

REPORT OF ACTIVITIES OF COMMISSION I: PRIMARY DATA
ACQUISITION

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1. RESOLUTIONS OF CONGRESS IN HAMBURG 1980

The Congress, noting that during the last four years period, the Commission I (Primary Data Acquisition) has emphasized,

- image quality and image geometry of sensor systems, with consideration of calibration parameters and environment,
 - measuring and recording the elements of exterior orientation of the camera or other sensor, as well as the elements of navigation,
 - space sensing systems for earth observation satellite projects in various countries,
- recognising
- that sensor performance should be defined in terms of user applications, related to interpretation and measurement tasks,
 - that the geometrical accuracy and the quality of imagery are subject to changes caused by the environments, and that these environments are seldom known with certainty,
 - that greater attention should be paid to problems related to the acquisition and processing of aerial photography,
 - that it has become possible to record the elements of exterior orientation at the instant of exposure with adequate accuracy and that new techniques are being developed to determine the position and attitude of both aircraft and spacecraft,
 - that several earth observation satellite projects are planned for the 1980's,
 - that remote sensing in and of aquatic environments is of increasing importance,

recommends

1. further investigations of measures of performance of aerial and satellite sensor systems, with particular emphasis on:
 - a) interrelationships between spatial and radiometric resolution,
 - b) possibilities of improving data quality through digital processing techniques,
 - c) establishment of sensor performance levels required to ensure image data of adequate interpretability and measurability for the compilation of topographic and

thematic maps at scales of 1:25,000 to 1:100,000, and

- d) investigations of the performance characteristics of imaging radars,
- 2. further studies of the stability of the elements of inner orientation and camera calibration, and of the environmental conditions which affect image position and quality. Mathematical methods required to correct geometric changes caused by specific environments will be investigated,
- 3. further study of the techniques of acquiring photographs with aircraft and satellites, and of the processing techniques required for optimum quality and geometry,
- 4. further investigation of procedures to determine sensor orientation, including the maintenance and recording of vehicle/sensor position and attitude. Specific attention should be given to Doppler, inertial, and satellite navigation techniques,
- 5. documentation of plans for acquisition of remotely sensed data from spacecraft. Specific consideration should be given to the development of sensor systems.

2. TERMS OF REFERENCE OF WORKING GROUPS

The resolutions were the framework for the preparation of the terms of reference of the working groups for 1980-84. Five working groups were finally determined with terms of reference confirmed by the President Dr. Fred Doyle in early 1981.

WORKING GROUP I/1: "Image Data Quality of Aerial and Satellite Sensor Systems", chaired by Prof. Roy Welch of the University of Georgia, U.S.A.

Terms of Reference

Further investigations of measures of performance of aerial and satellite sensor systems, with particular emphasis on:

- (a) interrelationships between spatial and radiometric resolution,
- (b) possibilities of improving data quality during acquisition and pre-processing stages through digital processing techniques,
- (c) establishment of sensor performance levels required to ensure image data of adequate interpretability and measurability for the compilation of topographic and thematic maps at scales of 1:25,000 to 1:100,000, and
- (d) investigations of the performance characteristics of imaging radars.

WORKING GROUP I/2: "Camera Calibration and Effects of the Environment", co-chaired by Dr. Hartmut Ziemann of the National Research Council, Canada, and Mrs. Clarice Norton of U.S. Air Force, Utah, U.S.A.

Terms of Reference

- (a) To further investigate and compare methods of camera calibration to determine interior orientation parameters for radially symmetrical and decentring distortion.
- (b) To further the studies of stability of elements of inner orientation, and the environmental conditions which affect the position of elements of inner orientation, image position and image quality.
- (c) To determine methods of correcting geometric changes in image position introduced by changes in environmental conditions.
- (d) To compare camera calibration and bundle adjustment with self-calibration with a view to deriving parameters for self-calibration from standardized calibration tests.
- (e) To work towards standardization of the various elements defining the geometrical optical performance of photogrammetric lenses.

WORKING GROUP I/3: "Aerial Photography - Sensor Orientation and Navigation", chaired by Prof. Francois Corten of I.T.C., Netherlands.

Terms of Reference

- (a) To study existing techniques for determining and recording of sensor orientation and navigation.
- (b) To study developments in these techniques leading to higher performances.
- (c) To establish useful methods for practical application in aerial survey.

