ISPRS Society

ISPRS Technical Commission I

Image Data Acquisition - Sensors and Platforms

By Alain Baudoin, President ISPRS TC I, e-mail: alain.baudoin@cnes.fr

The organization of ISPRS Technical Commission I is described in this Highlights issue. Seven Working Groups belong to Commission I and two are shared with Commission V. Each Working Group has already proposed activities which now should be realized within the next four year period until the Beijing Congress. An overview and the foreseen activities of each Working Group are described below.

WG I/1 Standards, Calibration and Validation

For the next 4 years, TC1/WG1 aims at contributing to the strengthening of the cooperation between the different entities involved in the fields of calibration and validation including the end-users. The activities of the ISPRS/CEOS Cal/Val Task Force should be continued under a new leadership. A workshop held by CEOS in Noordwijk in October 2004 on intercomparison of large scale optical and infrared sensors pointed out the necessity of satellite instrument intercalibration. Intercalibration of large field of view image sensor is proving to be a positive outcome of test sites sharing. Such sites sharing should be promoted as well for geometric calibration of remote sensing systems.

Also it is expected to see a significant increase in the number of applications based on the multi-sensor data-fusion techniques. In the same time, more and more systems both scientific and commercial propose value added products (geometrically referenced, mosaics, spectral bands combinations, optical properties and temperature at ground level, ...) to end-users. Therefore it is becoming especially critical to enhance users ability to understand and evaluate sensor performance and data quality in a uniform manner across all sensor and data of interest. In that regards, TC1/WG1 will strongly promote and encourage all efforts towards standardized definitions of the calibration parameters and a consistent classification of the calibration and validation methods as well as ground truth data sets and test sites.

WG I/2 SAR and LIDAR Systems

Active sensor-based SAR and LiDAR technology, introduced in the late 90s, has received wide acceptance in airborne surveying as a leading tool for obtaining high-quality surface data in an unprecedentedly short turnaround time. The adoption of the new technology was fairly smooth and quick, primarily due to the high-level of automation of the data processing. With an increasing number of systems sold, vendors have been able to refine the technology rather quickly, delivering a continuously improving performance, measured in terms of number of points. LiDAR systems nowadays do range measurement with an increasing number of points per surface, count multiple returns per single shot, deliver reflectance values of the illuminated surface and capture the full waveform of the backscattered laser light. The role and capabilities of Interferometric SAR (InSAR or IFSAR) continue to expand, particularly with respect to wide area DEM creation. Interest spans both short (X- and C-Band) and long (L-and P-Band) wavelengths. Areas of significant technical interest and application include Polarimetric InSAR and Differential InSAR with respect to quite different but important applications. Fusion of high resolution SAR images with optical is again of interest as new techniques are applied. Over the next few years several new SAR satellites will be launched with increased capability and coverage implying expansion of application and use.

WG I/3 Multi-platform Sensing and Sensor Networks

With the increasing development of new sensors, the integration of multi-platform sensors as well as enhanced networking and fusion of multiple sensors are considered a central issue for end users, and mission-critical applications. For example, integration of in-situ sensors with airborne and space-borne sensors can provide an enhanced capability in comprehensive monitoring, and on-the-fly modeling and validation. Disaster management and environmental monitoring application requires a cluster of sensors or sensor networks including imaging and non-imaging sensors for a continuous monitoring. Although research has been largely devoted on the exploitation of individual sensors and the fusion of the sensory data, effective mission planning, configuration, networking and inter-connection of multiple sensors for targeted mission has not been addressed.

There are a variety of recent activities in IEEE/ISPRS and government remote sensing programs on making use of networked sensors for integrated sensing. In order to respond to the growing activities, the WG is established to coordinate activities in addressing the scientific, technological and engineering issues for multiple-platform (ground, airborne and space) sensor integration and multi-type sensor networking. It focuses on the integration of imaging and non-imaging sensors, mission planning of multi-platform sensors, interoperability and standards of multi-type sensor transfer parameters, connection and

networking of sensors, sensor networks and sensor web, etc issues.

The WG's activities will be developed based upon the work of past WG I/4 - Advanced Sensor Systems and WG I/5 – Platform and Sensor Integration. This WG would have a close link with WG -I.1, WG-I.7 and IC WG I/V as well as related WGs in COM II, and COM VII.

WG I/4 Airborne Digital Photogrammetric Sensors Systems

The current interest in the topic of airborne digital photogrammetric sensor systems was reflected in a well attended ISPRS WG I/6 (airborne optical sensor systems) technical session at the XXth ISPRS Congress, Istanbul. The TS comprised speakers from established manufacturers, Z/I Imaging, LH Systems and Vexcel, plus relative newcomers, STARLABO Corporation (Japan) and Wehrli & Associates (USA) and GeoSystem (Ukraine). The new sensor systems from STARLABO and Wehrli, the STARIMAGER and 3-DAS-1 respectively, follow the three-line scanning principle adopted in the Leica ADS40 rather than the multiple area array approach used in the Intergraph DMC and other systems. With several different sensor systems now commercially operational (at the Congress, Intergraph and Leica reported 14 and 20 units respectively sold to date), the challenge for the 2004–2008 period is in establishing commonly accepted procedures for calibration and testing of the multiple design concepts available (including line, single and multiple area array geometries), evaluating the performance of sensors and derived products relative to more established methods, integration with other sensors and in developing guidelines for new workflows. In addition, the emergence of the unpiloted aerial vehicle (UAV) as a sensor platform necessitates scientific investigation into the potential of light payload digital sensor systems for mapping purposes.

WG I/5 Geometric Modeling of Optical Space-borne Sensors and DEM Generation

The use of high resolution earth observation systems for mapping made large progress. Several optical space borne sensors are available now and additional systems will come in near future. There are different geometric models for handling the variety of image products; some are rigorous, some are based on approximations, some do use available sensor orientation parameters and some do not. The optimal solution in relation to the given conditions has to be identified, respecting also possible problems of the images and sensor parameters. Especially the orientation with a limited number of not well distributed control points or even without control points has to be investigated. 2- and 3-line sensors do allow a check or an improvement of the orientation data just by means of tie points; the advantage of these stereo systems against the satellites with flexible view direction has to be investigated.

From the largest part of the world the height information is available from the SRTM-mission free of charge. These DEMs do have a spacing of 3", sufficient for several applications. Limitations are in especially mountainous areas where the spacing does not guarantee the full morphologic information; in addition the accuracy is not so good in inclined areas up to gaps caused by Radar lay over. Of course also in steep areas DEMs based on optical space images do have some limitations what has to be analyzed in detail depending upon the used matching technique. The simple height accuracy relation just as a linear function of the height to base relation is valid only for flat and open areas with sufficient contrast. The optimal height to base relation has to be identified for different terrain types including also build up areas. This has to respect also the influence of not close to synchronous imaging causing radiometric differences based on changes in the object space and different length of shadows.

The geometric models and the generated DEMs have to be verified by independent reference data. An overview of available test sites shall be generated.

WG I/6 Small Satellites

Small satellites are now used either for scientific or operational purposes by more and more countries. Developing countries acquire space capability and observation capacity while developed countries realize certain missions on small satellite platforms thanks to low cost of development, realization and exploitation and shorter development times of small satellite projects. Even though it is debatable that their performances can be compared to those of traditional satellites, they have great potential for many applications and many users, hence, they should be evaluated and results should be publicized.

Already other international societies are organizing meetings and conferences on the subject. The 6th 4S Symposium – Small Satellites Systems & Services was held in La Rochelle in September 2004 and the 5th IAA Symposium on Small Satellites for Earth Observation will be held in Berlin in April 2005. The General Assembly of ISPRS has voted a resolution on the subject, expressing its importance and justifying the organisation of a new Working Group.

WG I/7 Intelligent Earth Sensing

The future of earth observing satellite systems lies in an incorporation of a higher degree of "intelligence". The increasing need for acquiring timely information about Earth system processes and for early warning of natural and human disasters, combined with a need to control costs and for coping with increased system complexity, suggests that intelligent satellites are appropriate for deriving information quickly and in near real-time for dissemination to non-science user communities. Such intelligent systems could include space-based architectures

capable of dynamic and comprehensive onboard integration of sensors, data processors, and communications.

- The first International Workshop on Future Intelligent Earth Observing Satellites (FIEOS), co-organized with ISPRS WG I/4 (Advanced Sensor Systems), the National Aeronautics and Space Administration, and Virginia's Centre for Innovative Technology (CIT), was held November 10-15, 2002 in Denver, Colorado.
- The 2nd International FIEOS Workshop in conjunction with ISPRS WG I/4 was held July 13-23, 2004, in Istanbul, Turkey.

IC WG I/V Autonomous Vehicle Navigation
Autonomous navigation of land vehicles, Unmanned Aerial Vehicles (UAV), and robots has enormous current and potential applications such as safe driving, automated environment mapping and monitoring, planetary exploration, and military operations. Navigation and mapping sensors may include GPS, INS, laser ranger, odometer, radar, digital cameras, and other active and passive sensors. Integrated calibration of the sensors is a prerequisite for high precision navigation. In order to make the vehicle truly autonomous, simultaneous mapping, localization, and object tracking must be realized fully automatically in real time. For example, this poses great challenges in a planetary environment where there is no GPS available, or in an urban area where the urban canyon blocks the GPS signal and there are lots of moving objects (other pedestrians and vehicles). New and innovative techniques and algorithms should be developed to support autonomous navigation in these difficult environments. For different applications, research on the combination and configuration of different sensors should be conducted to make the navigation system optimal in terms of performance, safety, and cost. This inter commission working group will focus on the research and development of technologies to improve accuracy and automation of the navigation system and to promote practical navigation systems in working environments.

Events Organized by Commission I
Some of the proposed workshops, conferences, symposia are still to be confirmed. Here is the foreseen events in which TC I should be involved in 2005 and 2006:

Events to be organised by TC I in 2005:
- High Resolution Earth Imaging for Geospatial Information, Hannover, 17-20 May 2005 (WG I/1 and I/5): http://www.ipi.uni-hannover.de/ISPRS_workshop_05/
- 3D Mapping from InSar and Lidar, Banff, Canada, 7-10 June 2005 (WG I/2)
- Mapping from airborne digital sensors, Southampton, UK, late 2005 (WG I/4)
- Proposed Workshop of WG I/5 and WG I/6, Ankara, Turkey, late 2005

Symposium of Commission I (Title TBD): Paris/Marne-la-Vallée, France, 3-7 June 2006

Other events where TCI WGs are or could be associated:
- CEOS WGCV meeting, Cordoba, Argentina, 3-5 March 2005 (WG I/1): http://wgcv.ceos.org
- 5th IAA Symposium on Small Satellites for Earth Observation, Berlin, Germany, 4-8 April 2005 (WG I/6)
- EuroSDR – 50th Photogrammetric Week, Stuttgart, Germany, 5-9 September 2005 (WG I/4): www.ipf.uni-stuttgart.de
- 9th International Symposium on Physical Measurements and Signatures in Remote Sensing (ISPMSRS) on Oct. 17-19, 2005 at Beijing, China (WG I/1 with WG VII/1): www.ISPMSRS2005.org
- 5th International Symposium on Mobile Mapping Technology (MMT 2006), Padua, Italy: www.cirgeo.unipd.it/sitoCIRGEO/mmt_frst.html

ISPRS Technical Commission II — Theory and Concepts of Spatio-Temporal Data Handling and Information

By Wolfgang Kainz, President Technical Commission II, Department of Geography and Regional Research, University of Vienna, Universitätsstraße 7, A-1010 Vienna, Austria, e-mail: wolfgang.kainz@univie.ac.at

Spatial data expose spatial and temporal characteristics that have stimulated numerous activities to establish a theoretical foundation and a framework for their use and application. The ISPRS Technical Commission structure addresses this fact with Technical Commissions II and IV who deal with the theoretical and application oriented aspects of spatial data handling, respectively. The foundation for Technical Commission II is laid in the terms of reference defined as dealing with:

- Fundamentals of spatial database design, spatial data structures, spatial analysis and geostatistics, spatial querying, spatial reasoning, spatial and temporal modeling
- Aggregation, generalization, abstraction and rendering of image and vector data
- Spatial decision support systems
- Processing, analysis and modeling of multi-dimensional geospatial data

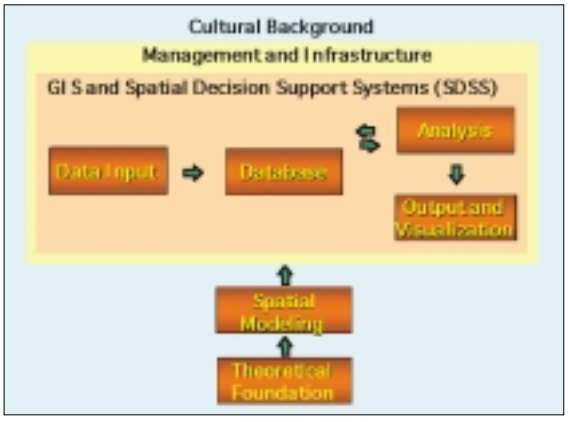


Figure 1: Context of Spatial Data Handling.

