COMMISSION III

Hannu Salmenperä
Tampere University of Technology

A PRELIMINARY INVESTIGATION ON THE USE OF THE SIMULTANEOUS ADJUSTMENT OF GEODETIC AND PHOTOGRAMMETRIC OBSERVATIONS

Abstract

The use of auxiliary data in connection with the analytical aerial triangulation has proved to be useful especially in areas with insufficient height control. Also the planimetric control can partly be replaced by using proper geodetic observations. In the article there are presented some results obtained on the basis of a test field material.

Introduction

The photogrammetric point densification has proved its usability in various applications. Aerial triangulation is applied to control extension for mapping at different scales, to cadastral surveys and also to the densification of geodetic network. The usability of methods has been improved in recent years primarily in two ways. The self calibrating block adjustment (use of additional parameters) improves the accuracy of the final result, especially when the prerefinement of systematic image errors has been insufficient. The method has proved to be useful at practical work in spite of the scale and the purpose of measurement.

Additional observations have improved the efficiency of the densification of points, especially in two ways: In large scale cadastral works the relative distance error of neighbour points has become critical. The situation has been improved by measuring short distances in the terrain. These distance observations have been processed in the same adjustment with photogrammetric observations. In small scale applications there

have been used as additional observations especially statoscope and APR observations and heights of shore line points (or height differences). By means of these functions there has been improved especially the accuracy in height. The need for height control points has thus essentially decreased.

Especially in small scale applications the accuracy in height can be improved or the amount of height control points can be reduced by using additional observations. A question has arisen, to what extent the control coordinates both in planimetry and in height could be substituted e.g. by geodetic observations. In the first place those in question would be the observations of slope distances, horizontal angles, vertical angles and height differences. Also the use of independent control point systems as a control might come into question.

In Tampere University of Technology there have been researched empirically the results obtainable by the simultaneous adjustment of geodetic and photogrammetric observations. In this article there are reported some research results. The research has for the present not been very extensive. The purpose has been to obtain grounds for planning a more detailed and varied research program.

Test material

This research is based on the Jämijärvi test field /1/. In the research there has been used the wide angle photography of the scale of about 1:4000. In Fig. 1 there are presented the control point net of the test field and the position of flight strips. In computation there have been used both the side lap of 60 % and the side lap of 20 %. In the former case the amount of flight strips is five, and in the latter case three.

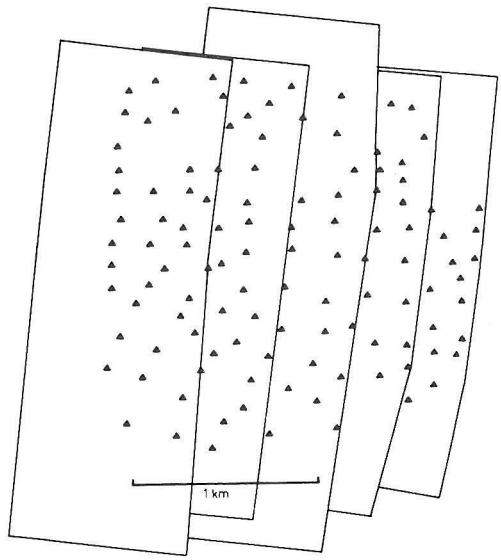

Fig. 1. The control net of Jämijärvi test field and the arial photography.

In computation there have also been used different control point patterns. They have been presented in Fig. 2. Further, there have been applied different geodetic observations (horizontal angles, vertical angles, height differences, slope distances and independent control point systems). They have been obtained by computing from known coordinates. In computation the weights have been estimated for them, according as if they had been done by typical geodetic instruments.

