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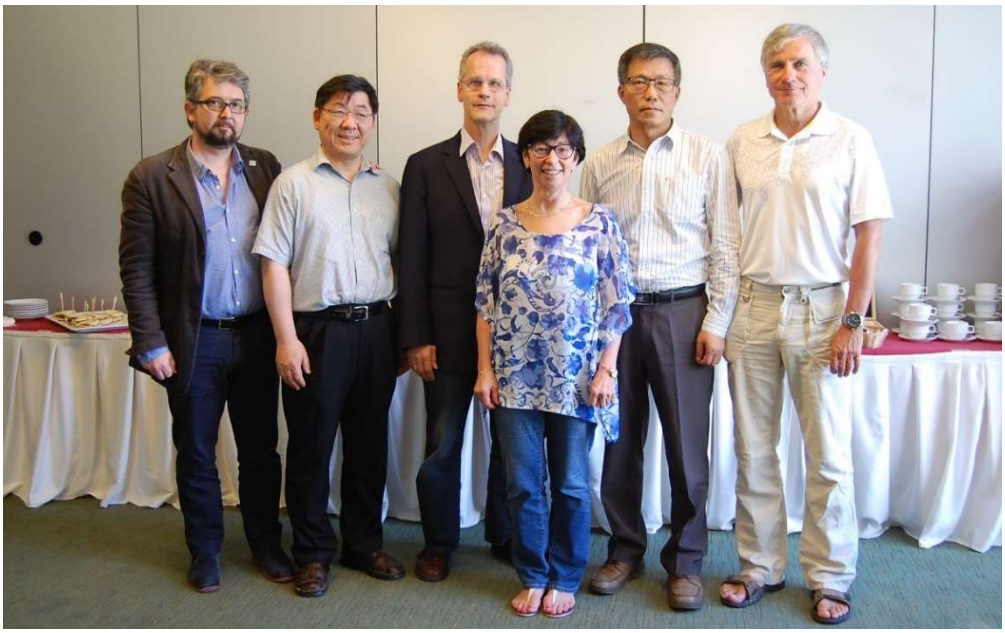

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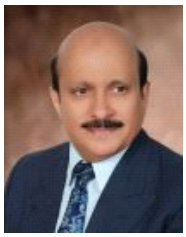

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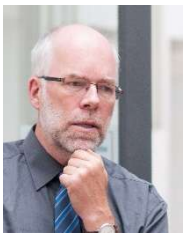

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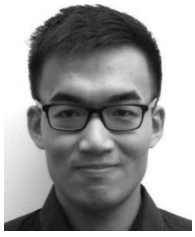

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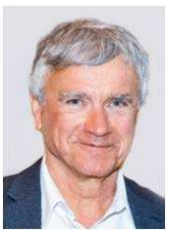

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- Innovative and integrated UAS-oriented sensor and (small) platform concepts
- Systems and methods for terrestrial and mobile mapping in complex indoor and outdoor environments
- Small and low-cost active sensing (micro-LIDAR and -RADAR sensors)
- Design and realization of sensors and constellations for digital aerial and spaceborne missions for Earth observation
- Geometric and radiometric properties, quality standards, and factors affecting data quality
- Benchmark definition, calibration and evaluation of imaging and non-optical imaging sensors
- Integrated platform guidance, navigation, direct georeferencing (positioning and orientation) and integrated sensor orientation
- On-board (pre-)processing and concepts for embedded systems

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- Design, calibration, simulation and physical modelling of hyperspectral and multispectral sensors
- Imaging spectroscopy based on snapshot frame- and line-based camera systems in the VNIR, SWIR and LWIR spectral ranges
- Sensor-oriented / physically-motivated hyperspectral data processing for performance analysis
- Feasibility study for the integration of emerging technologies such as smartphone spectrometers for validation purposes
- System performance investigations based on multi-sensor data fusion and multi- and hyperspectral applications

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WG I/2 Terms of Reference

- Design and assessment of topographic and bathymetric LiDAR sensor systems (e.g., multi-pulse, full-waveform, multi-/hyper-spectral, single-photon) mounted on airborne and spaceborne platforms
- Geometric and radiometric evaluation of optical sensor systems mounted on airborne and spaceborne platforms
- Data quality and performance validation of LiDAR and optical systems for digital surface modelling and 3D feature reconstruction
- Development and evaluation of innovative algorithms and software tools towards real-time LiDAR and optical data processing onboard airborne and spaceborne platforms
- Investigation and evaluation of systems integrating LiDAR and optical sensors

WG I/3 - SAR and Microwave Sensing

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WG I/3 Terms of Reference

- Investigations on recent and upcoming spaceborne SAR sensors
- SAR big data and global coverage from Sentinel1 mission
- Investigations on new airborne SAR systems
- Evaluation of advanced SAR sensor modes and SAR constellations (e.g., bi-static, multi-baseline, multi--aspect, multi-frequency, polarimetry etc.)
- Fusion of SAR data and complementary data (e.g. optical imagery)
- Liaison with other groups and societies, mainly TCIII-2, TCIII-3, as well as IEEE-GRSS

WG I/4 - Calibration and Validation of Satellite Sensors

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WG I/4 Terms of Reference

- Parameter design and simulation of space borne optical system
- Geometric/radiometric calibration and validation including laboratory and in-flight calibration of space borne optical sensors
- Geometric imaging modeling of space borne optical sensors and/or LiDAR systems
- Analysis of direct sensor orientation accuracy and changes during the lifetime of sensors
- Evaluation of space borne sensors for DEM/DSM and DOM generation (cooperation with one working group of Commission II)

WG I/5 - New 3D Sensors for Metrology and Industrial Vision

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WG I/5 Terms of Reference

- Developments and investigations on modern active sensing techniques (single photon detection, amplifying, statistics, etc.)
- Metric quality and (self-)calibration of low-cost 3D sensors (structured light cameras, time-of-flight cameras, etc.)
- Analysis of low-cost / micro-LIDAR and micro-RADAR systems
- Advances in industrial applications of 3D sensors (metric measurements, hand-eye-calibration, real-time object identification/recognition)

WG I/6 - Multi-sensor Integration and Fusion

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WG I/6 Terms of Reference

- Multi-sensor system design and on-board processing;
- Cross-platform sensing with land-, air-, and space-borne platforms;
- Data quality control/assurance and enhancement for multi-sensor multi-platform solutions;
- Ubiquitous sensing solutions with non-conventional low cost sensors in mobile devices;
- GNSS/IMU/image/ranging sensor integration and fusion for positioning and navigation (for indoor and outdoor);
- Inter-sensor synchronization and In-situ stability analysis of system calibration parameters.