- System integration and modeling aspects for data and geo-information processing
- Interoperability of heterogeneous spatial information systems
- Semantic and geometric integration of heterogeneous spatial information
- Communication and visualization of spatial data
- Data mining, filtering, retrieval and dissemination
- Spatial data quality and spatial model quality

The breath of the issues addressed in the terms of reference can also be seen in the fact that many scientific and professional organizations dealing with spatial information converge at items mentioned above.

Background

The general context of spatial data handling can be summarized as shown in Figure 1.

Based on the fundamental disciplines of geo-information science spatial models form the basis for a spatial database that is at the core of every geographic information system (GIS). Data is entered into the database where it is maintained and kept for further analysis, output, and visualization.

Geographic information systems can be extended to spatial decision support systems providing input to decision processes where spatial data are involved. All spatial data handling needs an organizational and a technical infrastructure. All activities in the mentioned context must be seen before the cultural background in which they are embedded.

Taking the terms of reference as well as the resolutions of the Istanbul Congress into account seven working groups and one Inter-Commission working group were established. Table 1 shows their names and the names of the working group officers.

The terms of reference and the work plans of the working groups reflect the whole range of topics in the theory and concepts of spatio-temporal data handling and information. When we map the working groups to the different areas in the context of spatial data handling (Figure 1) we can depict overlapping areas as displayed in Figure 2.

Every working group is represented by an ellipse. The thematic ties between the groups are represented by overlapping areas. WG II/1 dealing with the theoretical foundations and spatial modeling provides the basis for the representation of spatial features in a database. WG II/2 investigates methods to detect information in spatial databases through data mining, spatial analysis, and reasoning. WG II/3 looks at representations of spatial features in various levels of detail in spatial databases and visualizations.
The use of GIS and decision support systems for spatial planning and decision making is the focus of WG II/4. Communication and visualization of spatial data in various ways is the focus of WG II/5.

WG	Name	Chair	Co-Chair	Secretary
II/1	Spatio-Temporal Modeling	Donna PEUQUET (USA)	TANG Xinming (China)	Monica WACHOWICZ (Netherlands)
II/2	Spatial Reasoning, Analysis, and Data Mining	LIU Yaolin (China)	Abdülvahit TORUN (Turkey)	AI Tinghua (China)
II/3	Multiple Representations of Image and Vector Data	Monika SESTER (Germany)	Lars HARRIE (Sweden)	Mark HAMPE (Germany)
II/4	Spatial Planning and Decision Support Systems	Ali SHARIFI (Netherlands)	Nik Nasruddin MAHMOOD (Malaysia)	Shattri MANSOR (Malaysia)
II/5	Communication and Visualization of Spatial Data	William CARTWRIGHT (Australia)	Hiroyuki YOSHIDA (Japan)	Gennady ANDRIENKO (Germany)
II/6	System Integration and Interoperability	Marinos KAVOURAS (Greece)	Stephan WINTER (Australia)	Margarita KOKLA (Greece)
II/7	Quality of Spatio-Temporal Data and Models	SHI Wenzhong (Hong Kong, China)	Robert JEANSOULIN (France)	Hande DEMIREL (Turkey)
II/IV	Dynamic and Multi-dimensional Systems and Applications	Christopher GOLD (United Kingdom)	LI Zhilin (Hong Kong, China)	Mir Abolfazl MOSTAFAVI (Canada)

Table 1: Technical Commission II Working Groups.

Both WG II/6 on system integration and interoperability as well as WG II/7 on the quality of spatio-temporal data and models cover a broad area of spatial data handling reaching from fundamental theoretical issues to questions related to spatial information infrastructures.

Finally, the Inter-Commission WG II/IV on dynamic and multi-dimensional systems and applications functions as the bridge between the more theory-oriented areas of Technical Commission II and the application oriented system approaches of Technical Commission IV.

Working Group Plans

The working groups have planned several activities for the near future. They are listed here in chronological order.

The 4th International Symposium on Spatial Data Quality (ISSDQ 2005) will be held at Beijing University August 25 – 26, 2005. This symposium is co-organized among others

by WGs II/7, II/1, II/2, II/IV, IV/1, VII/5, and VII/6 (http://www.lsgi.polyu.edu.hk/issdq2005/).

The International Symposium on Spatial-Temporal Modeling, Spatial Reasoning, Spatial Analysis, Data Mining and Data Fusion (STM'05) will be held just after ISSDQ at Beijing University August 27 – 29, 2005. This is a joint event of WG II/1, II/2, II/7 and VII/6. It provides an interdisciplinary forum for international scientists and researchers to present their latest research development and share their experiences in this field. The symposium will include keynote speeches, panel discussions and an exhibition.

Two publications will be printed for the symposium. The proceeding will be published on CD-ROM before the symposium. All accepted papers will be presented in oral sessions or poster sessions during the symposium, and will be published as a volume of the International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences. The papers will be fully peer-reviewed. Selected papers will be published in the ISPRS Book Series. Figure 3 shows the local organizing committee of the Chinese Academy of Surveying and Mapping. More information about the symposium can be found at http://isstm2005.casm.ac.cn/home.htm.

The 4th ISPRS Workshop on Dynamic and Multi-dimensional GIS (DMGIS'05) will be held at the University of Glamorgan, United Kingdom, September 5 – 8, 2005. This event is organized by the Inter-Commission working group II/IV. For more information visit the web site at http://www.comp.glam.ac.uk/GIS/DMGIS05/default.html.

The Workshop on Service and Application of Spatial Data Infrastructure, October 14 – 16, 2005, in Hangshou, China, is co-organized by Inter-Commission WG II/IV (http://isprs-wg41.nsdi.gov.cn/).

WG II/4 is planning a pre-conference technical Workshop on Spatial Planning and Decision Support Systems,

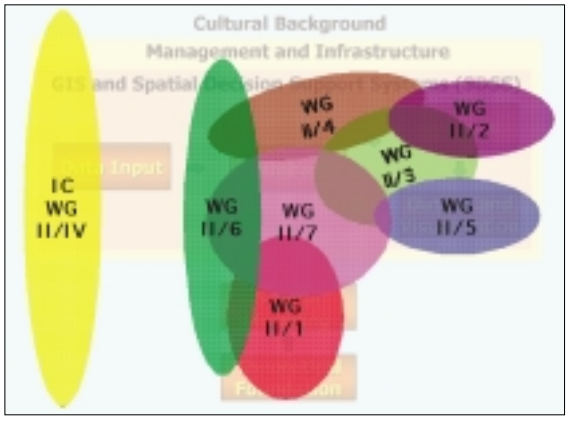


Figure 2: Commission Working Groups and their Relationship to the Spatial Data Handling Context.

Figure 3: Local Organizing Committee of STM'05 at the Chinese Academy of Surveying and Mapping.

November 5 – 6, 2005, and a joint ACRS-ISPRS session at the 25th Asian Conference on Remote Sensing, Hanoi, Vietnam, November 7 – 11, 2005. They will also conduct a workshop at MACRES, Malaysia, on December 8 – 10, 2005. Workshop papers will be compiled; possibly, selected papers will be published as a special issue in the ISPRS Journal, Journal of The Malaysian Surveyors, or The Malaysian Journal of RS & GIS. The publication of two volumes on spatial decision support systems in theory and practice is planned.

Working Group II/5 will be associated with the 3rd Symposium on Location Based Services and Tele-Cartography, to be held at the Vienna University of Technology, Austria, from November 28 – 30, 2005 (http://cartography.tuwien.ac.at/symposium2005/).

In order to facilitate communication and cooperation between the Working Group and other parallel activities, members of WG II/6 plan to attend a number of important upcoming events such as AGILE and GISPlanet 2005 in Lisbon, COSIT 2005 in Buffalo, USA, the First Conference on Geospatial Semantics - GeoS 2005 in Mexico City, and the First International Workshop on Semantic-based Geographical Information Systems - SeBGIS'05 in Cyprus. The possibility of organizing a common workshop together with WG II/3 is also investigated, since the two groups share common interoperability issues. Another workshop, focused on the WG II/6 interests, is being planned to take place in Greece in 2007.

On March 1, 2005, Marinos Kavouras attended a meeting of the newly established EuroGeographics (http://www.eurogeographics.org) Expert Group on Cadastre, in Paris. This launches a coordinated effort towards cadastral interoperability issues, as they also relate to INSPIRE

(http://inspire.jrc.it/). Stephan Winter has established contacts with the CAD/GIS Interoperability WG associated with OGC, and contributed to a forthcoming book in this field.

A Workshop on Spatial/Spatio-Temporal Data Mining (SDM) and Learning (with special emphasis on using SDM techniques in remote sensing and GIS) is planned by WG II/2 in Ankara, Turkey, for late November 2005.

Commission Symposium

The Technical Commission II Symposium will be held July 12 – 14, 2006, in Vienna jointly with an IGU and an ICA event. It will feature the Technical Commission II Symposium together with the 12th International Symposium on Spatial Data Handling (SDH), and the Central European Cartographic Conference.

This will be a special occasion where three of the major societies dealing with spatial information will convene in one place. The program will be prepared in such a way that the participants will be free to move between the parallel events. More information will follow shortly on the Commission home page.

Acknowledgement

All working group officers who have provided information about their activities are gratefully acknowledged.

ISPRS TC IV: Geo-databases and Digital Mapping

Trends and Challenges

By Shailesh Nayak, Technical Commission IV President, e-mail: snayakadl@sancharnet.in

Spatial information has been the most effective means of depicting events over space and time. Historically, the spatial information has been depicted in the form of a map generated by various means. The value of representing information in a spatial domain has been realised and extensively practised by the ancient civilisations. Transition of mapping technologies from historical artistic depiction to complex digital cartography has been due to the development of computerised cartographic techniques, which have made it possible to represent data and information in digital formats for processing in the computer using specialised software. The availability remote sensing data and the organisation of spatial databases around a Geographical Information Systems (GIS), combined with the Global Positioning System (GPS), the process of systematic spatial information acquisition has received new impetus. The development in computer technology, communication technology, database technology, digital cartography, and other related fields has revolutionized the use of geo-databases to the mankind.

The need for timely and accurate geo-spatial information is steadily increasing due to changing requirements of the society world over. It is necessary to improve the technology related to the acquisition, processing, storing, querying, analysis, dissemination and presentation of geo-data and geo-information for effective use of such data for sustainable economic development and protection of environment. The advancement in availability of multi-sensor, multi-spectral, multi-resolution data from varied sensors and platforms on a global scale as well as pattern recognition and image analysis techniques for extraction of thematic information have provided unique spatial information about natural resources, hazards and the environment in space and time. The information form such systems and other collateral data have led to the development exhaustive databases. The effective use of such geo-databases can be can be ascertained through analytical and predictive modelling through GIS. The recent advances in the development of the Decision Support System (DSS) have added another dimension. Models based on artificial neural networks, fuzzy logic and hybrid soft computing techniques have also been under development. The development of geo-grid computing will facilitate analysis of large databases very efficiently. The following are the major elements in utilising geodatabases at local, regional, global and extraterrestrial level.

Spatial Data Infrastructures (SDI)

Many countries have realized a need for establishing of Spatial Data Infrastructure (SDI) to aid decision-making process at various levels. Such infrastructure essentially consists of geo-databases, having certain standards, content, scale depending its envisaged uses. Such databases are developed to meet requirements at the local, regional and national level. They facilitate generation of alternate scenario and thus aid decision makers to derive appropriate starategy. The challenges of SDI in the future are i) meeting stringent demands for technology solutions for spatial data capture, integration and representation, ii) synergy of information, technology and access, iii) designing information transfer mechanisms over a networking of the sectoral and hierarchical information systems iv) planning strategy for updation and v) integration of environmental and developmental information for decision-making for economic and social development, fiscal management, exploitation and regeneration of natural resources and other policies. In order to achieve these things, there is a need of the standards to be evolved for content, framework, data access and metadata. Metadata engine, which allow querying datasets and select records from the actual data is an area of research.

Image Databases and Information Systems

The need of the hour for image databases and information systems is focused on multi-dimensional, multi-scale, dynamic data. The traditional mapping is primarily based on static, two-dimensional displays of the Earth's surface. The temporal and third spatial dimensions are often treated as attributes within these traditional 2D representations. The need for adequate mapping of temporal and three-dimensional aspects of the data has increased, as has the computing power available to meet these needs. The merging of multi-scale data sets often results in inefficient and statistically inappropriate analysis and display. Therefore, an interdisciplinary approach involving image analysis, photogrammetry, GIS, and expert systems is required. It includes co-registration and synchronization of data sets, disparate scales between data, disparate spatial and temporal domains, models for data integration, and the mosaic making or composition of individual scenes of data. Various natural resource development applications related to coastal mapping, beach profile studies, flood inundation, urban planning, city 3D models and infrastructure development to be developed. The development of digital library of imagery in web-based GIS environment is another issue to be addressed. The management of large quantities of imagery in spatio-temporal databases, indexing, organisation, access and query of imagery residing in large databases, context-base retrieval, derivation explicit knowledge from implicit data, spatial data mining techniques to be developed.

