

Twelfth Congress of the
International Society for Photogrammetry

Ottawa, Canada
July 23–August 5, 1972

Report of Commission I Photography and Navigation

AT THE 1968 ISP Congress in Lausanne, Switzerland, the United States was assigned the responsibility for Commission I for the period 1968–72. Designated as officers of the Commission were:

Mr. Marvin B. Scher, President
Mrs. Clarice Norton, Secretary
Mr. J. Robert Quick, U. S. Correspondent
Mr. James Halliday, Corresponding Secretary.

Commission members who accepted major assignments within the Commission's sphere of activities include:

Dr. S. K. Ghosh (USA), Director of the Commission I Symposium—May 1970
Dr. H. Ziemann (Canada), Commission representative on the Program Coordination Committee of the Conference on Image Deformation—June 1971
Dr. E. Welander (Sweden), Chairman, Working Group on Modulation Transfer Functions
Dr. P. M. Fagundes (Brazil), Chairman, Working Group on Remote Sensing
Mr. J. Cruset (France), Rapporteur on Photographic Materials
Mr. S. Dossi (USA), Rapporteur on Color Photography
Mr. F. Corten (The Netherlands), Rapporteur on Navigation Systems.

The activities of the Commission were directed primarily to respond to the resolutions of the Eleventh Congress at Lausanne in 1968. Additional recommended activities indicated that the areas of interest of the Commission have continued to increase in variety and scope, and reflect the bold challenges that have been imposed on sensing and recording systems by recent technological advances.

In brief, the resolutions of the Eleventh Congress suggested the following activities for Commission I:

1. To consider the image-formation and image-recording properties of remote sensing systems. To cooperate with Commission VII in determining the relevant parameters and operating procedures of these systems.
2. To support further work on the application of Modulation Transfer Functions for aerial cameras and other imaging and recording sys-

tems and Optical Transfer Functions for lenses. The ultimate goal in the latter activity should be the establishment of performance standards.

3. To publish and distribute Appendix 5 of the report of the Working Group on Image Quality as an addendum to the ISP "Recommended Procedures for Calibrating Photogrammetric Cameras and for Related Optical Tests."
4. To foster the practical application of Resolution 4 from the Lisbon Congress (1964). Resolution 4, entitled "Accuracy of Photogrammetric Data," concerned the need for developing detailed specifications and tolerances for the geometric and imaging qualities of aerial photographs under operational conditions.

ACTIVITIES IN RESPONSE TO RESOLUTION 1

Early in 1969 Commission I initiated correspondence with Commission VII with the aim of forming an Intercommission Working Group on Remote Sensing to determine the optimum parameters and operating procedures for remote sensing systems. The effort had the full cooperation of the President of Commission VII and the initial activities were encouraging. Unfortunately, the problems of international mail hampered communication within this Working Group and severely limited its accomplishments.

A great many conferences and symposiums on remote sensing were held during the past four years. A bibliography of the published reports for this period, covering the experiments and results obtained with an ever-increasing number of sensing systems, would require more space than could be accommodated in this report. (A bibliography of the titles of published documents on remote sensing, recently compiled for NASA, required approximately 1,300 pages.) From August 1968 to September 1971, the library of the Center for Remote Sensing Information and Analysis at the Willow Run Laboratories, University of Michigan, reviewed and abstracted approximately 1,000 documents on the subject of remote sensing. Many of these papers

were presented in the last few years at International Symposiums on Remote Sensing of the Environment held at the Center. Proceedings of these symposiums are available through the Center, Post Office Box 618, Ann Arbor, Michigan 48107, USA.

Because of the widespread interest and activity in the field of remote sensing, a Working Group on the subject was established within Commission I. Dr. Placidino M. Fagundes (Brazil) was named Chairman. The mission of this Working Group was to follow and report on a large-scale project in which remote sensors were being applied to evaluate the natural resources of Brazil. The project, known as the SERE project, involves the international cooperation of the National Commission for Space Activities (CNAE) of Brazil and the National Aeronautics and Space Administration (NASA) of the USA. The Chairman of the Working Group will report to the Congress on this project, which includes the acquisition and analysis of about 4,000,000 square kilometers of radar imagery as well as significant amounts of color infrared and multispectral photography.

