STATUS OF ISO STANDARDS FOR PHOTOGRAMMETRY AND REMOTE SENSING

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Ad-hoc Group on Standards

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ABSTRACT:

This paper addresses the work on standards for photogrammetry and remote sensing. In the past the ISO/TC 211 published standards regarding a reference model for imagery, an extension to the metadata standard, and the georeference of airborne and space borne imagery. The Open Geospatial Consortium has published the Sensor Web Enablement that is a suite of standards including the Sensor Modeling Language. Today the hot topics are a new standard for calibration and validation of imagery sensors and data (ISO/TS 19159) as well as an extension of the georeference standard towards SAR, InSAR, Lidar, and Sonar sensors (ISO/TS 19130-2). A long-term liaison between the ISPRS and the ISO/TC 172 "Optics and photonics" was revitalized last year.

1. INTRODUCTION

Compared to the era a decade ago the world of sensors in photogrammetry and remote sensing has undergone a fundamental change. Digital aerial cameras have completely replaced film-based systems. The Lidar-technology has reached maturity. Space borne systems – optical as well as micro wave – deliver imagery data of unprecedented resolution. The data models of formerly separated application fields such as hydrography begin to merge with classical GIS and let new sensor types come in such as Sonar.

The numerous new sensors types and their heterogeneity in design foster the demand for standards regarding quality and interoperability.

While the first generation of imagery standards essentially formalized de-facto standards of the past such as the photogrammetric orientation the present projects are going to standardize new topics where often consensus about the details has not been found yet. So the development of the standards runs synchronously with the consensus building process of the interested parties.

The text will reference the three standardization bodies that are most important for photogrammetry and remote sensing: The ISO/TC 211 "Geographic information / Geomatics", the ISO/TC 172 "Optics and photonics", and the Open Geospatial Consortium (OGC).

2. ISO/TC 211 AND OGC: COMPLETED IMAGERY STANDARDS

The standardization organizations most relevant for photogrammetry and remote sensing are the ISO/TC 211 "Geographic information / Geomatics" and the Open Geospatial Consortium.

2.1 ISO/TC 211

Within the ISO/TC 211 the Working Group 6 "Imagery" integrates all related developments. Though the work started in the late nineties the first standards were completed almost 10 years later apart from two review summaries and a framework standard which may all count as preliminary work.

The following three standards are the present outcome of Working Group 6:

- ISO/TS 19101-2 "Reference model – Part 2: imagery"
- ISO 19115-2 "Metadata – Part 2: Extensions for imagery and gridded data"
- ISO/TS 19130 " Imagery sensor models for geopositioning"

The ISO 19101-2 provides a summary of topics that are considered relevant for standardization in the field of imagery. The ISO 19115-2 is an extension of the widely accepted metadata standard towards imagery applications. The ISO/TS 19130 contains methods of georeferencing image data which are discussed in more detail below.

2.2 Open Geospatial Consortium

The Open Geospatial Consortium defined a more general approach to sensors, as they include any sensor of any type that is accessible via the Internet. OGC's Sensor Web Enablement (SWE) is a set of interfaces and protocols that enable a “Sensor Web” through which applications and services will be able to access sensors of all types over the Web. Foundational components for Sensor Web Enablement are:

- Observations & Measurements (O&M)
- Sensor Model Language (SensorML)
- Transducer Markup Language (TML)
- Sensor Observation Service (SOS)
- Sensor Planning Service (SPS)
- Sensor Alert Service (SAS)

- Web Notification Service (WNS)

(Percivall, 2008)

Presently the Observations & Measurements are forwarded towards ISO/TC 211 and will become the ISO 19156.

Compared to the ISO standards the OGC focuses on the interoperability while the ISO rather defines theme-specific metadata.

3. ISO/TS 19159 "CALIBRATION AND VALIDATION OF REMOTE SENSING IMAGERY SENSORS AND DATA"

The ISO/TS 19159 is named "Calibration and validation of remote sensing imagery sensors and data". The "TS" stands for Technical Specification. This means formally that the development period is slightly shorter compared to an International Standard. However, the document must be revised after three years instead of five. After two of those three-year periods a Technical Specification must become an International Standard or will be withdrawn. Sometimes the ISO/TS 19159 is called the CalVal standard.

3.1 Demand for a CalVal standard

In the year 2000 the ISO/Review Summary 19124 "Imagery and gridded data components" defined geometric and radiometric calibration as one of the important component functions. Since that time the launch of a related standardization project has regularly been discussed in the Working Group 6 "Imagery" of ISO/TC 211.

Within the last decade digital aerial cameras have practically replaced the former aerial film cameras completely. However, this new technology has introduced a large variety of technical solutions regarding image size, dynamics (grey values), spectral resolution, multi camera head setups, focal length, speed etc. This variety has fostered a strong demand for the development of standardized systems and procedures.