Web-based GIS

The main purpose of web-based GIS is not to translate conventional GIS functions into website instead it is the user's request that is to be translated into the website to make an easily understandable interface with GIS resources. Therefore, the developers need to have an in depth understanding of user needs and their working methods. For example, the users need information that combines data from different sources on a single map, i.e. to retrieve data from an infrastructure and a land-use database, and then combine these two with a socio-economic database and display them together in a map. Moreover, to make this information truly useful, the publisher needs to deliver intelligent map features, viz. each feature in the map needs to have sufficient intelligence to know which database to search for its attribute information permitting end-user to retrieve data about any "hot spot" feature on the fly. Users also need to see maps that integrate data from multiple data formats, possibly stored in different map projections.

Finally, users may want to have image (satellite/aerial) backdrops to their maps. This additional visual information expands and enhances the viewers' understanding of the map display. Therefore the challenges for the web GIS ahead are:

- To be able to access and manipulate data in its native format.
- To provide the ability to view data from different formats and projections in one view.
- To provide live access, i.e. on the fly transformation from different coordinate systems, projections and datum.
- To develop algorithms for geo-grid computing
- To combine raster and vector data in the same map and both should be queryable.
- To perform real-time GIS analysis i.e. the user should be able to analyse vector features of urban land use information over a raster of soil and then replace soil raster with a vegetation raster without regenerating the entire map.
- To provide application intelligence with navigation tools (pan, zoom, re-project etc.).

Spatial Databases and Digital Mapping

The availability of high-resolution orbital imagery has renewed interest in the development towards ortho-image generation, mapping and update. Efforts are needed towards development of data fusion at the pixel, feature and decision level. The quality of fused data sets needs to be assessed and evaluated. Mapping based on data integration include transformation of recorded data from different sources (air- and space-borne imagery) to common standards. In this regard, the monitoring a change in object condition from a multi-temporal and multi-source data is a major issue. The automatic extraction of information from high-resolution imagery needs to be focused. For information extraction and change detection from imagery, the emphasis is on semi-automated and automated approaches. The use of high-resolution optical imagery and active sensors like SAR, INSAR in generating spatial databases is increasing. It is also envisaged to focus on integration and fusion of disparate data to create a new data product by fusing information from disparate sources or to derive a better understanding of relationships between observations using correlative analysis or visual fusion of disparate data. Integration of methods and algorithms of remote sensing, GIS, photogrammetry and data visualisation is necessary to integrate diverse information and their processing. The theme based information systems for retrieving, querying, analysing, modelling for supporting decision-making to be developed. The upcoming constellations of small satellites will provide specific thematic information. Issues related to development of GIS-driven approaches for extraction and updating information from imagery, near real-time mapping, etc. need to be addressed.

Digital Landscape Modelling

Landscape application is a valuable addition to the statistic database using GIS and remote sensing techniques. Efforts are continuing in the field of 3D urban and terrain models using multi-scale image segmentation to delineate landscape elements. Generation of various landscape models such as DSM, DTM, DEM, etc. and 3D urban models is a major requirement. The advent of high spatial resolution data has enhanced the capabilities of generating these models to a greater extent in the recent past. Thus, there is a need to evaluate various models for the pur-

pose of generating accurate landscape models, their visualization and derivation of various terrain parameters such as slope, drainage, watershed boundaries, morphological structures from 3D urban models etc.

Global Databases

The development of global databases including topographical, environmental, geophysical, hydrographical, biota, geographic, etc. continues to be an important activity, in view of various international protocols and treaties. A number of global databases viz. Global 30 Arc Second Elevation Data Set (GTOPO-30), Global Land Cover Characteristics Database (GLCD), VMAP level 0 representing drainage, transportation and political including coastlines, etc. are available to meet the needs of various people engaged in the natural resources development. In addition to this, a number of missions supply high-resolution satellite imagery (IKONOS, Quick Bird, SRTM, LISS IV) to meet various demands at global level. However, these databases should be verified in terms of their accuracy (position, thematic and temporal), visualisation, quality control, etc. A establishment of a network of regional areas for ground truth of global data sets is a necessity. Thus, there is a need to address problems related to the level of detail of quality specifications, fuzzy boundaries, and specifications of completeness, concept of fitness-for-use compared with the issue of compliance-with-specifications, linguistic aspects of geographic information, conceptualisation and formalization of uncertainty in the geometric and thematic description of spatial objects. In order to deal with the above data specifications, it has become necessary to characterise and evaluate global databases and to promote their integration with various types of resource databases for their sustainability. Hence, the cooperation with CEOS, IGBP, ISCGM (International Steering Committee for Global Mapping) and other international bodies as well as with ISPRS TC VII is crucial.

Extra-terrestrial Geo-information System

A number of missions are on way to explore the resources on our solar system. These are i) The Japanese Nojomi, ii) The American Mars exploration Rover twins i.e. Spirit (MER-A), Opportunity (MER-B), iii) The Mars Express by European Mission, iv) The Moon mission by Indian Space Research Organisation and v) the Cassini mission (US-European) for the Saturn (expected to send 500,000 images during next four years). It is expected that information provided by these missions will herald new era in mapping of extra-terrestrial systems and creating spatial databases and ultimately understanding of our solar system. The High Resolution Stereo Camera (HRSC) on board the "Mars Express" provides multi-spectral image data with a spatial resolution up to 10 m as well as continuous stereo coverage revolutionises the data acquisition on the Martian surface. The MER rover has provided lot of data by travelling hundreds of metres. Therefore there is a need to address the reference system (Ellipsoid), Digital Terrain Models, scale of mapping, projection, map sheet layout, sheet designation and name, nomenclature on extra terrestrial bodies etc. for the successful creation of spatial databases related to extra-terrestrial systems. In addition to this the documentation of existing and planned systems for planetary mapping, acquisition techniques and proposed availability of spatial data products, spatial framework in GIS, data capture, storage, integration are important issues to be taken up on a priority basis. In this regard, it is necessary to have cooperation with space agencies and develop methods for GIS applications and information systems to facilitate exploration.

Marine GIS

The ocean plays a very important role in governing weather, providing transportation routes and both living and non-living resources. The need for organising marine databases in a GIS environment is a challenging task. Many marine parameters are highly dynamic and thus have fuzzy boundaries as well as have full three or four dimensions. Marine surveys provide data for the vertical plane, essentially from drifting or moored buoys. Marine GIS should address issues related relationships between physical parameters such as sea surface wind, sea surface temperature and their impact on marine ecology and organisms. As the oceanic processes and objects are dynamic, following issues need to be addressed. The first one relates to mapping, analysis and display in 3-D environment. Other issues are mapping in fuzzy or mobile environment, type and unit area of mapping and spatial and temporal scale.

Geo-information Systems and Industries

The spatial databases, information marketplace, client/server and Internet computing are the three major areas, which are transforming the geo-information based industries in the world. The ability to manage spatial data types natively in an object-relational database is a major challenge for the geo information management industry. With native support for long transactions, geo image management and Java methods in the database management system, the industry should now address to deploy an entirely new class of highly scalable, cost-effective World Wide Web mapping applications and location services. Similarly, in "information market place", the industry should concentrate how best it can provide the low-cost public information, value added data products to the users, cost effective tools for sharing the database etc. which will surely influence the market development and industry growth in geo-information management. Thus, the architecture of client-servers to internet computing is the major area for discussion in future. In addition to this, the advances in many aspects of geospatial software capabilities have been more evenly paced, but always driven by growing imaginations and challenges, and spurred on by a competitive marketplace. Therefore, the evaluation of currently available and planned systems for automated and semi-automated digital mapping, and design, development and update of information systems needs to be carried out. The industry needs and their capability to be analysed and documented.

ISPRS Technical Commission VI

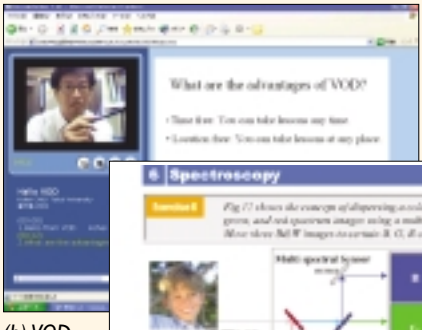
'Education and Outreach: Where are we going?'

By Kohei Cho, President, ISPRS Commission VI, e-mail: kcho@keyaki.cc.u-tokai.ac.jp

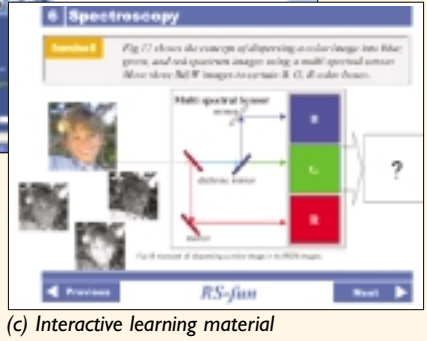
In recent years, e-Learning has become one of the most widely used technical terms in the field of education. The highly integrated multimedia technologies of e-Learning are changing the style of education (see Figure 1). However, on the other hand, many people recognize that something important is spoiled in e-Learning and the importance of face to face education remains. The needs of education are also changing. The rapid advancement of technologies is expanding the needs for on job training and life-long education. The interest to education is increasing more than ever. Where are we going now?

Table 1 shows the topics of the five Working Groups (WGs) and one Special Interest Group (SIG) of Commission VI: "Education and Outreach". Some aspects of each WGs and SIG are described bellow.

(a) Distance learning



(b) VOD



(c) Interactive learning material

Figure 1: New stiles of education.

WG VI/1	: Educational Frameworks and Methodologies
WG VI/2	: e-Learning
WG VI/3	: International Cooperation and Capacity Building
WG VI/4	: Internet Resources and Datasets
WG VI/5	: Promotion of the Profession to Students
Special Interest Group	: Technology Transfer Caravan

Table 1: Working groups Topics of Commission VI, 2004-2008.

Pedagogy is becoming very important in the age of e-Learning. Without certain educational theory, good e-Learning materials or systems cannot exist. Moreover, we have to clarify that what kind of education are more effective in e-Learning, and what kind of education are more effective in face to face education. Accreditation is another important issue. E-Learning is expanding the possibility of distance learning and international education. However, there are still many problems in accrediting e-learning courses within national and international frameworks of education. These issues will mainly be discussed in WG VI/1.

For the beginners of remote sensing or GIS, most of the commercial software are too expensive. In order to encourage the development of good free or low-cost software for education, Commission VI has been organizing the educational software contest CATCON every four years since 1996. The CATCON 3 was organized at the 20th ISPRS Congress in Istanbul in 2004 (see Figure 2). Total of eleven software packages were demonstrated at the contest. Following the PC technology advancement of the last few years, the ability of each software packages has much increased than before. The Gold Awards were given to "Integrated Sensor Orientation Module" developed at University of Hannover, and "Digital Elevation Model from

Figure 2: Demonstration of CATCON 3.

Interferometric Systhetic Aperture Radar" developed at Intermap Technologies. It was quite encouraging for us to know that private company such as Intermap is developing and distributing such a good e-Learning material on free of charge. The private companies are starting to recognize that good educational software may contribute to enlarge the future commercial market of new technologies. The WG2 will continue to collect and disseminate material, software and data for e-Learning.

Figure 3: The panel discussion of the Youth forum organized during the ISPRS Congress in Istanbul in 2004.

International cooperation and capacity building are another important topics in the framework of education. Various kinds of international and regional organizations are now involved in capacity building, including technology transfer and training. WG VI/3 will work on developing connections with organizations, such as ESCAP, FAO, CEOS, to optimize the roll of ISPRS for capacity building. In capacity building, each region or continent has it's own needs or problems. In order to harmonize the regional needs with ISPRS activities, WG VI/3 has set up a new position, Regional Coordinator (RC). The RC is assigned for each continent or region to watch, coordinate and organize regional & international activities related to education. The Special Interest Group (SIG) on Technology Transfer will be organizing small workshops or seminars ones or twice every year mainly in developing countries for technology transfer. The SIG is organized by the highly skilled and well experienced professionals of ISPRS.

Nowadays, various kind of educational materials are available on the internet. However, when beginners are looking for good educational materials on photogrammetry, remote sensing, or GIS, it is quite difficult for them to find which is good and which is bad. One of the biggest problems about the resources on the internet is that the quality of which are not always guaranteed. In WG VI/4, we are planning to set up a kind of reviewing process for evaluating educational web pages/materials on the internet, and recommend good ones in the homepage of WG VI/4.

