ISPRS Intercommission Working Group II/III

"DESIGN AND ALGORITHMIC ASPECTS OF DIGITAL PHOTOGRAMMETRIC SYSTEMS"

Report to Commission II

H. Ebner*, I. Dowman**, C. Heipke*

*Technical University Munich, Federal Republic of Germany
**University College London, United Kingdom

1. The XVI. Congress of the International Society for Photogrammetry and Remote Sensing in Kyoto 1988 accepted resolution II-2 (WG II/2 on "Photogrammetric digital image processing systems") saying:

The Congress

Noting — the contents of the Working Group II/2 technical sessions at this Congress and that during 1984-1988 the Working Group II/2 has successfully carried out research, disseminated the results and contributed to promotion in the area and further noting that the progress in the area of digital systems is very rapid and substantial

Recognizing — that the need for development and evaluation of systems, and dissemination of knowledge is increasing

Recommends — that the activities of the Working Group II/2 be continued under the same name and terms of reference.

and resolution III-4 (Algorithmic aspects of digital photogrammetric workstations) saying:

The Congress

Noting — that digital data is becoming increasingly available and high performance hardware components are offered at reasonable cost to support processing of this data

Recognizing — the need for developing and expanding fully digital systems including on-line triangulation, interactive treatment of digital terrain models, and image analysis techniques

Recommends — the study of algorithmic aspects to support objects feature extraction and location on digital photogrammetric workstations.

Based on these resolutions and on final discussions during the meeting of the ISPRS Council and Commission Presidents in Zürich in November 1988 the Intercommission Working Group II/III (IC WG II/III) "Design and algorithmic aspects of digital photogrammetric systems" was established. Prof. Dr.-Ing. H. Ebner and Dr. I. Dowman were invited to act as Chairman and Co-Chairman. Dipl.-Ing. C. Heipke was appointed secretary of the IC WG II/III.

2. IC WG II/III deals with the following three topics:

Topic 1 Definition of functionallity and performance of digital photogrammetric systems.

A digital photogrammetric system is defined as hardware and software to derive photogrammetric products from digital imagery using manual and automated techniques. The output from such systems may include object point coordinates, reconstructed surfaces, extracted features or orthoimages.

The design aspects include system architecture and components, interfaces to data capture, data output and geographical information systems (GIS) and the human interface.

The algorithmic aspects are related to on-line and real-time procedures, restitution modes such as mono, stereo, multi image and parallel processing.

Topic 2 Critical evaluation of systems existing so far.

The existing digital photogrammetric systems can be divided into two main groups: the general purpose stereo systems for directly recorded digital images or digitized aerial photographs and near real-time systems for close range work.

The requirements for data storage and data manipulation are greater in the first case. These systems have mainly been produced by large manufacturers. Examples are the Kern DSP1, the Topcon PI-1000, the Matra Traster T10, the Terragon Context Mapper, the Autometrics Pegasus, and the DVP Digital Video Plotter of Laval University.

In the second category speed is the most important issue, but the complexity of the image content and the data volumes are lower. The development of these systems has mainly been carried out for special applications by research establishments like ETH Zürich, University of Cape Town, National Research Council, Winnipeg, and Helsinki University of Technology.

Further instruments without continuous stereo viewing have been reported e.g. from Helava Associates and from University College London.

A comparison of the different systems in terms of cost and performance has still to be undertaken.

Topic 3 Proposals for development with the final goal that such systems are widely used in practice.

Some proposals for the further development of digital photogrammetric systems have been formulated, but not yet been discussed on a broader base. They include:

- faster display for stereo viewing including continuous roaming, zooming, and image rotation,

- improved possibilities for interactive measurement of image coordinates with subpixel accuracy,

- simultaneous use of more than two digital images,

- greater integration of automated procedures for digital image matching, feature extraction, and image understanding,

- improved integration with vector and raster GIS,

- improved human interface.

No practical tests are planned for the present period.

3. As of September 1990 IC WG II/III has 69 members from 14 countries, 55 members from 11 countries in Europe, 10 members from two countries in North America and 4 members from one country in Asia.