WORKING GROUP I/4: "Acquisition of Remote Sensor Data from Spacecraft", chaired by Dr. Bob McEwen of U.S. Geological Survey.

Terms of Reference

- (a) To document current and future plans for remote sensor data acquisition from space.
- (b) To consider the appropriateness of such systems for specific remote applications.
- (c) To consider developments of new sensor systems designed for remote sensing.
- (d) To consider means of documenting existing remote sensing data appropriate for specific purposes.
- (e) To study pre-processing techniques of satellite data to obtain optimum quality and geometry. Contact should be

maintained with Working Group I/1 (Data Quality of Aerial and Satellite Sensor Systems) to relate processing techniques to data extraction requirements.

WORKING GROUP I/5: "Acquisition and Processing of Aerial Photography", chaired by Mr. Ray Dando of the United Kingdom. Dr. Lorenz of I.T.C. Netherlands was subsequently made Co-chairman.

Terms of Reference

- (a) To study the technology associated with aerial photography, particularly the photographic aspects including acquisition, processing, printing and materials, to obtain optimum quality and metric accuracy.
- (b) To determine standardized procedures and specifications for acquisition and subsequent handling of the aerial photography to obtain optimum quality and metric accuracy.
- (c) To establish useful methods for practical applications in aerial survey.

3. AREAS OF SPECIAL INTEREST

Special emphasis was placed on certain topics and these are described below.

Working Group I/1

Parameters of measurement of image quality for photographic and electro-optical systems had been the subject of discussion prior to and during the 1980 Congress. It was believed that expressions of image quality currently used were inadequate for certain applications in remote sensing. Working I/1 was especially requested to consider this problem and report to the 1984 Congress. An Invited Paper to this Congress will discuss this topic. During the 4-year period major advances have been made in the development of solid-state electro-optical systems incorporating CCD linear arrays. Future earth resource satellites designed for detection of reflected visible and infrared electro-magnetic radiation will incorporate such systems. Developments of this technology will be reported on in this Congress.

The study of Imaging Radars was included for the first time in the terms of reference of Commission I, and although SAR systems are still under development, investigations of the quality of the images will be reported on at this Congress.

Working Group I/2

Separate working groups which studied camera calibration and effects of the environment on the geometry of cameras in the period 1976-1980 were combined with joint Chairmanship in the period 1980-1984. The Congress sessions in 1980 revealed that there was overlap between the areas of laboratory calibration studied by Commission I and self-calibration derived from block

adjustment studied by Commission III. Correspondence was therefore established between the two relevant working groups to provide for cooperation and a joint congress session has been arranged at the Congress with Commissions I, III and V.

Working Group I/2 was also requested to study the "Recommended Procedures for Calibration of Photogrammetric Cameras and Related Optical Tests" which had been adopted by ISP in 1952 and reaffirmed at each Congress except Hamburg in 1980. In pursuing this task, it has been revealed that many International Organization for Standardization (ISO) standards relate directly to activities of ISPRS, and therefore it has been considered desirable that the new recommended procedures be drafted with close liaison with the ISO standards. Redrafting will not be completed by June 1984, and therefore it is recommended that the new Commission President for 1984-1988 should ensure that redrafting is achieved.

Working Group I/3, was a newly formed working group responsible for documenting the navigation and position fixing equipment available for aerial photography. Such equipment is valuable for improving the quality of navigation during photography, but in many cases provides estimates of the exterior orientation of the camera during flight. Data on aircraft position and attitude may prove to be sufficiently accurate for inclusion in aerial triangulation adjustments, which are the responsibility of Commission III. In order that this connection between Commissions I and III is recognised the corresponding sessions of the two Commissions at the Congress have been programmed on the same day. Several papers discussing the application of such data in aerial triangulation have been included in Commission I technical sessions.

Working Group I/4 had a major responsibility in collecting and documenting information on the satellite programs which are operational, in design stage, or planned for photogrammetric and remote sensing purposes. In the Commission's period of responsibility, an impressive list of satellite programs has become available, as displayed by the number of papers offered for presentation at the Congress. The rapid developments in space programs incorporating photography, electro-optical and radar image acquisition systems is a major feature of the 1980-84 period. These developments demonstrate the importance of the activities of this working group in documenting and informing the Society of such developments. It is essential that these activities are continued.