This is documented by a unisonous demand of the user communities. The International Society for Photogrammetry and Remote Sensing (ISPRS) has established an Ad-hoc group on standards. The Calibration and Validation Working Group of CEOS (CalVal WG) indicates that the user community is waiting for this standard to be completed. The European Digital Aerial Camera Certification group (EuroDAC²) is laying a broad technical foundation for the development of this Technical Specification.

3.2 Scope

The ISO/TS 19159 shall define the calibration and validation of identified airborne and space borne remote sensing imagery sensors and data. The term calibration refers to geometry and radiometry, and includes the instrument calibration in a laboratory as well as in-situ calibration methods.

The validation methods are split into process- and product-validation, and include the prerequisites for installing a validation environment.

This Technical Specification will also cover the associated metadata that has not been defined in other ISO standards for geographic information (ISO/TS NWIP 19159, 2009).

3.3 Calibration, Validation, Certification

Originally the ISO/TS 19159 was planned to cover calibration, validation, and certification. However, it soon turned out that this is not possible because the ISO is not a certification body. The ISO simply provides the management standards such as the ISO 9001 or the ISO 14001 that form the basis for certification bodies which audit organizations applying for ISO 9001 compliance certification.

The remaining topics of calibration and validation may also not be covered in full depth as standards can only be developed as far as input from interested parties is provided.

At this time it can be taken for granted that the calibration of digital aerial cameras and airborne laser scanners as well as the validation of their calibration data will be in. Depending on further input the calibration of radar imaging systems, high resolution space borne cameras, "water borne" Sonar as well as the validation of remote sensing data may also become a part of the standard.

3.4 History

The Draft New Work Item Proposal was proposed by the National Standardization Body of Germany, the DIN, in December 2008 (ISO/TC 211 document N 2607). In January 2009 mostly positive comments were received from Australia, Canada, Japan, the United Kingdom, as well as from the two liaison organizations, EuroSDR and the ISPRS (ISO/TC 211 document N 2613). One of the comments denied ISO's functional responsibility for certification which led to its removal from the standard's scope. The New Work Item Proposal (NWIP) with a 50-pages outline attached was set out for vote in August 2009 and a due date in November 2009. The NWIP was accepted with nine National Standardization Bodies voting in favor and thus exceeding the minimum of five. The participating countries are Canada, China, Finland, France, Germany, Italy, Japan, Thailand, and the USA. The first project team meeting is schedules in May 2010.

3.5 Resources

Several resources have already contributed to the outline document. Further input will come and is really needed for some of the sections. Thus an important move forward is expected from the EuroCOW-workshop and the ISPRS midterm symposia in 2010.

The "Quality Assurance Framework for Earth Observation" compiled by the Group on Earth Observation and CEOS contributed to validation and overarching ideas (Lecomte, 2008).

The outcome of the EuroDAC²-group will be the major input regarding camera calibration (Cramer, 2007). Some German DIN standards, above all the DIN 18740-4:2008 "Requirements of digital aerial cameras and digital aerial photographs", contributed details for aerial cameras. Input regarding airborne laser scanners is expected from Canada.

The ISO/IEC Guides 98 and 99 provided the terminology for measurement and metrology.

The International Archives of Photogrammetry and Remote Sensing covered data fusion.

Two white papers on "Validation" and "Radiometric theory and applications programs for remote sensing" summarized much of the publicly available resources.

3.6 Outline

The outline that was attached to the New Work Item Proposal has seven chapters and five annexes. The chapters one to five are built according to the ISO template with predefined titles such as "4 Terms and definitions". The specific chapters are "6 Calibration" and "7 Validation". The outline gives only a structure of those two chapter and no contents yet.

The chapter "6 Calibration" splits into geometric calibration and radiometric calibration. The subdivisions of geometric calibration are titled

- Instrument (frame camera, line camera)
- Degree of integration (component, system-based like multi-head systems)
- Calibration environment (laboratory, in-situ)
- Test site calibration (real-time/post processing, provision of the exterior orientation)
- Reliability
- Wavelength dependent issues (wavelength/bands, spectral resolution)
- Time (calibration date, time-dependent calibration parameters, influence of striking events, e.g. launch).

The subdivisions of radiometric calibration are titled

- Calibration type (absolute radiometric, spectral, vicarious, others)
- Reference standard (desert test site, moon etc.).

The chapter "7 Validation" splits into qualification, process, and product. The subdivision of Qualification is titled documents, mathematical models, and equipment.
The subdivision of Process is titled technical procedures, software, and test sites.
The subdivision of Product is titled data, including calibration data for reference standards.

