A Test Wall for the Close-Range Photogrammetric Calibration

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UDC 528.74.087.6

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A TEST WALL FOR THE CLOSE-RANGE PHOTOGRAMMETRIC CALIBRATION

Abstract

In close-range photogrammetry the use of the reference point networks for the calibration of systems and instruments is obviously important. A two-dimensional test wall of the object distances of 5 to 30 metres is constructed at the Technical Research Centre of Finland. In the paper the test wall is described.

Introduction

The cost efficiency in close-range photogrammetry is a today's problem for the photogrammetrists. The best way to widen the economic usability of the photogrammetric methods for non-topographic applications is to know thoroughly the performing capacity of the method itself and the instruments. With a strict calibration we are able to evaluate the use of photogrammetric method objectively and compare it with other metric measuring techniques. At the same time we can take the accuracy requirements into account and even reduce the total costs of the measuring process.

The geometric calibration of the close-range photogrammetric systems and instruments is usually performed using reference point networks like test fields and three-dimensional test objects. The network consists of a set of signalized points whose geometric relationships are determined with a more accurate measuring procedure, often including geodetic methods.

In Finlad there are three different reference point networks built for the calibration of close-range photogrammetric systems and instruments. The latest one, which will now be described, is constructed for an object distance of the range of about 5 to 30 metres. It is a plane-formed two-dimensional vertical test field. In addition to it there are a smaller test wall at the Tampere University of Technology and a corner-formed test field at the Helsinki University of Technology. The latter one is three-dimensional and constructed for an object distance ranging from about 2 to 6 metres.

The test wall

The reference point network of the new test wall consists of 39 fixed black-and-white cross-shaped targets lying on an outer wall of the main building of the Helsinki University of Technology . Furthermore there are two reference points for scaling equipped with centering devices (Figure 1). The dimensions of the test wall and the distribution of the reference points are sketched in Figure 2.

The determination of the reference points

The preliminary estimating of the accuracy

The reference point coordinates have to be determined with such an accuracy that the errors may be considered negligible when calibrating the photogrammetric systems. In this case the adequate accuracy was to be obtained by geodetic means. The mutual position of each reference point was to be determined by horizontal and vertical angle observations using an one-second theodolite Kern DKM2-A. Some 20 metres was chosen for the average pointing distance to these direction observations. Thus the estimated standard error of one direction observation was 0,5 mgon, which is equal to 0,16 mm on the test wall. The scale had to be determined with a precision distance meter Kern Mekometer ME 3000 by measuring the distance between the two scale points on the lower side of the test wall. It was made as a difference measurement, as the two scale points lay in a straight line with the Mekometer at the distance of 40,0 m and 59,9 m from it. The scale distance was expected to be determined with the standard error of 0,18 mm consisting of the standard error

Figure 1. The reference point target on the test wall and the centered scale reference point.

of the Mekometer itself (0,15 mm) and that of centering and levelling the reflector (0,10 mm). Thus the relative accuracy of the scale of the test field is 1:100 000.

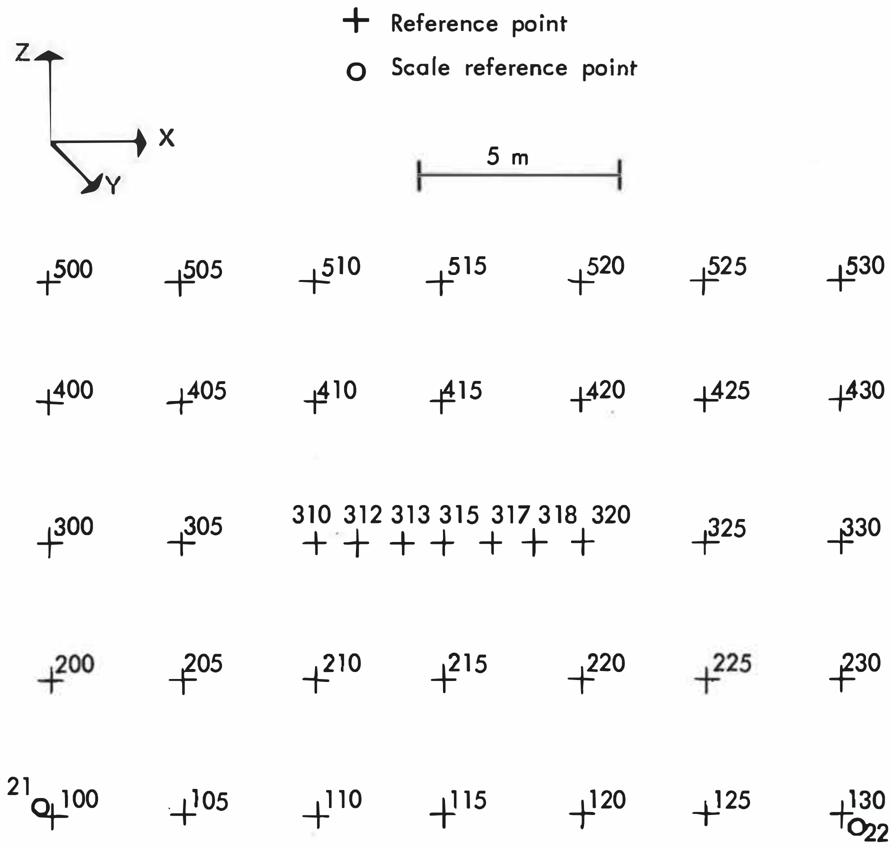

Figure 2. The reference point network.

