ISPRS Technical Commission VII

Thematic Processing, Modeling and Analysis of Remotely Sensed Data

2010 Annual Report

1. State of Science and Technology of Commission VII Topics

ISPRS Technical Commission VII (TC VII) deals with the "Thematic processing, modelling and analysis of remotely sensed data". It covers the following thematic areas, represented by its working groups (WGs):

- WG VII/1 - Physical modelling and signatures in remote sensing
- WG VII/2 - SAR Interferometry
- WG VII/3 - Information extraction from hyperspectral data
- WG VII/4 - Methods for land cover classification
- WG VII/5 - Methods for change detection and process modelling
- WG VII/6 - Remote sensing data fusion
- WG VII/7 - Theory and experiments in radar and lidar
- ICWG III/VII - Pattern recognition for remote sensing

Recently, several general trends in earth observation have been identified that have their impact on the thematic topics covered by TC VII. These developments have been fed by the increasing need for high accuracy data for specific purposes and the ever increasing role of earth observation in endorsing national and international political agendas, e.g. with respect to climate change, natural disasters and food security. These common trends include:

- Rapid developments of specialised missions, e.g. for the water cycle (SMOS, SMAP, CryoSat-2, GOCE), ocean colour and mineralogy (EnMap and PRISMA imaging spectrometers).
- Rapid developments in SAR remote sensing data sources, such as such as the high resolution RADARSAT-2 from Canada, the COSMO-Skymed SAR satellite from Italy, the German TerraSAR-X and TanDEM-X, and ESA's upcoming Sentinel-1 and Sentinel-2 in support of GMES.
- The recognition that a fundamental conception and modelling of the physical processes is required to robustly retrieve thematic information from earth observation data.
- Observed Earth surfaces are no longer regarded individually but instead considered as part of a series of observations (multimission strategies, time

series, multiple satellite constellations such as the Global Precipitation Mission(GPM) and TerraSAR-X/ TanDEM-X) or signatures (e.g. spectral and angular, radar in combination with optical observations)

- Last two components have led to an increase in multiple sensor approaches (e.g. image fusion, multiple sensor classifications) for improved characterisation of land and water surfaces, increased temporal resolution, and extended time series in support of global change and climate studies.

The relevance of the above aspects is reflected by the developments within the thematic focus covered by the individual WGs.

2. Accomplishments of Commission during the current year

In 2010, Technical Commission VII has attracted significant attention from the scientific community, mainly through successfully (co-)organising several conferences and workshops in all the thematic disciplines covered by TC VII. The workshops took place worldwide and also reached the scientific communities in emerging economies such as China, India, And Brazil.

2010's highlight was certainly the organization of the TC VII symposium in conjunction with the 100th anniversary of ISPRS (http://www.isprs100vienna.org/). The TC VII symposium was held from 5-7 July in Vienna, Austria and had as theme: "100 Years ISPRS - Advancing Remote Sensing Science". 380 participants from 46 countries participated to the Symposium (Figure 1). In total there were 113 oral presentations divided over 2 plenary sessions and 18 oral sessions. 185 posters were presented in 2 poster sessions. The topics of the contributions were representative for the thematic fields covered by the working groups within TC VII (Figure2). All working groups were involved in the review and selection of the submitted contributions. The scientific output of the Symposium is presented in Proceedings IAPRS vol. XXXVIII 7A (fully reviewed papers) and 7B (abstract reviewed papers). Moreover, a selection of papers will be published in a special issue of "Remote Sensing". The special issue will be entitled "100 years ISPRS – Advancing Remote Sensing Science".