Commission I has also invited Mr. William A. Fischer (USA), Program Manager of the U. S. Geological Survey's Earth Resources Observation Systems (EROS), to present to the Twelfth Congress a comprehensive review of the various sensors that are currently available, their image-forming and image-recording characteristics, the variables affecting their performance, and the factors to be considered in the selection of sensor systems.

ACTIVITIES IN RESPONSE TO RESOLUTION 2

The Commission decided that the effort required to develop standard methods and calibration procedures for Optical Transfer Functions was such that the separation of this activity from further studies of Modulation Transfer Functions was warranted. Accordingly, a separate Working Group on Modulation Transfer Functions (MTF), was established to concentrate attention on photographic films and systems. Dr. Erik Welander (Sweden) was assigned the chairmanship. A major purpose of the Group was to continue the MTF activities of the former Working Group on Image Quality and report on developments that have occurred since 1968. The activities in this area will be reported to the Congress by the Chairman of the Working Group.

The Commission attempted to establish a Working Group to develop international standards for measuring Optical Transfer

Functions (OTF). Experts who were asked to participate in this activity expressed the opinion that the pursuit of such an objective was premature. Their position was supported by the experiences at laboratories where meaningful correlations in OTF measurements of lenses had not been obtained. Some experts reported that they are applying an OTF technique for the measurement of lenses as a production-control technique but doubt that their approach would meet the requirements of a standard. Others, noting the high cost and complexity of equipment and techniques, questioned the desirability of recommending a specific method for measuring the OTF of camera lenses. They agreed, however, that further study and investigation to develop OTF standards should be encouraged.

Dr. Robert E. Hopkins (USA) will present an invited paper on this subject to the Congress. In his paper, "Standardization of the Optical Transfer Function," Dr. Hopkins considers it appropriate to standardize definitions and to list acceptable OTF-measuring procedures. He suggests that it may be possible to develop a standard which permits a wide variety of testing methods, and to reduce measurement data to a single *figure of merit* for expressing the image-forming qualities of an optical system.

A questionnaire on the feasibility of establishing a standard for OTF testing techniques was forwarded by the Commission to those experienced with OTF measurements. Mrs. Clarice Norton, Secretary of the Commission, will summarize the response to this canvass to the Congress. In addition, she has agreed to serve as moderator of a panel which will discuss the results of correlation testing. Because Mrs. Norton was a member of the Working Group on Image Quality of the previous Commission I, continuity is maintained with the exceedingly valuable accomplishments of that Working Group under the competent leadership of Mr. Gerald Brock (United Kingdom). Mr. Brock will also be a member of the OTF panel.

ACTIVITIES IN RESPONSE TO RESOLUTION 3

In January 1969 the Commission distributed copies of Appendix 5 of the report by the previous Working Group on Image Quality to more than 100 persons, agencies, and institutions throughout the world. Distribution was limited to those who had previously received the original ISP publication, "Recommended Procedures for Calibrating Photogrammetric Cameras and for Related Optical Tests," because it was recognized that the

Appendix would not be meaningful without the original document.

ACTIVITIES IN RESPONSE TO RESOLUTION 4

Resolution 4 recommended the sound development of the basic geometric and photographic qualities of aerial photographs. The Commission has supported and encouraged the development of such principles and many countries have conducted investigations in this area during the past four years. The extent of this activity is indicated by the many papers presented at the Third International Conference on Image Deformation, held June 16-18, 1971, in Ottawa, Canada. The Conference was jointly sponsored by Commission I and the National Research Council of Canada, and organized under the direction of Dr. T. J. Blachut of the latter organization. The meetings, attended by about 60 participants, covered a wide range of subjects including the geometric anomalies of aerial film, deformations occurring during exposure and processing, methods of deformation correction, and the economic aspects of such corrections. Papers of the Conference that have been published to date are listed in the bibliography below. A summary report on the Conference and its findings will be included in an invited paper, "Image Geometry," to be presented by Dr. Hartmut Ziemann (Canada).

SYMPOSIUM ON PHOTOGRAPHY AND NAVIGATION

Commission I sponsored an International Symposium on Photography and Navigation in 1970 during the quadrennium between Congresses. The Symposium was organized with the cooperation and financial support of the American Society of Photogrammetry, the National Science Foundation, and The Ohio State University, Columbus, Ohio, USA, and was held at the host university May 25-28, 1970. Dr. S. K. Ghosh (USA) directed the preparations for the meetings and served as Symposium Chairman. Seventy conferees representing eight countries heard technical papers and exchanged views on a variety of subjects including aircraft navigation, aerial film, color photography, underwater photography, space photography, camera calibration, image-quality analysis, and remote sensing. The complete proceedings of the meetings have been published in a hard-cover edition entitled, "The 1970 International Symposium on Photography and Navigation," and are available from the host uni-

versity and the American Society of Photogrammetry. The technical papers included in this publication are listed in the bibliography below.

