



# **ISPRS Technical Commission III Photogrammetric Computer Vision and Image Analysis 2008-2012**

2010 Annual report

## **Technical Commission Officers:**

- President: Nicolas Paparoditis
- Vice-President: Marc Pierrot-Deseilligny
- Secretary: Clément Mallet

## **1. General status:** (N. Paparoditis, M. Pierrot-Deseilligny, and C. Mallet)

The goal of Commission III is to develop mathematical, image processing and computer vision methods and tools to fully automate 3D data collection from satellite, aerial, street level or close-range remote sensing data (mainly optical and Lidar). The key topics which are addressed by this commission are:

- Sensor pose estimation
- Surface reconstruction
- Pattern recognition
- Image indexation and image retrieval
- Interpretation of images of complex scenes
- 3D reconstruction
- Image sequence analysis

This commission is in the continuity of the previous Commission III organizations with some slight changes: two previous working groups on “Automatic Interpretation for City Modelling” and “object extraction for Road Modelling” have been fused in one working group called “Complex Scene Analysis and 3D reconstruction”. A dedicated “pattern recognition in Remote Sensing” inter-commission working group has been created, this field being particularly active and innovative in the last few years. Another working group on

“Image Analysis for Image Indexation and Retrieval” has also been created, this field being a particularly hot topic, for the processing of, and the navigation within, huge data sets and image archives acquired from satellite, aerial and street-level platforms.

All working groups of Commission III will address the topics of benchmarking, performance evaluation, and self diagnosis of algorithms. Indeed, these subjects are a good way to promote our field and also a way to bring together researchers of different fields.

More information are available on the TC III website: <http://www.commission3.isprs.org/>

## **2. Accomplishments of Commission during the current year** (N. Paparoditis, M. Pierrot-Deseilligny, and C. Mallet)

- TC website

The [website of TC III](#) is gathers any relevant information coming from each WG. It is up-to-date.

- Commission III Symposium (PCV 2010):

The mid-term symposium “Photogrammetric Computer Vision and Image Analysis” has taken place in Saint-Mandé, France, from 1-3 September 2010 at the French Mapping Agency (Institut Géographique National). The 2010 Symposium had special sessions which covered all of the ISPRS Technical Commission III Working Groups as well as the Intercommission Working Group. It discussed recent developments and trends on sensor pose estimation, surface reconstruction, point cloud processing, automatic object extraction, and complex scene analysis. The conference was focused on methodological research. It addressed researchers and practitioners from universities, research institutes, industry, national mapping agencies, government organizations, and private companies.

It has been organised by the MATIS Laboratory of IGN under the umbrella of of the French Society of Photogrammetry and Remote Sensing (SFPT).

The scientific committee was composed of Nicolas Paparoditis (General Chair), Marc Pierrot-Deseilligny, Clément Mallet, and Olivier Tournaire. They are also editors of the paper and CD-ROM proceedings.

### **Paper review process**

Prospective authors were invited to submit:

- full papers of a maximum length of 6 pages for peer-review process by the Program Committee and additional reviewers. We received 76 full papers for peer review. The submitted full papers were subject to a rigorous double blind peer review process. 66% of these papers were reviewed by 3 members of the reviewing committee. 24% were reviewed by 2 and 10% were reviewed by 4.
- abstract of 1 page, reviewed by the Scientific Committee. 44 papers were received for such review process.

### **Program committee and reviewers**

65 people were involved in the review process, including both members of the working groups of Commission III, their students, and other major researchers on photogrammetry, computer vision, pattern recognition, and image processing.

### **Review results**

Altogether 51 papers were accepted based on the full reviews. This corresponds to a rejection rate of 34%. The accepted papers were published as printed proceedings in the IAPRS series vol. XXXVIII part 3A as well as on CD-ROM. 28 abstract were selected for publication in the IAPRS series vol. XXXVIII part 3B, and were presented in poster sessions. In all, the part B proceeding contains 41 full papers.

In total, papers coming from 26 countries have been published in the IAPRS proceedings of this event (Australia, Austria, Brazil, Canada, China, Egypt, France, Germany, Greece, Hungary, India, Iran, Israel, Italy, Japan, Lebanon, Norway, Poland, Russia, Spain, Switzerland, Taiwan, the Netherlands, Turkey, the United Kingdom).