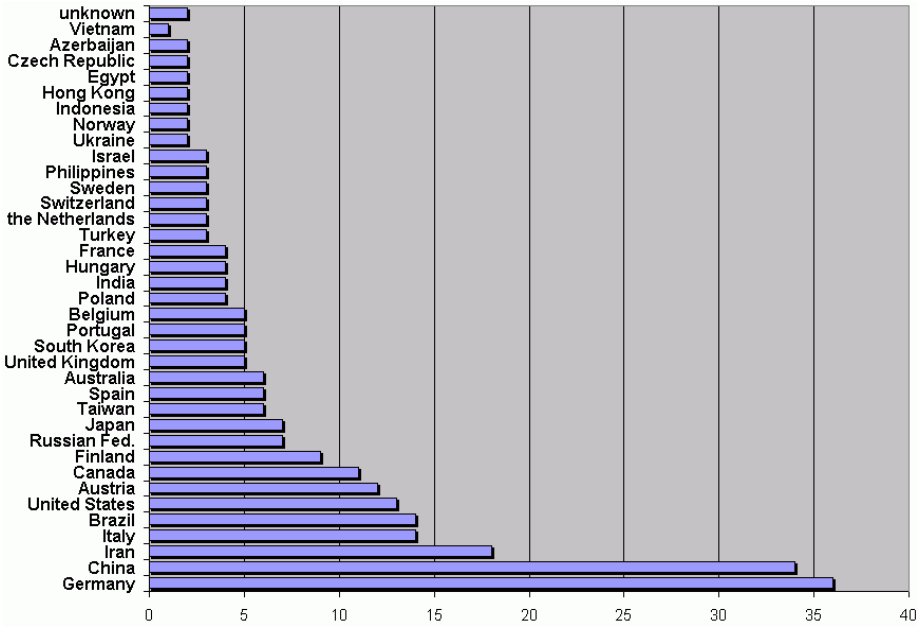

Figure 1 Provenance of participants ISPRS TC VII Symposium.

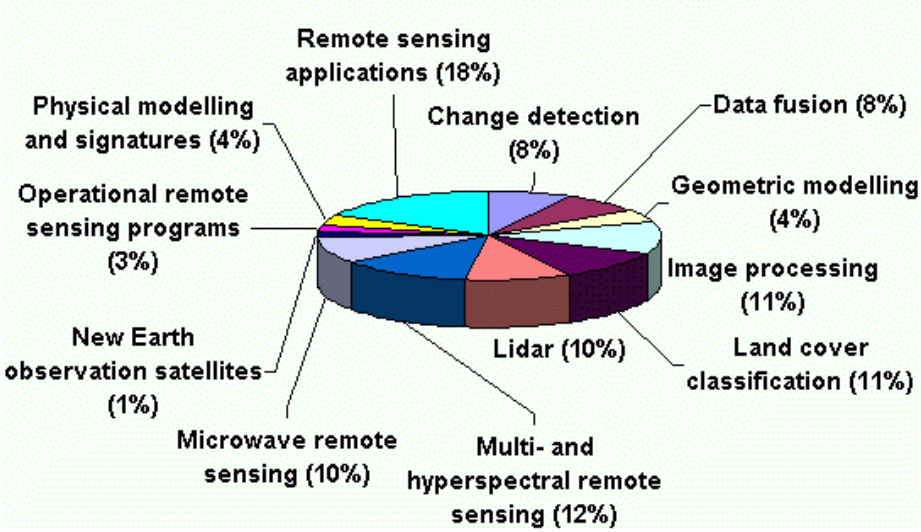

Figure 2. Percentual share of topics covered by ISPRS TC VII Symposium.

In 2010, Wolfgang Wagner has become co-chair of the CEOS Land Product Validation Focus Group on Soil Moisture. The Committee for Earth Observation Satellites (CEOS), recognized as the space arm of the Group on Earth Observations (GEO). CEOS plays a key role in coordinating the land product validation process. The Land Product Validation (LPV) focus group on soil moisture aims to address the challenges associated with the validation of global soil moisture products. The group is jointly led by Tom Jackson, USDA, and Wolfgang Wagner, TU Wien.

In 2009, the Open Access journal "Remote Sensing" (http://www.mdpi.com/journal/remotesensing) was first published. Wolfgang Wagner

is Editor-in-Chief of journal. From initially 4 issues in 2009, the journal has rapidly evolved to 12 issues in 2010 (138 articles).

