COMMISSION III: Theory and Algorithms

T. Schenk, President Commission III

Changes in Commission Organization

Heinrich Ebner resigned as WG III/3 chair. The Commission and the WG III/3 officers agreed that Helmut Mayer should be the new chair of the WG, which was approved by ISPRS Council.

Accomplishments of Commission during 1997

In a joint effort with NASA, NGS and OSU, a multisensor data set has been obtained from an area along the beach of Ocean City, Maryland, USA, including the city. NASA's laser altimeter system and NGS's Daedalus multispectral scanner (11 channels) was used on the same platform. Nearly at the same time, NGS flew a normal photo mission with the RC30 camera. After processing, the data will be made available to the working groups for experimental studies in sensor integration, data fusion, surface reconstruction with stereo and laser data, and multispectral classification and object recognition.

The first announcement and call for papers for the Commission Symposium has been distributed at various conferences.

A proposal was submitted to the editor of PAMI concerning a special journal issue with the best symposium papers. Although the request was finally declined it helped intensifying the contacts with vision community.

Contacts with Technical Commission VII have been intensified. Intercommission activities concerning theoretical aspects of integrating methods in remote sensing (classification) and in vision (object recognition) are under way. A formal proposal for fostering such activities is pending.

State of Science and Technology of Commission Topics

1. Automatic sensor orientation is an important subject. While GPS kinematic positioning renders cm precision, INS is still not reliable and precise enough to render attitude data that would result in exterior orientation data for sensors that are comparable to those achieved in aerial triangulation.
2. Theoretical models and approaches of multi-sensor integration are still missing. Current approaches have a strong ad hoc character.
3. Surface reconstruction of more complex scenes, such as, urban areas at large scale, is still a research topic. As additional sensors become more readily available (e.g. laser), solid concepts of integrating this information must be developed.
4. Feature extraction enjoys much attention, not least by the availability of multispectral information. The vision community is beginning to explore the potential of multispectral data.

5. Although a great deal of research focuses on object recognition and image understanding there is still a remarkable lack of theories and concepts. For one, no adequate models of real world objects, as they appear on aerial scenes, are available.
6. As the user community of softcopy workstations increases, pressure for automating photogrammetric procedures is mounting. Interior and relative orientation of standard photogrammetric models works well within an interactive workstation environment. Automatic aerial triangulation has not yet achieved that same level, however. Automatic DEM generation of rural areas for the purpose of orthophoto generation works satisfactorily. A major issue is the quality control and the reduction of human editing.
7. Not surprisingly, the automatic generation of maps has not progressed significantly. Research concentrates on extracting and grouping features, such as buildings and roads.
8. A lot of synergism can be expected from merging remote sensing techniques (classification) with approaches from vision (object recognition). The efforts of bringing together specialists from different disciplines are beneficial (see also activity report WG III/5).
9. The integration of SAR data with other sensory information---if carried out at all---is still of ad hoc nature.

Commission News

1. The Commission will actively participate in symposia of Commissions IV and VII.
2. An organizational and work plan will be put together with Commission VII related to the integration of multisensor information
3. The Commission will organize the symposium entitled 'Object Recognition and Scene Classification from Multispectral and Multisensor Pixels' July 6 to 10, in Columbus, OH. Up to date information on this event is available from http://wwwphoto.eng.ohio-state.edu

Working Group Activities during 1997

WG III/1 Integrated Sensor Calibration and Orientation

Chair: Peggy Agouris
Co-chair: Ismael Colomina
Secretary: Anthony Stefanidis

Accomplishments

1. Established the WG Web page: http://www.spatial.maine.edu/~peggy/ISPRSWGIII1.html
2. Distributed a WG newsletter and call for participation.
3. Created a Web-accessible questionnaire, which allows interested researchers to provide information on their activities and communicating details of advancements, opinions, and news.

