12.4 CORSE
There were no new issues for ICORSE but it was noted that TCVII and TCVIII would be attending the ISRSE programme committee in St Petersburg and that several members of Council would attend the Symposium.

13. Forthcoming Meetings (ID)
The presence of ISPRS at forthcoming meetings was discussed and consequently a list of meetings requiring Council Attendance was prepared.

14. Relations with International and Other Organizations (ID)
14.1 CEOS
ID reported on the recent CEOS Plenary in Beijing.
14.2 United Nations
Council discussed the invitation from OOSA to be represented on the Action Team on GNSS and decided that there was insufficient interest for ISPRS to justify additional resources.
14.2 ICSU
Information was tabled on the ICSU Grants programme, International Polar Year (IPY) and electronic Geophysical Year (eGY). These had been discussed at the Joint Meeting.
14.4 IEEE
OA tabled information on IEEE-GRSS Technical Committees, and noted that TCPs had been encouraged to look for opportunities to collaborate. ID would seek an opportunity to meet the IEEE-GRSS President.
14.5 GEO
ISPRS would join GEO and ID will attend GEO-6.
14.6 ION
JT had been in contact with ION and a MoU draft is waiting for approval by the ION Board.
14.7 JBGIS
ID would attend the next meeting in April 2005.
14.8 OICC
A letter from OICC was tabled, suggesting ISPRS take part in a pilot project to support and monitor urban development in Egypt. Council had no funds for this but ID would continue the discussion with OICC.

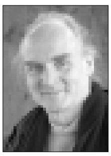
15. Review of Decisions and Actions on Council (OA)
A list of Actions from the previous period was discussed and reviewed at the meeting.

16. Reports from Council (All)
Reports of the Council Members on their activities in the past 2 months were presented.

17. Other Business
There were no other items to be discussed and ID thanked the Council Members for their contributions and reminded the very urgent business matters arising from this meeting.

18. Next Council Meeting
Next Council Meeting is in Zurich at 12 (early arrival)-15(late departure) May 2005.

19. Close
ID closed the meeting and thanked Shunji Murai once more for hosting this meeting.



ISPRS Comm. III – Contribution to ISPRS Highlights

By Wolfgang Forstner, President, e-mail: wf@ipb.uni-bonn.de, and Helmut Mayer, Vice President

The long term progress of photogrammetry, remote sensing and geoinformation systems depends on the formulation and solution of basic questions concerning the acquisition and analysis of spatio-temporal data. Knowledge about the physical processes of the sensors, the ontology of the spatio-temporal objects to be acquired and mathematical tools based on strong concepts are combined into efficient computer algorithms. Within ISPRS Commission III 'Photogrammetric Computer Vision' is responsible for this development.

In the following we will sketch a few of the most important basic research problems. All of them are addressed in the research community, some will be solved in the next few years, yet most of them will stay with us beyond the next congress.

1. Calibration and Orientation of Images and Image Sequences
Photogrammetric research was characterized for a long time by finding efficient procedures for calibration and orientation of cameras, from relative orientation procedures for analogue instruments via adjustment procedures for photogrammetric blocks to self-calibrating bundle block adjustment. The availability of GPS and INS on one hand and of digital imagery on the other hand seemed to bring this development to an end, by easing the problem of initial value determination or even replacing photogrammetric orientation procedures, thus allowing full automation.

However, this view appears a bit narrow as it only looks at the calibration and orientation of aerial images. It does not take into account the ubiquity of digital still and video cameras. The limitation of research to images of *photogrammetric* cameras, having a stable interior orientation, limits the progress of photogrammetric techniques.

The potential of photogrammetric applications could be increased by at least two orders of magnitude if the basic photogrammetric problems, namely calibration and orientation were solved for cameras in the hand of a normal consumer.