Noteworthy are the first steps made by WG4 in establishing various benchmark data sets for land use and land cover classification and freely sharing the data with the scientific community through a web portal.

3. Working Group Activities During the current year

WG VII/1 - Physical modelling and signatures in remote sensing

State of Science

Focus topics of the WG remain and emerge increasingly in advanced methods of forward and inverse modeling. Forward approaches are discussing direct radiance assimilation of satellite measurements into process models, where inverse approaches are either mathematical inversion (Hadamard criteria), intermediate or hybrid inversions (eg Minnaert-k), or biophysical and/or biochemical parameter inversion with their associated ill-conditioned and ill-posed constraints. The use of spectral invariants (recollision probability theory) has found its way into generating products in remote sensing.

Accomplishments of Working Group in 2010

The working group was involved in the organization of four major events throughout the year 2010:

1. Support to ESA's Hyperspectral Workshop, held at ESRIN (Frascati, Italy) from 17-19 March, 2010.
   http://www.congrex.nl/10c02/
2. Initiation of CEOS-LPV Albedo activities.
   http://lpvs.gsfc.nasa.gov/srad_background.html
3. Contribution to WMO-BIPM workshop on Measurement Challenges for Global Observation Systems for Climate Change Monitoring (position paper).
   http://www.bipm.org/utils/common/pdf/rapportBIPM/2010/08.pdf
4. Intercomparison of 15 spectrometers experiment (EC FP7 MC-RTN Hyper-I-Net)

Upcoming Working Group participation

1. Major activities in 2011 will focus on the organization of the joint ISPMSRS-IWMMM (International Symposium on Physical Measurements and Signatures in Remote Sensing - International Workshop on Multiangular Measurements and Models) workshop (final decision still open and pending).
2. Contributing to ESA's Sentinel Potential Science Products Assessment & Consolidation Workshop: http://www.sen4sci.org/
3. Contributing to the 7th EARSeL Workshop in Imaging Spectroscopy: http://www.earsel2011.com/

WG VII/2 - SAR Interferometry

State of Science

The current hot topics of SAR Interferometry are DEM generation from space borne high-resolution SAR data, for example, from TerraSAR-X/TanDEM-X or COSMO-Skymed imagery, and surface deformation monitoring with SAR Interferometry and Persistent Scatterer Interferometry based on time series differentials of satellite SAR data.

In June 2010 TanDEM-X was launched, the sister satellite of TerraSAR-X. Both satellites will perform systematic bi-static mapping of Earth for the period of three years. From this data a global DEM shall be derived by DLR, which will be commercialized by Infoterra Company, Germany. The final DEM will complement and most probably clearly outperform well known SRTM data: the grid size is planned to be about 10 m and the vertical point-to-point errors are expected to be below 2 m (90%). Compared to traditional repeat-pass Interferometry conducted by single satellites taking images separately at repeated cycles, single-pass image acquisition comes along with at least two advantages: no temporal decorrelation occurs and the phase terms caused by atmospheric phase delay cancel out.

The advent of high-resolution civil SAR satellite sensors gives the opportunity of urban area mapping with much finer level of detail than ERS type of devices could provide. A striking example for the capability of the new sensor generation is the dramatic rise of so-called persistent scatterers (PS) preferably found in settlement areas in stacks of TerraSAR or COSMO-Skymed imagery. There are several reasons for this rise, we give two here: Firstly, close-by PS, which would lie in the same resolution cell for ERS, are mapped into different cells now due to finer spatial grid. Secondly, also weaker PS may be detected since they compete with clutter signal of a far smaller area.

The dense grid of PS boosts advanced techniques that rely on time series of satellite SAR images, for example, multi-baseline SAR Interferometry, Persistent Scatterer Interferometry, SAR Tomography, and Differential SAR Tomography. Those approaches usually require quite demanding signal processing methods, for instance, sophisticated spectral estimation techniques or compressive sensing. Besides the required further development of such approaches still many efforts have to be conducted in the future to validate such techniques, for example, in terms of accuracy and reliability in order to be able to apply those new methods to operational monitoring tasks, be it driven by public authorities or the private sector.

