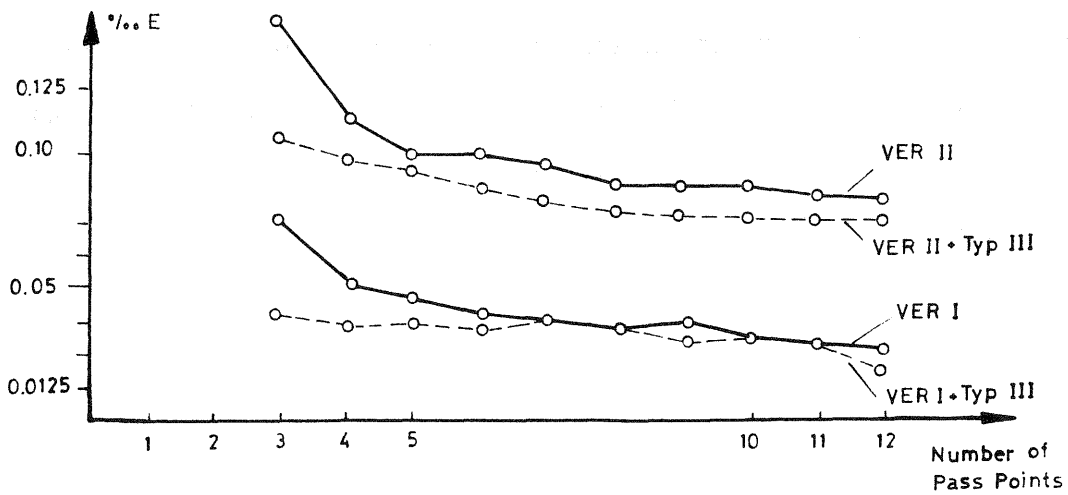
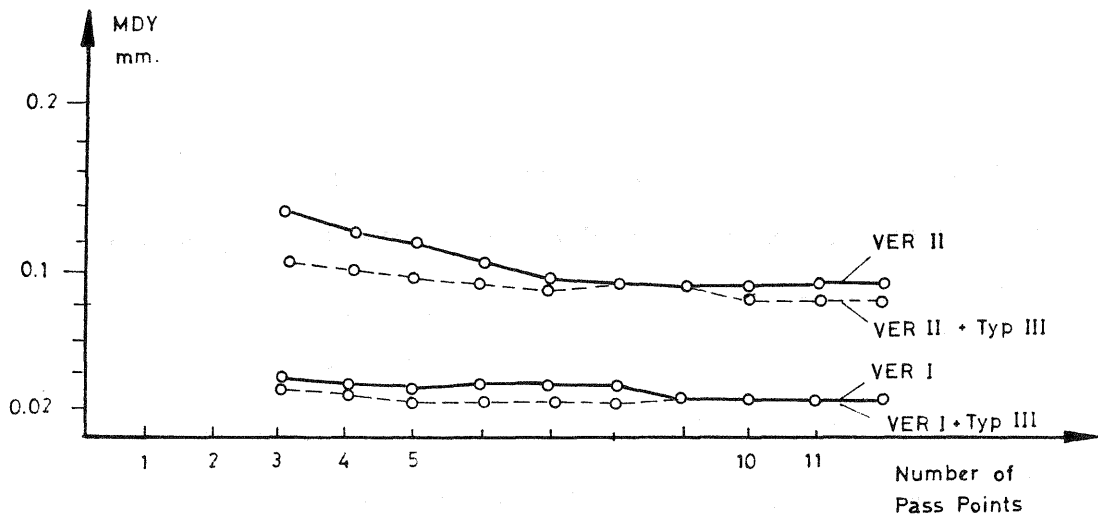
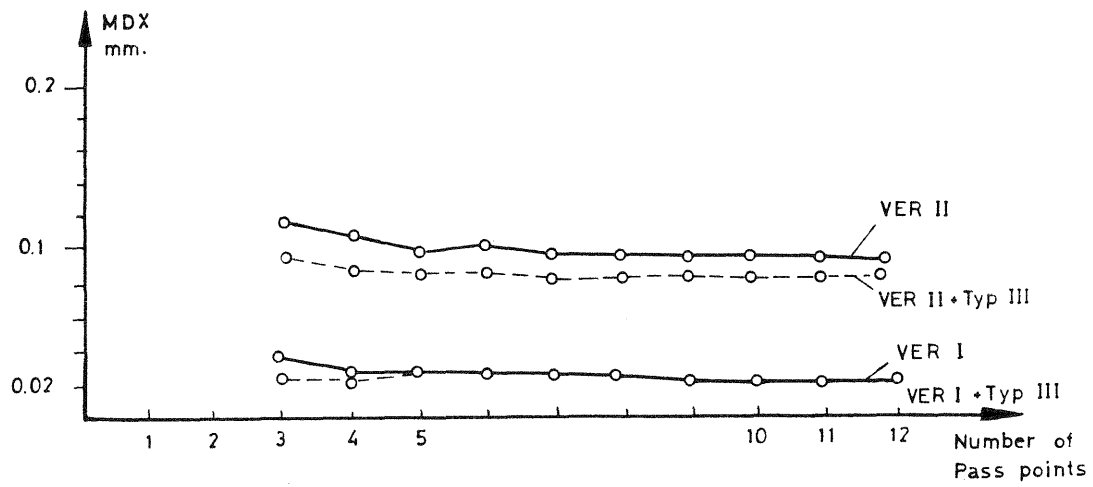