WG I/7 - Mobile Mapping Technology

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WG I/7 Terms of Reference

- Design, development and evaluation of mobile mapping systems
- Design and development of real-time data processing algorithms for mobile mapping systems
- Automation of information extraction from land-based mobile imaging and ranging sensor data
- Development of novel applications in virtual reality, GIS, transportation infrastructure mapping and assessment, including pavement and asset mapping, emergency response
- Cooperation with ICA, IAG, FIG, and other ISPRS WGs on 3D mobile mapping; image indexing and retrieval; 3D object reconstruction and city modelling; sensor integration and multiple sensing solutions; and applications in LBS and disaster management.

WG I/8 - Satellite Constellations for Remote Sensing

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WG I/8 Terms of Reference

- Geometric and radiometric characterization of satellite constellations data (e.g. Planet, RapidEye, DMCII, etc.), spectral interpretability analysis.
- Comparison of constellations and with monolithic systems in algorithms and applications
- Data quality, usability, availability and timeliness; geometric, radiometric characterization of data from satellite constellations, spectral interpretability through remote sensing studies
- Advancements in image time series analysis through satellite constellations
- Evaluation of new applications with single or multiple satellite constellations, e.g. traffic monitoring using video from the space, time series 3D mapping with data from satellite constellations
- Development and evaluation of new algorithms and software tools of processing high temporal and spatial resolution data
- Collaborate with ISPRS WGs and other societies, including AGU, IEEE-GRSS, CV and other communities (Civil, Environmental, hydrology, etc.), to promote the use of satellite constellations for remote sensing applications.

WG I/9 - Integrated Sensor Orientation, Calibration, Navigation and Mapping

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WG I/9 Terms of Reference

- General rigorous modeling of positioning and attitude sensors.
- Spatial absolute, relative and temporal modeling of non-standard sensors (low-cost, new-geometry, combined-geometry configurations).
- Use of Stochastic Differential Equations in orientation and calibration for photogrammetric applications.
- Orientation/calibration with UAV and micro aerial vehicles.
- Photogrammetric/LiDAR orientation and calibration: measurement techniques and models.

WG I/10 - Sensor Systems Verification, Benchmarks, Evaluation

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WG I/10 Terms of Reference

- Characterisation of sensor behaviour from UV to LWIR, RADAR
- Traceability
- Image (data) quality (PSF & SNR)
- Prerequisites (Lab equipment): Radiation sources, collimators, integrating spheres
- Spatial, radiometric, etc. characterization on sensor level
- Linearity, PTC, PRNU, DSNU, CTE, …
- MTF, keyston, smile, etc.
- Algorithms and data evaluation, Usability

ICWG I/II - UAS & Small Multi-sensor Platforms: Concepts & Applications

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ICWG I/II Terms of Reference

- UAS navigation and positioning in outdoor and indoor environments
- UAS data processing and analysis for Photogrammetry and Remote Sensing applications (Scientific Research, Commercial, Defense)
- UAS platforms, payloads, instruments and their on board integration for Photogrammetry and Remote Sensing (LIDAR, Multi and hyperspectral, Thermal, SAR, gas detectors, etc.)
- Integration of UAS data with information acquired by different platforms (satellite, airborne and terrestrial) and sensors (active and passive)
- Documentation and comparison of innovative UAS systems and sensors in Photogrammetry and Remote Sensing
- Comparison of UAS regulations and contribution to new regulations in different countries
- Dissemination of learning and teaching material on the use of UAS in Academia
- Collaboration with other scientific communities and associations involved in UAS applications (EuroSDR, robotics, computer vision, electronics, etc.)
- Cooperation and involvement of industrial partners in ISPRS activities

ICWG I/IV - Robotics for Mapping and Modelling

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ICWG I/IV Terms of Reference

- Address challenges in employing robotics for mapping and challenges in map representations for robotics and autonomous vehicle navigation
- Assess robotic mapping platforms for indoor and outdoor environments
- Evaluate localisation and mapping sensors for indoor and outdoor robotics
- Investigate the use of on-board sensors of autonomous vehicles for mapping and map updating purposes
- Research and apply spatial representations, data structures and database technologies for large scale mapping and map updating
- Address the derivation and updating of sustainable urban and building models
- Investigate the semantic enrichment of urban and indoor models, specifically for analysis and autonomous navigation purposes
- Exploit synergies between indoor mobile mapping and building information modelling (BIM)
- Investigate new robotic and indoor mobile mapping applications
- Develop and implement indoor mobile mapping benchmarks
- Establish and strengthen contacts with the robotics community

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Terms of Reference

- Sensor pose estimation and autonomous navigation
- Multi-image geometry, DEM and 3D model generation
- Spatial, spectral and temporal analysis of image and range data, including pattern analysis and machine learning methods for object detection and recognition, image classification and point cloud processing
- Integration and fusion of multiple data sources for advanced object detection, scene understanding and 3D modeling
- Upscaling of photogrammetric processing methods, big data and cloud computing
- Image-based and range-based systems and methods for mapping, industrial, heritage, space, underwater and environmental applications
- Liaison with Commission I on sensors and platforms for photogrammetric applications
- Liaison with Commission III on photogrammetric methods for remotely sensed data
- Liaison with Commission IV on geometric content creation for GIS and mapping applications
- Liaison with Commission V on knowledge transfer and outreach

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WG II/1 Terms of Reference

- Orientation of non-conventional image sources, i.e., oblique images, cameras with rolling shutter, crowd-sourced images
- Feature extraction and stereo/multi-view sparse matching
- Image alignment and applications such as mosaicking, denoising, deblurring, super resolution, etc.
- Direct and indirect geo-referencing
- Intrinsic/extrinsic camera calibration including methods based on single images, online approaches, or handling ambiguous and degenerate configurations
- Structure from Motion and SLAM
- Geometric/algebraic computer vision, multi-image geometry, and modern approaches to Bundle Adjustment, e.g., large-scale or structureless BA
- Evaluation of performance, reliability, robustness and generality of methods

WG II/2 - Point Cloud Generation

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WG II/2 Terms of Reference

- Stereo and Multi-View-Stereo approaches for terrestrial / UAV / aerial / spaceborne imagery
- Methods for mesh generation
- Filtering, fusion and integration of point clouds from different data sources or sensors for surface reconstruction
- Quality and performance evaluation of point cloud generation with respect to computational complexity, precision, robustness and scalability of methods