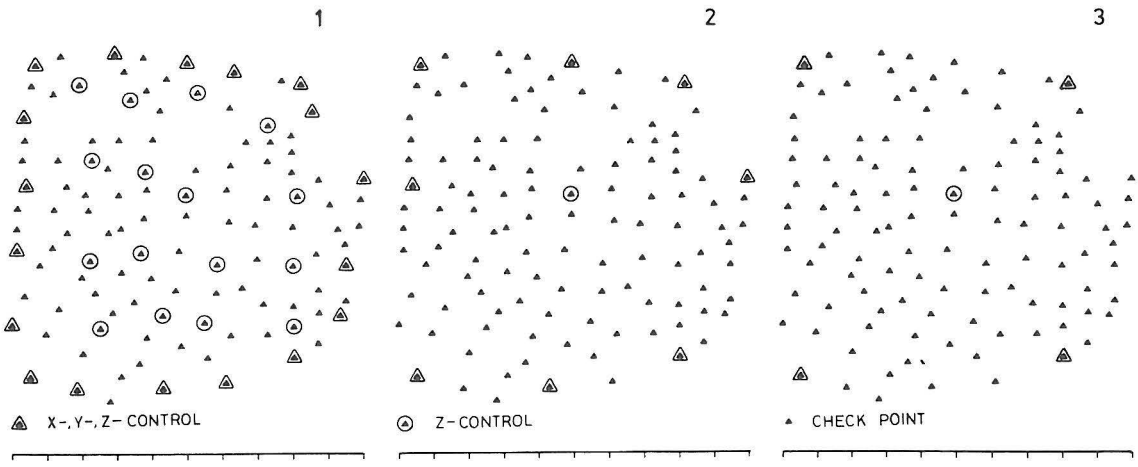

Fig. 2. The control point patterns used in the test blocks.

In this article there are reported only some typical cases. The geodetic observations used in them have been presented in Fig. 3. In computation there have been used weights as follows:

- image coordinate (μm) 1
- distance (mm) 4
- angle (mgon) 4
- height difference (mm) 16

The computer program used in computation has been described in /2/.

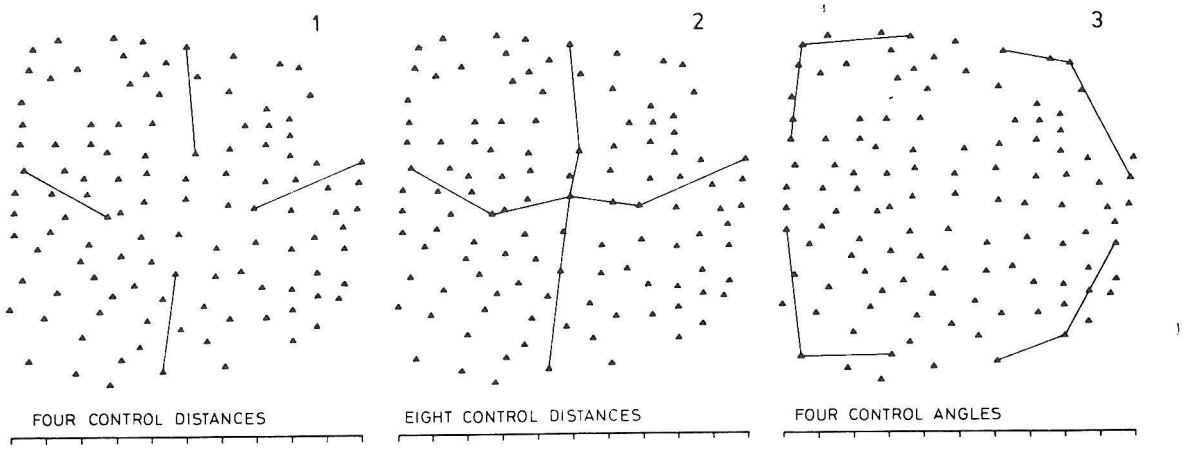

Fig. 3. The additional observations.

Typical results

The original purpose was to research only the effect of a side lap, a control pattern and additional observations on the accuracy of the final result. Some results have been presented in Table 1. In Figures 4 and 5 there have been presented the discrepancies in check points in one case. In Fig. 4 there is a pure photogrammetric block. In Fig. 5 there are added 8 distance observations to that. In Fig. 5 one notices that the above mentioned distance observations cannot quite essentially prevent the systematic deformation of the block.

Because it appeared that the used test material included obviously more systematic error than usually, there was also tried the effect of additional parameters together with additional observations.

Table 1. RMS errors in check points in some test blocks.

