Welcome address

This year's tutorial, which 'opens' the 50th Photogrammetric Week, continues a series already started in 1993. The ongoing success of this pre-event shows us, that the participants of the Photogrammetric Weeks welcome the tutorials on Sunday as a further education event to update knowledge in theory, development and application in a selected area.

During the past Photogrammetric Weeks, tutorials were held on topics like *Geo-Information-Systems*, *GPS/INS integration*, or *Photogrammetry and 3D Visualisation*. The title of this year's event *Best of Photogrammetric Image Data Processing* seems to be similar to the very first tutorial of this series, which was held on *Algorithms and Automation of Photogrammetric Image Processing*. However, the fundamental change in the contents of both events is interesting to note. Digital image processing was just emerging into practice 12 years ago, while in the meantime digital photogrammetric systems are used in the daily work of photogrammetric enterprises. Thus, the covered topics changed from basic image operations, which have become common knowledge in our daily business to dedicated strategies, which are required to fully exploit the potential of today's sensors for digital photogrammetric data collection.

The four lecturers, Dieter Fritsch, Norbert Haala, Jan Böhm and Michael Cramer have prepared and worked out this compendium and hope to have made a representative selection. We very much appreciate you being here in Stuttgart this Sunday and we regard your personal engagement. We would like to thank you for your interest and wish you an instructive participation in this tutorial and an interesting 50th Photogrammetric Week.

Stuttgart, September 2005

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One of the main problems which aggravated the development of digital airborne camera systems was the limited size of available CCD frames. Meanwhile, both concepts to overcome this problem – pushbroom and multi-head – have proved to be operationally within commercial systems. However, the loss of the traditional camera format and geometry requires the adaptation of photogrammetric image processing and promotes the application of new technologies. As an introduction, the first part of the tutorial *Digital imaging in photogrammetry* reviews the basic principles of the digital imaging processes. The participant will learn how CCD, CID and CMOS technology operates – pros and cons are given. We hope, that afterwards we finally arrive at a better understanding of digital camera technology.

In the second part of the tutorial on *Photogrammetric Low-Level image processing* pixel-based techniques are discussed, which were originally developed for processing of space-borne imagery. This demonstrates the ongoing merge of photogrammetry and remote sensing. One example are image restoration algorithms used to fully exploit the potential of digital airborne image collection. The presented determination of image resolution is an important issue for analysing the quality of pre-processed data, which is frequently produced during the generation of 'virtual' images prior to further photogrammetric evaluation. Pan-sharpening and image restoration algorithms to improve the spatial resolution of multi-spectral images by higher resolution panchromatic data are another example of such pixel-based techniques.

In addition to camera systems an abundance of sensors is commercially available for dense range data acquisition. Even larger is the number of sensor systems in the research field. In the third part of the tutorial on *Range Data Processing and Segmentation* we attempt to clarify the terms and definitions of range scanners. Both triangulating sensor and time-of-flight sensors are discussed. The tutorial introduces to typical systems on the market, both for airborne sensors and terrestrial sensors. System characteristics and performance issues are discussed. The crucial step to the success of range scanners is the availability of software systems and algorithms, which are able to turn the data captured by the sensors into information. The tutorial introduces range data processing algorithms, starting from simple operators such as edge filters. More complex operations based on differential geometry are developed and discussed. Registration of range data finally concludes this part of the tutorial. The registration is essential both for multi-station configurations and for multi-sensor data fusion. A robust registration scheme based on the iterative closest point algorithm is presented.

In correspondence to the registration of range data, the georeferencing of airborne image data the essential step within geometric image data processing. From that this part of the photogrammetric production line is highlighted within the final topic of the tutorial on *Georeferencing of airborne image data*. Starting with some general definitions the mathematical model of aerial triangulation is presented. The presented models are based on the collinearity principle, alternative approaches like projective geometry are without the scope of this tutorial. Although well known – at least from theory – some additional background information is given on 3D rotation matrices and the different types of matrix parameterisations commonly used in airborne photogrammetry. The standard collinearity equations are extended for use of linear pushbroom image geometries. This directly leads to the additional use of GPS- and/or inertial observations within the orientation process. The orientation fixes approach and the direct georeferencing model is presented. All this more theoretical background is illustrated in the last half of this tutorial part, where some results of the comprehensive geometric performance study on ADS40 sensor data from the ifp Vaihingen/Enz test site are discussed in detail.