State of Science and Technology of WG Topics:

There is a need to bring together research on sensor orientation performed within the computer vision (CV) and photogrammetric communities. This will permit the substantial advancements made on this subject within the softcopy photogrammetric community (e.g. automated orientations and triangulations) to make the transition to CV applications, with all their particularities (e.g. different types of sensors and set-ups). Hence, an impromptu meeting with members from the CV community was held during the CVPR Conference in Puerto Rico (June, 1997). The objective was to gain some exposure for ISPRS activities within a community, to which traditionally ISPRS has had rather limited access. Information on the Commissionï¿½s activities was distributed to interested researchers at the meeting. A larger participation of researchers from the CV community is expected in future activities of the Commission.

Specific WG News:

Following the Commission Symposium in 1998, future plans include the co-organization of a workshop with WG III/3 in 1999 in Europe, and a Workshop in the US in 1999, which involving the participation of the CV community.

WG III/2 Algorithms for Surface Reconstruction

Chair: Amnon Krupnik
Co-chair: Charles Toth
Secretary: Maxim Fradkin

Accomplishments

1. Working Group home page at http://www.technion.ac.il/people/krupnik/wg.html, which includes information about the Working Group objectives and activities, and the latest news and updates.
2. A second circular letter issued
3. Organization of the Workshop on Theoretical and Practical Aspects of Surface Reconstruction and 3-D Object Extraction in Haifa, Israel, on September 9-11, 1997, jointly with ISPRS Working Groups III/2, III/3 and II/8. A total of 23 papers were presented in 8 technical sessions, which concentrated on the following topics:
    - automatic aerotriangulation
    - data acquisition systems
    - feature extraction
    - 2-D and 3-D point location
    - surface interpolation and generalization
    - object extraction
    - multi-source surface reconstruction

    The Workshop was attended by 58 participants from 9 countries. Most of the presentations were followed by interesting, broad and informal discussions. A social program that included a banquet, a half day tour and a dinner contributed to the informal discussions as well. The workshop was proceeded by a technical tour at the Survey of Israel and A.D.M. (a private mapping

organization). All the participants characterized the Workshop as very useful and successful, and mentioned its high organization level.

Workshop proceedings are available as part 3-2W3, Vol. 32 of the International Archives of Photogrammetry and Remote Sensing.

In a following discussion, it was suggested to create and distribute a "benchmark" set of images for testing different algorithms for surface reconstruction and verification. This test will include not only the image models with known camera and orientation parameters, but also an accurately measured DEMs for these areas. Obviously, it is desirable that the set will cover different types of areas (open, suburban, urban, etc.) in order to enable a comprehensive examination of the surface reconstruction algorithms. This work is being currently undertaken, and we hope to have the data on our Internet site by the Commission III meeting in summer 1998. External contribution of data sets is expected.

Specific WG News

The next business meeting of the working group is expected to take place at the Commission III meeting in Columbus. In addition, the working group will take part in the organization of a conference on digital photogrammetry, which will be held in Munich on September 1999.

WG III/3 Feature Extraction and Grouping

Chair Helmut Mayer
Co-chair Ram Nevatia
Secretary Albert Baumgartner

Accomplishments

1. May 5-9 1997: WG business meeting during Ascona Workshop, Ascona, Switzerland
2. September 9-11 1997: Participation in Workshop at Technion, Haifa, Israel in cooperation with WGs III/2 and II/8, including a business meeting
3. Establishment of a WWW site for the working group: http://www.photo.verm.tu-muenchen.de/isprs/wgIII3/wgIII3.html
4. Mailing of two WG newsletters by email only

State of Science and Technology

Though feature extraction is a rather old topic, the importance of some concepts on how to deal with it have only recently become clear. This is notably true for differential geometry and scale-space theory. The former enables one to define the features rather formally while the latter allows for handling the dependence of features on scale. Especially the combination of both ideas seems to be highly promising for an improved feature extraction.

Grouping is essential for many applications because feature extraction alone cannot be expected to derive parts of objects, due to disturbances such as shadows. Recently, two particular trends can be noticed:

- Grouping uses more and more attributes of the features themselves as well as of adjacent features. This allows in many cases for ruling out unwanted groups.