Accomplishments of Working Group in 2010

1. Co-organisation of the benchmark activity: Validation of DEM from

high-resolution SAR images of modern satellite sensors. DLR provides 60 TerraSAR-X images over Barcelona, Hannover, Edmonton, Trento, and Istanbul. Currently, 12 international groups of scientists participate. The groups conduct various techniques for elevation extraction from SAR data: Radargrammetry (e.g., SAR stereo), conventional InSAR (two images), and multi-baseline InSAR using image stacks. First results already have been published, more are in preparation. At the end of the year a proposal has been submitted to DLR to extend the work also to data of the TanDEM-X mission. The scientific evaluation of such data is for the reasons mentioned above of large interest both for the scientific community and the public.

Upcoming Working Group participation

1. The WG will organize the ISPRS Workshop for High-Resolution Earth Imaging for Geospatial Information. Hannover, June 14 - 17, 2011. http://www.ipi.uni-hannover.de/ipi-workshop.html
2. A special issue of ISPRS journal will be organized by the WG, the Call for paper is scheduled for spring 2011, the publication for spring 2012.

WG VII/3 - Information extraction from hyperspectral data

State of Science

Hyperspectral remote sensing has become mature in the past few years. The added value compared to multispectral systems has been broadly recognized which is evidenced by the large number of approved satellite missions including DLR/GFZ's EnMap and ASI's Prisma missions. In Summer 2009, ESA's airborne benchmark instrument APEX made its first aquisitions. There is a lot of ongoing research and activities in the field of hyperspectral remote sensing where an establishment of operational algorithms can be observed. Other progress includes:

1. Establishing a ground based validation site for HSR: Makhtesh Ramon Israel, has suggested as a calibration/validation site and now is placed on the CEOS website: http://calval.cr.usgs.gov/sites_catalog_template.php?site=makh. In March 2009 it was visited by more than 80 scientists worldwide to be recognized by the HSR community.
2. Quality Layer indicator for hyperspectral remote sensing data has been established within the EUFAR program and will be available soon in the EUFAR homepage. This was done after sending questioners to many HSR users in Europe.
3. A new approach on how to better correct the atmosphere in a non stable HSR sensor utilization has been developed and was sent to publication (Brook and Ben Dor Remote Sensing of Environment).
4. A new approach to correct for smile effect in Hyperion data over desert environment has been developed (Dadon A., E. Ben Dor and A. Karnieli (2010), Use of derivative calculations and minimum noise fraction (MNF)

transform for detecting and correcting the spectral curvature effect (smile) in Hyperion images, published in IEEE Transactions on Geoscience and Remote Sensing.

5. Errors in soil spectral measurements using ASD field spectrometer were studied and presented at the ASD IEEE Workshop. A paper accepted for publication on that subject is to be published in Soil Science Society of America by Feinstein et al, 2011.
6. Soil Spectral Group was established and aimed to collect soil spectra libraries worldwide (http://groups.google.com/group/soil-spectroscopy). So far spectral from 43 counties were gathered. Leader of the group is Raphael Viscarra Rossel.
7. Within the EUFAR program, an expert working group on hyperspectral applications for soil was created (www.eufar.net), lead by Eyal Ben-Dor. So far the group has 100 members.
8. A new scientific journal "Journal of Imaging Spectroscopy" has been established and the first volume is to be issued. The journal aimed at gathering all potential IS users under one umbrella. Ben-Dor is appointed as an associated editor managing the terrestrial application section.

