A SUMMARY OF TOPOGRAPHICAL MAPPING ON THE SCALE OF 1:500 WITH B_{8S} AVIOGRAPH FOR SHENYANG CITY

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With rapid development of air survey technique and requisition of urban construction, especially recent years, aerial photogrametric mapping has been a common method in basic mapping on the scale of 1:1000 for Chinese cities. In present, Lange-scale map of 1:500 is developing more rapidly. In this case, the aerial photogrametris mapping on the scale of 1:500 for Shenyang city was carried out by our Institution. Through hard trial of our Institution. It isssuccessful to use B_{8S} Aviograph for topographical mapping on the scale of 1:500 without precedent to go by inChina. It is worth to note that the author was supported energetically and helped warmly during the trial by colleague of Exploration Institution of Shenyang City. They worked pin-prick and positioning and examined map to give a criteria of mapping accuracy, though they were busy. So, this result could be considered to be made by joint efforts of them and the authors.

A summary of the work is drawn as follows.

1. General operation

It is well known that B_{8S} Aviograph is a stereometrograph of mechanical intersection and fixing focal distance with rrconstruction beam. Change of the pricipal distance of the device is depented on different frame. It has four forms of the frame of principal distance, namely 88.5mm, 100mm, 115mm, and 152mm. Therefore, in general, it is available only for the aerial photo by the aerial camera with above four focal distances.The aerial photo of ShenyangCity is 213.81mm in the focal distance and 1;3300 in scale. Using this information to make topographical map of 1:500 with B_{8S} Aviograph, the main problem is unconcordance between the focal distance of aerial camera and the pricipal distance of B_{8S} Aviograph. An operation of changing the beam made to solve the problem. The process of the operation

is as follows. At first, the frame of pricipal distance of 100mm was used and the principal distance value of 100.00 was set. Then a gear cluster of 2:5 was installed on the polar coodinate plotter for 2.5 magnification. Thus the photo focus F is 213.81, principal distance P is 100.00 and the scale of map is 1:500. So, a series of enlarging from photograph to model is 500× 2.5×(213.81 ÷ 100.00)=2672.625, namely the model is 1/2672.625 in scale. Because of no elevation plate of 1/2672.625 among the ten elevation plates of B8S Aviograph, an approximate elevation plate of 1:2500 was used. Thus, it is effectively reduoed K(K=2672.625÷2500=1.06905). Therefore, the quotient of dividing the altitude value of four (or six) vertical control points by 1.06905 is the reading on the elevation plate for every point might be calculated. In fact, the author calculated all quotients at the same time to be used in orientation.

2. Technical steps

Point is the mathematic basis for aerial photometric topographical map. therefore, the selection and interpretation, and the positioning of the photo-control is particurally important to aerial photogrametric mapping accuracy. The choosed photo-control must be pinned on the objects which should be obviously resoluted in photograph and it would be best if they are crosing points. The operation of changing the beam without correction for eccentricity requires that the elevation of the very different to be easy to correct orientate parallax. In addition, pole is not ideal to be choosed as photo-control because it is too large in area to difine its precise position in a large-scale model.

Besides the photo-control, the accuracy of an aerial photometric topographical map is directly dependent on image data, which are derived from aerial camera, photographic plate and measurement devices etc. As aerial photographic resolution is the base of the smallest information in measuring image on photograph. In addition, it should keep away from using only one clip to grip a corner of polyester fiore plate, when it is developed, to prevent deformation of it. Some other steps in our operation are as follows.

1) Orientation (relative orientation and geodetic orientation)

orientation is the base of measuring accuracy. In a sense, orientation error results in increasing or decresing systematic error in measurement (except measurement error). Therefore, to regard the orientation of consecutive pair is required when making orientation for an image-pair. Although the residual error permited by geodetic orientation is accidental error but to note it subconsciously can get good result. For example, if the orientation accuracy of point N_5 in consecutive hairs must be oriented in same direction (↑) as far as possible or when orientation can not be same or even reversed (↓) it should be less than ↓ 0.2mm or the error of edge connection of photos would be over permissible error. If the orientation of a point is ↗ 0.5mm in an image-pair and ↙ 0.5mm in next image-hair, the error of edge connection of photos would be ↙ 1mm, being over the permissible error. So it is a link not be ignored in large-scale mapping. In same reason, it is also important to geodetic orientation. For exsample, if point N_5 is oriented with altitude orientation error of +0.3m in an image-hair, its errors in all adjacent image-pairs are better to be (+). The error of (-) enlarges certainly the error of eoge connection. Although the altitude has not been measured in this mapping, the horizontal location is effected by orientation accuracy.