### **Conference Managing Tool**

Conftool (Professional version) was used as CMT. PCV was eligible for the free version of the software but did not have all the requested functionalities (Paypal payment, session management etc.).

Conftool is an efficient tool that has been already extensively used for ISPRS workshops. Feedback on Conftool Pro can be asked to the TCIII secretary.

### **Symposium**

There were 135 participants (with 54 PhD students), coming from 26 countries.

The papers were presented in 8 oral sessions and in 2 poster sessions. Only a selection of 28 papers (over 51) could be presented orally due to the single track design of PCV 2010 and also due to the generous time slots reserved for discussion.

The opening ceremony on September 1 included address speeches by Orhan Altan, president of ISPRS, Laurent Polidori (president of SFPT), and Nicolas Paparoditis (president of TC III). Then, the conference started with a keynote by Wolfgang Förstner, from University of Bonn (Germany), on Graphical Models for image analysis. His excellent presentation introduced the attendees to various models as well as several feature extraction problems, such as real-time curb detection for a mobile sensor. The first technical session, chaired by Professor Förstner, dealt with pattern classification and classification, and the second one was on Surface reconstruction and matching, chaired by Helmut Mayer and Maxime Lhuillier. The afternoon started by a dense but very eclectic interactive session of 28 papers, followed by a plenary session on point cloud processing, both from airborne and terrestrial sensors, chaired by Frederic Bretar and George Vosselman. The session showed that very new machine learning and computer visions methods are now commonly used in the laser scanning community. The day ended with an attractive presentation of the ISPRS congress in Melbourne (Australia), in 2012, by Chris Bellman, which was a smooth transition to the ice-breaker, where the second vice president of ISPRS, Ammatzia Peled, officially rewarded the three students that have benefited from travel grants.

September 2 started with the eagerly awaited talk by Richard Hartley, from the Australian National University, on Camera and Convex Optimization. Professor Hartley described recent works on geometric vision problems that have exploited convexity properties to obtain globally optimal solutions. He presented in details the tight connections between different

types of convexity and optimality conditions for a large class of multi view problems. He then chaired the session on the registration of data from mobile devices and mapping systems. Another registration session followed, more focused on sensor pose estimation problems, chaired by Chris McGlone and Markus Gerke. The afternoon began with the poster session with 27 new posters which still reflected the huge diversity of sensors (from satellites and UAVs, videos, to various kinds lidar devices,) methods, and applications, that are gathered in Commission III topics. Caroline Baillard and Gunho Sohn chaired the final oral session on building reconstruction that showed such problem can be solved from multiple points of view (orthoimages, oblique imagery, lidar, and radar).

Eventually, September 3 was composed of two oral sessions, on façade reconstruction and modelling, and roads (respectively chaired by Franz Rottensteiner and Michel Roux, and Uwe Stilla and Matthias Butenuth). Both airborne and terrestrial data are involved for such tasks, and the two sessions showed the great use that is nowadays made of data from mobile mapping systems.

Nicolas Paparoditis and Laurent Polidori closed the symposium by rewarding the best poster and best papers and announcing that the French Society of Photogrammetry and Remote Sensing was officially candidate for hosting the ISPRS Congress in 2016. Nicolas Paparoditis will lead this candidature.

### **Awards**

There were a competition for the best paper and the best poster at PCV. The paper and poster awards committee was composed of the officers of the ISPRS Technical Commission III and the invited speakers.

- The best paper has been selected among a short list of papers that had received the best reviews or had been recommended for such award by one of the reviewers. Stefan Kluckner, and Horst Bischof (Institute for Computer Graphics and Vision, TU Graz, Austria) has been rewarded for their paper *Image-based building classification and 3D modeling with super-pixels*. They received a cash amount of 500€, a book offered by one of the sponsor, and a magnum of Champagne.
- The best poster has been selected among the 54 posters that have been presented by the authors during the interactive sessions. Philipp Meixner, Franz Leberl (Institute for Computer Graphics and Vision, TU Graz, Austria) has been rewarded for their paper *Characterizing building façades from vertical aerial images*. They received a cash amount of 250€, a book offered by one of the sponsor, and a magnum of Champagne.

### **Travel Grants**

Three students have benefited from ISPRS travel grants for attending the symposium.