Accomplishments of Working Group in 2010

1. Organisation of the workshop „Quantitative applications of soil spectroscopy", GFZ, Potsdam, Germany, 15-16 April 2010: 46 participants from 17 countries attended this workshop giving in total 36 presentations. The workshop was composed of five sessions of oral presentations, most of them unpublished results of recent work in quantitative soil spectroscopy, and one demonstration session. This session presented state of the art instrumentations in soil spectroscopy either in the laboratory (Agriquant) or in the field (SpecTool) and available softwares, free and commercial (SPECCHIO, TSG, Unscrambler) that can handle large soil libraries spectra and analyze quantitatively its information. More information on: http://www.gfz-potsdam.de/portal/gfz/Neuestes/Veranstaltungen/Tagungen+und+Konferenzen/2010-Conferences/100415-16-Soil_Spectroscopy
2. Organisation of a special Hyperspectral session at the ICARE conference. Toulouse, France, 27-30 October 2010.
3. Organisation of an Hyperspectral Calibration Validation campaign –ValCalHyp EUFAR- Transnational access. The main objective of this study was to examine both the Smart Vicarious Calibration (SVC) system and the Quality Assurance (QA) Quality Indicator (QI) protocols developed within the EUFAR activities. An "unmixing" validation mission was carried out by RAM preparing an additional playground site including well known mixed targets in the sub-pixel size dimension in ONERA air base. Sensors used: INTA – CASA aircraft : AHS and CASI-1500i, NERC - Do228 aircraft : AISA Dual.

Upcoming Working Group participation

1. A summer school is being organized regarding soil HSR mission including cal val activities
2. A special issue in Applied and Environmental Science is being planned on soil spectroscopy (final decision still open and pending)
3. An Hyperspectral Soil Mapper (HYSOMA) interface is being created under the EUFAR umbrella for non-expert users to use soil mapping hyperspectral methodologies. This software is envisioned to be distributed freely. A publication is in preparation on the subject.
4. A new TA EUFAR mission DeMinTir to develop a TIR hyperspectral activity was accepted and will be conducted over Sokolove mining area Czech Republic on July 2011. This mission is part of the EO-MINERS EU project and will use INTA AHS aircraft and sensor.

WG VII/4 - Methods for land cover classification

State of Science

Very high resolution (VHR, better than 1 m) optical, polarized radar, and high density lidar (denser than 1 m) data are increasingly available to remote sensing community for research and application. Existing classification techniques have faced tremendous challenges to effectively extract information from these new data sets. Therefore:

- The number of research papers on classification of VHR optical imagery and polarized radar imagery is rapidly increasing;
- Research on classification using LiDAR data or multi-polarization SAR data starts to increasingly appear in publications;
- There are also many papers on combination of optical, radar and/or LiDAR data for classification.

Within the area of classification of VHR optical imagery, research on object-based classification is most active. However, most research is based on how to use eCognition software to achieve desired classification results. Research papers on new algorithms or new methods independent of eCognition are not many.
In the area of classification of polarized radar data, most papers have been trying to adopt, improve or change existing algorithms or concepts of optical image classification for classifying polarized radar images.

Since the launch of WorldView-2 satellite in October 2009, research activities have been increased on whether high resolution 8-band mulispectral images (2m MS, and 0.5m pansharpened MS) can improve the classification accuracy. These research activities have been promoted by DigitalGlobe through providing researchers (upon applaictions) with WorldView-2 images free of charge.

Accomplishments of Working Group in 2010

1. Establishing an online database to provide researchers worldwide with common datasets for land cover classification testing and evaluation. Geographical locations of the datasets:
    - Girona, Spain;
    - Fredericton, Canada;
    - Hobart, Australia.
    - Beijing, China (available soon)
    - Cape Town, South Africa (available soon)
    - Vienna, Austria (available soon)

   The types of datasets include:
    - Medium resolution satellite: Landsat-7, SPOT;
    - High resolution satellite: Ikonos, QuickBird, GeoEye-1;
    - Airborne digital camera: DMC;
    - Airborne LiDAR
2. Conducting evaluation and comparison of classification algorithms using the ISPRS WG VII/4 common datasets by individual WG VII/4 members and posting the published results
3. Applying for ICSU (International Council for Science) funding on behalf of ISPRS to support an international activity and workshop on land cover classification benchmark testing.
4. Participating in the classification benchmark testing of the Higher resolution Global Land Cover Mapping Project, launched by the Ministry of Science and Technology of the People's Republic of China.