Fig. 3.1 Variation of MDX, MDY and %E in the Geodetic information Typ III

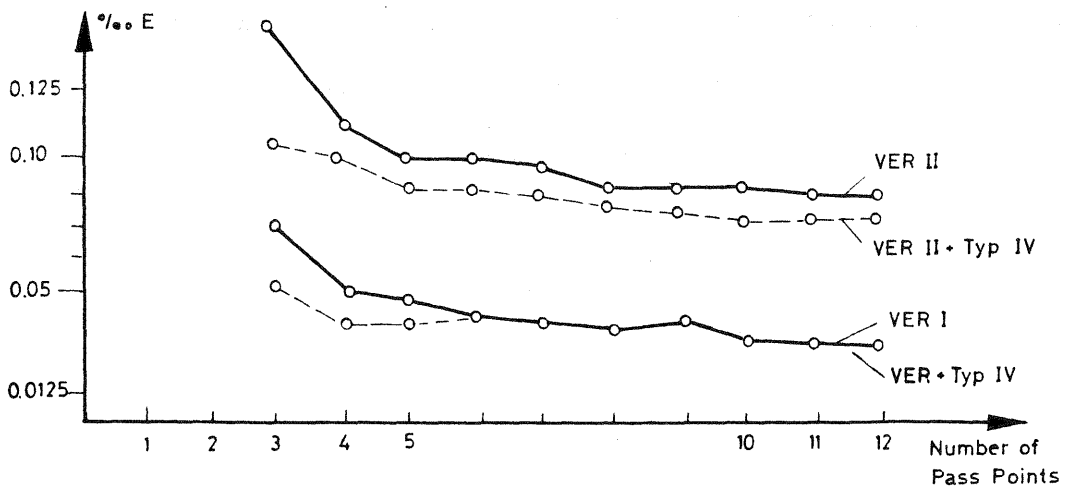
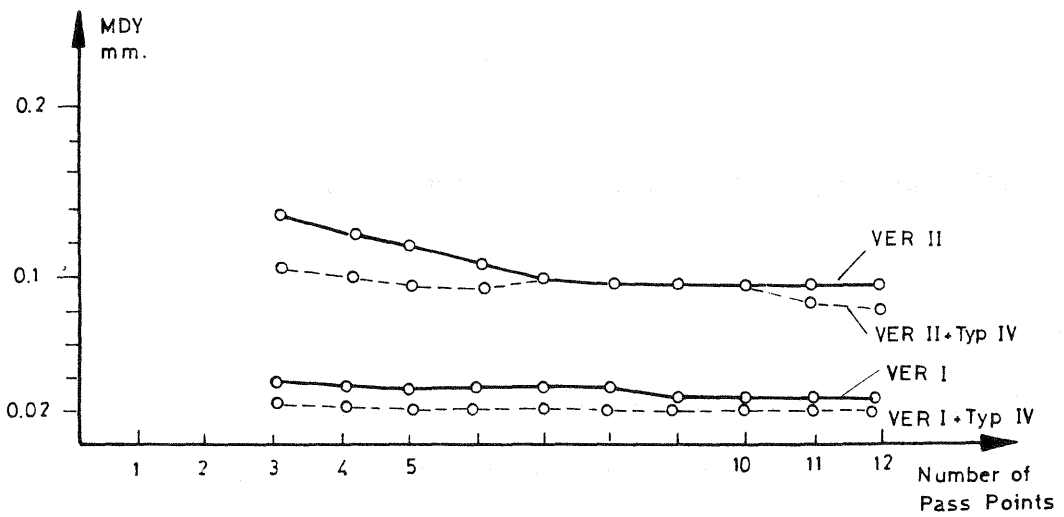
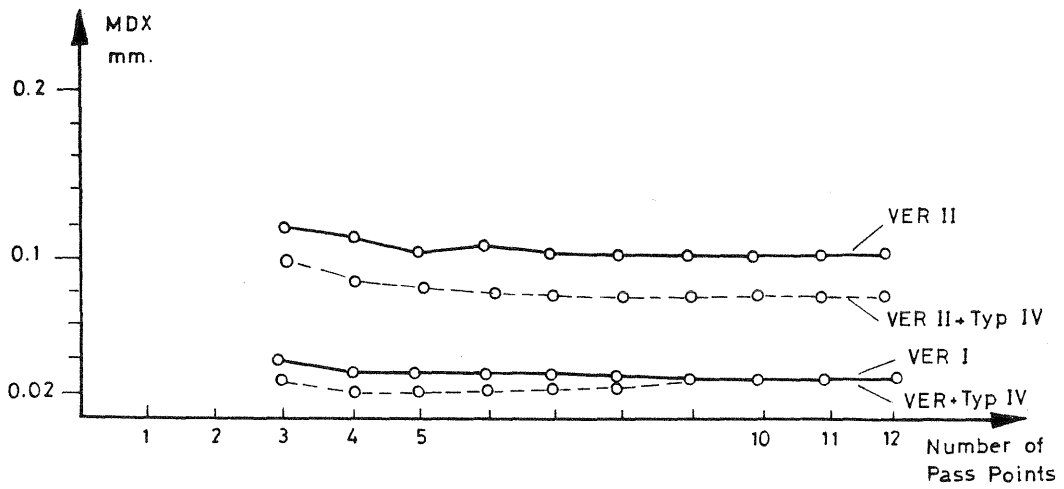


Fig. 3.2 Variation of MDX, MDY and % E in the Geodetic information Typ IV

From the course of the curves one can see that the geodetic observation gives only better results up to the 6 number of pass points. It is not shown by the graphics but the types of Geodetic Information I and II doesn't give any significant change in the accuracy.

CONCLUSIONS

In this work, it is tried to investigate how the geodetic information can give an improvement in the accuracy of photogrammetric point determination. Therefore the data, which was obtained by the test-field was used. It has shown, that in case of lack of pass point (less than 6) geodetic data can help to increase the obtained accuracy.

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