4. The first IC WG II/III meeting took place in Stuttgart on September 13, 1989 together with a meeting of WG III/3 "Thematic information extraction from digital images" (Chairman Prof. Dr. T. Schenk, Ohio, Co-Chairman Dr.-Ing. B.S. Schulz, Frankfurt). The meeting was attended by 38 participants.

   In the discussion it was pointed out that a digital system should have all features of analytical systems and more.

   In view of rapid hardware changes, portable software was seen as the key factor for the success of any digital photogrammetric system.

5. A Joint Workshop of IC WG II/III and WG V/3 "Image analysis and image synthesis in close range applications" (Chairmen Dr.-Ing. D. Fritsch, Munich, and Dr. J.P. Muller, London) was held in London on February 13 and 14, 1990, entitled "Hardware and software for fast image data processing". The workshop was attended by 36 participants, mainly from the photogrammetric and the computer vision communities. In three sessions 12 papers were presented.

   The results of the workshop can be summarized as follows:

   - Instead of special hardware, off-the-shelf products are mainly used for digital photogrammetric workstations.

- An increasing use of transputers, transputer based systems and of the RISC architecture can be observed.

- Digital image matching algorithms can be successfully applied to satellite and small scale images, as well as to images taken in especially controlled environment in close range applications. Further work is needed for large scale images.

- Further research and development is necessary in feature extraction and for the efficient parallelization of algorithms.

6. At the Symposium of Commission IV, held in Tsukuba from May 15 to 17, 1990 several papers on digital stereo systems and on digital orthoprojection were presented. They are included in the proceedings.

7. During the Symposium of Commission III, held in Wuhan from May 22 to 25, 1990 the second IC WG II/III meeting took place on May 23. In the closing session on May 25 a report was given on the progress in work and research of IC WG II/III. The great importance of algorithmic aspects was emphazised. From this point of view, many of the papers presented at the Symposium were related to IC WG II/III. Moreover, in Wuhan contacts were established and renewed with WGs III/1, 2, 3, and 4 to guarantee that the progress achieved in Commission III can be utilized by IC WG II/III.

8. During the Symposium of Commission II, held in Dresden from September 8 to 12, 1990 one session was devoted to IC WG II/III. In total, 5 papers were presented in this session. Three additional papers were strongly related to the subject of IC WG II/III. In the closing session on September 12 a report was given on the work of IC WG II/III. The characteristics of the different experimental and commercial systems with respect to interactivity and the application domain was discussed. Furthermore, contacts were established and renewed in Dresden with other WGs of Commission II, in particular with WG II/5.

9. Future activities of the IC WG II/III include:

   - a Workshop on design aspects in in Boulder, Colorado, USA from March 21 to 22, 1991 (local organizer: Dr. Franz Leberl, President of Vexcel Corp.)

   - a Conference on digital photogrammetric systems in Munich from September 4 to 6, 1991

   - two WG sessions and additionally one session together with Commission IV during the XVII ISPRS Congress in Washington, DC in August 1992. The planed titles are:
     Session in Commission II :
     "Design aspects of digital photogrammetric systems"
     Session in Commission III:
     "Algorithms for digital photogrammetric systems"
     Joint session of Commissions II and IV:
     "Digital photogrammetric workstations and applications"

Working Group II/1 Analytical Instrument Activities

prepared by
Morris L McKenzie

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WORKING GROUP MISSION

The objectives of ISPRS Working Group II/1 includes the promotion and dissemination of information on analytical instruments through reports, technical meetings, and workshops. Over the past 14 years, in an effort to help both users and manufacturers, we have put together a packet comprising four components useful in procuring analytical instruments:

- tables of manufacturers, their instruments, and salient features of the instruments,
- standards and specifications for analytical instruments,
- an analytical stereoplotter evaluation guide,
- testing procedures for analytical instruments.

The intent in preparing this packet is to help the prospective buyer: the tables are for locating manufacturers and instruments of interest for further investigation; the standards and specifications are for guidance in preparing requests for proposals and contracts; the evaluation guide is for choosing the best-suited instrument from among several offered; and finally, the testing packet is for evaluating the accuracy of the instrument chosen.

