

ANALYTICS OF NON-TOPOGRAPHICAL PHOTOGRAMMETRY:

A report on the activities of Working Group V/1 (1980-84)

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Report of WG V/1

Abstract

This is a report on the activities and accomplishments of ISPRS WG V/1 during the period 1980-84. Non-Metric cameras became fully accepted as a viable data acquisition system in close-range photogrammetry, along with metric data acquisition systems, as a result of intensive investigations and experimentations during the preceding period 1972-80. So the fields of interest during the period 1980-84 have shifted to development and improvement of data reduction systems for both metric and non-metric imageries. Special emphasis was given to prediction of precision and reliability, inter-activity in data reduction, and studies in optimal design of close-range control networks. Yet another myth of traditional photogrammetry has been refuted. Traditionally glass photographic plates were preferred over film as a recording medium because of their superior lateral dimensional stability. Recent investigations have indicated that unflatness of plates can cause significant deformations of photogrammetric models. Considerable progress has been made in the use of micro-computers for data reduction of even the most elaborate simultaneous adjustment programs. Progress made prior to, during, and since the ISPRS '82 York Symposium is discussed and analyzed. The technical program planned for the ISPRS '84 Rio Congress is summarized and the current trends in the activities of WG V/1 are identified, discussed and analyzed. It is recommended that this working group be continued for the period 1984-88. Fields of interest for this period are suggested.

1. Introduction

Resolution T.V/4 adopted by the 14th Congress of the International Society for Photogrammetry and Remote Sensing (ISPRS) in Hamburg in 1980 recommended "the establishment of a working group to be responsible for giving special emphasis to prediction of precision and reliability, inter-activity in data reduction, and studies in optimal design of object-space control." Based on this recommendation, WG V/1 "Analytics of Non-Topographical Photogrammetry" was established by Commission V in July 1980 and confirmed by ISPRS Council in March 1981. This working group is a continuation of the 1976-80 WG V/1 "Analytics of Close-Range Photogrammetric Systems" and its predecessors (WG V/1 (1972-76): "Analytical and Semi-Analytical Approaches in Terrestrial, Close-range, and Micro-Range Photogrammetry", and WG V/1 (1968-1972): "Close-Range Photogrammetric Systems").

2. Membership

In early 1981, invitations were sent out by the undersigned to a number of colleagues who had shown interest in the areas of activity of the working group. It was deemed desirable to have the membership of this WG open-ended, and an open invitation was extended to any other interested person to join. The group eventually reached a total of 18

participants from 11 countries.

3. Format and Program

The consensus of the membership was that the working group should preserve the character of a study group. It was agreed to concentrate on chosen subjects by conducting individual studies and investigations. This format has proven to be fully satisfactory.

With non-metric cameras having become fully accepted as viable data acquisition systems in non-topographic photogrammetry, along with metric data acquisition systems, as a result of concentrated research efforts during the period 1972-80, WG V/1 concentrated its efforts since 1980 on: 1) improvement of the accuracy and reliability of both metric and non metric close-range photogrammetric systems, 2) introduction of new metric cameras (both film and plated), 3) evaluation of the effects of photographic plate unflatness in close-range photogrammetry, 4) evaluation of photographic plate distortion due to humidity changes, 5) improvement of camera calibration methods and accuracy, 6) improvement of system calibration approaches, and 7) improvement of software accuracy and reliability.

Between the 1982 York Symposium and the 1984 Rio Congress, work has continued on the above items in addition to 1) more work on reliability and statistical concepts, 2) monitoring earth subsidence by photogrammetric means, 3) improvement of accuracy and reliability of the DLT and DLT-type methods, 4) overall improvements of accuracy and reliability of close-range photogrammetric systems, and 5) use of modular fully integrated data reduction systems to meet various degrees of accuracy.

Scientific investigations and publications during the period 1980-84 have dealt mainly with developments in the task of handling more diverse and more complex input data in an effort to further improve the accuracy of photogrammetric systems by realizing the potential of simultaneous photogrammetric and geodetic adjustments, self calibrations, multi-station convergent recording, elimination of systematic errors by additional parameters, blunder detection, localization and elimination by advanced statistical analyses, optimization of network design, development and improvement of data reduction packages to solve close-range photogrammetry tasks using analytical plotters and microcomputers, development of analytical plotters suitable for data reduction from non metric photography, evaluation of the unflatness of photographic plates as a source of systematic error in close-range photogrammetry, and numerous other innovations.