The Commission is pleased to acknowledge the interest and support received from members of the ISP Council. President Luigi Solaini, 1972 Congress Director Samuel G. Gamble, and Secretary General G. Carper Tewinkel attended both the Commission Symposium at The Ohio State University in 1970 and the Conference on Image Deformation in Ottawa in 1971.

PREPARATIONS FOR THE 1972 CONGRESS

At a business meeting held during the May 1970 International Symposium, the Commission received a number of suggestions regarding subjects to be covered in the Commission's program for the 1972 Congress. Officers of Commission I subsequently met with representatives of the other ISP Commissions and the Society Council in Paris, France, in September 1970, to avoid duplication of themes presented by the Commissions and agree on the program format for the Congress.

As a result of these meetings, the Commission added presentations treating research and applications of color photography and new developments in photographic materials to those subjects already suggested by the 1968 resolutions. In addition, Commission I could not overlook man's giant leap to the moon and the other space explorations that have occurred during its four-year tenure. These most significant accomplishments could not have been achieved without the assistance of highly-developed navigation, photographic and other remote sensing systems. In his invited paper, "Imaging Sensors for Space Vehicles," Mr. Frederick J. Doyle (USA) will present to the Congress a review of the special optics, cameras, and other sensors that have been used in orbiting satellites and space probes, as well as those planned for use in future space missions.

Parallel with man's urge to explore outer space is his growing interest in underwater exploration. Our expanding world population provides impetus to the search for food and other resources beneath the seas. Mr. Gomer McNeil (USA) will present a paper, "Underwater Photography," and will lead a panel of experts in discussions of the problems and activities associated with the acquisition of imagery for metric and interpretative purposes in this challenging environment.

COMMISSION I PRESENTATIONS FOR
THE 1972 OTTAWA CONGRESS

INVITED PAPERS AND REPORTS

1. "Modulation Transfer Functions—Report of Working Group," Dr. Erik Welander (Sweden), Chairman.
2. "Standardization of the Optical Transfer Function," Dr. Robert E. Hopkins and Dr. David Dutton (U.S.A.).
3. "Color Photography," Mr. Serenus W. Dossi (U.S.A.).
4. "Photographic Materials," Mr. Jean Cruset (France).
5. "Image Geometry," Dr. Hartmut Ziemann (Canada).
6. "Underwater Photography," Mr. Gomer T. McNeil (U.S.A.).
7. "Imaging Sensors for Space Vehicles," Mr. Frederick J. Doyle (U.S.A.).
8. "Remote Sensing—Report of Working Group," Dr. Placidino M. Fagundes (Brazil), Chairman.
9. "A Review of Remote Sensing," Mr. William A. Fischer (U.S.A.).

PRESENTED PAPERS*

- Ebron, Gene I., (U.S.A.), "The ES-75 Color Photography Processing and Developing Facility." (3)
- Edwards, R. W., (Canada), "Development and Application of Fixed Base Aerial Photography." (5)
- Halliday, James, and Welch, Roy, (U.S.A.), "Imaging Characteristics of Photogrammetric Camera Systems." (1)
- McLaurin, John D., (U.S.A.), "The Skylab Earth Terrain Camera." (7)
- Carman, P. D., and Kalensky, Z. D., (Canada), "Definition in the Three Image Layers of Aerial Color Film."
- Collins, Stanley H., (Canada), "The Block Adjustment of Colour in Aerial Photography." (3)
- Ducloux, J., (France), "Examination of Film Deformation for Aerial Photography."
- Ghosh, Sanjib K., and Martucci, Louis M., (U.S.A.), "Image Quality Effects on Image Geometry of a Metric Camera." (5)
- Forkey, Richard E., and Womble, David A., (U.S.A.), "Unique Lens Design for Multispectral Photographic Cameras." (7)
- Gerencser, Miklos G., (Hungary), "Comparative MTF Tests of Entire Aerial Photographic System in Black-and-White and Color." (1)
- Welch, Roy, (U.S.A.), "Modulation Transfer Functions." (1)
- Welch, Roy, (U.S.A.), "Quality and Applications of Aerospace Imagery." (7)
- Voggenthaler, John A., (U.S.A.), "An Artificial Star Field Camera Calibrator." (5)
- Benesh, Milosh, (U.S.A.), "Mariner Mars '71 Photogrammetric Calibrations." (7)
- Schlienger, R., (Switzerland), "A New Range of