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WG II/3 Terms of Reference

- Development of new methodologies, algorithms and applications for point cloud processing
- Information extraction from point clouds, including low-level feature extraction, segmentation and classification
- Point cloud registration and fusion
- Cloud Computing and high-performance computing for massive point cloud processing
- Geospatial Big Data processing for point clouds
- Point cloud rendering and streaming for massive point clouds
- Point cloud processing for building information modelling (BIM)
- Ubiquitous point cloud sensing

WG II/4 - 3D Scene Reconstruction and Analysis

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WG II/4 Terms of Reference

- Models and techniques for extracting features, geometrical primitives and objects from data acquired by airborne and/or terrestrial sensors, including object recognition and 3D object reconstruction, and possibly integrating information about multiple object classes and their relations within complex scenes.
- Classification and semantic segmentation of point clouds and surface meshes with or without radiometric information.
- Generation and update of high-resolution 3D city models and road databases, including mesh based, polyhedral, parametric and multiscale representations possibly with level-of-detail (LOD) and (semantic) attributes, and texturing of the resultant 3D models.
- Object detection, recognition and 3D reconstruction in the context of robotics or autonomous driving.
- Multimodal data fusion: performing any of the tasks mentioned above by exploiting the complementarity of using different viewpoints (space-borne, nadir/oblique aerial, UAV, fixed/mobile terrestrial), different sensor types (monoscopic/stereoscopic images, LiDAR, (In)SAR), and existing data (traditional cartographic products, CAD models, urban GIS).
- Assessment of efficiency and quality and of their dependence on the quality of the input data, including uncertainty analysis and uncertainty propagation, for any of the tasks mentioned above.

WG II/5 - Dynamic Scene Analysis

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WG II/5 Terms of Reference

- Videogrammetry
- Dynamic scene understanding from image sequences.
- Models and methods to determine ego-motion for photogrammetric and computer vision applications including but not limited to navigation, geo-referencing and object reconstruction.
- Detection, reconstruction, classification and tracking of single and multiple objects in image sequences
- Event reconstruction and scene analysis from single and multiple image streams.
- Offline and real-time 3D processing of image sequences (MOCAP system, mobile mapping, etc.)
- Quality assessment techniques for calibration, orientation and object detection from image sequences
- Benchmarking of object detection and semantic segmentation from image sequences
- Change detection in image time-series and/or 3D point clouds

WG II/6 - Large-scale Machine Learning for Geospatial Data Analysis

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WG II/6 Terms of Reference

- Large-scale image classification,
- Machine learning, deep learning,
- Pixel-wise semantic segmentation at large-scale,
- Supervised, weakly supervised, transfer, and human-in-the-loop learning
- Multi-view, multi-temporal, multi-modal image interpretation
- Change detection and environmental / urban monitoring

WG II/7 - Vision Metrology

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WG II/7 Terms of Reference

- Performance evaluation of active and passive systems
- Definition of accuracy and best practice
- Contribution to international standards
- System developments and industrial applications
- Very close range and large volume measurement applications
- Camera-controlled robot and machine guidance
- Measurement of dynamic processes
- Structural deformation analysis
- Medical systems and applications
- Greater involvement of industrial partners in ISPRS activities

WG II/8 - Data Acquisition and Processing in Cultural Heritage

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WG II/8 Terms of Reference

- Development and promotion of data acquisition strategies, data processing techniques and data management solutions (such as the spatial information systems GIS and BIM) applicable to all subjects that can be categorized as cultural heritage.
- Integration of data and measurement techniques supporting metric and remote sensing surveys, and monitoring actions for the valorization, conservation, restoration and archiving of archeological, architectural, urban and natural landscape heritage.
- Development and dissemination of best practice protocols to aid appropriate application across related cultural heritage fields.
- Development and promotion of low-cost, rapid, innovative, automated, commercial and open-source approaches for metric and remote sensing survey of heritage assets.
- Development of both virtual and augmented reality as well as online applications and advanced visualization systems to promote the dissemination and the correct use of 3D metric surveys.
- Close co-operation with related disciplines, national / international groups (e.g., CIPA, EAA, ICOMOS etc.) and other ISPRS working groups

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WG II/9 Terms of Reference

- Definition of best practice for geometric calibration, color correction and validation of systems for underwater 3D measurements

- Geometric and stochastic modeling of multimedia geometry for underwater image and range measurements
- Lidar bathymetry for seafloor and water surface measurement
- Algorithms and methods for underwater localization and navigation used in ROVs, AUVs and augmented and virtual reality applications
- Combined above water, through water and underwater techniques for 3D modeling of artefacts and mapping of coastal areas
- Integration and performance evaluation of platforms such as ROVs, AUVs, towed bodies and diver controlled systems
- Underwater applications and techniques in archaeology, 3D/2D mapping, modeling and visualization, biomass estimation, habitat monitoring, metrology, inspections and volumetric reconstruction for flow tracking

WG II/10 - 3D Mapping for Environmental & Infrastructure Monitoring

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WG II/10 Terms of Reference

- Improve methodology for 3D mapping and monitoring of geohazards, geomorphology and vegetation
- Study and promote the use of 3D photogrammetric techniques for inspection and life cycle monitoring of infrastructures like bridges, buildings, dikes, and to improve on the integration with structural component analysis
- Analyse, share and promote best 3D approaches and results in biomedical applications in collaboration with the biomedical society
- Study techniques for near-continuous spatio-temporal 3D monitoring of environmental, infrastructural and biomedical processes.
- Evaluation and integration of new 3D and 2D imaging sensors for the purpose of 3D mapping for environmental and infrastructure monitoring

ICWG II/III - Pattern Analysis in Remote Sensing

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ICWG II/III Terms of Reference

- Automatic identification and learning of 2D and 3D patterns in uni-modal and multi-modal remote sensing data, e.g., multi-scale aerial and satellite data; multi- and hyperspectral data; SAR-, radargrammetric and SAR-tomography data
- Automatic identification and learning of temporal patterns in remote sensing data, e.g., image-based flow estimation and learning from InSAR data (traffic, glaciers, currents, etc.); analysis-by-synthesis approaches for motion and deformation modeling with passive and active sensors
- Integration of radiometry and radiometric models into pattern recognition; radiometrically enhanced object models for range-intensity images and sequences; integration of SAR-simulation into SAR-image and analysis
- Recognition of 2D and 3D patterns in remote sensing data exploiting 3d and 4d models (GIS / CAD / BIM)