During the ISPRS Congress in Istanbul, the youth forum was successfully organized mainly by young researchers and students. At the panel discussion of the youth forum, the council members and the author had discussed with students about the future activities of students within ISPRS (see Figure 3). Through the discussion, it became clear that students need from ISPRS not only support but also freedom to develop their activities in ISPRS. Following the discussion, we have decided to set up WG VI/5 to promote student activities within ISPRS. Under this WG, the Student Consortium (SC) was set up. WG VI/5 will act as the interface of SC to ISPRS. The SC is now planning to organize summer camp in Istanbul in June 2005. We believe that this new mechanizum may activate the student activities within ISPRS.

Through the activities of these WGs and SIG, we would like to cooperate with you for the next four years to find ways to solve the various subjects in education.

Local Organizers of the ISPRS 2008 Beijing

By Chen Jun, Congress Director ISPRS Council 2004 – 2008,
e-mail: chenjun@nsdi.gov.cn

The Chinese Society of Geodesy, Photogrammetry and Cartography (CSGPC), ISPRS ordinary member of category seven, attracted attention of international community for photogrammetry, remote sensing and spatial information sciences in July, 2004 for succeeding in bid for the ISPRS 2008. Many people and organizations are interested in the CSGPC. Following information may help you have a better understanding.

The CSGPC, found in February, 1959, is a non-profit organization in surveying and mapping field, aimed at providing service and advice, promoting scientific research and exchanges, and disseminating knowledge to the general public. Its main responsibilities include (1) carrying out academic exchange and cooperation nationally and internationally; (2) sponsoring workshops, seminars and exhibitions; (3) acting as the "think-tank" on national policies, development strategies, laws and stipulations in surveying and mapping; (4) undertaking project feasibility study and assessment; (5) introducing advanced technology, management theories and engineering experiences on surveying and mapping; (6) publishing scientific and technical papers,

journals and educational materials; (7) providing technical advice and service.

The CSGPC has 13 commissions and two editorial boards:

1. Commission on Geodesy.
2. Commission on Photogrammetry and Remote Sensing.
3. Commission on Cartography and Geomatics.
4. Commission on Engineering Survey.
5. Commission on Surveying and Mapping Instruments.
6. Commission on Hydrographic Surveying and Charting.
7. Commission on Mine Survey.
8. Commission on Surveying and Mapping Economy and Management.
9. Commission on Cadastral Survey and Land Information System.
10. Commission on Surveying and Mapping Education.
11. Commission on Scientific Popularization.
12. Commission on Consultation.
13. Commission on Surveying and Mapping Terminology.
14. Editorial Board for "Surveying and Mapping History of China"
15. Editorial Board for "ACTA GEODAETICA et CARTOGRAPHICA SINICA"

The commissions and editorial boards are chaired by organization members of the CSGPC.

The CSGPC has been active in international activities. It became an ordinary member of ISPRS in July 1980. It is also a member of the International Cartographic Association (ICA) and the International Federation of Surveyors (FIG).

To make the ISPRS 2008 Beijing into one of the most successful ISPRS Congresses, supports from the governments will be necessary. Here I would like to introduce you another important organizer-the State Bureau of Surveying and Mapping of China (SBSM), which strongly supported the CSGPC's bidding for the ISPRS 2008 and has been working closely with the CSGPC to prepare for the ISPRS 2008 Beijing.

The SBSM is the national administrative agency of surveying and mapping. Its main responsibilities designated by the state council are as follows:

- To draw up administrative regulations and rules of surveying and mapping; to formulate national development plans of surveying and mapping undertakings, management policies and technical standards, and to supervise their implementation; to organize fundamental surveying and mapping, national and administrative boundaries survey, cadastral survey, national or key surveying and mapping projects, and major research programs.
- To draft up measures of the management on the examination and approval of surveying and mapping qualification; to examine and approve the grade A qualification of surveying and mapping units, external supply of Chinese surveying and mapping results, and foreign applications for surveying and mapping activities in China; to investigate and punish serious lawbreaking cases of surveying and mapping.
- To manage the national fundamental geographic information data, organize and supervise public services of fundamental geographic information; to manage the national surveying and mapping datum and surveying control systems; to draw up the sample maps defining the international boundaries of China in conjunction with the Ministry of Foreign Affairs; to examine and release key geographic information data upon authorization; to supervise the management of surveying and mapping results and the protection of surveying markers nationwide.
- To formulate plans and technical standards of cadastral surveying and mapping; to manage and approve the qualification of cadastral surveying and mapping units; and to validate cadastral surveying and mapping results.
- To supervise the compilation of maps; to examine and approve maps to be published and displayed; to supervise and approve the geographic names labeled on maps.
- To supervise and manage government budgets of surveying and mapping and other earmarked funds.
- To organize external cooperation and exchange in surveying and mapping.

We fully understand that the local organizers must do their utmost for a successful ISPRS 2008 Beijing. We also believe that the more supports we get, the more successful the Congress will be. You and we have the same goal – to witness an excellent ISPRS 2008 Beijing. Contribute your supports by sponsoring the Congress, providing papers, offering suggestions etc.. You are welcome to contact us at:

Local Organizing Committee for ISPRS 2008 Beijing
Chinese Society of Geodesy, Photogrammetry and Cartography
9, Sanlihe Road, Beijing 100830, China
Tel: +86-10-68339095/88383951
Fax: +86-10-68311564
E-mail: fanbsm@public.bta.net.cn

Invitation to Attend Joint ISPRS Workshop

The joint ISPRS Working Groups workshop on 'Service and Application of Spatial Data Infrastructure' will be held in Hangzhou, China from 14-16 October 2005.

This workshop is a jointly organized by ISPRS WG IV/1(SDI), WG IV/8(Spatial Data Integration for Emergency Services) and Inter-Commission WG II/IV (Dynamic and multi-dimensional Systems and Applications).
It is co-organized by PCGIAP-WGs, CEOS-WGISS, GSDI and ISO/TC211 AG on Outreach.

The themes of the workshop include:
(1) advanced technology for SDI;
(2) value-add services and operational applications of SDI, and
(3 regional development of SDI.

You are invited to come to attend the workshop. Deadline for abstract submission is 31 March 2005.

For detailed information, please visit http://isprs-wg41.nsdi.gov.cn or contact:
Mr Gang HAN
Division of Thematic Applications
National Geomatics Center of China
1 Baishengcun, Zizhuyuan,
Beijing, 100044
P.R.China

Phone: +86-10-68483218
Fax: +86-10-68424101
E-mail: isprswg41@nsdi.gov.cn, hgbj0001@sohu.com, jiangjie_263@263.net

Joint Workshop of ISPRS and the German Association for Pattern Recognition

On 'Object Extraction for 3D City Models, Road Databases and Traffic Monitoring - Concepts, Algorithms, and Evaluation' (CMRT05)
Vienna, Austria from 29-30 August 2005

Scope

Automated extraction of topographic objects from remotely sensed data is an important topic of research in both Photogrammetry and Computer Vision. This joint workshop of the ISPRS and the German Association for Pattern Recognition (DAGM), held at Vienna University of Technology, will bring together researchers from both communities to present and discuss recent developments, the potential of various data sources, and future trends both with respect to sensors and processing techniques in automatic object extraction.

Workshop Topics

- Building and road extraction from aerial and space-borne images
- Building and road extraction from LIDAR and SAR
- Updating of existing city models and road data bases
- Detection and velocity estimation of vehicles from remote sensing data
- Methods for micro- and macro-scale traffic monitoring
- Detection and modelling of vegetation classes and single trees
- Level-of-detail modeling of topographic objects
- Data fusion for automatic object extraction
- Integration of terrestrial images and laserscanner data for city modelling
- Quality assessment of automatically extracted topographic objects
- Large-scale mobile mapping for monitoring disasters
- Image extraction for automatic texturing of 3D city models

Keynote Speaker

Manos Baltsavias (ETH Zurich)

Paper Submission

You are kindly invited to submit a paper for the technical sessions of the workshop. All papers will be subject to a double blind peer review process. Full papers prepared according to the ISPRS guidelines should be e-mailed to: cmrt05@bv.tu-muenchen.de. The important dates are:

15 April 2005	Submission of full papers
1 June 2005	Notification of acceptance
1 July 2005	Submission of final papers, registration

Hardcopy proceedings will be published in the format of the ISPRS archives.

Registration

The registration fee is 180 EUR / 215 EUR before / after July 1, 2005. It includes coffee breaks, the conference dinner,

and the proceedings on paper and CD. Student registration is 90 EUR / 110 EUR before / after July 1, 2005 (CD proceedings only). Authors must register before July 1, 2005 to warrant publication of their paper in the proceedings.

Conference Chairs
- Franz Rottensteiner (UNSW, Australia)
- Uwe Stilla (TU Munich, Germany)

Program Committee
- Hans-Erik Andersen (University of Washington)
- Peggy Agouris (University of Maine)
- Andrea G. Fabbri (Free University Amsterdam)
- Wolfgang Förstner (University of Bonn)
- Paolo Gamba (University of Pavia)
- Christoph Gierull (Defence R&D Canada)
- Norbert Haala (University of Stuttgart)
- Stefan Hinz (Technical University of Munich)
- Jonathan Li (Ryerson University Toronto)
- Helmut Mayer (Bundeswehr University Munich)
- Theo Moons (Catholic University of Brussels)
- Franz Rottensteiner (University of New South Wales)
- Michel Roux (ENST, Paris)
- Uwe Stilla (Technical University of Munich)
- Chunsun Zhang (CRC-SI, Melbourne)
- Sisi Zlatanova (Technical University of Delft)

Organizers
- ISPRS Working Group III / 4 (Automatic Image Interpretation for City-Modeling)
- ISPRS Working Group III / 5 (Road Extraction and Traffic Monitoring)
- ISPRS Working Group IV / 8 (Spatial Data Integration for Emergency Services)
- Institute of Photogrammetry and Remote Sensing, Vienna University of Technology
- Institute of Photogrammetry and Cartography, Technical University Munich

Local Organising Committee
- Camillo Ressl
- Petra Deschmann
- Sabine Zischinsky

Contact Address
Ms Petra Deschmann
Institute of Photogrammetry and Remote Sensing
Vienna University of Technology
Gußhausstraße 27-29, A-1040 Vienna, AUSTRIA
phone: +43 - 1 - 58801 12200
fax: +43 - 1 - 58801 12299
e-mail: cmrt05@bv.tu-muenchen.de
URL: http://www.gmat.unsw.edu.au/wgiii4/ws05

Changes at the ISPRS Journal

New Editorial Team

By George Vosselman, Editor-in-Chief, e-mail: vosselman@itc.nl

As of January this year George Vosselman succeeded Manos Baltsavias as Editor-in-Chief of the ISPRS Journal of Photogrammetry and Remote Sensing. At the same time Marguerite Madden and Eberhard Gülch started as additional associate editors.
Olaf Hellwich continues as associate editor.

Manos Baltsavias was appointed Second Vice President of the ISPRS at the Istanbul Congress. He served the ISPRS Journal for seven years.

The new editorial team decided to distribute their tasks according to their fields of expertise: Marguerite Madden will manage the review and editing process for articles on optical remote sensing and GIS applications. Eberhard Gülch will be responsible for articles on aerial photogrammetry and spatial database technology. Olaf Hellwich will deal with articles on radar remote sensing and close-range photogrammetry, while articles on airborne and terrestrial laser scanning will be assigned to George Vosselman. The first priority of the new editorial team will be to reduce the article processing time and to increase the publication rate of journal issues.

New Paper Management System
On March 14, the Elsevier Editorial System (EES) has been launched to provide a much more user-friendly communication between authors, reviewers and editors. EES is accessible through http://ees.elsevier.com/photo. It replaces the old paper management system Elsubmit. EES enables a completely web-based review process and an article classification system for identification of expert reviewers. It also provides overviews on the current status of submitted articles for authors, reviewers and editors. New articles for the ISPRS Journal now need to be submitted through EES.

New Website
The website of the ISPRS Journal has been moved from ETH Zürich to ITC at http://www.itc.nl/isprsjournal. In cooperation with Elsevier the instructions for authors were revised and updated. The website will continue to provide ISPRS related information like special subscription rates and Heleva award announcements. All publisher related information can be found at Elsevier's website http://www.elsevier.com/locate/isprsjprs.

The Otto von Gruber Award

The Otto von Gruber Award, which is donated by (ITC) consists of a medal and a monetary grant, and is presented to the author, under 35 years of age, of a paper of outstanding merit in the photogrammetry, remote sensing and spatial information sciences over the 4 years prior to the Congress. The winner of the award is Stephan Heuel (currently from Switzerland).

Stephan Heuel is a very capable young scientist; he obtained his PhD degree from the University of Bonn, Germany. He successfully developed a unified approach for projective geometry and statistics in the field of photogrammetry. His research deals with the uncertainty aspects of projective geometry applications in computer vision; in this work he integrated concepts from computer vision and photogrammetry.