Whereas the technical problems of acquisition, storage, processing and display of large amounts of images or of videos are or will be solved, many conceptual and technical problems of calibration and orientation are still open and are core questions of basic research:

- *Autonomous calibration and orientation of cameras*, provided only images are given. This transfers automatic aerotriangulation to the close range domain.
- *Real-time ego motion* determination from image sequences. This is the successor of on-line triangulation, being a hot topic two decades ago.
- *Autonomous calibration and orientation of video camera networks* without user interaction.
- *Guiding the user in image acquisition*. This is the successor of network design.
- *Integration of other sensors*. This might refer to a micro compass in the camera or a GPS receiver in the watch of the user, the camera being linked to a *wearable computer*.

These problems refer to single images as well to image sequences or streams assuming nothing or only little about the interior orientation, e. g. from the header of the image file. They also refer to non-standard situations, such as cameras with fish-eye-lenses or stereo-camera heads with two or more cameras. The challenges are to robustly and reliably cope with all types of scenarios including weaknesses in the configuration, to exploit all diagnostic tools and to translate the result of network design into *recommendations which are understandable for the user*.

These are prerequisites for photogrammetry to become available for everybody. They are only realizable if the basic theoretical questions have been solved. One can expect many of these problems being successfully addressed in this period of Commission III.

2. Intensity and Range Images for Surface Reconstruction

One of the basic products of photogrammetry are digital surface models. Though automatic matching procedures for deriving surface models have been developed in the last two decades, their impact has heavily decreased with the availability of laser scanners. The latter have significant advantages in capturing surface models, giving 3D data directly, being weather independent to a large extent and penetrating foliage. All this suggests, that the surface reconstruction problem has become solved.

However, this is only true if one accepts a point cloud as result and the high price of the active sensor laser scanner compared to the low price of the passive sensor digital camera and therefore a lower efficiency. Actually, both sensors yield silly pixel or point sets which for most applications at least need to be structured to be of any value. The basic problems, though, have a different flavour for image and laser data.

2.1 Surface reconstruction from images

Reconstructing surfaces from images means inverting the physical imaging process. The problem is known to be ill-posed, i. e., does not give a unique solution without further assumptions. Early attempts assume a Lambertian reflection and smooth surfaces. The under-determinedness increases in case of non-Lambertian reflection. The roughness of real surfaces can increase the difficulty of the correspondence problem dramatically. Some of the basic problems specific for the reconstruction from images are the following:

- *Occlusion handling*. The challenge is the efficient determination of occlusions during the reconstruction process.
- *Texture free surface areas*. The principle "No news is good news" (Grimson) may be used as a motivation for smooth interpolation. Integration of shape from shading is a challenge due to its strict assumptions and mathematical complexity.
- *Partially specular surfaces*. The challenge is the integration of – significantly - more than two images for recovering a locally varying parameterized bidirectional reflectance function simultaneously with reconstructing the surface.
- *Quasi transparent surfaces*. This is a particularly challenging variation of the occlusion problem, e. g., occurring when trees occlude buildings.

The ease of the human visual system to reconstruct surfaces from only two views often has lead to the wrong supposition the problem to be easily solvable. All experience points to the contrary.

2.2 Surface reconstruction from point clouds

Reconstructing surfaces from point clouds can be viewed as an interpolation or prediction problem. The point clouds may directly be measured, e. g., by a laser range finder or derived indirectly, e. g. by an image stereo algorithm. The problem is easier than the reconstruction from images, as one starts from 3D information. However, it also poses basic problems:

- *Point cloud segmentation*. The problem is similar to the image segmentation problem, which inherently is not well defined, without referring to a task. Given a certain model for the type of surface, the challenge is to simultaneously handle the estimation and classification problems for dealing with irregular point distributions, outliers, and missing data and at the same time achieving high efficiency.
- *Surfaces from range and intensity images*. The partially complementary properties of intensity and range images suggest an integrated reconstruction of sur-

faces. The challenge is the handling of inconsistencies, e. g., with respect to occlusions or reflection, due to the different and possibly independent sensing process.