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Terms of Reference

- Focus on physical modelling of electromagnetic radiation, the analysis of spectral signatures, image classification, data fusion, pattern recognition, and quality control;
- Enhance the applications in monitoring and assessing environment, landuse/landcover, nature resources, weather/atmosphere and climate, cryosphere, coastal and ocean, forestry/agricultural and ecosystems/biodiversity
- Integrate the global efforts by effective out-reach through data/algorithms sharing and capacity building, cooperates intensively with national space agencies, alliance with the International Committee on Remote Sensing of Environment (ICORSE)

WG III/1 - Thematic Information Extraction

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WG III/1 Terms of Reference

- Promote scientific studies of new technologies and methodologies of thematic information extraction with emphases on the diachronic, multi-scale and multi-sensor approaches.
- Develop data architecture tackling with big data and crowd sourcing data for thematic information and its dynamics
- Virtual reality for thematic information demonstration
- Promote the technique transfers through collaboration and networking between universities, research organizations, national space/mapping agencies, and policy makers
- Promote the education, communication and collaborations through courses, articles and workshops
- Collaborate with RS National and International forums and organization (GEO, GEOSS, CEOS, etc) and interact with international agencies of environmental research and protection (IPCC, WMO, UNEP, IMD, Mountain Partnership, GLISPA, etc.).

WG III/2 - Microwave Remote Sensing

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WG III/2 Terms of Reference

- Promote advanced research, engineering development, and operational use of theories, methods, systems for the analysis of remotely sensed microwave observations of the Earth from air-, space- and ground-borne sensors;
- Focus on physical modelling of microwave radiation, the analysis of spectral signatures, radar image classification, data fusion, pattern recognition, and quality control;
- Enhance the applications in monitoring and assessing environment, geohazards, landuse/landcover, nature resources, weather/atmosphere and climate, cryosphere, coastal and ocean, forestry/agricultural and ecosystems/biodiversity;
- Integrate the global efforts by effective out-reach through data/algorithms sharing and capacity building, cooperates intensively with international professional societies, national space agencies, and alliance with the International Committee On Remote Sensing of Environment (ICORSE).

WG III/3 - SAR-based Surface Generation and Deformation Monitoring

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WG III/3 Terms of Reference

- Generation and accuracy assessment of DEM from SAR imagery
- Object extraction from InSAR data
- Differential SAR Interferometry and Persistent Scatterer Interferometry
- Ground based SAR Interferometry

WG III/4 - Hyperspectral Image Processing

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WG III/4 Terms of Reference

- Visible, Ultraviolet, NIR, SWIR and thermal imaging spectroscopy from satellite, aerial, UAV and ground platforms
- Processing and analysis of 1D signals, 2D images, 3D hypercubes and 4D hyperspectral video datasets
- Radiometric, atmospheric and geometric calibration/corrections of hyperspectral data
- Efficient hyperspectral image classification and analysis for the consistent estimation of geo- and bio-physical parameters, mapping, vegetation analysis in agriculture,

forestry and others, and environmental remote sensing
- Fusion of hyperspectral data, other sensor data (e.g., Lidar, SAR) and a priori information
- Processing and interpretation of hyperspectral image data from low-cost, miniaturized sensors from UAV and other platforms
- Detection, classification and tracking of moving objects/phenomena in hyperspectral video sequences
- Efficient hyperspectral data processing through parallel programming, graphic card implementation and FPGAs

WG III/5 - Information Extraction from LiDAR Intensity Data

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WG III/5 Terms of Reference
- Development and research of non-topographic LiDAR data applications for surface condition assessment
- Geophysical parameters retrieval from LiDAR intensity data
- Development and evaluation of new methods and algorithms of laser intensity-based classification and segmentation
- Integration and performance evaluation of LiDAR data intensity and other data types for synergy of new information
- Data processing and application of multi-wavelength and full-waveform LiDAR
- Development and dissemination of new methodic and technology of exploiting intensity data from terrestrial laser scanning sensors for surface condition assessment
- Processing of intensity data from bathymetric LiDAR for quality assessment of underwater conditions
- Promoting applications based on LiDAR intensity data, also integrated with other data sources, to cope with societal challenges

WG III/6 - Remote Sensing Data Fusion

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WG III/6 Terms of Reference
- Pixel, feature and decision level fusion algorithms and methodologies
- Automatic geometric registration for fusing images with different spatial, spectral, temporal resolutions; phase information; or acquired in different modes
- Data assimilation
- Multi-source data fusion-based classification and information extraction
- Multi-modal sensor data fusion
- Multi-temporal data fusion
- Image and data mining from multi-platform, multi-source, multi-scale, multi-temporal data sets
- Data fusion applications in geographic-related fields such as

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WG III/7 - Landuse and Landcover Change Detection

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WG III/7 Terms of Reference

- To investigate and enhance algorithms and methodologies for land-use and land-cover change-detection
- To suggest advanced solutions for monitoring land –cover changes
- To further the study of the dynamics of land-use and land-cover change in different regions of the world
- To further the research and investigations into predicting land-use changes
- To study urban land-use development cycles and changes in rural land-cover and land-use (e.g., Agriculture, forestry, recreation), based on data and information fusion
- To further the research into automatic updating of spatial data bases
- To foster investigations and research toward autonomous updating of core spatial data bases using spectral and non-spectral remotely sensed data fused with data and information acquired by other sources.
- To cooperate with other Geospatial Information societies such as ICA and FIG on Change detection based on remotely sensed data and updating of spatial data bases.

WG III/8 - Remote Sensing of Atmospheric Environment

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WG III/8 Terms of Reference

- Development of satellite observations on atmospheric environment including air pollutants, aerosol and its dynamic process
- Development of new models for estimating atmospheric aerosol optical depth, characteristics and particulate matters (PMs) concentration
- Development of new models for extracting atmospheric parameters through sounders/GPS/LiDAR/radio occultation, etc.
- Development of spatio-temporal methodologies and GIS-based systems for atmospheric environment analysis
- Evaluation and validation of satellite observations on atmospheric components and PMs concentration
- Assessment of the impact of urbanization and fossil energy on atmosphere environment
- Collaborate with GEO to serve for public affairs and human health with data and maps