The measurements

In 1978 three different measurements were performed to determine the distance between the two scale points. Furthermore one measurement was performed in 1979 to pay attention to eventual scale deformation. The results are shown in Table 1. The standard error of one distance measurement computed from all the four measurements is 0,13 mm, the standard error of the mean being 0,07 mm. If the standard error of the mean is considered as an inexactitude caused by centering and levelling the prism and the standard error of the phase-measurement is added to it, we get 0,17 mm for the standard error of the measured scale distance.

Table 1. The results of the scale distance measurements.

Date	The distance (mm)	The difference to the mean (mm)
18.8.1978	19885,18	+ 0,17
28.8.1978	19884,85	- 0,16
31.8.1978	19885,00	+ 0,00
18.6.1979	19884,99	- 0,02

The direction measurements were performed with the theodolite using a tripod at four different station points (Figure 3). Two separate sets of observations were made at the station points no. 1 and 3 and one single set at the stations no. 5 and 6. Both the horizontal and vertical angles were made simultaneously. As all the sets of observations were performed separately the precision of angle observation could be evaluated only after the adjustment.

The adjustment

The three-dimensional coordinates of the reference points of the test wall were computed using the general block adjustment program by the computer CDC Cyber-173. In the adjustment there were 492 angle observations and one heavy-weighted distance observation. There were 137 coordinate unknowns and 6 orientation unknowns, so that the amount of extra observations was 350. The standard error of one angle observations computed from residuals was 0,61 mgon for horizontal angles and 0,47 mgon for vertical angles.

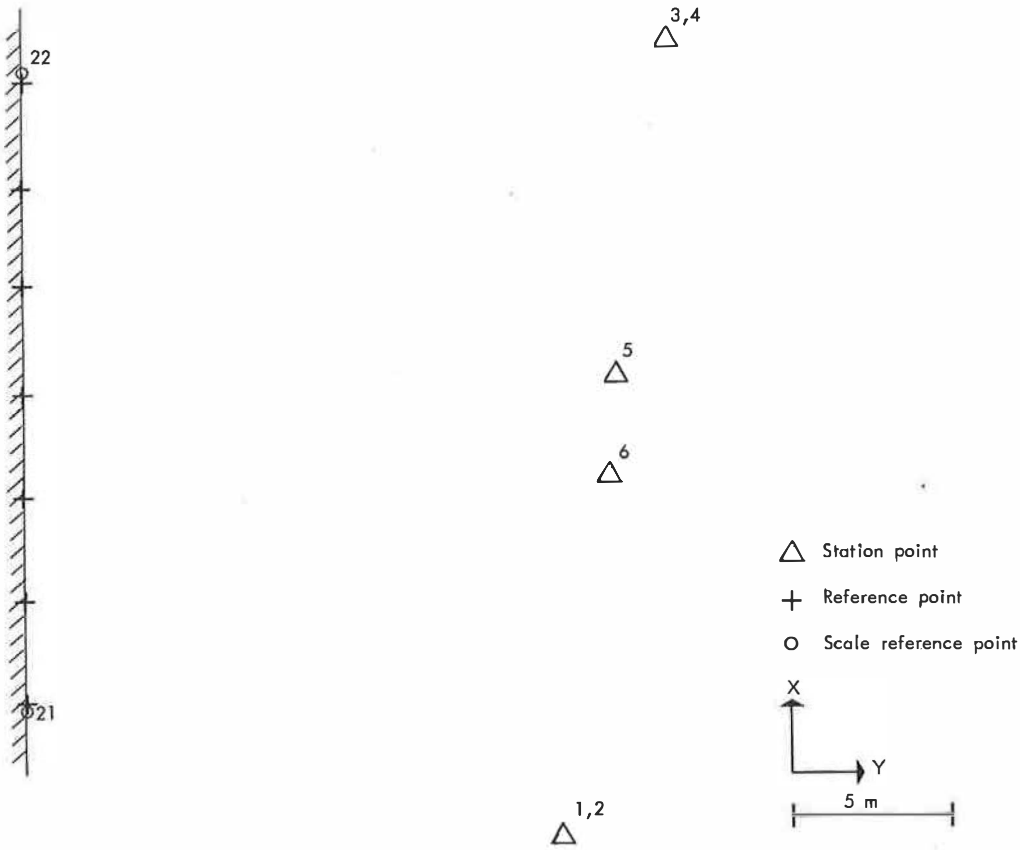

Figure 3. The system of direction measurements.

The accuracy of the reference point coordinates

Because of the methods used for solving the equations in the general block adjustment it is not possible to estimate the standard errors of the reference point coordinates directly. If the mutual position accuracy of the points is estimated on the basis of the standard error of one direction and the average pointing distance, we get 0,17 mm for the standard error of one coordinate. This figure describes the precision of the test wall. As the relative accuracy of the scale we can consider about 1:100 000 on the basis of the standard error of the distance measurement. Thus the relative accuracy and the precision of the reference point network meet the expectations and the network may be used for close-range photogrammetric calibration experiments.

Concluding remarks

The use of reference point networks will in the future have an even more important role in calibrating the close-range photogrammetric systems. When it is to choose between different measuring systems one can use simulative models for evaluting the results and the costs in order to get comparable indicators for decision making. The estimates and deductions are always somewhat unreliable if we cannot test them in practice. Therefore we have to use proper reference point networks to get practical experience and improvement in setting the values to the parameters of the simulative model. Thus with simple predicts and exact values of the accuracies and tolerances achieved with photogrammetry we may also assure the users what the performing capacity of the close range photogrammetric system is.