Some of the ideas he developed with Prof. Förstner, but he can nevertheless be considered as an independent thinker. He developed a very fundamental approach in this respect. His work provides an excellent consistent algebraic description of points, lines, planes and their transformations in the context of projective geometry. He integrated statistics into the algebraic framework by analyzing the behaviour of homogeneous covariance matrices. Stefan Heuel delivered a proof of concept by applying the derived methods to the task of polyhedral object reconstruction.
His PhD thesis is being published by Springer Verlag with the title "Uncertain Projective Geometry – Statistical Reasoning for Polyhedral Object Reconstruction". He has presented his work with great enthusiasm and clarity to scientific conferences of both the computer vision and photogrammetric communities, and publishes his work in both journals and conference proceedings of both communities. He was recently awarded the DAGM (The German Association for Pattern Recognition) prize.

The U.V. Helava Award

The U.V. Helava Award, sponsored by Elsevier B.V. and Leica Geosystems GIS & Mapping LLC, was established to encourage and stimulate submission of high quality scientific papers by individual authors or groups to the ISPRS Journal of Photogrammetry and Remote Sensing, to promote and advertise the Journal, and to honour the outstanding contributions of Dr. Uuno V. Helava to research and development in Photogrammetry and Remote Sensing. The award consists of a monetary grant of Swf 10,000, certificates and a silver plaque, partly funded by the Institute of Photogrammetry and Remote Sensing, Helsinki University of Technology (the University where Helava studied). The plaque was designed by the 1980-88 ISPRS Technical Commission III President, Einari Kilpelä, previously Professor at the Helsinki University of Technology.

A five-member jury, comprising experts of high scientific standing, whose expertise covers the main topics included in the scope of the Journal, evaluated 114 papers for the period 2000-2003. For each year of the four-year evaluation period, the Best Paper was selected and has been announced in the ISPRS Journal, ISPRS Highlights and on the WEB sites of ISPRS and Elsevier. The paper receiving the U.V. Helava Award was selected from these four papers. It was published in Vol. 58, Issue 5-6, by Changno Lee (South Korea) and James S. Bethel (USA), entitled "Extraction, modelling, and use of linear features for restitution of airborne hyperspectral imagery".

The jury stated: This clearly written, instructive and informative paper deals with the semi-automated line extraction incorporating the orientation process for linear array CCD sensors. It is an interesting, important and very relevant topic, considering the current development of digital aerial cameras and existing problems in the orientation of linear CCDs. The authors use up-to-date techniques for trajectory modelling, line feature extraction and their integration into the geometric sensor model and provide convincing and thorough experimental tests and a transparent analysis of the results. This research provides a very good balance between theory and practice, while its high practical significance is increased by the use of GPS/INS and the reduction of the needed for control line features.

Report on First Meeting of ISPRS Working Group V/6 on Medical Image Analysis, Human Motion and Body Measurement

By Nicola D'Apuzzo, HOMOMETRICA CONSULTING, Zurich, Switzerland, www.homometrica.ch and Petros Patias, The Aristotle University of Thessaloniki, Faculty of Rural & Surveying Engineering, Thessaloniki, Greece, www.commission5.isprs.org/wg6

Introduction

The first meeting of the newly formed working group V/6 of ISRPS was held in Zurich on Monday 21st of February 2005, from 10 am to 6 pm. It was hosted by Prof. Dr. Gábor Székely of the Computer Vision Laboratory of the Swiss Federal Institute of Technology (ETH). Participants at the meeting were five of the seven members of the board: Prof. Dr. Petros Patias (chair), Greece, Dr. Nicola D'Apuzzo (secretary), Switzerland, Prof. Dr. Gábor Székely, Switzerland, Prof. Dr. Hans-Peter Meinzer, Germany, Prof. Dr. Petros Koidis, Greece. Board members excused from the meeting were: Prof. Dr. Serge Van Sint Jan, Belgium and Dr. Harvey Mitchell, Australia. Guests of the meeting were Dr. Emmanuel Baltsavias of ETH Zurich as second vice president of ISPRS and Fabio Remondino, also of ETH Zurich, as responsible of the liaison between ISPRS and ISB (International Society of Biomechanics).

From left to right: Fabio Remondino, Petros Koidis, Petros Patias, Gábor Székely, Nicola D'Apuzzo, Hans-Peter Meinzer, Emmanuel Baltsavias.

In this report, we briefly describe the topics discussed during the meeting. Note: the version published on ISPRS Highlights has been edited. The full report can be downloaded at the WG's homepage.

1. Introduction of the Working Group, Aims of the Meeting

At the beginning of the meeting, Petros Patias introduced the goals of the working group and explained the basic structures of ISPRS to the members not familiar with them.

He listed the aims of the first meeting of the working group in five important points: (i) get to know each other, (ii) review the working group terms of reference, (iii) select focal points, (iv) set strategic targets and (v) set actions plans.

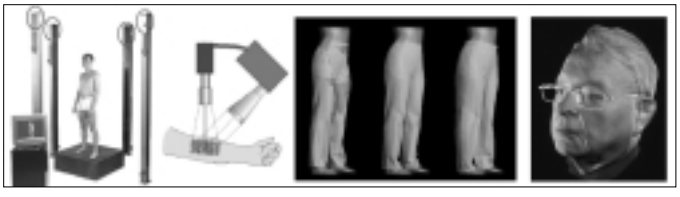
Snapshots of Petros Patias's introduction: aims of the meeting (left), ISPRS commissions (center), functions of the WG V/6 website.

Petros Patias, chair of the Working Group V/6 and former chair of the Commission V, found very attractive and challenging the topic "medical image analysis". He has done some work about medical image analysis during his career, however his great contribution to the working group is his deep knowledge of the structures and organization of ISPRS. He stated that the current structure of our working group is very uncommon to ISPRS and that the goals of the next four years are to make it for the first time a very active and producing working group, capable of organizing workshops, tutorials, conferences, as well as to connect people from different communities and to perform together important works and projects.

2. Presentations of Board Members

After the introduction of Petros Patias, all the board members present at the meeting shortly introduced themselves. In this way, everybody could know each others better and an overview of the different expertises and activities of the board members could be determined. Some information and images extracted from the individual presentation are listed in this report.

Nicola D'Apuzzo has a background of mechanical engineering with focus on biomedical applications. Moreover



Some of the consulting activities of Nicola D'Apuzzo (from left to right): full body laser scanner, skin measurement system, "best fit" application of full body 3D scanning in the fashion industry, "virtual-make-over" application as virtual glasses on a 3D scanned head.

he received his Ph.D. in the topic of human body measurement and tracking from video images. Currently he directs in Zurich a consulting firm in the field of human body measurements (www.homometrica.ch). His main activities regard 3D human body scanning for various applications in medicine and fashion/beauty.

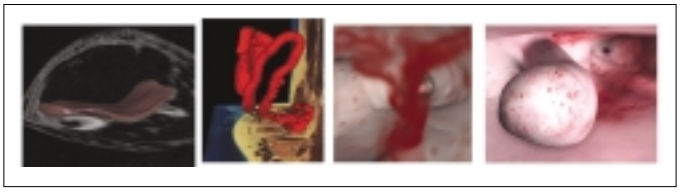
Gábor Székely currently directs the Medical Image Analysis and Visualization group of the Computer Vision Laboratory of ETH Zurich. The main research topics of the group are: computer aided surgical navigation, segmentation of medical images, visualization of medical data, image registration from different sources (e.g. CT, NMR, PET, surface), quantitative X-ray analysis and surgical simulation.

Hans-Peter Meinzer is director of the division Medical and Biological Informatics of the German Cancer Research Center in Heidelberg. He explained his rich background on bioinformatics and medical imaging. The current main research activities of his group are: segmentation of medical images (CT, NRM, echography) for diagnosis and therapy support, augmented reality and navigation in computer aided surgical intervention, 3D echography, and 3D simulation of cell migrations. The current main applications are cardiology, heart surgery and liver surgical planning.

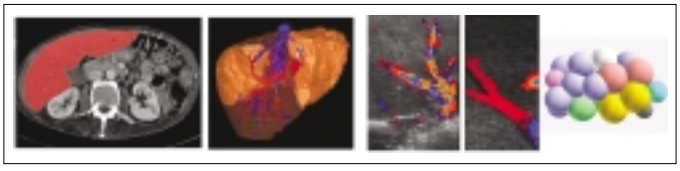
Petros Koidis is the only health personnel of the board. He is professor at the Department of Fixed Prosthesis and Implants Prosthodontics of the Dental School of the Aristotle University of Thessaloniki in Greece. His current activities imply mouth rehabilitation and biomaterials for medical and dental applications. The main topics of his actual research are focused on: dental and implant treatment planning and therapeutics, modification of existing materials, development of new materials corresponding to biological structures, biomimetics and tissue engineering.

Fabio Remondino was present at the meeting as responsible of liaisons between ISPRS and ISB (International Society of Biomechanics). He is also co-chair of the ISPRS Working Group V/4 on Virtual Reality and Computer Animation. He is currently at the final stage of his Ph.D. at the Institute of Geodesy and Photogrammetry of ETH Zurich. His expertise is mainly focused on human body and human motion reconstruction from video sequences.

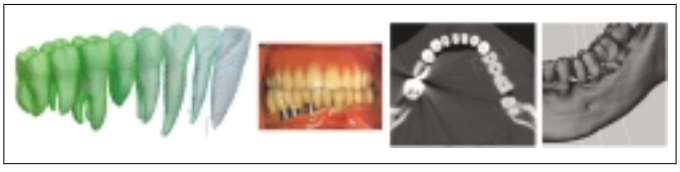
Serge Van Sint Jan could unfortunately not attend the meeting because of an illness. However, he submitted a presentation describing his activities. He is professor at the Department of Anatomy of the University of Brussels in Belgium. The research activities regard functional anatomy and biomechanics.



Some actual works of the medical imaging group directed by Gábor Székely (from left to right): automatic segmentation of patellar cartilage from NMR, 3D visualization of medical data (colon), surgical scene simulation (bleeding in hysteroscopy), generation of virtual anatomical model.

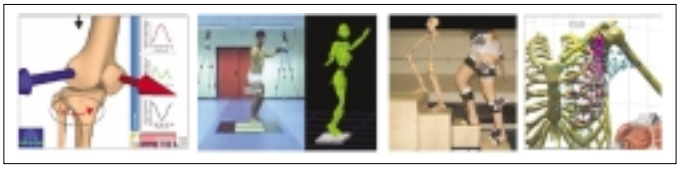


Some actual works of the Medical and Biological Informatics group directed by Hans-Peter Meinzer (from left to right): segmentation of liver in CT images, 3D reconstruction of liver and vessel systems, blood flows in echographic images of liver, 3D simulation of cell migrations.



Some areas of the research performed by Petros Koidis.

Some of the activities of Fabio Remondino (from left to right): human body reconstruction from uncalibrated still images, a frame of a video sequence, reconstructed movements, animated view.



Some of the works where Serge Van Sint Jan is involved (from left to right): kinematic analysis of knee joint, motion capture for animation and video games, virtual simulation of movements for ergonomy, biomechanical modeling of musculo-skeletal system.

Some of the works where Serge Van Sint Jan is involved (from left to right): kinematic analysis of knee joint, motion capture for animation and video games, virtual simulation of movements for ergonomy, biomechanical modeling of musculo-skeletal system.

3. Goals for the Next Four Years

After a lunch break the meeting continued and the discussion about the activities of the working group started. Five different topics were considered: (a) the goals of the working group, (b) possible joint projects, (c) the organization of a workshop, (d) the participation at conferences, (e) the definition of datasets, (f) next tasks.

3a. Goals of the Working Group

The term of reference as listed in the home page were taken as basis for the discussion about the general goals of the working group. Following Meinzer's suggestion, the goals are kept open as much as possible to allow more researchers to integrate into the working group and to make it interesting to larger communities:

- Research and development in techniques and systems for analysis and 3D reconstruction in medical imaging, dentistry, and biomaterial engineering, biomedical and biomechanical engineering, tele-medicine, advanced 3D computer vision techniques and medical VR/AR.
- Research and development in techniques and systems for analysis, 3D reconstruction and applications in sport medicine and fitness (e.g. motion capture, human gait analysis, full body measurement, shape tracking) and face and expression analysis.
- Vision techniques in biometry research, security applications and forensics.
- Applications of 3D surface measurement techniques for medical applications (orthodontics, prosthetics, orthopedics, plastic surgery, reconstructive medicine, forensic medicine, dentistry, ORL, cosmetics).
- Applications of 3D motion capture techniques for clinical motion analysis, registration of patient-specific data.
- Adaptation of photogrammetric techniques for geometric modelling and (self-)calibration of X-ray and tomography systems.
- Cooperation and collaboration between ISPRS and the communities of medical/biomedical engineering, human/user interface development and animation.