No	Block parameters			RMSE in check points (mm)			S_o	
	Side lap %	Control pattern	Additional control	X	Y	Z	µm	
1	60	1	-	15	11	22	4.0	
2	60	1	1	14	9	22	4.0	
3	60	1	2	14	9	22	4.0	
4	60	1	3	15	11	22	4.0	
5	20	1	-	19	16	33	3.9	
6	20	1	1	18	15	32	4.0	
7	20	1	2	18	14	32	4.0	
8	20	1	3	15	11	22	4.0	
9	60	2	-	29	16	52	3.7	
10	60	2	1	26	15	50	3.8	
11	60	2	2	25	15	49	3.8	
12	60	2	3	26	15	48	3.7	
13	20	2	-	29	24	68	3.5	
14	20	2	1	30	22	69	3.6	
15	20	2	2	29	21	66	3.6	
16	20	2	3	26	16	49	3.7	
17	60	3	-	35	19	111	3.4	
18	60	3	1	35	18	109	3.4	
19	60	3	2	30	16	94	3.6	
20	60	3	3	33	20	109	3.4	
17A	60	3	-	25	18	110	3.4	*
19A	60	3	2	18	16	105	3.7	*
21	20	3	-	37	29	131	3.2	
22	20	3	1	37	28	120	3.2	
23	20	3	2	39	20	124	3.5	
24	20	3	3	33	20	109	3.4	

* self calibrating parameters for affinity

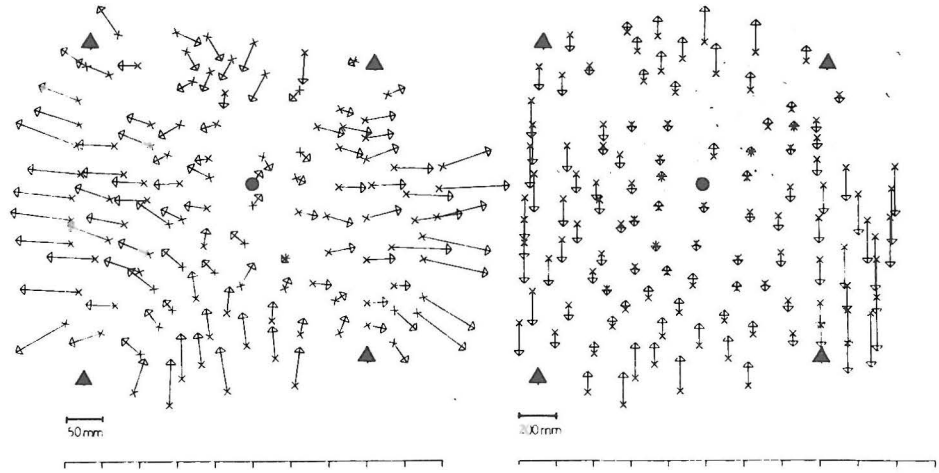

Fig. 4. Discrepancies in check points in a test block. No additional observations.

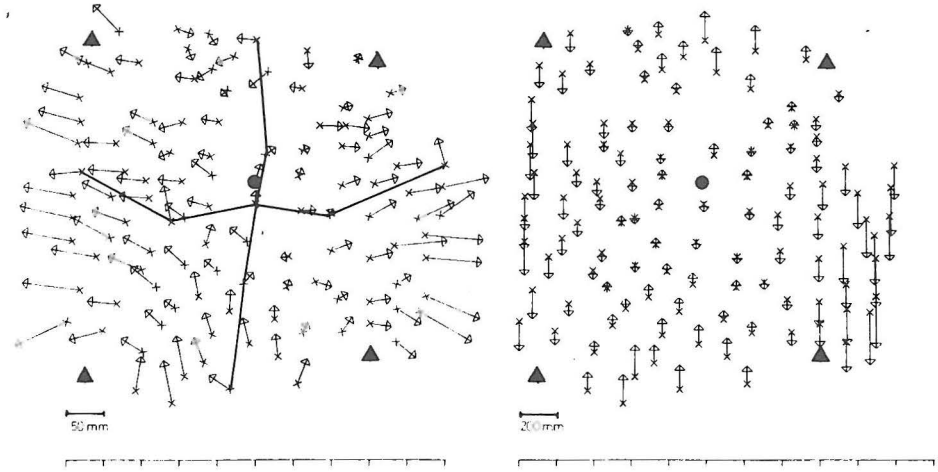

Fig. 5. Discrepancies in check points in a test block. Eight distances as additional control.

When in the block adjustments presented above in Figures 4 and 5 there were used as additional parameters the affinity of pictures (scale difference between coordinate axis and lack of orthogonality), the results presented in Figures 6 and 7 were obtained. From the Figures there can be stated the essential effect of additional parameters in this example.