- Grouping is done in three-dimensional object space using photogrammetric camera models. This further reduces the number of groupings especially when object knowledge is introduced.

Optimization techniques like snakes, which were used mainly in a semi-automatic manner until recently, show a high potential for the verification of automatically extracted hypotheses for objects.

WG News

Plans for Meetings

July 6-10 1998: WG Sessions during Symposium of Commission III, Columbus, Ohio, USA

Fall 1999: Conference in Munich, Germany possibly in cooperation with WGs III/1, III/2, III/4 and II/8

Spring 2000: Workshop in Los Angeles, USA

July 2000: WG Sessions during Congress of ISPRS, Amsterdam, The Netherlands

Plan for a Test

The working group plans a test assessing the results of different approaches for automatic road extraction from aerial imagery based on experiences of TU Munich in cooperation with IGN, Paris. The test is scheduled to start by fall '98, and results will be presented at the conference in Munich in September 1999.

WG III/4 Image Understanding/Object Recognition

Chair Wolfgang Eckstein
Co-chair Eberhard Gulch
Secretary& Carsten Steger

Accomplishments

1. Establishment of WWW site at: http://wwwradig.informatik.tu-muenchen.de/ISPRS/wgIII.4.htlm
2. Mailing of 2 WG newsletters

3. Participation in the joint ISPRS CIII/IV workshop on '3D reconstruction and modeling of topographic objects integration of multiple information sources and image understanding', Stuttgart, Sept 17-19, 1997, organized by WGIII/4, WGIV/2, and WGIV/III.2
4. Collection of WG related www pages (on WGIII/4-WWW site)
5. Collection of publications on WG topics
6. Establishment of A Calendar of events (on WGIII/4-WWW site)

State of Science and Technology

1. Fusion of multiple data sources is applied in research, but so far it is mostly limited to two sources, multiple images and map (GIS) data, digital surface models (DSM) and map (GIS) data, or DSM and image data. No general trend can be observed, nor comparative evaluation of the suitability of either combination on various tasks.
2. Existing cartographic information is regarded as use for object recognition and reconstruction tasks, despite unsolved problems of handling generalization or outdated information. Little research concerns the automation of change detection and almost none on the updating process.
3. Building extraction from images and/or laser scan data attracts numerous researchers, as well as road/road network extraction from aerial and satellite imagery. Multiple views are a prerequisite for many algorithms, with color information being of increasing interest. Several commercial systems offer laser scan data of high quality, suitable for detection and coarse reconstruction of buildings, including detection of vegetation. However, the automatic extraction of building ground plans and heights in urban areas are still unsolved.
4. In building and road reconstruction more complex models are used, e.g., buildings are reconstructed in parts, or road detection algorithms are able to handle crossings or partially occluded areas. Newest developments concern the learning of models to reduce the search space. The problem of correctness, accuracy, and optimal choice of level of detail of the models are still unsolved.
5. Object recognition tasks are more and more modeled in an object-oriented manner. This trend may be inspired by the work done within IUE project.
6. Almost all object recognition systems developed so far contain a problem-specific control structure. Therefore, the adaptation of these systems to, even slightly, changed conditions or new applications remains very difficult.
7. There is definite trend to real incorporation of interaction, due to so far limited success rates of so called 'fully automatic' methods. Both types of interaction, post-editing of automatically derived results or accompanying the extraction process, are applied. However there are no comparative studies on the advantages of either method.
8. Few investigations concern the quality and efficiency of image understanding algorithms, despite some ISPRS and OEEPE test material. There is a definitive lack of development of methodologies and of more comparative studies on more than the usual examples. However, there is an increasing interest in the performance characteristics of algorithms from the computer vision community documented by various workshops and ECVNet benchmarking and performance evaluation activities.

WG News

Participation in the midterm symposium of CIII in Columbus, July 6-10

Conference on digital photogrammetry in cooperation with ISPRS WGIII/3 and WGII/8, Munich, September 1999.