### **Website**

The [website of PCV](#) is a permanent IGN website. It gathers all relevant information concerning the symposium: committees, proceedings, invited talks, and pictures of the event. It has received 13,300 visits from September 2009, coming from 112 countries.

### 3. Working Group Activities during the current year

**a. WG III/1 (Helmut Mayer):** Pose estimation and surface reconstruction from image and/or range data

#### 1. State of Science and Technology

The WG aims to promote within ISPRS more or less fully automatic methods for calibration and orientation without requiring markers, and for surface reconstruction. Current state-of-the-art methods are well known and to be tested with respect to general applicability, reliability, and performance. Thereby, a further refinement and robustification of the methods is to be fostered.

- Research on feature matching addresses scale-invariance linked to large off-image-plane rotations for wide-baselines.
- For surface reconstruction from images the complex reflexion properties of natural materials are addressed by advanced reflexion functions.
- New application area for (direct) pose estimation are lightweight Unmanned Aircraft Systems – UASs.
- 3D reconstruction is extended to large image sets (millions of images) taken from the Internet based on keywords. See for instance: – “Building Rome on a Cloudless Day” (no cloud computing). J.-M. Frahm, P. Georgel, D. Gallup, T. Johnson, R. Raguram, C. Wu, Y.-H. Jen, E. Dunn, B. Clipp, S. Lazebnik, M. Pollefeys, [“Building Rome on a Cloudless Day”](#), *ECCV*, Heraklion, Greece, October 2010.

The WG still cooperates with other organizations such as the International Association for Pattern Recognition (ICPR conferences), the Institute of Electrical and Electronical Engineers (IEEE) as well as the organizing committees of the major computer vision conferences (ICCV, ECCV, ACCV).

#### 2. Activities of the WG in 2010

- Participation in the midterm symposium PCV10 in Paris, France
- Meeting of the working group during an EuroSDR workshop in Munich (Germany), in November 2010.

#### 3. Planned activities of the WG in 2011

- Co-organization of the ISPRS Workshop on Photogrammetric Image Analysis (PIA) in Munich, Germany, October 5-7 2011, in collaboration with WGs I/3, III/1, and III/5 (<http://www.pf.bv.tum.de/isprs/pia11/>)
- Participation in preparation of ISPRS congress in Melbourne (Australia).
- Organization of tests for pose estimation.

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## **b. WG III/2 (Frédéric Bretar): Point Cloud Processing**

### 1. State of Science and Technology

The ISPRS Working group III/2 aims to promote the development of new methodologies, algorithms and applications related to the processing of point clouds acquired by airborne or satellite lidar system, terrestrial laser scanners as well as from other sensors. To this purpose, the WG organizes workshops to exchange the latest developments on processing point clouds. Furthermore the WG provides (links to) publicly available datasets and organizes international comparative tests on the performance of algorithms for processing point clouds for various applications. Finally, the WG will continue to work closely with WG V/3 and WG III/4 and will establish links with WG VII/7 and WG I/2.

### 2. Activities of the WG in 2010

- Review process of the Commission III Midterm Symposium in Paris, France, September 1-3.
- Recruitment of members (20 active members / 7 passive members)
- Organisation of a special issue of the ISPRS Journal of Photogrammetry and Remote Sensing [Advancements in LiDAR data processing and applications](#). Approximately 60 reviewers have been contacted to perform the reviews. We have now 32 submitted papers. Decisions will be posted to authors in the forthcoming weeks.

### 3. Planned activities of the WG in 2011

- Propose new airborne laser scanning datasets for the community.
- WG officials take part in the program committee of the Laserscanning Workshop in Calgary, Canada, August 29-31 2011 (<http://www.ucalgary.ca/laserscanning2011/>)
- WG officials take part in the program committee of the ISPRS Joint Workshop on 3D City Modeling in Wuhan, China, 26-27 June 2011 (<http://www.lmars.whu.edu.cn/3DCMA2011/>)

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## **c. WG III/3 (Mathieu Cord): Image Analysis for Indexation and Image retrieval**