WG III/9 - Cryosphere and Hydrosphere

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WG III/9 Terms of Reference

- Develop remote sensing data for assimilation in cryospheric and hydrological models
- Conduct assessment of errors in the retrieval of satellite cryospheric and hydrological parameters
- Assemble historical records of consistently derived geophysical parameters for studies of changes and trends in the cryosphere and hydrosphere
- Assess glacier and ice sheet mass loss and relationships to sea level rise with consideration of thermal expansion, tectonic causes and other factors.
- Investigate the asymmetry in the changes of sea ice in the Arctic and Antarctic regions
- Study trends and changes in albedo at high latitudes and relationships with changes in snow cover and melt patterns
- Monitor variability and trends in surface temperature and how they affect snow cover, sea ice extent, glaciers and ice sheet volume, soil moisture and the permafrost regions
- Measure, characterize, understand, and predict the storage and transport of momentum, heat, water (salinity), and greenhouse gases in the ocean and the surface signatures (temperature, salinity, dynamic topography) of the ocean's response to surface forcing (wind stress, fresh water, turbulent and radiative heat flux) from diurnal to decadal time scales, and from coastal to open oceans
- Understand the oceans' role in the changes and interactions amongst the biological, chemical, and energy/water cycles in the oceans and their influence on terrestrial and cryospheric changes
- Help coordinate present and future remote sensing missions especially those related to ocean, snow/ice, and terrestrial hydrological observations, and provide expertise in the calibration, validation, and dissemination of the resulting data
- Develop early warning systems for natural disasters like droughts and floods

WG III/10 - Agriculture and Natural Ecosystems Modelling and Monitoring

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WG III/10 Terms of Reference

- Development of new methodologies and algorithms for improving the contribution of remote sensing towards knowledges related to agriculture and natural ecosystems
- Test and assess new remote sensing algorithms for monitoring natural and anthropogenic ecosystems
- Apply remote sensing for supporting precision agriculture by spectral signature in crops for smart farm management
- Support climate change studies through remote sensing applications for global and regional scales dynamics monitoring and modelling
- Collaborate with related academia, researchers, industry and other stakeholders

ICWG III/II - Planetary Remote Sensing and Mapping

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ICWG III/II Terms of Reference

- Development of new methodologies and algorithms for sensor calibration, data fusion and information extraction from planetary remote sensing data
- Development of advanced techniques in planetary photogrammetry and robotic vision for the mapping of celestial bodies
- Evaluation and refinement of reference systems, coordinate systems, control networks, map sheet definitions, etc. and their standardization
- Development of spatial information systems to support extra-terrestrial exploration and science
- Cooperation with related planetary exploration working groups in space agencies and organizations, and liaisons with the ICA Commission on Planetary Cartography

ICWG III/IVa - Disaster Assessment, Monitoring and Management

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ICWG III/IVa Terms of Reference

- Generation of vulnerability and hazard zone maps for different type of disasters, such as forest fire, cyclone, floods, drought, volcano eruptions, earthquakes, landslides etc. and identification & assessment of potential risk zones
- Integrate remotely sensed observations and communication strategies with enhanced predictive modelling capabilities for disaster detection, early warning, monitoring, damage assessment and response
- Development of disaster management plans for pre, during and post disaster situations and enhance support for early warning systems, emergency events mitigation and decision making.
- Collaborate with international bodies such as GEO, JBGIS, ICSU GeoUnions, IRDR
- Continue to organize Gi4DM Conference series and ISPRS-URSI Special Sessions on Disaster Management during URSI GA's and ISPRS Congresses.
- Organise, develop and conduct supporting educational activities (training courses, workshops, webinars, etc.) in the interdisciplinary area of remote sensing and disaster management. The educational activities will contribute to further education and professional development of both experienced and early-stage remote sensing scientists and engineers.

ICWG III/IVb - Remote Sensing Data Quality

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ICWG III/IVb Terms of Reference

- Assess the current status of scientific development and applied practices, related to Remote Sensing Data Quality, and suggest development plans, researches, activities and projects for the improvements and advent of the same.
- Liaison with sister commissions and WGs involved partially with

data quality, and also with other international organizations to assist the development and improvement of Remote Sensing Data Quality Standards and Protocols, and promote their implementations worldwide.

- Inventory and classify the elements of Remote Sensing Data Quality, and relate it to the quality of other disciplines, the usage and fitness of purpose, and to the simulated world model of data and information.
- Encourage and support scientific works that deal with the improvement of remote sensing data quality processes and management steps, also that clarify and regulate the effects of error propagation due to acquisition, referencing, storing and archiving, processing, analysing, reporting and other operations related to remotely sensed data.
- Clarify the quality aspects of Remote Sensing data, resulting and inherited from raster or vector-raster operations, such as but not limited to pixel processing, segmentation, classification, object base image analysis, image sensitivity analysis, etc.
- Study the reliability and quality measures of Remote Sensing data, in relation to the different application areas that encounter remote sensing, such as environmental monitoring and sustainability, urban planning, city smartness and quality of life, also humanitarian projects for the developing world among other areas of application.
- Assess Remote Sensing Data Quality with respect to the usage of automated major signatures of the electromagnetic spectral different phases, as much as the relations of the type to the sensors used and the area of application, coverage, visits. Sensor positions, sky clearness, etc.

ICWG III/IVc - Environment and Health

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ICWG III/IVc Terms of Reference

- Review the United Nations Office for Outer Space Affairs (UNOOSA) mandate, activities and plan that relate to human health.
- Advance knowledge in Remote Sensing and other geospatial technologies for applications in Tele-epidemiology.
- Develop a white paper for clinicians documenting the capability of Remote Sensing and other geospatial technologies in capturing environmental variables to incorporate into clinical practices as a disease risk factor.
- Bridge the geospatial science, Earth science and health science communities to explore interdisciplinary collaborations to improve our overall health and well-being.
- Develop two expert groups: 1) Remote Sensing and geospatial technology applications in estimating environmental exposure risk factor for clinical practices and 2) Remote Sensing and geospatial technology applications in ecosystem, climate change and variability, and public health studies.
- Advance knowledge in estimating allergen abundance.
- Review current applications of tools, such as, machine learning, in estimating air pollutants using remotely sensed and other data.
- Contribute to the GEOSS open access public health data resource.