- Wild High-Performance Lenses for Photogrammetry." (5)
- Meier, Hans K., (West Germany), "Automatic Exposure Meters for Aerial Cameras." (4)
- La Fouasse, Paul, and Pouleau, Jacques, (France), "The Modulation Transfer Function Measurement by the Acofam-Matra Apparatus and the Generalization of an Evaluation Method of the Optical System." (1)
- Gibbons, J. G., and Masry, S. E., (Canada), "Rectification of Infrared Imagery." (9)
- Carman, P. D., (Canada), "Camera Vibration Measurements." (5)
- Powell, Richard W., (U.S.A.), "AN/USQ-28 Verticality Verification Test." (5)
- Hakkarainen, Juhani, (Finland), "Calibration of Aerial Cameras with a Horizontal Goniometer." (5)
- Hakkarainen, Juhani, (Finland), "The Resolving Power and the Modulation Transfer Function of Terrestrial and Aerial Cameras in Working Condition." (1)
- Salmenpera, Hannu, (Finland), "Camera Calibration Using a Test Field." (5)
- Niemann, B., (U.S.A.), "Applications of Remote Sensing to Watershed Management." (9)
- Ragotzkie, R. A., (U.S.A.), "Application of Remote Sensing to Surface Parameters of Large Water Bodies." (9)
- Stephenson, D. A., (U.S.A.), "Application of Remote Sensing to Hydrogeology." (9)
- Hoopes, J. A., and Villemonte, J. R., (U.S.A.), "Application of Remote Sensing to the Determination of Mixing Zone for Waste Effluents Discharged into Rivers or Lakes." (9)
- Scherz, J. P., (U.S.A.), "Applications of Remote Sensing to the Determination of Water Quality." (9)
- Kraft, C., (U.S.A.), "Achromatic and Chromatic Stereoscopic Performance." (3)
- Roedel, R. K., (U.S.A.), "Optimizing Sensitometric Data for Color and Black-and-White Aerial Film." (3)
- Trollinger, W. V., (U.S.A.), "The Role of Color Photography in Natural Resources Exploration." (3)
- Anson, A., (U.S.A.), "Color Applications to Military Geographic Intelligence." (3)
- Adams, M. S., (U.S.A.), "Application of Remote Sensing in Determining Water Quality." (9)
- Bergman, A., and Smedberg, A., (Sweden), "Experiments with Aerial Photographs Using Differently Coloured Signals." (3)
- Smedberg, A., and Welander, E., (Sweden), "The Calibration of Aerial Cameras for Practical Purposes." (5)
- Gerasimova, O. A., (USSR), "The Use of Modulation Transfer Functions for Solving Problems in Aerial Photography." (1)
- Arjanov, E. P., (USSR), "An Investigation of Film-Flattening." (5)
- Poletayev, Yu. I., and Gorin, G. S., (USSR), "Navigation in Aerial Surveying." (4)
- Glushkov, V. M., Komarov, V. B., Lostshilov, V. S., Njavro, B. P., and Starostin, V. A., (USSR), "Side-Looking Imaging Radar System 'Toros' and its Application for Ice Conditions Study and Geological Explorations." (9)

BIBLIOGRAPHY

Papers presented at the Commission I International Symposium on Photography and

* Number in parenthesis indicates theme of invited paper to which presented paper applies.