In producing these documents, several considerations were observed. The working group operates with incidental funds now being provided by the American Society of Photogrammetry and Remote Sensing and by reproduction assistance from the organizations of working group members. Therefore, operating costs must be kept low. So far, the organizations of members have been generous in assisting us and we are grateful.

Tables of Manufacturers of Analytical Instruments

Originally, the working group produced a catalog of analytical instruments comprising brochures published by the manufacturers. The catalog proved to be impractical because it was a loose-leaf notebook that was relatively expensive to produce, update, and mail. To defray some of the expenses, a nominal charge had to be levied so the demand was small. Additionally, the brochures became outdated almost as soon as they were placed in the notebook.

After the first update, it was decided to replace the catalog with a set of tables listing manufacturers in alphabetical order, their analytical instruments, and the salient features of each instrument. These tables are produced and updated with a wordprocessor, and they will be mailed to users free. Before they are released, each manufacturer will be given a chance to review them for accuracy.

Standards and Specifications for Analytical Instruments

Producing standards and specifications for analytical instruments was a working group objective for several years before a beginning was made. While generally most users and a few manufacturers favor standards and specifications, many oppose it for various reasons.

The first document produced was a guide on preparing specifications for procurement. It was intended as a starting point for expansion, and the present working group is upgrading and expanding this document. The work is to be completed before the present term of Working Group II/1 expires in 1992.

Analytical Stereoplotter Evaluation Guide

The first version of the evaluation guide was produced under the 1976-80 tenure of Dr. B. Makarovic, and it has needed revising only once. This was done during the 1984-88 tenure of the Working Group by Mr. Daniel Andrews of the Tennessee Valley Authority. It has been reviewed by the present Working Group II/1 and judged sufficiently up-to-date.

The evaluation guide is designed so that analytical stereoplotters are evaluated in an hierarchical, tree-like structure with each category of features being broken down into groups and subgroups. Features are weighted according to their importance and for each feature each instrument is assigned a numerical rating according to the degree to which it fulfills the feature. Both the weights and the numerical ratings are entered into the formula used to compute a numerical evaluation for each instrument. In the

end, the instruments are ranked with the best choice having the highest numerical evaluation.

Testing Packet for Analytical Instruments

Originally, the document on testing was envisioned as a set of standard procedures for accuracy testing for all analytical instruments, but just as in the case of establishing standards and specifications, much shadow boxing was done before the first document was produced. The testing procedure adopted for accuracy testing was one proposed by Larry Fritz for calibrating comparators, and it is based on making multiple readings by several operators on a grid plate containing five rows and five columns of grid intersections. Each operator observes the grid plate several times at four 90^{o} rotations of the plate. The end result is an evaluation for each operator, the grid, and the instrument. Calibration parameters are computed for use in correcting instrument coordinates, even in real-time correction of analytical stereoplotter coordinates.

The theory behind this approach to evaluating analytical instruments relies on the assumption that if the instrument contains inherent accuracies in measuring coordinates, then overall accuracy follows. However, this approach leaves many components untested, including the software and firmware. A task group within the Working Group under the direction of Dr. Anita Laiho, Helsinki University of Technology, Finland, is revising parts of the present manual and preparing recommendations for future Working Groups.

USER/MANUFACTURER SURVEY FOR PROBLEM AREAS

One of our most important assignments is to survey users and manufacturers to identify areas where future Working Groups II/1 can help most. The Task Group for this objective under the leadership of Mr. Roger R. (Sky) Chamard, E. Coyote, is to make this survey and prepare a report of recommendations.

DISTRIBUTION

Updated versions of the existing documents and the table of manufacturers are not scheduled for completion until the end of 1991, but the current versions are available free of charge with the exception of the catalog of analytical instruments which is not available at all.

Requests for the complete packet or for individual components should be made to:

Morris L. McKenzie
Chairman, ISPRS WG II/1
Route 1, Box 101
Catlett, VA 22019
USA

After the 1992 Congress in Washington, DC, requests should be sent to the new chairman of the Working Group.