3b. Joint Projects

The second topic discussed was about the possibility to submit a proposal for a joint project for the EU 6th Framework Program. Biomedical related topics were present in the IST program. However, the deadline for proposal submission was fixed on March 22 2005 and therefore little time would be available for the definition of a project. Finally it was decided to wait for the calls of the 7th Framework Program. This should appear soon, probably April 2005 and the deadlines for proposal submissions should be for March 2006. For the 7th FP, our working group should have enough time to organize ideas for one or more joint projects.

3c. Organization of Workshop

The next topic of the discussion was about the organization of a workshop in November 2005. Székely proposed to focus the workshop on 4D (4 dimensions) or 3D+T (3 dimensions + time). The topic would be very interesting and attractive. It includes several research and application areas, such as movement analysis and joint kinematics, navigation in computer aided surgical interventions, dynamic 3D surface measurement, long time shape tracking. It was decided to enlarge the topic from "human" to "living organism" which include also biology.

It was proposed to invite lecturers and also to invite clinicians to the workshop. In this way, the workshop could represent a first attend to establish a platform to connect photogrammetry, medical imaging and medicine. Tutorials about medical imaging issues could also be offered at the workshop.

Patias proposed Agios Nikolaos, a picturesque small town in Crete, Greece as place where the workshop should be held. The period of November 2005 was also judged appropriate.

3d. Participation at Conferences

The complete list of conferences related to medical imaging was analyzed and the following conferences were listed as probable candidates for an active participation of our working group, by organizing technical sessions and/or tutorials: SPIE Medical Imaging 2006, MICCAI 2005 (Medical Image Computing and Computer Assisted Intervention), CARS 2006 (Computer Assisted Radiology and Surgery), CAOS 2006 (Computer Assisted Orthopaedic Surgery), 9th Symposium on 3D Analysis of Human Movement 2006, ISPRS Comm. V Symposium 2006.

Responsible persons should be designed for every conference where the working group will be active.

3e. Definition of Datasets

The next topic of the goals of the working group was about the publication of problems and datasets. One or more problems for medical imaging that could be solved by photogrammetrists should be identified and clearly presented at the web page of the working group. The description should include: (a) the definition of the problem to solve, (b) the dataset (e.g. images) and (c) what is expected as result.

3f. Next Tasks

The last theme of discussion was about the short term tasks. Four were identified: (a) the publication of a report on ISPRS Highlights about the WG V/6 meeting, (b) the publication on the WG web page of an invitation letter, (c) the board members should forward the link of the WG web page to possible new WG members, (d) an action table should be prepared with issues, deadlines, responsible and actions.

Final Words
All the participants of the working group meeting were satisfied with the results achieved. Everybody knows the other board members better and the aims of the working group are now stated more clearly. The meeting was closed with a glass of wine.

All readers of this report, working in the fields of the working group, are invited to join and become active members. Please visit our homepage at the following web address: www.homometrica.ch/isprs.

The First International Symposium on Geoinformation for Disaster Management

By Sisi Zlatanova, Chair ISPRS WG IV/8 Spatial data integration for emergency services, e-mail: s.zlatanova@otb.tudelft.nl

The First International Symposium on Geo-information for Disaster Management, Delft, The Netherlands, 21-23 March 2005 was the first event allowing people with different background and interests to meet and discuss topics important for disaster management. Amongst the 331 registered participants of 58 countries (from 6 continents) were researchers, developers, end-users and geo-providers. The event was organised by Delft University of Technology in cooperation with ISPRS (WG IV/8, WG IV/3), OOSA, AGILE, EuroSDR, ICA, FIG, OGC). The symposium was sponsored by Bentley, Intergraph, ESRI, GIN, Rijkswaterstaat, and Octaafadviesgroep.

The goal of the symposium was to establish the state-of-the-art in Disaster Management by:
- reviewing tools, software, existing geo-information sources, organizational structures and methods for work in crisis situations
- outlining drawbacks in current use, discovery, integration and exchange of geo-information, and
- making suggestions for future research directions

The presentations and discussions were centered around following topics: user needs and requirements, technology developments, data collection and management, end-user environments for interaction, visualization and updating, positioning and location-based communication. The three days symposium included 4 keynotes, oral presentations

Figure 1: Jacob Fokkema opens the symposium.

Figure 2: Welcome by the mayor of Delft in the City hall.

distributed in 22 plenary and 49 parallel sessions, 50 posters, an ISPRS panel session, a workshop on 'Geo-Web services in flood situations', as well as social activities.

The symposium was opened by Jacob Fokkema, the Rector of the Delft University of Technology. The first keynote speaker, Henk Geveke (Director Crisis Management, Ministry of the Interior and Kingdom Affairs, the Netherlands), presented the policy of the responsible national government institution. Mike Goodchild (University of California, Santa Barbara, USA) presented desired contributions to disaster management from the geo-information science angle. Richard Guillande (GeoSciences Consultants s.a.r.l, Bagneux, France) and Dudung Muhally Hakim (Bandung Institute of Technology, Indonesia) concentrated on the Tsunami disaster in South Asia. Richard Guillande presented the help GeoSciences has provided in the first days to the countries affected by the Tsunami. Dudung Hakim discussed the development of the disaster in Aceh, Indonesia.

During the symposium two basic types of presentations could be recognized: the ones with more focus on research and development of geo-information technology, and the ones with more focus on the practical needs and solutions for users and managers in disaster management. Several presentations were directly related to the Tsunami in South Asia, discussing availability of data, damages in

Figure 3: ISPRS panel.

different regions and the help provided by international and national geo-organisations.

The ISPRS panel (Karen Fabbri, European Commission, Thomas Kemper, German Aerospace Center and Nick McWilliam, Map Action) moderated by Orhan Altan (Secretary General ISPRS) addressed challenging questions for disaster management, such as:

- whether geo-specialists can deliver appropriate, timely geo-information after disaster
- quality/accuracy of geo-information for disaster management
- needed scientific and technical expertise after disaster
- involvement of geo-information scientists in prediction, prevention and mitigation

All the discussions (during the ISPRS panel, oral and poster sessions and coffee breaks) have clearly shown the problems for the disaster management sector are still numerous. It was possible to hear various opinions:

'GIS is a tool, it does not solve everything by itself'
'there is difference between 'small' disasters and 'big' disasters'
'we have to educate disaster managers'
'geo-ICT has to learn from disasters'
'technologically everything is possible'
'the problem is organization and communication between partners'

Figure 4: The Auditorium of Delft University of Technology during the Symposium.

'our geo-information dates from 1973'
'response phase cannot be isolated from prevention'
'data integration should be based on ontology and semantics'
'data are available after 3 days' vs. 'data were available after 3 hours'
'we have to stay close to the users'
'not all the people can work with total station but everybody can measure with steal type'
'is it possible to extend this software to 3D?'

Everybody agrees geo-information technologies offer a variety of opportunities to aid management and recovery in the aftermath of natural disasters, industrial accidents, road collisions, etc. However, in development of geo-technology several factors should be taken into account:

- Type and extend of the disaster (e.g. fire in a building vs. flood affecting several countries). Many countries have recognised the importance of this factor and have well-developed organisational structures. Unfortunately in many cases this is only on paper.
- Phase of disaster management. It is apparent that technology for different phases may vary since the tasks and the goal of the phases are distinct.

Figure 5: Poster session.

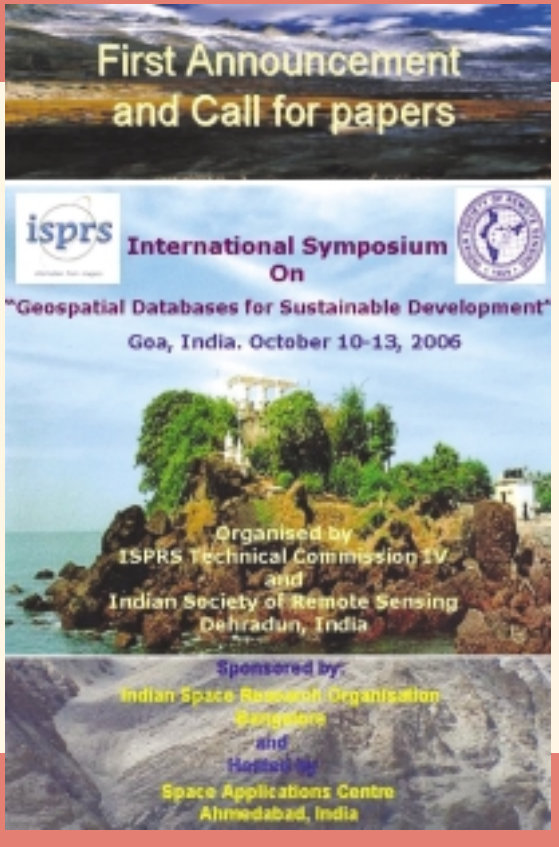
- Decision-making level. It should be always taken in consideration who needs the information – rescue teams in the field (requesting for a particular building or neighbourhood) or a crisis response centre (responsible e.g. for several provinces)
- Available data & technology (which vary from country to country). Presentations and discussions clearly revealed large differences in availability of geo-information in different parts of the world. While some countries possess geo-data in various forms (maps, images, 3D models, etc.), others only have 10-20 years old maps.
- Legislation & agreements between parties involved in disaster management
- Human factor. Developing technology for emergency response should be closely related to studies of the human psychology and behaviour (stress, pain, fatigue etc.) in disasters.

A large number of papers focused on technology needed for the response phase. About 15 of these papers were selected as a basis for a book ´Geo-ICT for emergency response`. The work on the book will be completed at the end of 2005. It is apparent that emergency response has the highest requirements in terms of performance, accuracy and presentation. Emergency response depends on timely delivery of large volumes of accurate, relevant, up-to-date geo-information that various organizations systematically create and maintain. To be used for decision making in emergency response many challenges are posed to data management, discovery, translation, integration, visualisation and communication based on heterogeneous geo-information sources with differences in many aspects: scale/resolution, dimension, classification and attribute schemes, temporal aspects, spatial reference system used, etc. Technology for emergency response has to be:

- Fast
- Context aware 'what/who/where/how'
- Based on integration from multiple sources
- 3D and 4D (time)
- Mixed: indoor (CAD) and outdoor (GIS)
- Able to provide analysis (evacuation routes, flooding prediction, etc.)
- Provide clear presentation (image, 2D/3D graphics, video, text, sound/voice)
- Up-to-date: monitoring by terrestrial, airborne, satellite sensors
- Aware of the position and allow navigation (GPS, Galileo, telecommunications)
- Wireless
- Web-based, open source
- Multidisaster, multiteam

These and many more other issues can be found in the 1434 pages proceedings of the symposium 'Geo-information for Disaster management', (eds.) Peter van Oosterom, Siyka Zlatanova and Elfriede Fendel, published by Springer Verlag.

Follow-up symposiums are already planned: Goa, India (2006, during the Commission IV midterm conference), Toronto, Canada (2007), Beijing, China (2008, during the XXIst ISPRS congress).



Address for Correspondence

ISPRS TC IV, Symposium Secretariat
Space Applications Centre (ISRO)
Ahmedabad – 380 015.

Phone : +91-79-26914187
or
+91-79-26914034
Fax: +91-79-26915825

Email: shailesh@sac.isro.gov.in
or
subhan_kp@sac.isro.gov.in

Website : www.commission4.isprs.org
isprs@icenet.net

The Bamiyan project: multi-resolution image-based modeling

By A. Gruen, F. Remondino, L. Zhang, Institute of Geodesy and Photogrammetry, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland

1 Introduction

The region of Bamiyan, ca 200 km North-West of Kabul, Afghanistan, was one of the major Buddhist centers from the second century AD up to the time when Islam entered the area in the ninth century. For centuries, Bamiyan lay in the heart of the famous Silk Road, offering rest to caravans carrying goods across the area between China and Western Empires. Strategically situated in a central location for travelers from North to South and East to West, Bamiyan was a common meeting place for many ancient cultures.

Afghanistan as a heavily hurt and damage country, with little hope for quick infrastructure reconstruction, economic improvements, political stability and social peace. Moreover at the end of the 1990's the extremist Taleban regime started an internal war against all the non-Islamic symbol. This led in March 2001 to the complete destruction of the two big standing Buddha statues of Bamiyan (Figure 2), as well as other small statues in Foladi and Kakrak. In 2003, the World Heritage Committee has decided to include the cultural landscape and archaeological remains of the Bamiyan valley in the UNESCO

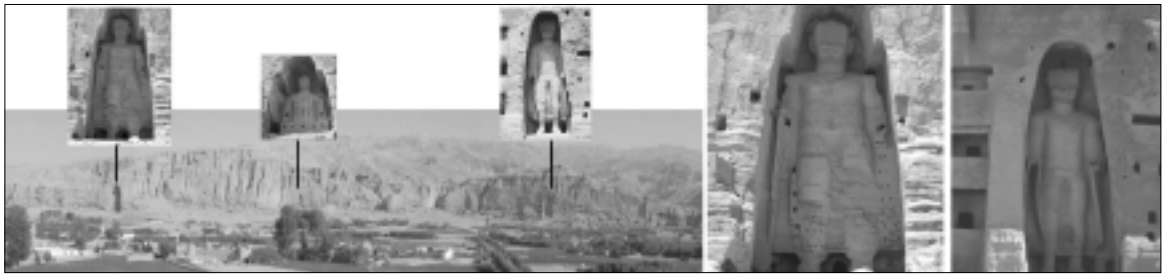


Figure 1: Panorama of the Bamiyan cliff with the three Buddha statues prior to demolition and a closer view of the two big standing statues of Bamiyan.

