Optimal Computer Support of Photo Coordinate Measurements and On-Line Data Check

Jacobsen, K., University of Hannover
Nienburger Str. 1, D3000 Hannover, F.R. Germany

0. Abstract

For optimal computer support of data aquisition with analytical plotters for block adjustment, the program B159 has been developed. If any preinformation about the location of points is available, this will be used for approximate or accurate automatic pointing. This supported pointing and a data check in the photo strip and also to other strips will limit the number of blunders. The fast supported pointing offers new possibilities of economic block configurations.

1. Introduction

The topic of this paper is the data aquisition for bundle block adjustment. The achieved photo coordinates of course can be used also for independent model adjustment. For a block adjustment there is no need for on-line information about preliminary ground coordinates. Depending upon the control situation very often it is not possible to calculate ground coordinates on-line. By economic reasons it is necessary to have a computer supported pointing in the analytical plotter based on preinformation about the location of the points. Also an on-line check of the final pointing should be done to reduce the number of blunders in the block adjustment. This on-line check is very important, because the remeasurement can be done immediately.

On-line does not mean realy on-line in any case. Only if an exact pre-information about point location is available, the blunder detection can be done immediately. But it is sufficiant to have a data check at the end of the handling of each model when the photos are still in the instrument.

2. Functions of the Program B159

2.1 Computer Supported Pointing

calibrated fiducial and reseau points

Fiducial and reseau points are supported pointed based on the calibrated coordinates and step by step improved transformations. A data check will be done by affinity transformation.

predigitizing of photos

Points which have not been measured in a neighboured strip, in the same strip or where approximate ground coordinates or photo coordiantes are not available have to be pointed manualy. This is time consuming because the operator has to move to the point and he has to type in the correct point number if this will not be done in ascending sequence. The operator will see just a part of the photos.
It is much more fast to have a predigitizing of the photos on a simple tablet and to use this for automatic approximate pointing. It saves time for the whole process and even more for the use of the expensive analytical plotters.

neighboured model

The tie points between neighboured models are used for approximate pointing. This is a standard procedure availabel for all analytical plotters.

neighboured strip

The program B159 computes in the background strip coordinates. In the overlapping area of neighboured strips, an approximate automatic pointing can be done based on this. Just two tie points in the first model of each strip have to be pointed manually.
This procedure should be used in any case, even if other preinformation will be used with higher priority, because no tie point will be forgetten by this method.

available photo coordinates of one or both photos

Photo coordinates of one photo are available if points have been predigitized by tablet. The program B159 is using at first the coordinates of the left hand photo and later on the right hand photo. The approximate pointing of the photos where no coordinates are available will be done based on a similiarity transformation.

Photo coordinates of both photos are available, if they have been calculated based on ground coordinates and approximate photo orientations by program APPROX or if a model shall be remeasured. A remeasurement can be done completely or selected for some specified points. Any procedure of B159 checks, if the points have been measured allways before, so double measurements are avoided.

ground coordinates

Approximate ground coordinates are available in the case of deformation control or in the case of blocks with 60% sidelap or crossed strips, if a preliminary block adjustment has been done with a simple photo coverage. The approximate automatic pointing can be done very accurate, so this includes also a data check.

manual pointing

The pointing usually will be done in the sequence: left photo, right photo, stereo check. This has been found as optimal. The pointing in the right hand photo will be supported based on the measurement of the left hand photo and a similiarity transformation. The point number can be typed or an automatic numbering can be used. The point numbers are checked if they always have been used in the model.
If a large number of points have to be measured, a marking by superimposing of a screen is very helpful.

2.2 Pointing Procedure

The data aquisition can be done in the sequence left, right, stereo or after relative orientation stereoscopic. The measurements for the relative orientation can be done with any procedure descriped above. After relative orientation all these procedures can be used again and the not up to now collected points can be measured.
The relative orientation will have a negative influence to the pointing accuracy, but if no exactly defined objects are available, it is helpful.