### 1. State of Science and Technology

Information retrieval from image databases has been the subject of intense interest over the past few years as the size of such collections has grown, but the proportion of this work devoted to satellite, aerial and street-view images, as opposed to generic image and

multimedia databases for example, is quite small. Satellite and aerial image indexing presents several specificities. First, remote sensing databases are operated by specialists from widely varying fields. The needs of the user are thus precise and complex, yet very different from one application to another. Second, the nature of satellite, aerial and street-view images is very different from those in generic databases. Textural and spectral measures are very important for remote sensing image understanding, but are seldom used in generic databases. Other elements, such as buildings, bridges, human activity, and so on, are better characterized by their inter-relations than by their individual characteristics. Third, the high-resolution imagery that will form the databases of tomorrow varies considerably in resolution. Methods to compensate for this variability are therefore essential, but again do not form part of existing information retrieval techniques. Another very important component of the satellite, aerial, and street-view image database processing is the huge amount of data. For retrieval purpose, this scalability aspect has to be carefully considered. For generic image databases, several indexing schemes have been designed to face this problem, but it is still a scientific lock with a lot of opened questions. Learning categories and semantic concepts from these data is also a very challenging problem. Recent advances have been done to fill the gap between the low-level features extracted from the data and the high-level semantic concepts that the final user attempts to manipulate. In particular, statistical learning framework allows to efficiently work on high dimensional data, complex categories or concepts and with on-line learning. Based on the above considerations, the objective of this working group is to promote works related to the use of low-level (textural and spectral) and high-level (structural) primitives for information retrieval from remote sensing databases containing images of widely varying resolutions, within a semantic learning framework based on working image retrieval systems.

Terms of Reference:

- Information mining in large satellite, aerial, and street view image archives;
- Satellite, aerial and street-view image indexing and retrieval;
- Machine learning and context aware image understanding;
- Image semantics and knowledge representation;
- Integration of heterogeneous features : textural, spectral and geometrical attributes;
- Integration of low and high level features (points, segments, regions, graphs, etc.);
- Integration of 3D information and spatial relations between the features;
- Multi-resolution image indexing;
- Image retrieval for localisation and pose estimation;
- Managing huge heterogeneous data sets.

## 2. Activities of the WG in 2010

- Review process of the Commission III Midterm Symposium in Paris, France, September 1-3.
- Availability of a dataset for automatic text extraction benchmark. 100 images of complex urban scenes from Paris (France) that were manually collected and annotated in a XML file. These images have various types and size of text regions. See <http://www.commission3.isprs.org/wg3/> (Performed tests, distributed datasets) for more details.

- Due to the novelty of the subject, it has been noticed that it is required to attract people not from the ISPRS community.

### 3. Planned activities of the WG in 2011 and 2012

**Note: Konrad Schindler has been appointed as WG chair for the period 2011-2012.**

- Propose a benchmark for feature extraction in 2011.
- Propose a joint workshop at ICCV (Barcelona, Spain), co-organised by TC III on "Computer Vision for Remote Sensing of Environment"
- Propose a tutorial at ISPRS Congress in 2012.

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#### **d. WG III/4 (Franz Rottensteiner): Complex scene Analysis and 3D reconstruction**

##### 1. State of Science and Technology

Terms of Reference of WG III/4:

- Models and techniques for extraction of buildings, roads, cars, vegetation, and other objects for the generation and update of high-resolution 3D city models and road databases from aerial, spaceborne and terrestrial image, laser, and (In)SAR data.
- Interpretation of the above sensor data possibly together with information from traditional cartographic products, CAD models, and urban GIS.
- Development of analysis tools and models required to integrate information about multiple object classes and their interconnections within complex scenes.
- Automatic and semi-automatic generation of urban models with level-of-detail (LOD) and inferred attribution including analysis of the trade-off between geometry and radiometry / texture for visualization.
- Assessment of efficiency and quality of techniques for these objects and their dependence on the quality of the input data.

In 2010 there was a notable trend to diversify the input data used for object extraction and 3D reconstruction. Apart from typical aerial imagery, oblique aerial images as well as image and laser data acquired from moving platforms at street level were used in this context. This was reflected by a large proportion of papers based on such data that were published at the Commission III Symposium. In terms of methodology, supervised classification techniques, in particular Conditional Random Fields have become very popular to solve object recognition tasks in complex scenarios. Some notable examples were presented by Wolfgang Förstner in his keynote at the Commission III Symposium. In the past, only a few classes of urban objects such as building roofs and road were targeted, which resulted in a number of research frameworks and related vision processes. In 2010, procedures for the automated

extraction of a larger variety of urban features were presented, including curbs, trees, street lamps and façades. There was quite some research on the processing of image sequences and high performance computing for tackling the challenges in dealing with massive datasets, which is currently a bottleneck for progress in the geospatial community.