Annex A is predefined by the ISO-template and named "Conformance and testing". Annex B is normative and titled "Metadata". It shall contain all metadata that are defined newly for this Technical Specification. Annex C is also normative and titled "Level definitions". However, it is not yet agreed whether consensus on level definition can be reached. The annex D is informative and named "Certification" in order to provide space for any text needed for the certification procedure. The annex E is a container for potential physical background information (ISO/TS NWIP 19159, 2009).

4. ISO/TS 19130-2 "IMAGERY SENSOR MODELS FOR GEOPOSITIONING, PART 2: SAR/INSAR, LIDAR, AND SONAR"

The ISO/TS 19130-2 is a follow-up Technical Specification of the recently completed ISO/TS 19130 "Imagery sensor models for geopositioning". While the ISO/TS 19130 deals with the photogrammetric orientation / georeference of frame cameras, line cameras, and some other sensors, the ISO/TS 19130-2 "Imagery sensor models for geopositioning, part 2: SAR/InSAR, Lidar, and Sonar" adds those sensors that were left out in the first standard, mostly because of lack of expertise.

It is still being discussed whether aerial triangulation may be included in the ISO/TS 19130-2 though this topic does not quite fit with the standard's scope.

The ISO/TS 19130-2 specifies the sensor models for geopositioning images remotely sensed by Synthetic Aperture Radar (SAR), Interferometric Synthetic Aperture Radar (InSAR), Light Detection and Ranging (Lidar), and Sound Navigation and Ranging (Sonar) sensors. It defines the metadata to be distributed with the image to enable user determination of geographic position from the observations.

The purpose of this Technical Specification is to generate detailed sensor models that include the case where rigorously constructed physical sensor models are needed. The associated metadata, to include accounting for uncertainties, is specified. Detailed information is provided for the following types of sensors: SAR, InSAR, Lidar, and Sonar. The intent is to standardize sensor descriptions and specify the minimum metadata requirements, by sensor type, for geopositioning imagery systems.

ISO/TS 19130-2 created a framework for constructing imagery sensor models in a standardized way, and provided standard models for frame, whiskbroom, and pushbroom sensors and some information for SAR. Specific information for InSAR, Lidar, and Sonar, and more details for SAR are needed. Part 2 will provide such information.

5. ISO/TC 172 “OPTICS AND PHOTONICS“

For many decades a liaison-relationship has existed between the ISPRS and the ISO/TC 172 “Optics and photonics“. This relationship was revitalized last year.

The ISO/TC 172 has 7 subcommittees whose titles are listed below:

- SC 1 “Fundamental standards”
- SC 3 “Optical materials and components”
- SC 4 “Telescopic systems”
- SC 5 “Microscopes and Endoscopes”
- SC 6 “Geodetic and Surveying Instruments”
- SC 7 “Ophthalmic Optics and Instruments”
- SC 9 “Electro-optical systems”

The subcommittees 1, 3, and 9 are of particular interest for photogrammetry and remote sensing because they develop standards for the hardware components of cameras and lasers.

6. SUMMARY

The article gives an overview over the present status of the standardization in photogrammetry and remote sensing. In the past the ISO/TC 211 focused on metadata standards in a wider sense and formalized de-facto standard such as the photogrammetric orientation while the Open Geospatial Consortium published a suite of components suitable for addressing any type of sensor across the Internet, the Sensor Web Enablement (SWE).

The new generation of ISO-standards deals with the numerous new sensors of the last decade and their calibration and orientation, as well as with validation. The ongoing technical developments and the not yet completed consensus building process are particular challenges of the work on those new standards.

References

Cramer, Michael, 2007. European Digital Airborne Camera Certification – EuroDAC². Position Paper, EuroSDR, Rotterdam

DIN 18740-4:2006 (draft). Photogrammetric products – Part 4: Requirements of digital aerial cameras and digital aerial photographs. Beuth-Verlag, Berlin

ISO/IEC Guide 98:1995. Guide to the expression of uncertainty in measurement (GUM)

ISO/IEC Guide 99, 2007. International vocabulary of metrology – Basic and general concepts and associated terms (VIM)

ISO 9001:2008. Quality management systems – Requirements

ISO/IEC 17025:2005. General requirements for the competence of testing and calibration laboratories

ISO/TS NWIP 19159, 2009. "Geographic information – Calibration and validation of remote sensing imagery sensors and data", ISO/TC 211 document N2756

Kresse, Wolfgang, Fadaie, Kian, 2004. ISO Standards for Geographic Information. Springer

Lecomte, Pascal et al., 2008. A Quality Assurance Framework for Earth Observation (QA4EO). Key guidelines, version 2.0, Group on Earth Observations / Committee on Earth Observation Satellites

Morain, Stan, Budge, Amelia eds., 2004. Post-launch calibration of satellite sensors. ISPRS Book Series - Volume 2, Balkema

Percivall, George ed., 2008. OGC Reference Model. OGC document 08-062r4, version 2.0