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Terms of Reference
Considering the state of the art in Spatial Information Science and the ISPRS TC IV 2012-2016 resolution, we define the following ToF:

- Strengthen the work on multidimensional spatial model and representations towards seamless data fusion (WG1)
- Advance the semantic modelling, development and linking of ontologies (WG2)
- Intensify the research data interpretation, quality and uncertainty modeling (WG3)
- Strengthen the research on crowdsourced data and public participation, towards community-driven and participatory applications, collaborative mapping and use/usability of maps (WG 4)
- Stringent the research on seamless indoor/outdoor location-based services, navigation and tracking, and analysis of human movement (WG5)
- Advance interoperable Internet of Things, Sensor web, SDI and linked data (WG6)
- Advance the research on spatial data types, indexing methods and analysis to further contribute to development of spatial DBMS for management and analysis of multi-dimensional data (WG7)
- Encourage the use of functional programming and streaming algorithms in development of demos and applications as well as parallel and distributed processing paradigms. (WG8)
- Advance visual analytics, online multi-dimensional visualization on mobile and desktop devices, considering human-centered applications, privacy and security issues (WG9)
- Advance knowledge on use of spatial information (BIM/GIS) for urban modelling (WG10)

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WG IV/1 Terms of Reference

- Reviewing conceptual models for spatial, temporal and spatiotemporal data
- Encourage the development of new models integrating time and scale dimensions with the spatial dimensions
- Investigating new algorithms and data structures taking advantage of multiple dimensions
- Investigating multidimensional models for multiple representation of data for data enrichment
- Promoting the use of these models in geospatial applications
- Facilitating exchanges between researchers on conceptual modelling and actors in GIS applications
- Integrating multisource data into open formats and encouraging the use of standards for sharing geospatial data and resources
- Promoting the use of multidimensional models in geospatial applications in collaboration with WGI/IV and ICWGIV/II

WG IV/2 - Ontologies, Semantics, and Knowledge Representation for Geospatial Information

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WG IV/2 Terms of Reference
In order to describe the scope and limitations of the activities of WG IV/2 the following terms of reference have been defined:

- Explore recent advances in geospatial ontologies, semantics, and knowledge representation.
- Explore ontologies and semantics of cutting-edge research topics such as semantic web, big data, linked data, and Volunteered Geographic Information.
- Work on spatial ontologies and semantics data quality and standards.
- Study the development, integration, and evolution of domain geospatial ontologies, classifications, nomenclatures, etc. (land use / land cover, hydrography, etc.).
- Investigate new applications of ontologies in domains such as disaster management, urban modeling, mobility, and architecture.
- Research formalisms, methods, and tools for semantic information representation, extraction, and visualization related to geospatial entities and events.
- Explore topics related to semantic interoperability, semantic similarity, semantic enrichments and semantic annotation, etc.

WG IV/3 - Spatial Data Analysis, Statistics and Uncertainty Modelling

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WG IV/3 Terms of Reference

- Review data mining methods applicable to spatial data
- Review methods for spatial data quality assessment for the several types of spatial data
- Develop new algorithms and/or combination of methodologies to integrate different types of spatial data
- Develop methods to assess quality of information resulting from data integration
- Advance knowledge in assessing spatial data fitness for use
- Performance assessment of spatial data optimization methods
- Development and evaluation of innovative algorithms and software tools of interoperability in GIScience
- Evaluation of various multi-criteria decision making methods
- Review crowd sourced data and VGI
- Address challenges in big spatial data on GISciences
- Investigation and evaluation of spatial data fusion/integration methods
- Review spatial statistics methods and their uncertainty assessment
- Review interoperability in spatial data bases

WG IV/4 - Collaborative Crowdsourced Cloud Mapping (C^3M)

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WG IV/4 Terms of Reference

- Design and develop collaborative geospatial environments and services for managing crowdsourced spatiotemporal data (acquiring, storing, publishing, sharing).
- Design and develop methods (and guidelines) for assessing/improving the quality and usability of crowdsourced data (validation and verification).
- Design and develop data and metadata models for crowdsourced data.
- Design and develop methods (and guidelines) for integrating crowdsourced data and
  - in situ/UAV/aerial/satellite sensor data;
  - authoritative geospatial information.
- Investigate social and organizational issues related to crowdsourcing, cloud-based geo-services, collaborative systems, participative platforms.
- Provide guidelines and support to connect the ISPRS network to humanitarian and SDG agendas.
- Review the scientific and technological state of art in Human-Machine Interaction.
- Advance knowledge in Human-Machine Interaction for Participative Mapping.
- Promote cooperation with related working groups and organizations including ISPRS WG IV/5; International Federation of Surveyors (FIG) - Commission of Spatial Information Management; GeoForAll; Humanitarian OpenStreetMap Team (HOT); International Cartographic Association (ICA) - Commission on Sensor-driven mapping, Commission on Maps and the Internet, Commission on Open Source Geospatial Technologies; Missing Maps; Open Geospatial Consortium (OGC); Open Source Geospatial Foundation (OSGeo); OpenStreetMap (OSM) communities; crisismappers network, digital humanitarian network and Open Forum on Participatory Geographic Information Systems and Technologies.
- Promote special issues with the ISPRS International Journal of Geo-Information and other related journals as well as books and reports.
- Involve master and PhD students and young researchers in a flagship initiative related to crowdsourcing (network of young volunteer mappers), coordinating this initiative with the HOT YouthMappers one.

WG IV/5 - Indoor/Outdoor Seamless Modelling, LBS and Mobility

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WG IV/5 Terms of Reference

- Stimulate the development of algorithms, standards for semantic modelling of indoor/outdoor seamless environments
- Promote integrated processing of semantic and spatial data for location-based services and disaster management in indoor/outdoor (including underground) seamless environments (in collaboration with WG IV/1, WG IV/4, WG I/6, WG I/7, WG II/3, ICWG I/IV and ICWG III/IVa).
- Advance knowledge in location-based big data and pedestrian movement in indoor/outdoor seamless environments.
- Benchmark the quality and practicality of semantic modelling methods, standards and mobility analysis algorithms.
- Seek co-operation and involvement in the BIM and GML domains (in collaboration with OGC)

WG IV/6 - SDI: Internet of Things and Spatial Decision Support

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WG IV/6 Terms of Reference

- Advance interoperable spatial data infrastructure (SDI), Internet of Things (IoT), Sensor Web, and spatial decision support system (SDSS) standards, algorithms, and system architecture
- Investigate efficient ways to connect, access, and task resource-constrained IoT and Sensor Web devices and sensors
- Develop and manage multi-level (national, regional and global) geospatial databases
- Advance knowledge in spatial data infrastructure and cyber infrastructure
- Promote spatial enablement of government and community
- Promote innovations in geospatial data access, integration, sharing and use
- Promote highly efficient data acquisition and processing from multiple sources including field surveying, remote sensing, real-time sensors and crowdsourcing
- Synchronize disparate geospatial resources to provide useful and usable frameworks that can be integrated with environmental and socio-economic data for research, discovery and web services
- Advance sensor data stream processing algorithms and architecture
- Design, develop, and evaluate innovative SDI, IoT, Sensor Web and SDSS applications
- Design, develop and benchmark implementation interfaces for the abstract ISO standards
- Collaborate with private sector industry to develop and evaluate data format definitions, meta data and software libraries
- Attend and cooperate with the related groups such as OGC working groups (e.g., SWE DWG, SensorThings API SWG, etc.), open source communities (e.g., FOSS4G, Eclipse LocationTech, etc.), ISO/TC-211 meetings, international efforts (GEOSS, Digital Earth, UNSDI, INSPIRE and GMES) and organizations (GSDI, WGISS, ICA, W3C, and EuroSDR)
- Work closely with ISPRS WGs IV/4, IV/5, IV/7, IV/8 and IV/11