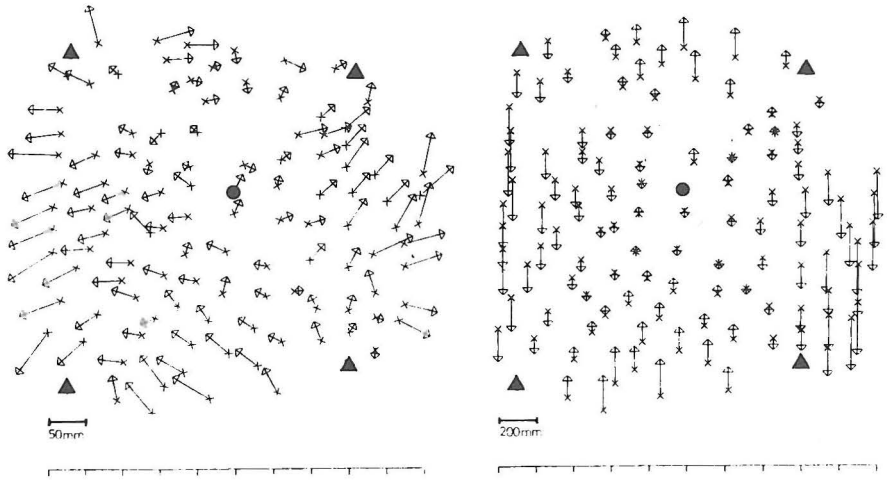

Fig. 6. Discrepancies in check points in a test block. No additional control. Self calibration for affinity of photographs.

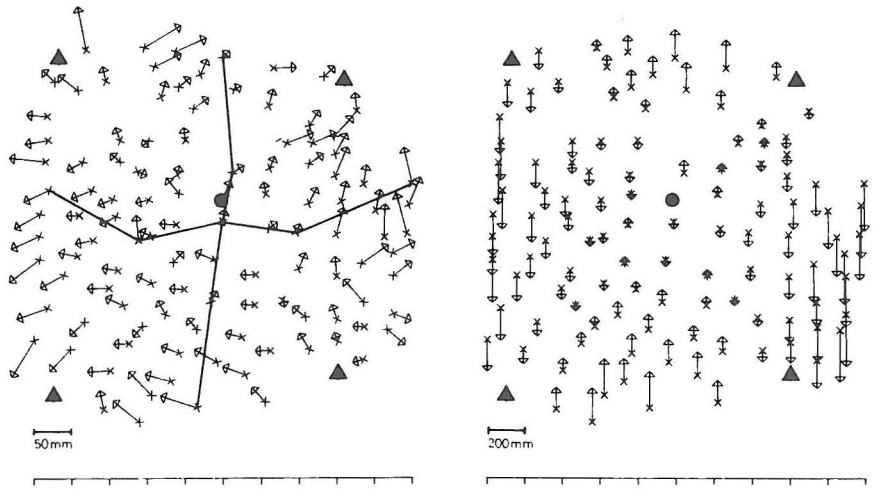

Fig. 7. Discrepancies in check points in a test block. Eight distances as additional control. Self calibration for affinity of photographs.

Concluding remarks

As a general verification of the results presented here there can be proved, that the substituting of control coordinates by geodetic observations has only been very restrictedly successful. The amount of observations must be increased quite a lot, until they can essentially restrict the systematic deformation of a block. On the other hand, the material treated in this research obviously included a greater amount of systematic error than usually. Further one has to notice especially, that the additional observations obviously are of greater value when the structure of a block is essentially weaker than that one presented here. This is the situation e.g. with a strip shaped block and a large block, where the amount of control points is restricted. Further with the combined adjustment of geodetic and photogrammetric observations there can be improved even in large scale applications at least the relative distance accuracy of neighbour points. The results presented in this article are intended to be used as auxiliary material for directing further researches.

References

/1/ Kilpelä, E., Salmenperä, H.: Analytical Block Triangulation in Finland - Theory, Practice and Results. The Photogrammetric Journal of Finland, Vol 8, No. 1, 1979.

/2/ Salmenperä, H.: Block Adjustments Using a Minicomputer of the Helsinki University of Technology. The Photogrammetric Journal of Finland, Vol. 7, No. 2, 1978.