Most of the business of WG V/1 was conducted by correspondence. A business meeting was conducted during the symposium of Commission V held in York, England in September 1982.

4. Papers Presented at the York Symposium

The following papers were presented in two sessions on Analytics of Non-Topographical Photogrammetry at the 1982 inter-congress symposium of Commission V:

- Brown, D. C. (USA), "STARS (Simultaneous Triangulation and Resection System), a turnkey system for close range photogrammetry."
- El-Beik, A.H.A. and Babaei-Mahani, R. (UK), "Quadrastational close range photogrammetric system."
- Faig, W. and El-Hakim, S. F. (Canada), "The use of distances as object space control in close range photogrammetry."
- Fraser, C. S. (Canada), "Film unflatness effects in analytical non-metric photography."
- Fuchs, H. and Leberl, F. (Austria), "CRISP: a software package for close range photogrammetry for Kern DSR-1 analytical stereoplotter."
- Granshaw, S. I. (UK), "Precision and the multistation bundle method: concepts and preconceptions."
- Kleinmann, R., Mauelshagen, L. and Wester-Ebbinghaus, W. (FRG)
"Simultankalibrierung einer Teil-Messkammer unter Versendung Zusatzbeobachtungen in Objektraum."
- Kotowski, R., Rössmann, H. and Wester-Ebbinghaus, W. (FRG), "Zweischalige Bündeltriangulation an einem Grossbauwerk."
- Larsson, R. (Sweden), "GENTRI--a system for simultaneous adjustment of photographic and other observations."
- Mauelshagen, L., Przybilla, H.-J. and Theis, M. (FRG), "Ein Beispiel für "mixed ranges" Kalibrierung in der Nahbereichsluftbildmessung."
- Okamoto, A. (Japan), "Geometrical problems in close range photogrammetry."
- Shortis, M. R. (Australia), "Sequential adjustment of close range stereopairs."
- Torlegård, K. (Sweden), "A low precision minicomparator."
- Wester-Ebbinghaus, W. (FRG), "Einzelstandpunkt-Selbstkalibrierung: Mathematische Formulierung und erste Erfahrungen."

5. Technical Program at RIO '84 ISPRS Congress

It was agreed in York at the Business Meeting of WG V/1 that only a very few "invited papers" would be personally requested (one, possibly two). The other papers on the program of WG V/1 (Presented Papers & Poster Papers) would be superior papers selected on the basis of the abstracts (summaries).

Two colleagues were invited to prepare papers for Rio: D. C. Brown (USA) on "Unflatness of Plates as a Source of Systematic Error in Close-range Photogrammetry," and I. A. Harley (UK) on "Calibration in Close-Range Photogrammetry."

After reviewing the abstracts of freely offered papers for Rio, the undersigned personally requested a small number of colleagues to prepare "presented" papers on topics not sufficiently covered by the freely offered contributions. At the Rio '84 Congress, WG V/1 has been assigned seven 90-minutes formal sessions and two 90-minutes poster sessions.

A joint session on "Compensation of Systematic Errors in Photogrammetric Systems" organized by Commissions I, III & V (WG I/2, WG III/1 and WG V/1) is also planned for Rio. The program of this joint session includes an invited paper by K. Torlegård (Sweden) on "Multi-Models Increase Accuracy."

Listed below are the papers included in the technical program of WG V/1. This list is indicative of the depth and breadth of the contributions of our working group to the XV ISPRS Congress.

5.1 Invited Papers:

- Brown, D. C. (USA), "Unflatness of Plates as a Source of Systematic Error in Close-Range Photogrammetry."
- Harley, I. A. (UK), "Calibration in Close Range Photogrammetry."
- Torlegård, K. (Sweden), "Multi-Models Increase Accuracy."

5.2 Presented Papers:

- Adams, L. P. & Rüther, H. (RSA), "Two Phase Photogrammetry with Displaced Control."
- Altan, M. O. (Turkey), "Accuracy Study of Photogrammetric Deformation Measurements at a Test Field."
- Armenakis, C. (Canada), "Deformation Measurements from Aerial Photographs."
- Baş, H. G. (Turkey), "Computing the Object Space Coordinates of a Point by the Linear Equations in Terrestrial Photogrammetry."
- Čerňanský, J. (CSSR), "Analytical Terrestrial Triangulation Method."
- Chamard, R. R. (USA), "US-2's Non-Topographical Applications."
- Dorrer, E. (FRG), "APL Application Software for Analytical Underwater Photogrammetry."