WG IV/7 - Geo-Data Management

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WG IV/7 Terms of Reference

The working group investigates new ways to manage n-dimensional geometric, topological, and semantic data handled by DBMS from a broad range of sources such as sensors, BIM, GIS, mobile devices, and others. By doing so it advances the enhancement of standards for metadata, data, and services as well as data integration from different disciplines.
The working group advances interfaces to other commissions and working groups such as WG II/3 on Point Cloud Processing, WG IV/1 on Multi-Dimensional Modelling, WG IV/2 on Ontology, Semantics and Knowledge Representation, as well as to WG IV/8 on GeoComputation and WG IV/9 on GeoVisualization.

- Review technical progress and OGC standards for Geo-Data Management.
- Develop new concepts to store and retrieve Big Geo-Data for knowledge discovery.
- Advance knowledge in geo-data access methods, geometric and topological relations, geo-data aggregation, integration and scalability.

WG IV/8 - GeoComputation and GeoSimulation

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WG IV/8 Terms of Reference

- Promote the development and application of geocomputational (e.g., geostatistical, econometric, machine learning) methods and algorithms for processing spatio-temporal data.
- Explore the use of spatio-temporal data for large scale predictive analytics.
- Explore and promote the use of machine learning methods (Neural networks, Genetic algorithms, and Evolutionary computing, etc.) in the GISciences.
- Explore and promote the use of agent-based simulation and cellular automata in modelling geospatial processes and human behaviour, and study their validation.
- Promote the development of geocomputational algorithms for large-scale network data analysis.
- Explore the potential of using high performance computing (cloud computing and grid computation) for modelling large scale spatio-temporal processes.
- Encourage applications in urban studies of geodemographics, health, criminology and transport; in environmental, ecological and biological modeling and analysis; and in modeling mobile, wireless, and location-based service networks, amongst others.
- Educate the ISPRS community and the next generation of GIScientists on tools and techniques of GeoComputation and GeoSimulation.

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WG IV/9 Terms of Reference

- Enhanced communication of geographic information and knowledge
- Geovisual analytics for (small and) big data exploration
- Usability testing and empirical experiments related to spatial cognition and visualization
- Geographic visualisation of multi-dimensional data
- Novel methods and tools for exploring and visualizing geographic decision spaces
- Platforms supporting geographical visualisation including the web and mobile devices
- Geographic visualisation of crowd sourced, social media, and government databases
- Development, application and evaluations of immersive and semi-immersive virtual reality visualization environments
- Virtual and augmented reality representations of space, place and time

WG IV/10 - Advanced Geospatial Applications for Smart Cities and Regions

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WG IV/10 Terms of Reference

- Review optimum methodologies for the integration of spatial data with heterogeneous data sources in order to achieve harmonized, possibly standard-based data repositories to be used as integrated data source.
- Advance knowledge about how to help urban models profit from Building Information Models (BIM), in that the gap between GIS and BIM is reduced.
- Develop innovative geospatial applications for digital cities and regions, based on integrated semantic regional or city models (possibly 3D).
- Promote testing, adoption and further development of standardized data models in order to overcome single-domain lock-ins and facilitate implementation of inter-domain applications.
- Foster communication among scientists and practitioners from heterogeneous applications domains, in order to facilitate understanding of common problems and reduce the gap – whenever possible – between homologous, sometimes incompatible, solutions.
- Disseminate new technical and methodological advances, innovations and research

outcomes in the field of both academic audiences (e.g. publications, seminars, workshops) and public (e.g. blog posts, exhibitions, public talks).

- Establish strong links between relevant international and regional organizations in order to achieve fruitful collaboration.

ICWG IV/III - Global Mapping: Updating, Verification and Interoperability

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ICWG IV/III Terms of Reference

- Advance knowledge on the global status of mapping and it's updating in databases. This is of particular importance for countries with large areas for which imagery has provided interim information.
- Investigate the update and verification of topographic vector datasets, digital terrain models, ortho-images and thematic (land cover) datasets from remotely sensed data with an emphasis on mapping in a production environment.
- Assess links between high resolution images and mapping tools developed through research and their implementation in mapping agencies and commercial organisations.
- Investigate synergy potentials between the various sensors for topographic and thematic mapping.
- Determine optimum methodologies for the integration of mapping data with heterogeneous data sources including the results of area frame sampling methods like LUCAS for Europe or GMFS for Africa.
- Review technical progress on global DEM data fusion methods and outcomes
- Evaluate semi-automated and automated algorithms for change detection, update and quality control of spatial databases.
- Evaluate web services for GLC data sharing, processing and validation
- Identify best practise applications of geospatial datasets and promote pathways leading from interoperability via uniformity towards standardization
- Collaborate with UN-GGIM and GEO tasks related to GLC (e.g., SB-02)
- Strengthen the cooperation and knowledge exchange between regional clusters according to the UN-GGIM groups, especially between Europe and Africa
- Promote the incorporation of administrations and industries in the development of application products of global and regional geospatial data sets

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Terms of Reference

Support, promote, and motivate

- Curricula Development at basic, professional and decision making levels for Geospatial information science;
- Cost-effective digital class teaching/training approaches and web-based sharing of resources for mass awareness programs;
- Regional/International cooperation in capacity building, citizen science and geospatial technology;
- Engaging tutors/trainers and preparing educational material and support, including open-source software education;
- Young people on Basic and advances in Photogrammetry, RS & Geoinformation Sciences through Students Consortium;
- Innovative Geospatial technologies for infrastructure planning and assets mapping.
- organizing regional and international summer students schools, seminars, workshops and tutorials, and cooperation with industry.