After finishing orientation, edge connection must be made to correct the error in the connection of image-pairs.

2) measurement

Except conventional method of operation, large-scale mapping has its own character of operation for a good accuracy. During the oppration, a big building may be accurately drawn with its geometric figure through linking the measured points with line, while it is bard to measure a single-storey house with eaves, At first, a method of eaves measurement revising was used but it is complex and requires too large amount of work, furthermore the accuracy is medium. Then, the first party (Exploration Institute ofShenyang City) proposed that the single-storey nouse with eaves may be directly measured after eliminating the eaves in accordance with special condition. Through repeated trial, the point location may be estimated based on the scale of the model and diameter of measuring mark. For this measurement, the scale of the model is 1:2672.625 and the diameter of measuring mark is 0.07mm. Thus a diameter of measuring mark

occupies a lenth of 0.187m in the model. If the eaves are 0.3m over the house, it should be revised 1.5 diameters of measuring mark inward for measurement and if the eaves are 0.4m over, it should be revised about 2 diameters of measuring mark inward (can be estimated only with eyes). In addition, the front and back eaves are convetionally wider than the lateral ones so that the revision for the lateral of a single-storey house should be less than that for the front and back ones, as shown in figure 1.

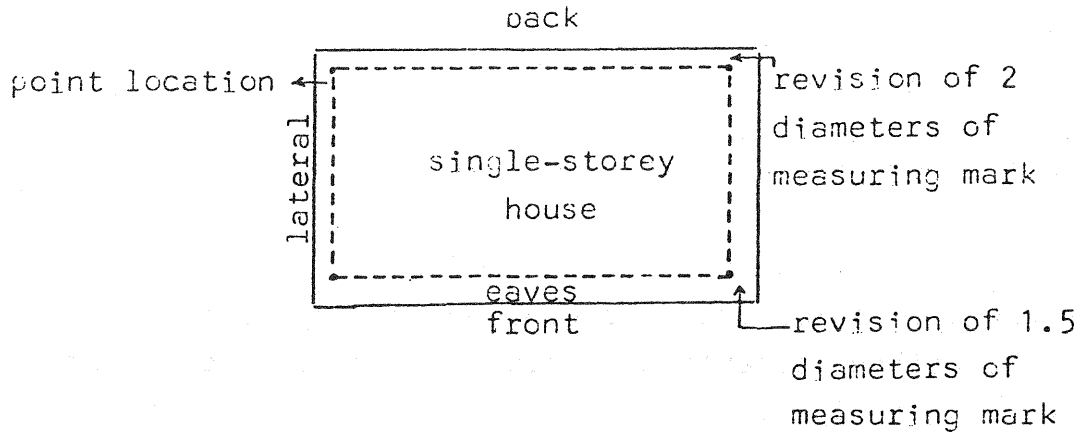

Figure 1 A schema showing estimating revision formeasured single-storey house with eaves

In short words, large-scale mapping requires revision for eaves. This revision may be made generally in two ways. One is to be revised by measurement on the spot after mapping and another is directly measuring the corner when the root part of a house can be seen during stereomapping, or calcurating the width of eaves when the corner of the house is hindden. Both the two methods were used in the mapping of the urban district of Shenyang city. The first one requires very large amount of field work and is uneconomical, and the second one that saves time and labour and can ensure the quality of mapping, may achieve greater, faster, better and economical results in mapping.

3) Accuracy

Before topographical mapping of Shenyang city on the scale of 1:500 with B_{8S} Aviograph, trial was done at first by the first party and our Institution. The latter took on indoor work and the former on field work including field pricking, positioning, field checking and verifying after mapping. The trial was only in one imagepair. During measuring, the author recognized that the measured buildings and houses are all conformed to the

condition of rectangular figue and whether for builing or for house, the lines between the measured points are good in both parallel and vertical relation and that the mapping with B_{8S} Aviograph will meet the measuring requirement certainly. The field examining supporteo this recognition and indicated that the mapping would ba fitful accuracy requirement. The mapping thus, formally started in August of 1986. The maps (about 500 sheets) finished last year passed examination and checking. Now, this project is still carrying out.