## 2. Activities of the WG in 2010

- Review process of the Commission III Midterm Symposium in Paris, France, September 1-3.
- Contributing to the reviews of GeoWeb 2010 in Vancouver, Canada, July 26-30.
- Establishment of a test data set for urban object extraction based on the data from the Camera Test of the German Association for Photogrammetry and Remote Sensing (DGPF) (ongoing) and another data set provided by Canadian public sector (City of Toronto) and private industries (Optech and First Base Solutions).

## 3. Planned activities of the WG in 2011

- WG officials take part in the program committee of the ISPRS Joint Workshop on 3D City Modeling in Wuhan, China, 26-27 June 2011

(<http://www.lmars.whu.edu.cn/3DCMA2011/>)

- WG officials take part in the program committee of the Laserscanning Workshop in Calgary, Canada, August 29-31 2011 (<http://www.ucalgary.ca/laserscanning2011/>)
- Co-organization of the ISPRS Workshop on Photogrammetric Image Analysis (PIA) in Munich, Germany, October 5-7 2011, in collaboration with WGs I/3, III/1, and III/5 (<http://www.pf.bv.tum.de/isprs/pia11/>)
- Provision of a test data set based on the data from the DGPF (German Association of Photogrammetry and Remote Sensing) Camera test and Canadian Toronto and iCampus data.

### Scope:

- Classification using Lidar and image data;
- Building roof reconstruction.

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## **e. WG III/5 (Uwe Stilla): Image Sequence Analysis**

### 1. State of Science and Technology

Image sequence analysis is playing an important role in many fields of close-range photogrammetry, computer vision, machine vision and robot vision for many years. With the development of modern, flexible digital sensors, automatic methods for analyzing and

evaluating image sequences are also entering the fields of aerial photogrammetry and remote sensing. Examples of the application of image sequence analysis in photogrammetry and remote sensing are 2D/3D object tracking, ego-motion determination, detection and characterization of dynamic processes, deformation measurements, monocular or stereoscopic mapping of the environment of a UAV or an autonomous robot, mobile mapping, biomedical motion analysis, and many others. However, recent research has shown that a pure transition of methods mainly designed for the analysis of (close-range) video streams to the aforementioned applications is not possible due to different camera characteristics, varying frame rates, other platforms and, in general, very challenging environments. Further theoretical and experimental developments accompanied by thorough validations are thus necessary to better exploit the huge information content of image sequences.

Terms of Reference:

- Studying camera and camera network calibration from image sequences including cameras with non-standard geometry and variable frame rate
- Studying ego-motion determination for navigation, georeferencing and object reconstruction
- Studying detection, reconstruction, classification and tracking of single and multiple objects in image sequences
- Studying event reconstruction from image sequences as well as single and multiple video streams
- Investigating the quality assessment of calibration, orientation and object detection using image sequences
- Benchmarking of calibration, orientation and object detection techniques using image sequences

## 2. Activities of the WG in 2010

- Workshop [Eurocow 2010](#), 10-12 February 2010, Barcelona (Spain): co-organization
- Review process of the Commission III Midterm Symposium in Paris, France, September 1-3.
- Workshop “[Multidimensional Geoinformation](#)”, 14.-15. Oct. 2010, Karlsruhe (Germany): co-organization, invited sessions, youth forum

Performed tests, distributed datasets:

We plan to provide datasets on our homepage to perform tests. The datasets will contain image sequences, reference data and additional meta data. Current data sets are:

- <http://vision.middlebury.edu/flow/> We highly encourage you to use this database if you are planning to test your optical flow algorithms.
- [http://www.mi.auckland.ac.nz/index.php?option=com\\_content&view=article&id=44&Itemid=67](http://www.mi.auckland.ac.nz/index.php?option=com_content&view=article&id=44&Itemid=67) This web site of the .enpeda.. (Environmental Perception and Driver Assistance) project offers sets of geometrically rectified stereo image sequences for the purpose of comparative performance evaluation of stereo vision, optic flow, motion analysis, or further techniques in computer vision.