Upcoming Working Group participation

1. Participating in the committee of The 2011 Joint Urban Remote Sensing Event (Urban 2011 & URS 2011), Munich, Germany, April 11-13, 2011, sponsored by IEEE GRSS and ISPRS.
2. Participating in the committee of The Third International Conference on Earth Observation for Global Changes (EOGC2011), Munich, Germany, 13-15 April 2011, sponsored by ISPRS, etc.
3. Assisting and attending *The XXII ISPRS Congress*, Aug 24 - Sep 3, 2012, Melbourne, Australia

WG VII/5 - Methods for change detection and process modelling

State of Science

Processing of multi-temporal images and change detection has been an active research and application field in remote sensing for decades. Although plenty successful

applications have been reported on the monitoring and detecting of environmental change, there are enormous challenges in applying multi-temporal imagery to derive timely information on the Earth's environment and human activities. In recent years, great progress has been observed to overcome technological obstacles by the development of new platforms and sensors. The wider availability of large archives of historical images also makes it possible for long-term change detection and modelling. Such a development stimulates further investigations to develop more advanced image processing methods and new approaches to handling image data in the time dimension.

The mission of the working group VII/5 is to further enhance international collaboration in the field of remote sensing change detection. The focus also extends to the study of geo-process modelling using long-term remotely sensed data. It is endeavoured to promote and encourage collaborated efforts for the development of new technology for processing multi-temporal imagery, detecting changing environment and objects, and modelling long-term geo-processes.

Accomplishments of Working Group in 2010

1. Organized technical sessions at the ISPRS Commission VII Symposium in Vienna, 5-7 July 2010, Vienna, Austria.
2. Co-organized Joint International Conference on Theory, Data Handling and Modelling in GeoSpatial Information Science with ISPRS Commission II and International Geographic Union, 26-29 May 2010, Hong Kong.
3. Organized ISPRS workshop on Remote Sensing Change Detection and Process Modelling, 18-19 November 2010, Cologne, Germany.

Upcoming Working Group participation

1. Organization of ISPRS working group workshop on "Remote Sensing Change Detection and Spatio-temporal Modelling", 15-16 December 2011, Hong Kong.
2. Co-organization of ISPRS working group workshop on 'Dynamic and Multi-dimensional GIS (DMGIS'11), 17-18 October 2011, Shanghai, China.
3. Co-organization of the 2011 International Symposium on Image Data and Fusion, 9-11 August, 2011, Tengchong, Yunnan, China.

WG VII/6 - Remote sensing data fusion

State of science

Image and data fusion aims at the integration of multi-sensor, multi-temporal, multi-resolution and multi-platform image data, together with geospatial data, GIS, in-situ, and other statistical data sets for improved information extraction, as well as

to increase the reliability of the information. Image and data fusion techniques are important for combining the many sources of satellite, airborne and ground based imaging systems, and integrating these with other related data sets for enhanced information extraction and decision making. Through scientific workshops and a dedicated journal, WG VII/6 coordinates and sponsors state-of-the-art discussions and developments on the theory, methodology and applications of image and data fusion including a) automatic registration of images with different sensor, different resolution, and different acquisition mode, b) concept study and methodology development of data fusion at different processing levels, especially at feature and decision level, c) multi-source/multi-sensor data fusion and integration methodologies, such as fusing laser scanning data with images, fusing high resolution satellite optical imagery with high resolution SAR imagery, d) applications of data fusion to feature extraction, object recognition, classification, mapping, disaster monitoring, change detection, and e) information mining from multi-platform, multi-source, multi-scale, spatial-temporal data, e.g., geometric information, topological information, statistical information, etc.

Accomplishments of Working Group in 2010

After many months of hard work and preparation, a new international journal entitled "International Journal of Image and Data Fusion" (IJIDF), has been successfully launched. Taylor & Francis is the publisher, and Prof. Jixian Zhang, Chair of WG VII.6, acts as the editor-in-chief (http://www.tandf.co.uk/journals/tidf). IJIDF provides a single source of information for all aspects of image and data fusion methodologies, developments, techniques and applications. A total of **22** papers in **4** issues have been published in 2010.