2.3 Data Check

A data check will be done on-line against the preinformation of point locations on a choosen tolerance limit. After finishing a model, a relative orientation will be computed for data check and the creation of strip coordinates. The relative orientation includes a check by data snooping. This method is very important. Because of the very different redundancy numbers the y-parallaxes can not be used for the blunder identification. Points can be remeasured or deleted after this.
The creation of strip coordinates includes also the check for identity in the strip. The check against the neighboured strip will be done during supported pointing, but the power of this test is limited because the transformation will be done just two-dimensional. A three dimensional transformation is only possible for blocks with 60% sidelap.

3. Experiences in Data Aquisition

Based on the program B159 a high number of blocks have been measured at the University of Hannover and other locations, where it has been installed also.
For standard blocks for mapping purposes (60% endlap, 20% - 30% sidelap, 9 points/photo), the predigitizing with a tablet and the supported pointing in the sidelap area can reduce the necessary time for data aquisition by 50%. Without supported pointing the searching for tie points in the overlapping area of neighboured strips if very time consuming and misidentifications are often.
For blocks with 60% sidelap the optimal procedure will be to measure at first a block with each second strip with the previous mentioned method. The remaining strips should be measured based on ground coordinates computed in a preliminary adjustment. The same should be done for crossed strips. So the approximate automatic pointing will be very accurate and blunders are identified immediately.
If crossed strips are used for saving vertical control points, a preliminary adjustment is not possible. In this case the crossed strips can be supported pointed based on the procedure develloped for neighboured strips, because this is not limited just to one overlapped strip.

In small scale space photos, the identification of control points is very time consuming. This has a negative influence to the photo coordinate accuracy. So based on the first measurements, remeasurements have been done very fast with supported pointing.
The supported pointing based on ground coordinates is optimal for deformation control. For example the reflight for the detection of subsidences in coal mining areas can be measured very fasr. Mistakes in point numbering are not possible. Also no point will be forgetten. The supported pointing based on object coordinates is also possible in close range application.

Bundle block adjustments have shown the advantage of supported pointing including on-line data check. The number of blunders has been reduced strongly. At first the on-line check will identify a lot of blunders and caused by the faster data aquisition, the operator remembers better the location of tie points.

4. Influence to Block Structure

Not only the final accuracy of ground points is important, but also the reliability. In the case of just map production this is not so important because the orientation of photos is based on more than 3 ground points or the photo orientations from bundle block adjustment are used directly for set up of the models in the analytical plotters. But for deformation control, densification of networks and cadastral purposes, the reliability of each single point is important. A point measured in only two photos has no reliability in the height. Such points can not be avoided in blocks with 60% endlap and 20% sidelap. So the overlapping has to be raised to 60% sidelap or crossed strips with also 20% sidelap have to be used. Caused by the extended overlap, the object coordinate accuracy will be improved, which allows the reduction of the photo scale. So based on the supported pointing a higher overlap will lead to the same accuracy but a much better reliability with no more time for data aquisition. The higher reliability is also available during the measurement process, because the data can be checked against prevalues.

In a coal mining area ground coordinates should be computed with an accuracy of +/- 3cm in all 3 components. It was not a problem to reach this with a photo scale 1 : 4000 based on 60% sidelap and a crossed flight with 20% sidelap with a low number of vertical control points. But with a photo scale 1 : 2500, 30% sidelap and a high number of vertical control points it was not possible. At first the reliability was poor and caused by the large photo scale it was difficult to get well defined tie points in the small overlapping areas. Also much more tie points which could not be used for deformation control had to be measured. The total time for data aquisition based on 1 : 2500 was exceeding the time for the block with a photo scale 1 : 4000.

5. Conclusion

Computer supported pointing together with on-line data check in analytical plotters will reduce the number of not detected blunders. It offers new possibilities in block configuration and opens new fields for photogrammetric block adjustment. In relation to this, a data aquisition with comparators is no more economic.

References

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