- Faig, W. (Canada), "Subsidence Monitoring in Mountainous Terrain-- An Example of Fourdimensional Photogrammetry."
- Fraser, C. S. (USA), "Multiple Exposures as a Practical Means to Enhance the Accuracy of Non-Metric Camera Applications."
- Fraser, C. S. (USA), "Network Design Optimization in Non-Topographic Photogrammetry."
- Fuchs, H. (Austria), "Ultra-Close Range Non-Metric Camera Set-Up on an Analytical Plotter."
- Gruen, A. (USA), "Processing of Amateur Photographs."
- Hådem, I., (Norway), "Generalized Analytical Relative Orientation in Close-Range Photogrammetry."
- Hunt, R. A. (UK), "Estimation of Initial Values Before Bundle Adjustment of Close-Range Data."
- Jaakkola, J. (Finland), "On the Accuracy of Non-Topographic Plotting."
- Karara, H. M. and Chen, L.-C. (USA), "Optimization of Analytical Non-Metric Close-Range Photogrammetric Networks."
- Kruck, E. (FRG), "BINGO: A Program for Bundle Adjustment for Engineering Applications--Possibilities, Facilities and Practical Results."
- Leberl, F. and Fuchs, H., "Universal Analytical Plotter Software for Photographs with Perspective Geometry (CRISP).
- McGlone, C. and Gillen, L. C. (USA), "Use of the MACO 35/70 in Close-Range Photogrammetry."
- Müftuoğlu, O. (Turkey), "Non-Linear Least Squares Estimation of the Collinearity Condition."
- Müftuoğlu, O. (Turkey), "Parallelity of the Stereometric Camera Base to the Datum Plane."
- Müller, F. and Stephani, M. (FRG), "Efficient Consideration of Geodetic Observations and Object Information in Bundle Adjustment."
- Munjy, R. (USA), "A Finite Element Analysis of the Effect of Having Fiducial Marks in Non-Topographic Photogrammetry."
- Murai, S., Matsouka, R., Okuda, T., Suzuki, Y. (Japan), "Self-Calibration of Non-Metric Cameras and its Application to Close-Range Photogrammetry."
- Nørbech, T. (Norway), "General Relative Orientation and General Spatial Resection in Numerical Photogrammetry."
- Pietschner, J. and Schulz, H.-U. (GDR), "Program System TEBIT--Survey and Basic Philosophy."
- Salkovič, L. (CSSR), "Use of the Projective Transformation in Terrestrial Analytical Photogrammetry."

- Waldhäusl, P. and Kager, H. (Austria), "Metric Restitution of Traffic Accident Scenes from Non-Metric Photographs."
- Wester-Ebbinghaus, W. (FRG), "MOR--Eine allgemeine Lösung für die Mehrbildorientierung."
- Wong, K. W. (USA), "Photogrammetric Measurement of Joined Rocks in Tunnel Models."
- Wu, S.S.C. (USA), "Error Analysis of Mapping Using Facsimile Cameras."
- Yang, X. Y. (PRC), "The Parameters of Convergent Photos for Close-Range Photogrammetry and their Applications."
- Zhu, C. and Yang, X. Y., "The Optimum Configuration of Convergent Case of Close-Range Photogrammetry."

6. Recommendations

It is recommended that the Working Group on "Analytics of Non-Topographical Photogrammetry" be continued for the period 1984-88. Areas of interest would include:

- a) System calibration in Non-Topographical photogrammetry.
- b) More work on the improvement of accuracy and reliability of metric and non-metric close-range photogrammetric systems.
- c) Investigation of the unflatness of glass plates as a source of systematic error in close-range photogrammetry.
- d) Development of modular fully integrated data reduction systems to meet various levels of accuracy.
- e) Improvement of the existing and introduction of new analytical plotters suitable for reduction of data from non metric photography.
- f) Improvement and development of software packages for non-topographic photogrammetry for various analytical plotters.
- g) Improvement and development of software packages for close-range photogrammetry for microcomputers. Microcomputer technology is advancing at an extremely rapid rate and it is anticipated that as software is developed, many new applications will evolve.
- h) Development of software packages for data reduction of close-range solid state imageries.

7. Conclusion

The undersigned wants to thank all members of WG V/1 for their cooperation throughout the past four years, and each of the authors who contributed to the technical program of this WG in Rio de Janeiro. Working with a highly experienced Commission President and a most efficient Commission Secretary made my assignment as chairman of WG V/1 during the past four years a most rewarding experience in which I had much fun.

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