WG VII/6 has also organized a special session on Image and Data Fusion at the ISPRS Technical Commission VII Symposium-Advancing Remote Sensing Science, held in Vienna, Austria, July 5-7, 2010, and participated in the scientific committee of the GEOgraphic Object-Based Image Analysis (,sponsored by ISPRS, etc), held in Ghent, Belgium, June 29- July 2, 2010 (http://geobia.ugent.be).

Upcoming Working Group participation

The main event to be organized by WG VII/6 in 2011 is the 2011 International Symposium of Image and data Fusion (ISIDF 2011), to be held in Tengchong, Yunnan, China, on August 9-11, 2011 (http://isidf2011.casm.ac.cn/). Sponsored by ISPRS, IEEE Geoscience and Remote Sensing Society, State Bureau of Surveying and Mapping, and Taylor & Francis Group, WG VII/6 along with the Chinese Academy of Surveying and Mapping will organize this symposium. This international event will provide a forum for leading international scientists and young researchers to present their latest research developments, exchange their research ideas, and share their experience in techniques and applications of image and data fusion. There will be technical sessions, poster sessions, and social events. Selected papers will appear

in the International Journal of Image and Data Fusion published by Taylor & Francis. All papers resulting from the symposium will be published via IEEE Xplore and indexed by EI.
WG VII/6 will also co-organize the ISPRS Workshop for Change Detection and Process Modeling (sponsored by ISPRS, etc), to be held in Hong Kong, December 15-16, 2011, and participate in the scientific committee of the International Symposium on LiDAR and Radar Mapping- Technologies & Applications, to be held in Nanjing, China, May 26-29, 2011(http://www.lidar2011.org), sponsored by ISPRS, IAG and FIG.

WG VII/7 - Theory and experiments in radar and lidar

State of Science

Radar is an active remote sensing system transmitting and receiving microwaves for the retrieval of biophysical properties. Several applications using radar imagery have been explored in the last decades, such as the retrieval of vegetation density, soil moisture, the mapping of areas of flooded surfaces, river heights, etc., for as well global scale as small scale applications. Several physically-based radiative transfer models have been developed and tested for their use in parameter retrieval. The success of these models however is generally hampered by the lack of knowledge of additional biophysical parameters needed in the inverse problem (e.g. soil roughness). To overcome these problems, change detection techniques are being proposed that allow for relative information (e.g. change in soil moisture).

Airborne laser scanning (ALS) is an active remote sensing system for surface topography and object characterization. It is based on lidar range measurements between an aircraft and the target, and produces a point cloud (x,y,z), and the intensity (I). ALS has found a large number of applications in remote sensing, e.g., forestry, agriculture, cultural heritage, and built environment. The radiometric calibration and usage of the intensity data have been intensively studied recently as the first calibration methods have been published. This will enhance the usage and interpretation of point cloud data for, e.g., automatic target recognition and classification of objects. Integrating ALS with photogrammetry has also been widely studied in the laser remote sensing community.

Terrestrial laser scanning (TLS) methods have also become widely used in remote sensing, and the applications are constantly increasing in, e.g., forestry, hydrology, glaciology, archaeology, geomorphology, etc. The TLS applications are also related to vehicle-based laser scanning (also called mobile mapping), which has become a topic of increasing interest because of its efficiency in producing large amounts of data and high future potential for applications. The most recent mobile applications of TLS are commercial, low-weight TLS+GPS+IMU implemented in an unmanned airborne vehicle (UAV) platform.

Accomplishments of Working Group in 2010

1. Preparation of review article on lidar-radar synergy

Upcoming Working Group participation

1. Co-organiser Laser Scanning 2011 in Calgary. Fusion of lidar & radar data appears in the list of topics
2. Supporting Silvilaser 2011 in Hobarth, Tasmania, Australia: http://www.cdesign.com.au/silvilaser2011/
3. Finalizing review article on lidar-radar synergy

4. Other Relevant Information (TCP)

no other relevant information

5. Commission Officer Address Updates (TCP)

no updates