WG V/1 - Framework for Multi-level Education & Training – Curriculum Development and Methodology

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WG V/1 Terms of Reference

- Support and promote the development of national and international geospatial-information curricula and educational modules;
- Promote and organize seminars, workshops and summer schools at different levels of education and different levels of governance; i.e., academics and professional, and public and private sectors;
- Strengthen cooperation with the user of spatial data in order to build educational modules in specific application sectors (such as cultural heritage, environment and risk management, urban planning, structural monitoring etc.)
- Organize activities through cooperation with other Technical Commissions;
- Compile and incorporate best practices for multi-level education and training;
- Cooperate in particular with WG 4/6/7 for the testing of the most technologically advanced tools for education (e-learning, web-based resources, innovative technologies)
- Cooperating with other national or international geospatial and related societies.
- Organise CATCON

WG V/2 - Promotion of International Collaborative Education Programs

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WG V/2 Terms of Reference

- Further support of existing ISPRS initiated projects collaborative education programs in the fields of Photogrammetry, Remote Sensing, Spatial Information, Mapping at Universities;
- Support, promote, stimulate and initiate international collaborative education programs dissemination efforts such as: seminars, tutorials, workshops, symposia, e-bulletins and other mechanisms & tools, in various levels aimed at: Researchers, PhD, MA, Undergraduate, Engineers, Technicians and other professionals;
- Cooperate with other working groups within Commission V and other ISPRS commissions, on how to synchronize the efforts and how to cooperate in launching seminars and workshops;
- Initiate and support: e-learning and remote teaching activities; development and integration of high-tech elements and tools in teaching and training;
- Cooperating with other Geo-societies on issues of: common themes and goals; mobilizing lecturers; adopting efficient ways for planning and running the seminars; and how to share and cut expenses;
- Cooperate with regional universities, organizations, and societies in order to stimulate them to cooperate, provide facilities, share local know how and offer a base for future further cooperation;
- Search for universities and individuals that will reiterate the WG Seminars and collaborative education programs dissemination in other regions;
- Dissemination of methodical recommendations, management of educational seminars and summer schools for the sharing of knowledge and experience of young professionals in the fields related to geo-sciences (photogrammetry, remote sensing, spatial information etc.);
- Dissemination of innovative courses and techniques for writing Master and PhD's thesis proposal, and academic writing;
- Dissemination of innovative educational courses on teaching and aimed at young university teachers working in the field of photogrammetry, remote sensing and spatial information.

WG V/3 - Promotion of Regional Collaboration in Citizen Science and Geospatial Technology

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WG V/3 Terms of Reference

- Citizen Science approaches in geoinformatics – from hypothesis generation to communicating results
- Geo-processing tools and technologies in citizen science
- Data quality assurance and data verification
- Integration of Web 2.0 / mobile technologies and citizen science
- Data, metadata and ownership within citizen science projects
- Investigation of data fusion and mashup algorithms
- Incorporation of game design elements in citizen science – towards geo-gamification
- Geodata enrichment and learning through citizen science
- Promoting open data, standards, interoperability and FOSS4G in citizen science

- Improvement of regional collaboration and community capacity building through citizen science projects

WG V/4 - Web-based Resource Sharing for Education and Research

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WG V/4 Terms of Reference

- Promotion of web-based resources with free access for Remote Sensing, Photogrammetry and GIS
- Cooperation with WG V/8 for joint events and other WGs in TC I to IV for data sharing
- Establishment of an online platform for discovery, sharing and geoprocessing
- Collaboration with academic partners to introduce more use cases for teaching and education and industrial partners to adopt and propagate new technologies.
- Increasing the motivation of students and researchers in a web-based resource sharing environment.
- Mass awareness through web based resource sharing and webinars.

WG V/5 - Promotion of the Profession to Young People

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WG V/5 Terms of Reference

- Provide guidance for Student Consortium activities and maintain the Student Consortium budget
- Advocate for support for Student Consortium activities from the ISPRS Foundation (TIF) and the ISPRS Council
- Harmonize all summer schools associated with the ISPRS under the Student Consortium brand
- Increase world wide networking to establish local branches of the ISPRS SC
- Link all ISPRS technical commission executives with the youth
- Support networking with international and regional societies relevant to ISPRS
- Arrange for Youth Forum sessions during the Commission V midterm symposium and the next congress
- Conduct regular meetings and document working group activities

WG V/6 - Distance Learning - Education and Training Services

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WG V/6 Terms of Reference

- Disseminate knowledge on "Distance-Learning Best Practices" through: 1) conference sessions, 2) "train the trainers" webinar(s) and/or workshop(s), and 3) peer-reviewed articles in ISPRS journals.
- Develop and deliver distance-learning courses on access and use of spatial information.
- Collaborate with Working Groups II, III, IV and V of the TC to develop the content of the distance learning courses and methodologies for sharing with the geospatial community.
- Collaborate with other international organizations engaged in geospatial capacity building activities.

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WG V/7 Terms of Reference

- Promotion of cooperation and knowledge exchange between ISPRS and the International Association of Educational Civil Engineering Institutions
- Methodical guidance, management of educational seminars and summer schools for the sharing of knowledge and experience of young professionals in photogrammetry, remote sensing, civil engineering and architecture, geomatics engineering, and GIS
- Provide assistance in submitting projects on integrated educational programs financing by various organizations and those of under EU auspices
- Innovative techniques and technologies in photogrammetry and remote sensing for Bachelor's and Master's degree curricula and postgraduate studies in architecture, town planning and civil engineering
- Development and implementation of innovative educational modules on photogrammetry and remote sensing for Bachelor's and Master's degree curricula in civil engineering and architecture
- Development and implementation of the integrated educational modules using the techniques and DEM creation for the purposes of construction design
- Development of educational programs for introduction in BIM and computer modelling
- Development of educational programs on applying photogrammetry, remote sensing

and GIS for solving problems of town-planning and spatial territorial management
- Teaching innovative photogrammetry and remote sensing technologies for getting learning skills in the assessment of environmental impact of construction
- Teaching innovative photogrammetry and remote sensing technologies for structure inventory and certification
- Outreach the concept of Smart cities among civil engineers and architects with aim to develop a new approach to town-planning and management

WG V/8 - Promotion of Open Source on Geospatial Technology

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WG V/8 Terms of Reference
- Open-source software promotion.
- Cooperation with Working Group V/4, working groups in Commission II, III and IV, and OSGeo for joint events and data sharing.
- Organize joint sessions on open-source, and invite authors of latest and popular open-source software to provide tutorials for open source promotion.
- Co-organize webinar to help people learn and use geospatial technologies with the aid of open sources.