- Navigation, May 25–28, 1970, The Ohio State University, Columbus, Ohio, U.S.A. Published in a hard-cover edition and available from the University and the American Society of Photogrammetry.
- Brandenberger, A. J., (Canada), "Future Development Programs on a World Wide Basis and Aerial Photography Requirements."
- Berquist, R. L., and Pate, A. R. (U.S.A.), "Improved Aerial Mapping Efficiency Through the Use of Precision Inertial Navigation."
- Guethner, T., (Poland), "Shape of the Surface of the Photographic Materials on the Triacetate and Polyester Base."
- Trott, T., (U.S.A.), "A Practical Vertical Reference in Verticality Sensing from Photographic Aircraft."
- Doyle, F. J., (U.S.A.), "Photographic Systems for Apollo."
- Dossi, S. W., (U.S.A.), "Color Photography Working Group—Progress Report."
- Kiefer, R. W., (U.S.A.), "Effects of Date of Photography on Airphoto Interpretation Using Color and Color-Infrared Films."
- Vary, W. E., (U.S.A.), "Remote Sensing by Aerial Color Photography for Water Depth Penetration and Ocean Bottom Detail."
- Gerencser, M. G., (Hungary), "The Discrimination of Stereoscopic Effect of Color and Prism Distortion in Horizontal Main Plane."
- Wenderoth, S., and Yost, E., (U.S.A.), "Multi-spectral Color Space Photography."
- Thomas, C. O., (U.S.A.), "Airborne Remote Sensing Techniques for Oceanographic Data Acquisition."
- Kuyper, W. H., Larson, D. A., and Latham, J. P., (U.S.A.), "Interpretation of Imagery Colors by a Television Scanning System."
- Stephen, J. G., (U.S.A.), "Ecological Surveillance Through Remote Sensing."
- De Almeida, E. G., Fagundes, P. M., and Scarabucci, R. R., (Brazil), "Remote Sensing Working Group—Progress Report."
- Welander, E., (Sweden), "Modulation Transfer Functions Working Group—Preliminary Report."
- Sorem, A. L., (U.S.A.), "Techniques for the Routine Measurement of Film Modulation Transfer Functions."
- Jones, R. A., (U.S.A.), "MTF Determinations Using Edge Gradient Analysis."
- De Belder, M., (Belgium), "Relation Between Edge Gradient Analysis and Common MTF Methods for Photographic Systems."
- Brock, G. C., (United Kingdom), "Analysis of Some Preliminary Results in the SIRA OTF Standardisation Programme."
- Glaser, G. H., and Mikhail, E. M., (U.S.A.), "Mensuration of Holograms."
- McNeil, G. T., (U.S.A.), "Some Photogrammetric Considerations of Underwater Photography."
- Corten, F. L. J. H., (The Netherlands), "Navigation Working Group—Progress Report."
- Guethner, T., (Poland), "Gelatin Effect and the Accuracy of Photogrammetric Plotting."
- Palgen, J. O., (U.S.A.), "Nimbus Simulations of ERTS Imagery."
- Anderson, R., (U.S.A.), "Commotion in the Ocean" (Banquet Speech).
- Hallert, B., (Sweden), "Calibration and Tests of Hasselblad EL-DATA Camera."
- Das, G. B., (India), "Calibration of a Photogrammetric System."
- Wurtz, G., (DDR), "MRB9/2323—A New Super-Wide-Angle Aerial Camera from Jena."
- Maune, D. F., (U.S.A.), "A Study of the Effects of Vibrations on Resolution and Acutance of Imagery from Zeiss RMK AR 15/23 Camera."
- Ghosh, S. K., (U.S.A.), "Focal Length and Aperture—MTF or Acutance?"
- Meier, H. K., (West Germany), "Mathematical Models for Photographic Disposition and their Comparison with Results of Practical Tests."
- Zeimann, Hartmut, (Canada), "Image Deformation and Methods for its Correction."
- Papers presented at the Third International Photogrammetric Conference on Image Deformation, June 16–18, 1971, Ottawa, Canada, and published in *Photogrammetric Engineering* by the American Society of Photogrammetry.
- Ziemann, H., (Canada), "Sources of Image Deformation," Dec. 1971.
- Adelstein, P. Z., (U.S.A.), "Stability of Estar-Base Films," Jan. 1972.
- Young, M. E. H., and Ziemann, H., (Canada), "Film Diapositive Deformation," Jan. 1972.
- Michener, B. C., (U.S.A.), "Thickness Uniformity of Kodak Aerial Films," Feb. 1972.
- Ziemann, H., (Canada), "Economics of Image Deformation Correction," Feb. 1972.
- Bender, Lee Uhrig, (U.S.A.), "Film Deformation Investigation," March 1972.
- Ligterink, G. H., (The Netherlands), "Film-Glass Differences," March 1972.
- Martucci, Louis M., (U.S.A.), "Image Quality and Image Geometry," March 1972.
- Clark, J. M. T., (United Kingdom), "Film Flatness in Survey Cameras," March 1972.
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