In the region, many Buddha statues and hundreds of caves were carved out of the sedimentary rock. In particular, near the village of Bamiyan, at 2600 meters altitude, there were three big statues of Buddha carved out of a vertical cliff (Figure 1). The larger statue of Bamiyan was 53 meters high while the smaller one measured 38 m. They were cut from the sandstone cliffs and they were covered with a mud and straw mixture to model fine details such as the expression of the face, the hands and the folds of the robe (Figure 1).

The invasion of the Soviet army in December 1979 started 23-years long period of wars and barbary that left

World Heritage List [http://whc.unesco.org/]. The area contains numerous Buddhist monastic ensembles and sanctuaries, as well as fortified edifices from the Islamic period. The site symbolizes the hope of the international community that extreme acts of intolerance, such as the deliberate destruction of the Buddhas, are never repeated again. The whole area is nowadays in a fragile state of conservation as it has suffered from abandonment, military actions and explosions. The major dangers are the risk of imminent collapse of the Buddha niches with the remaining fragments of the statues, further deterioration of still existing mural paintings in the caves, looting and illicit excavation.

Figure 2: The explosion of March 2001 that destroyed the Buddha statues (Image Source: CNN). The two empty niches, where the Buddha once stood, as seen in August 2003 during our field campaign.

The main goals of the Bamiyan project are:
- the terrain modeling of the entire Bamiyan area from satellite images for the generation of virtual flights over the UNESCO cultural heritage site;
- the modeling of the rock cliff where the Buddha were carved out;
- the 3D computer reconstruction of the two lost Buddha statues and the mapping of all the frescos of the niches;
- Buddha statues once stood;
- the documentation of the cultural heritage area with a topographic, tourist and cultural information system.

The project is an excellent example of image-based modeling, using many types of images, with different spatial and temporal resolution. It shows the capabilities and achievements of the photogrammetric modeling techniques and combines large site landscape modeling with highly detailed modeling of objects (i.e. the statues) by terrestrial images. Automated image-based modeling algorithms have been specifically developed for the modeling of the Great Buddha statue, but, at the end, manual measurements revealed to be the best procedure to recover reliable and accurate 3D models.

2 Terrain Modelling from Satellite Imagery

For the 3D modeling and visualization of the area of interest, an accurate DTM is required. Aerial images were not available to us and the idea to acquire them was unrealistic, due to the absence of any surveying company operating in that area. So space-based image acquisition and processing resulted as the only alternative to the aerial photos or any other surveying method. Nowadays space images are competing successfully with traditional aerial photos, for the purpose of DTM generation or terrain study in such problematic countries as the current Afghanistan. Also, the availability of high-resolution world-wide scenes taken from satellite platforms is constantly increasing. Those scenes are available in different radiometric modes (panchromatic, multispectral) and also in stereo mode.

For the project, a B/W stereo pair acquired with the HRG sensor carried on SPOT-5 and a PAN Geo level IKONOS image mosaic over the Bamiyan area were available. The SPOT5 images were acquired in across-track direction at 2.5m ground resolution while the IKONOS image has a ground resolution of 1 m.

The sensor modeling, DTM/DSM and ortho-image generation were performed with our software SAT-PP, recently developed for the processing of high-resolution satellite imagery [Zhang and Gruen, 2004; Poli et al., 2004; Gruen et al., 2005].

The IKONOS mosaic orientation was based on a 2D affine transformation. On the other hand, the SPOT scenes orientation was based on a rational function model. Using the camera model, the calibration data and the ephemeris contained in the metadata file, the software estimates the RPC (Rational Polynomial Coefficients) for each image and applies a block adjustment in order to remove systematic errors in the sensor external and internal orientation. The scenes' orientation was performed with the help of some GCPs measured with GPS. The DTM was afterwards generated from the oriented SPOT stereo pair using the SAT–PP module for DTM/DSM generation. A 20 m raster DTM for the whole area and 5 m raster DTM for the area covered by the IKONOS image were interpolated from the original matching results (Figure 3), using also some manually measured breaklines near the Buddha cliff. The matching algorithm combines the matching results of feature points,

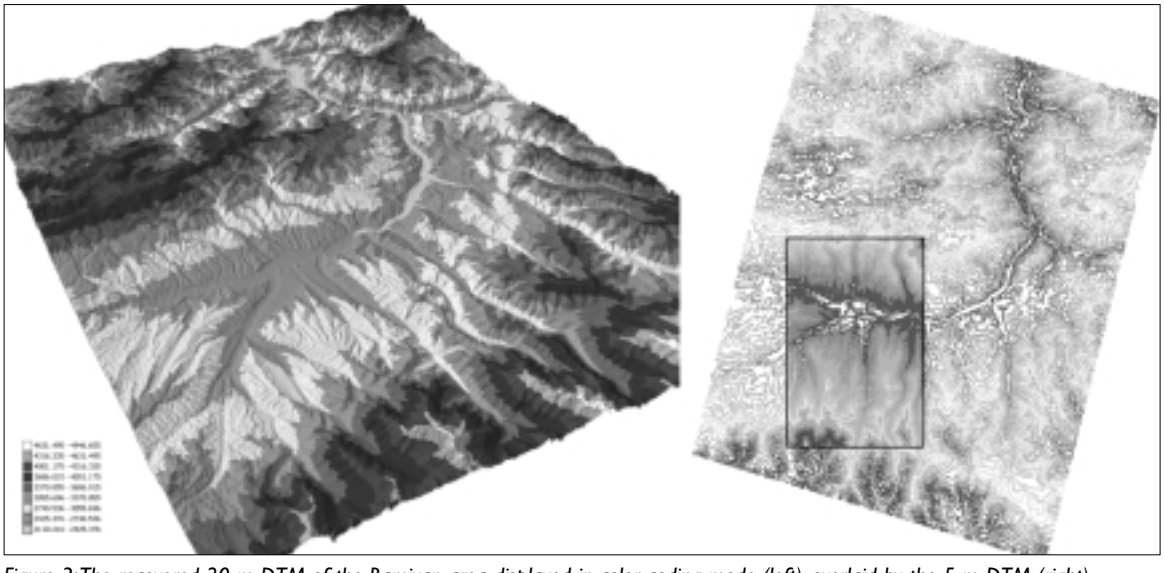


Figure 3: The recovered 20 m DTM of the Bamiyan area displayed in color coding mode (left), overlaid by the 5 m DTM (right).

Figure 4: The Bamiyan cliff, approximately 1 km long and 100 m high modeled with ca 30 images.

grid points and edges. It is a modified version of MPGC (Multi Photo Geometrically Constrained) matching algorithm [Gruen, 1985; Zhang and Gruen, 2004] and can achieve sub-pixel accuracy for all the matched features.

For the photo-realistic visualization of the whole Bamiyan area, a 2.5 m resolution B/W ortho-image from SPOT images and a 1 m resolution RGB ortho-image from the IKONOS image were generated. The textured 3D model (rendered with Erdas-Virtual GIS) is shown in Figure 8 where two closer views on the 3D IKONOS textured model of the Bamiyan cliff and the old Bamiyan city (the pyramid-type hill to the left) are presented.

3 3D Modeling of the Rock Cliff

For the reconstruction and modeling of the Bamiyan cliff (Figure 4), a series of terrestrial images acquired with an analogue Rollei 6006 camera was used while ca 30 control points (measured with a total station) distributed all along the rock cliff were used as reference. The images were digitized at 20 micron resolution and then oriented with a photogrammetric bundle-adjustment. Then manual measurements were performed on stereo-pairs in order to get all the small details that an automated procedure would smooth out. The recovered point cloud was triangulated, edited and finally textured, as shown in Figure 5.

4 3D Modeling of the Great Buddha and Its Actual Empty Niche

The 3D computer reconstruction of the Great Buddha statue was performed on different image data-sets and using different algorithms [Gruen et al., 2004]. Various 3D computer models of different quality, mostly based on automated image measurements were produced. However, in most of the cases, the reconstructed 3D model did not contain essential small features, like the folds of the dress and some important edges of the niche. Therefore, for the generation of a complete and detailed 3D model, manual photogrammetric measurements were indispensable. They were performed along horizontal profiles at 20 cm interval on three metric images, acquired in 1970 by Prof. Kostka [Kostka, 1974] and scanned at 10 micron resolution.

The final 3D model of the Great Buddha (Figure 6) was used for the generation of different physical models of the Great Buddha. In particular, a 1:25 scale model was generated for the Swiss pavilion of the 2005 EXPO in Aichi, Japan.

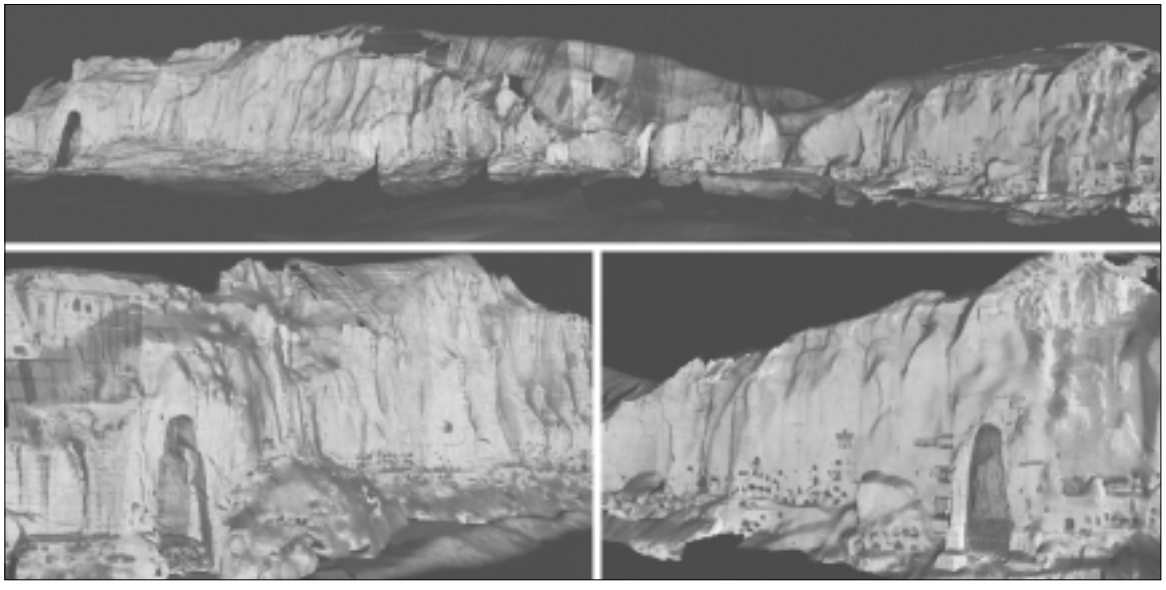


Figure 5: Textured 3D model of the Bamiyan cliff. The entire cliff (above) and two closer views of the niches (left: Big Buddha, right: Small Buddha).

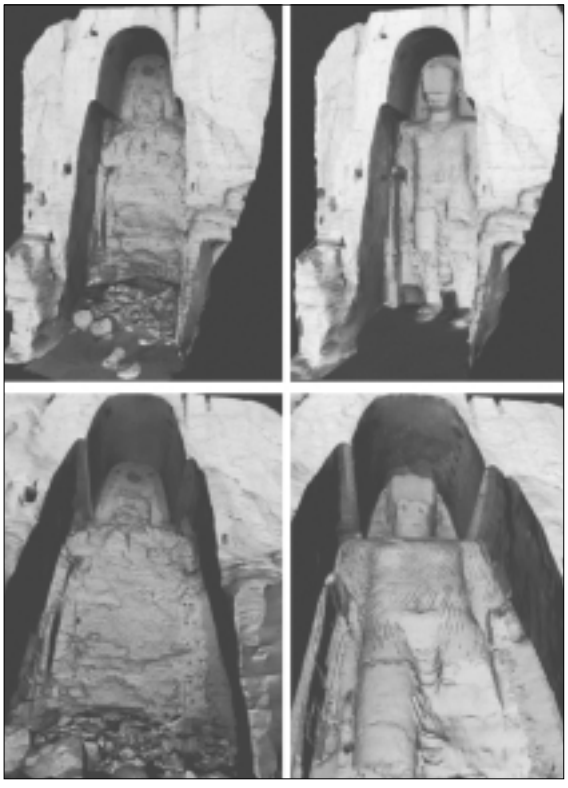


Figure 6: The 3D textured model of the Great Buddha of Bamiyan and its actual empty niche.