- *Real-time surface reconstruction*. This becomes a requirement with the availability of real-time orientation procedures for both types of sensors, e.g., for applications in robotics. The challenge is an adequate surface representation, which allows the fusion of widespread surface data.

Common to all surface reconstruction techniques is the problem of developing a rich enough and realistic generic model for the surface to be recovered. The challenge is the variability of surface types from polyhedral, over smooth and piecewise smooth to fractal and the need to automatically locally identify the adequate surface type. There is obviously an intensive overlap with the interpretation of the surfaces.

3. Image Interpretation and Cognitive Vision

The value of images lies in the high information density available for image interpretation. The cognitive abilities of the human operator are regularly underestimated when trying to transfer them into algorithms.

Interpretation tasks for photogrammetric images are varying from very simple, e. g., detecting fiducial marks to extremely complex, e. g., identifying and classifying industrial regions. In case of interpreting video streams the situation is similar, the tasks ranging from obstacle detection on a planar pathway to identifying the intentions of a driver in the car in front of the own one. The basic questions have not changed over the last 20 years, comprising knowledge representation, reasoning under uncertainty, coping with the large search spaces of concepts for object recognition or for modelling the spatio-temporal structures of multiple moving objects.

Image interpretation systems were intensively studied until the mid of the 90's. While only few photogrammetric groups have continued research in this area over the last ten years, the topic has reached high attention again in the last few years. Today the problem of object detection and categorization is in the central focus of the computer vision research community. Whereas the last decade could be characterized by research in multiple view geometry, we now find statistical modelling with graphical models, especially Bayesian networks and highly sophisticated estimation and classification techniques, cf. the seminal paper by Mumford (The dawning of the age of stochasticity. In: Mathematics: Frontiers and Perspectives 2000, AMS, 1999, 197-218.) The European Commission funds basic research for building cognitive systems with computer vision capabilities (cf. www.ecvision.org). The EU funded network 'PASCAL - Pattern Analysis, Statistical Modelling and Computational Learning' „will pioneer principled methods of pattern analysis, statistical modelling and computational learning as core enabling technologies for multimodal interfaces that are capable of natural and seamless interaction with and among individual human users". The basic problems addressed are the same we photogrammetrists need to tackle for making possible computer supported interpretation of image and range images.

4. Conclusions

The above sketch shows that Commission III addresses highly interesting problems. This is the basis for a lively exchange between all groups conducting basic research in our field. As engineers we only believe in our results if they are adequately evaluated. The work in the working groups therefore not only aims at fostering the communication between the different research groups, but also at providing a platform for comparing procedures based on common data sets.

The activities of the working groups are documented on their home page, which you may find under the home page of the Commission (www.ipb.uni-bonn.de/isprs). When writing this report, the workshop on 'New Generation 3D-City Models', organized by the Chair for Geoinformation, Bonn has already taken place, cf. the report by Th. Kolbe.

We want to invite you come to the Symposium of Commission III 'Photogrammetric Computer Vision '06' (PCV '06) in Bonn, September 18-22, 2006 and submit a paper until March 27, 2006. Details will be found on our homepage.

The goal of the work in Commission III is to design, develop and evaluate mathematical models and methods for automatic image analysis.

- orientation and calibration of images,
- surface reconstruction,
- fusion of multi-modal data,
- processing and interpretation of laser range data,
- interpretation of images and
- image sequence analysis

with emphasis on

- integration of geometry, statistics and semantics,
- modelling of spatial objects and temporal events,
- modelling context,
- scale behaviour of appearance models,
- use of graphical models, especially Markov random fields and Bayesian networks.

The work should intensify the links with the computer vision and pattern recognition community, especially by integrating key players into the working groups. Following the good tradition of photogrammetric research, benchmarking is one of the main practical ways to promote the field and at the same time bring together researchers of different fields.