### 3. Planned activities of the WG in 2011 and 2012

- 2011, 11-13 April: co-organize the conference “Joint Urban Remote Sensing Event (JURSE 2011)”, Munich (Germany) <http://www.pf.bv.tum.de/jurse2011/>
- 2011, 11-13 April: co-organize the conference “Earth Observation of Global Changes (EOGC 2011)”, Munich (Germany) <http://www.pf.bv.tum.de/eogc2011/>
- 2011, 05-07 October: organize the conference “Photogrammetric Image Analysis (PIA11)”, Munich (Germany), in conjunction with other working groups of Commission III, follow up of the PIA07 conference in 2007. <http://www.pia11.bv.tum.de/>
- 2012, 25 August – 1 September: organize sessions at the ISPRS congress in Melbourne (Australia). <http://www.isprs2012-melbourne.org/>

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### **f. ICWG III/VII (Wolfgang Förstner) - Pattern Recognition for Remote Sensing**

#### 1. State of Science and Technology

The goals of the working group is to:

- coordinate the research in the development of pattern recognition methods for remote sensing applications
- bring together researchers for photogrammetry, remote sensing, pattern recognition and machine learning
- discuss the used methods
- evaluate the methods based on common benchmarks.

Fortunately the WG is closely linked to the Technical Committee 7 on ‘Remote sensing and Mapping’ of the International Association for Pattern Recognition ([www.iapr-tc7.org/start](http://www.iapr-tc7.org/start)).

Terms of Reference:

- Statistical and non-statistical methods,
- Pixel-based and object-based methods,
- Graphical models (random fields, Bayesian nets) and stochastic grammars,
- Scale space methods,
- Data fusion,
- Quality and uncertainty,
- Benchmarking.

#### 2. Activities of the WG in 2010

- Review process of the Commission III Midterm Symposium in Paris, France, September 1-3.

- The PEPRRS'09 workshop on Performance Evaluation of Pattern Recognition in Remote Sensing that would have been held with the DAGM conference has been cancelled (only 2 papers submitted). It has been substituted by the 6th IAPR Workshop on Pattern Recognition in Remote Sensing in 2010 (PRRS'10), that has been held on August 22 during the ICPR conference in Istanbul, Turkey. The chairs were Selim Aksoy, Nicholas Younan, and Wolfgang Förstner. 17 papers were submitted. This one-day workshop was composed of two invited talks (Roger King from the Mississippi State University, and Giovanni Marchisio, from DigitalGlobe) and 9 oral presentation, for an attendance of 40 people.

### 3. Planned activities of the WG in 2011 and 2012

- A benchmark based on multichannel-images and ground truth for evaluating and comparing image interpretation methods will be set up in 2011 and the results will be presented at the ISPRS Congress in 2012. This is already known that a key issue is the difficulty to have data and ground truth.
- Contacts will be established with the EuroSDR to ask mapping agencies which kinds of applications are foreseen.

### 4. **Other Relevant Information** (N. Paparoditis, M. Pierrot-Deseilligny, and C. Mallet)

- The Commission III will propose a workshop at ICCV 2011 (Barcelona, Spain) on “3D point cloud in Computer Vision”. It is aimed to be a joint event between the photogrammetric, computer vision, and computer graphics communities.
- Summary of the activities of the six WG of TC III for 2010:

WG	III/1	III/2	III/3	III/4	III/5	ICWG III/VII
<b>Active members</b>	4	20	6	23	19	82
<b>Passive members</b>	0	7	1	3	-	-
<b>Benchmark</b>	x		x (in 2011)	x (in 2011)		x
<b>Datasets</b>	x	x (2004-2008)	x	x (in 2011)	x	x
<b>Software</b>		x	x			
<b>2010 workshop</b>						x
<b>Link with other committees or conferences</b>	Computer Vision conferences					IAPR TC7

## **5. Commission Officer Address Updates (N. Paparoditis, M. Pierrot-Deseilligny, and C. Mallet)**

- Konrad Schindler from ETH Zürich is the new chair of WG III-3.

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- Olivier Tournaire (secretary of WG III-3) has moved from IGN - laboratoire MATIS (France) to CSTB (France)

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