WG III/5 Remote Sensing and Vision Theories for Automatic Scene Interpretation

Chair DeLiang Wang
Co-chair Beata Csatho
Secretary Erzsebet Merenyi

Accomplishments

Since WGIII/5 is a brand new working group, the initial steps were to identify a focus for the first year's activities and establish administrative tools for communication and collaboration.

1. A web page has been set up and connected to the ISPRS main web site at: http://polestar.mps.ohio-state.edu/~csatho/wg35.html.
2. Working group members have been recruited and listed on the web page. Working ties have been established with Commission/WG III/3, IV/2, and VII/4.
3. The two main professional areas our activities in 1997 are the analysis and interpretation of multi- and hyperspectral imagery; and the analysis of multi-sensor imagery. Hyperspectral imagery in particular receives an emphasis because of its relative novelty, and its special challenges associated with the analysis (classification) of hyperspectral images. A web page has been set up by E. Merenyi (the Secretary) with information related to hyperspectral imagery. This page will develop over the next year with the intent of providing central links to knowledge on the subject.
4. Three circular letters have been sent out. The first dealt with membership recruiting; and the second advertised upcoming meetings. The third commenced a longer term professional work that our group will pursue: the establishment of standard remote sensing data sets (both single and multiple sensors) for algorithm development and testing. These will be real data sets with great complexity (such as in real situations), and with adequate ground truth according to leading sampling theories. A "standard" problem (e.g., classification challenge) will be assigned to each so algorithms under development can be gauged against others. The success of these plans hinges on membership contributions of data and willingness to adhere to guidelines. WGIII/5 will provide the guidelines and organization. The third circular solicited responses to concrete suggestions.
5. The joint Workshop of III/2, III/3 and II/8, "Theoretical and Practical Aspects of Surface Reconstruction and 3-D Object Extraction" in Haifa, Israel, Sep 9-11, 1997, was attended by Beata Csatho (the Co-Chair), who gave a presentation on Surface Reconstruction of Urban Scenes from Laser Altimeter and Stereo (with co-author Toni Schenk).

WG News

- Beata Csatho and Erzsebet Merenyi attended a workshop in Budapest, Hungary, February 19-20, 1998.

- DeLiang Wang is currently organizing a special issue on 'Target Detection' for the journal of the American Society for Photogrammetry and Remote Sensing, with an expected publication date in 1998 or early 1999.
- The fourth circular will be distributed in 1998.
- The Pan American Center for Earth and Environmental Studies, University of Texas at El Paso, volunteered to provide the resources for maintaining a data base that will house the standard data sets. Two members volunteered to contribute professional work on a regular basis.

WG III/6 Theory and Algorithms for SAR

Chair Laurent Polidori
Co-chair Soren Madsen

Accomplishments:

Issued circular letters

WG has recruited 29 members

Refined the scientific agenda at a meeting between chair and co-chair in Lyngby, Denmark

State of Science and Technology

In the theory of SAR interferometry processing topics of interest in the WG include:

State-of-the-art phase unwrapping

Spatial resampling issues

Algorithms for using correlation images (DEM quality assessment, thematic mapping)

Slope map generation

Evaluation and potential synergy of complimentary techniques, for example interferometry, stereoradargrammetry, shape from shading.

Impact of SAR image quality on interferometric performance

Non-conventional SAR algorithms as applied to interferometry (e.g. scan-SAR)

Generation of map products based on SAR data, such as orthoimages, mosaics, DEMs

Quality assessment of images and map products

Feature extraction from SAR images

Review state-of-the-art technologies

Evaluate algorithms from other fields (AI, photogrammetry, CV) for their suitability to extract features from SAR imagery

Automatic identification of image tie points and ground control points

Automatic mapping, such as extracting roads, land cover, buildings, streams/rivers.

WG News

A workshop was held in January 28-30, 1998, in Cannes, France, on the topic, Advances and limitation of SAR image processing techniques.