4) Several works for experience

It is well known that the B_{8S} Aviograph has not been set with eccentric unit. However, during the operation with changed bean to set the polyester fibre plate should be revised eccentricly. It is a problem. Fortunately, Shenyang city is in a low-relief area and the relative has little difference in an image-pair.In addition, the aerial photo is good in quality with high level-ness. So, without eccentric correction, the vertical parallax may be essentially conceled. In an image-pair with gentle-siope, of course, if the buildings are made in different times with different form and different levels just as uneven surface, vertical parallax would be not eliminated. For this problem, the author takes following steps.

(1) When single-storey house is dominant in an image-pair, the neight of the house may be used as the base of orientation to eliminate vertical parallax. If measured high building(over five storeys) shows vertical parallax less than one diameter of measuring makr, namely two marks are just connected with their edges (having little influence to stereoscopic feeling) (Fig.2).

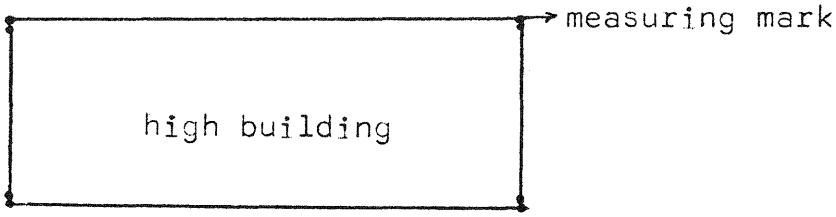

Figure 2 A scheme showing vertical parallax of buiding corners meeasurement is less that one diameter of measuring mark, two marks are just connected with their edges.

the following method be used for measuring the cornor of

building. It must be noted that after orientation an investigation should be made on stereoscopic model to find the presence of any vertical parallax over one diameter of measuring mark for the top of high building all over the image-pair. If present, the polyester fibre must be resetted and to work in orientation again until achieving the requirement of measurement(in some image-pair, it was repeated to orientate).

(2) If high building is many in an image-pair, orientation should be based on these buildings to prevent vertical parallax In the same way, after orientation, a stereoscopic investigation is required to know the case of vertical parallax. only the vertical parallax is less than one diameter of measuring mark, the measurement may be made. The treatment is in a way same to that in (1).

(3) In an image-pair, if single-storey house and building occupies the roughly equil areas, the orientation should be based on a medium height. Although some vertical parallax may be present for both single-storey house and building, the stereoscopic investigation is not be influenced.

(4) As respect of magnification in mapping, the author's inperience of mapping for over ten years shows that by magnification of about 7 times, larger-scale aerial information is better in accuracy that smaller-scale one. For example, comparing the topographic mapping on the scale of 1:2000 based on aerial information on the scale of 1:14000 with the topographic mapping of 1:500 based on aerial information of 1:3300, the latter is better in accuracy that the former. It is due to that the larger the scale of photo is, the higher the resolution for object is. On the stereoscopic model for present measured topographical map of Shenyang city on scale of 1:500, the road sign line (the central line of road-white) and zebra crossing, the men in road and at yard may be obviously seen under the device. A clear photograph would improve the accuracy of measurement.

(5) For the accurcy of measurement, the other important factors are the level, inperience and sence of responsibility of the operators. It must often care for and instruct them to make them progressing and highening their level.

Table.1 The statistical coordinate errors(compared with data determined on the spot)

error	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	count
points	13	0	8	5	5	3	10	3	1	0	5	53

$$M_{point} = \pm \sqrt{\frac{13.03}{53}} = = 0.50$$

Tabal.2 The statistical coordinate errors(compared with data of adjoing map A_{10})

eroor	0.0	0.1	0.2	o.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2
points	3	0	4	13	13	6	9	6	9	5	7	3	0

eroor	1.3	1.4	1.5	count
points	1	0	2	81

$$M_{adjoin} = \pm \sqrt{\frac{37.72}{81}} = \pm 0.68mm$$