Working Group I/5 was a newly formed working group responsible for studying the acquisition and processing of aerial photography. Some participants at previous congresses were of the view that this area had been neglected by the Society. This working group has been given the responsibility of preparing a set of specifications of aerial photography for presentation to the Congress in Rio in 1984. It is hoped that these specifications will receive the endorsement of the Congress.

4. SYMPOSIUM

The 1982 Symposium was held in Canberra, Australia from 14 - 16 April; total attendance was 110, 34 of whom were from overseas. Proceedings which were published after the meeting, included all papers, answers to questions and text of panel discussions and are available at the above address. Sessions were organised on a working group basis with panel discussions held for most working groups.

Significant aspects of the symposium are as follows:-

- (i) Measures of image quality used by authors were generally based on Resolving Power, either as line pair/mm or m/line pair and various parameters of the MTF curve for photography, and IFOV for electro-optical systems. The working group aims to confirm the use of MTF and IFOV for photography and electro-optical systems respectively at this Congress. Two papers concluded that for the reliable identification of cultural features, electro-optical data with an IFOV of better than 10m is required. Further, if stereoscopic coverage of the area is available, the resolution need not be as high as is required for monocular observations.
- (ii) The content of section 2 of the Recommended Procedures for Camera Calibration was reviewed in a presented paper and discussed in a panel discussion. Stability of cameras, the use of polynomials for lens distortion curves, results from self-calibration tests were also discussed in the presented papers.
- (iii) It was revealed that data on the exterior orientation of the camera derived from equipment such as the GPS Navstar system will be sufficiently accurate for inclusion into aerial triangulation adjustment provided they are assigned appropriate variances. A number of papers described navigation equipment that can provide guidance of the aircraft in very regular flight runs in predetermined locations.
- (iv) In a panel discussion in Working Group I/4, several questions were addressed: the expected technical developments; whether valid requirements were being identified; and whether international cooperation is possible. It was argued that users should have more say in dictating their needs in terms of systems and that it is wrong that the ISPRS should have so little influence on the selection of equipment and determining space programs. It was also felt that international cooperation will be difficult although it is desirable, to avoid the duplication of satellite systems.

The subject matter covered by Working Group I/4 tended to be more directed to photogrammetry than remote sensing and it was recommended that the Commission should aim at broadening its areas of interest to include more remote

sensing. This will be reflected in sessions of the Working Groups at this Congress.

- (v) New films, and developments in processing and materials for photoconductive technology were presented at the Symposium. Papers reviewing aerial photographic processing equipment, gave a description of various continuous film processors, while recommendations were given for assessing the quality of aerial photography by documenting the complete history of each film. The initial version of the draft proposals for specifications of aerial photography were given and discussed in detail in a panel discussion. This discussion was the basis for further discussion before the determination of the final version to be presented at Rio.

5. SUMMARY

- (i) The Commission recommends the image quality parameters currently used i.e. MTF and IFOV for photography and electro-optical systems respectively be maintained. There was no justification for developing further parameters for specific applications.
- (ii) This period has seen an extension of the studies of image data quality to include imaging radar systems. Radar systems will be important for remote sensing in the next decade, and their study should be expanded in the next four years.
- (iii) Recommended Procedures for Camera Calibration and related optical Tests should be studied in relation to the ISO standards and finalised by 1988.
- (iv) Communication should be established by Commission I with Commission III so that documented information on the equipment available for the determination of exterior orientation parameters is clearly provided to that Commission. The economy of such information should be investigated for cases where ground control is difficult or expensive to establish.
- (v) The range of coverage of Commission I should be extended to ensure that acquisition systems designed for both photogrammetry and remote sensing are studied.

Attempts should be made through the Society to improve cooperation between member countries to avoid duplication of satellite systems. Further, members of the Society should seek opportunities to participate in planning and design of space systems so that their needs are more fully met.

- (vi) New specifications for vertical aerial photography have been prepared and will be presented for consideration by the Congress.

- (vii) The Commission has promoted the cross Commission investigation into several topics especially additional parameters in camera calibration and block adjustment, satellite sensor investigation and program development, and exterior orientation parameters in aerial triangulation.