The modeling of the empty Buddha niches was instead performed using five digital images acquired with a Sony Cybershot F707 during our field campaign in August 2003. The image size is 1920x2560 pixels while the pixel size is ca 3.4 mm. After the image orientation, three stereo-models were set up and points were manually measured along horizontal profiles, while the main edges were measured as breaklines. Thus a point cloud of ca 12 000 points was generated. The final textured 3D model is displayed in Figure 6.

5 Mosaicking and Mapping of the Frescos

The niches of the Bamiyan Buddha statues were rich with paintings, which have been partly destroyed earlier in history and ultimately during the explosions. The best way of proper documentation and visualization of this lost art is the generation of an accurate and photo-realistic image-based 3D model.

In particular, the ceiling part of the Big Buddha niche (approximately 15 m of diameter and 16 m depth) was rich with mural paintings, of many different colors, representing Buddha-like figures, bright-colored persons, ornaments, flowers and hanging curtains. Using available images that tourists acquired in the 60's and 70's, we were able to create different mosaics of the paintings and the use them for the photo-realistic texture mapping of the 3D model [Remondino and Niederoest, 2004].

6 Integration of Multi-resolution Image-based Data

In the last years a big number of sites and objects have been digitally modeled, using different tools, mainly for visualization and documentation. A great force for this trend has been the availability and improvement of image and range sensors, as well as the increasing power of computers for storage, computation and rendering of the digital data.

The Bamiyan project is a combination of multi-resolution and multi-temporal photogrammetric data, as summarized in Table 1. The geometric resolution of the recovered 3D data spans from 20 m (SPOT5) to 5 cm (Buddha model) while the texture information is between 2.5 m (SPOT5) and 2 mm (fresco) resolution. A factor 400 exists between the different geometry resolutions, while there is a factor 1250 in the texture. The whole triangulated surface model covers an area of ca 49x38 km and contains more than 4 millions triangles, while the texture occupies ca 2 GB. The fusion of the multi-resolution (and multi-temporal) data is a very complex and critical task. Currently there is no commercial software able to handle all these kinds of data at the same time, mainly for these reasons:

- the data is a combination of 2.5 and 3D geometry, limiting the use of packages for geodata visualization, usually very powerful for large site textured terrain models;
- the amount of data is too big for graphical rendering and animation packages, generally able to handle textured 3D data.

Source of data		Year	Image resolution	Geometry resolution	Texture resolution
Satellite images	SPOT 5 - HRG	2003	-	20 m	2.5 m
	IKONOS	2001	-	5 m	1 m
Terrestrial images	Rollei	2003	20 micron	1 m	50 cm
	Sony	2003	4 micron	50 cm	10 cm
	[Kostka, 1974]	1970	10 micron	5 cm	1 cm
	Frescos	60's & 70's	20 micron	N.A.	2 mm

Table 1: Multi-resolution data (geometry and images) used in the Bamiyan project.

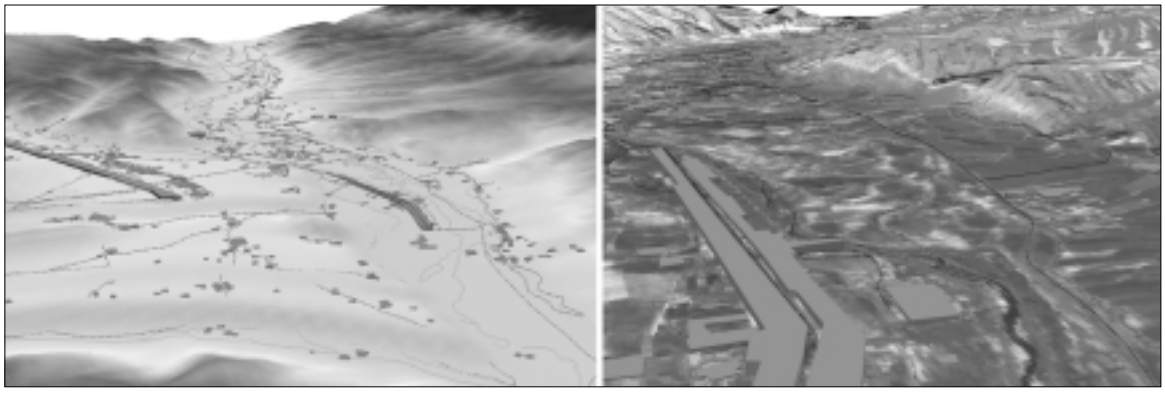


Figure 7: Two views of the 3D model of the Bamiyan area with the extracted rivers and man-made structures (streets, houses and airport).

- The high-resolution texture information exceeds the memory capacity of most current graphic cards.

Therefore there is a need for rendering techniques able to maximize the available amount of visible data with an optimal use of the rendering power, while maintaining smooth motion during the interactive navigations. Towards this goal Borgeat et al.(2003) developed a multi-resolution representation and display method that integrates aspects of edge contraction progressive meshes and classical discrete LOD techniques. It aims at multi-resolution rendering with minimal visual artifacts while displaying high-resolution and detailed scenes or 3D objects.

7 Tourist Information System

The information recovered from the high-resolution satellite imagery is imported in GIS software (ArcView and ArcGIS) for further analysis, data visualization and topographic information generation.

The use of Geographic Information Systems in heritage management has been also underlined by UNESCO, as a GIS allows: (1) historical and physical site documentation, (2) the as-sessment of physical condition, cultural significance and administrative context, (3) the preparation of conservation and management strategies, (4) the implementation, monitoring and evaluation of management policies [http://www.unescobkk.org/culture/gis/index.html]. Furthermore, a GIS tool generates permanent records of heritage sites, including also text documentation, virtual flight-overs and 3D models.

The Bamiyan valley includes 8 protected locations, identified with an area of interest and a buffer area. [http://whc.unesco.org/pg.cfm?cid=31&id_site=208]. All the areas were mapped and documented within a GIS, together with man-made objects (e.g. streets and buildings) and rivers from IKONOS imagery. A total of 243 objects were extracted and then overlapped onto the recovered DTM and ortho-image (Figure 7). Finally, using the contour lines generated from the DTM and the extracted objects, a new plan of the Bamiyan area was also generated, as the previous one was done by the Russian in 70's.

8 Conclusions

The reported Bamiyan project is a complete image-based 3D modeling application that combines multi-resolution geometry and multi-temporal high-resolution images. The modeling of the whole cultural heritage site of Bamiyan required the use of different types of sensors and produced a detailed terrain model as well as 3D models of other objects. The 3D data is now used for visualization, animation, documentation and for the generation of a cultural and tourist information system.

For the photo-realistic rendering and visualization of the generated digital models different commercial packages have been used separately, as the management and visualization of the whole data is still problematic, in particular for real-time rendering.

The 3D model of the Great Buddha has been used for the production of a 90 minute movie about "The Giant Buddha", which is planned to be shown in movie theatres late in 2005.

9 Acknowledgements

The authors would like to thank Daniela Poli for her help in the satellite image acquisition, CNES for providing the SPOT-5/HRS images [www.spotimage.fr] at special conditions through the ISIS program [http://medias.obs-mip.fr/isis/?choix_lang=English] and Space Imaging [www.spaceimaging.com] for providing a IKONOS scene for free. We also appreciate the contributions of Natalia Vassilieva in terms of doing photogrammetric measurements and the work done with Jana Niederoest for the mosaicking of the frescos.

10 References

- Borgeat, L., Fortin, P.-A. and Godin, G., 2003. A fast hybrid geomorphing LOD scheme. *Proceedings of SIGGRAPH'03*, Sketches and Applications (on CD-ROM).
- Gruen, A., 1985. Adaptive Least Squares Correlation: A

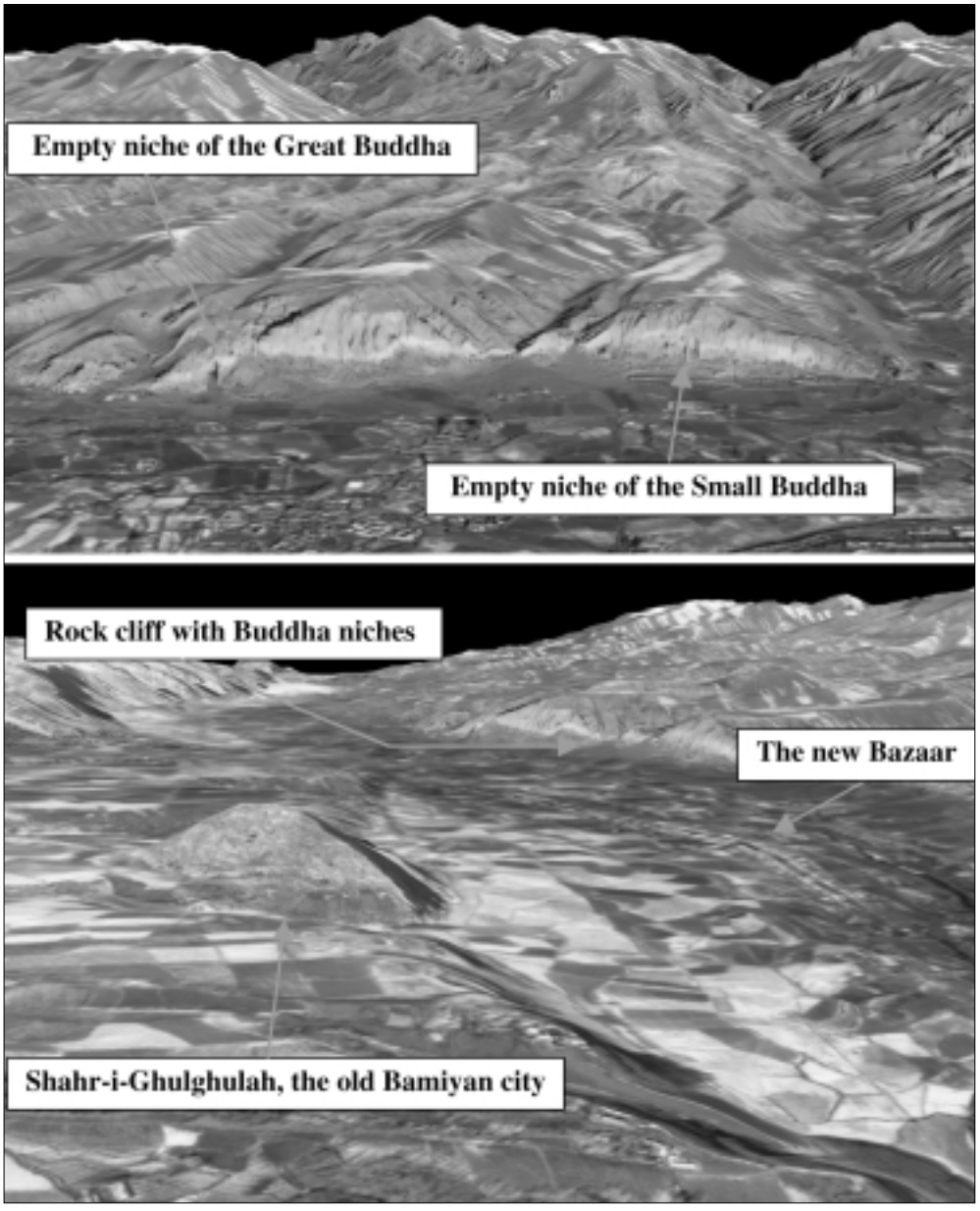


Figure 8: Close view of the Bamiyan terrain model textured with an IKONOS ortho-image.

powerful Image Matching Technique. *South Africa Journal of Photogrammetry, Remote Sensing and Cartography*, 14 (3), pp. 175-187.

- Gruen, A. Remondino, F. Zhang, L., 2004. Photogrammetric Reconstruction of the Great Buddha of Bamiyan, Afghanistan. *The Photogrammetric Record*, 19(107), pp. 177-199.
- Gruen, A., Zhang, L., Eisenbeiss, H., 2005: 3D Precision Processing of High-resolution Satellite Imagery. *Proceedings of ASPRS Annual Meeting*, Baltimore, Maryland, USA
- Kostka, R., 1974. Die Stereophotogrammetrische Aufnahme des Grossen Buddha in Bamiyan. *Afghanistan Journal*, 3(1), pp. 65-74.
- Remondino, F. and Niederoest, J., 2004. Generation of high-resolution Mosaic for photo-realistic texture-mapping of cultural heritage 3D models. *Proc. of the 5th International Symposium on Virtual Reality, Archaeology and Cultural Heritage (VAST)*, pp. 85-92
- Poli, D., Zhang, L., Gruen, A., 2004. SPOT-5/HRS Stereo Images Orientation and Automated DSM Generation. *International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, Vol.XXXV-B1.
- Zhang, L., Gruen, A., 2004. DSM Generation from Linear Array Imagery. *International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, Vol.XXXV-B3.