STATUS REPORT ON IMAGE TRANSFER STANDARD (ITS)

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ABSTRACT

During the ISPRS-congress in Vienna the Working Group II/7 "Practical and Implementation Issues in Digital Mapping" was formed. This was caused by the urgent necessity for a smooth exchange of photogrammetric images and data demanded by system manufacturers and users in particular. In autumn 1998 a Development Committee (DC) was formed in order to steer the development of the standard. The basics of the Image Transfer Standard (ITS) were laid down during a four-day meeting of the DC in Neubrandenburg, Germany, in December 1998.
At about the same time the International Organization for Standardization (ISO) started to work on the same subject. Within the Technical Committee 211 (TC211) the projects "Imagery and Gridded Data" and "Imagery and Gridded Data Components" were defined. Participation in the projects made it possible to establish ISPRS-ITS as the basis of the data model of the ISO-standard.
While working with ISO/TC211 contacts were established to the Standards Working Group of the Federal Geographic Data Committee (FGDC, U.S.) as well.
Cooperation took place with the Open GIS Consortium (OGC), too. The ISPRS-ITS was presented at the OGC-meeting in Enschede, The Netherlands, in April 1999.
The ITS was conceived as a generic standard which covers any sensor geometry and any image configuration, is 3D-capable and valid for practically any image resolution.

KURZFASSUNG

Verursacht durch die bei Systemherstellern und vor allem Anwendern dringende Notwendigkeit zum einfachen Austausch von photogrammetrischen Bildern und Daten wurde während des ISPRS-Kongresses in Wien die Working Group II/7 "Practical and Implementation Issues in Digital Mapping" gegründet.
Im Herbst 1998 wurde das Development Committee (DC) mit dem Ziel gebildet, die Entwicklung des Standards zu steuern. Die Grundlagen für den Image Transfer Standard (ITS) sind bei einer viertägigen Zusammenkunft des DC in Neubrandenburg, Deutschland, im Dezember 1998 entstanden.
Etwa zeitgleich begann die International Organization for Standardization (ISO) damit, sich dem Thema zu widmen. Innerhalb des Technical Committee 211 (TC211) wurden die Projekte "Imagery and Gridded Data" und "Imagery and Gridded Data Components" ins Leben gerufen. Die aktive Mitarbeit in den ISO-Projekten eröffnete die Chance, den ISPRS-ITS als Grundlage für die ISO-Normung zu etablieren.
Über die Arbeit in der ISO entstanden intensive Kontakte zur Standardisierungsgruppe des Federal Geographic Data Committee (FGDC) der USA.
Auch mit dem Open GIS Consortium (OGC) fand wiederholt ein Gedankenaustausch statt. Der ITS wurde im April 1999 beim OGC-Treffen in Enschede, Niederlande, vorgestellt.
Das Entwicklungsziel des ITS ist ein generischer Standard, der für beliebige Sensoren und Aufnahmeanordnungen Gültigkeit besitzt, 3D-fähig ist und praktisch für alle Bildauflösungen geeignet ist.

1 PURPOSE OF THE IMAGE TRANSFER STANDARD

Digital photogrammetric techniques have become widely used in production and research in the last decade. In some fields they have almost completely replaced traditional methods, e.g. in orthophoto production. After pioneer work at universities the first generation of complete systems successfully introduced world wide has been developed by the large system manufacturers in the photogrammetric market. These systems

were quite self-sufficient and provided processing up to the final product but in general interfaced well only with other product lines of the same supplier.

Characteristics of the present stage of digital photogrammetry are:

Algorithms and software for solving standard tasks are generally known and available. Therefore photogrammetric components are often being integrated in existing geo-information-systems. The number of suppliers of photogrammetric products has increased considerably.

The strict separation that has existed between largescale airborne applications using frame cameras and smallscale spaceborne applications using other sensors is in flux. Two examples are airborne digital CCD-line cameras (pushbroom) and the so-called meter satellites.

Resolution and geometric quality of radar images have been improved to the point where largescale applications are practical.

There have been first successful tests of the use of laser scanning data for imaging purposes.

The latest tendencies in the development of photogrammetric applications demand far more extensive data exchange across system borders then before. The lack of all-encompassing and well accepted data formats costs time and money, necessitates specialized solutions and slows down further development.

For these reasons, the initiative of ISPRS aims at the development of a data format accepted world wide for the storage and the exchange of photogrammetric data. This format shall be independent of manufacturers or sensors, expandable and serve as a common platform for the exchange of image and orientation data.

In order to push the development, WG II/7 “Practical and Implementation Issues in Digital Mapping“ was founded during the ISPRS-congress in Vienna, in 1996.

Since then, WG II/7 has developed the framework of a data format standard which has been named "Image Transfer Standard" (ITS). The original plan was to develop ITS into a complete software interface ready for integration into existing photogrammetric and remote sensing systems. This goal has not yet been achieved. However, the concept of ITS has been accepted by standardization efforts of the International Organization for Standardization (ISO), the U.S. Federal Geographic Data Committee (FGDC) and by the German Institute for Standardization (Deutsches Institut für Normung, DIN).

2 DESCRIPTION OF THE IMAGE TRANSFER STANDARD

Preliminary work has been done during meetings of WG II/7 in Stuttgart (1997) and Cambridge (1998). In the autumn of 1998 a subcommittee of WG II/7, the Development Committee (DC), was founded, consisting of Lluis Colomer, Wolfgang Schickler, Tobias Heuchel, Frank Scholten and the author. The DC was intended to be a steering committee during the development phase. In a four-day meeting in Neubrandenburg, Germany, in December 1998 the basic principles of ITS were agreed upon.

The ITS will serve as a unique representation of geo related images and their descriptive data to enable compatibility among photogrammetric and geo-information-systems. The unit of definition is the image. The ITS defines a minimum set of data needed to geo reference the image (Kresse, 1999).

The ITS describes all geometric aspects of the transformation between an image, 3D-object space coordinates and an orthoimage. A generic description of all sensor geometries is a part of ITS. Radiometric image manipulation and interpretation is not included in ITS. Derived products beyond the orthophoto level are not included in ITS either.

2.1 General concepts

Georeferenced data derived from an imaging sensor can be described in the form of a rigorous, geometric model based on the physical properties of the sensor. The georeferenced data consist of the four components: Image data, sensor model, geo reference of the sensor and ancillary data.

The rigorous functional representation which is defined by the sensor model and the geo reference model can also be represented by an approximation, which directly describes the functional relation between the 3D-object position and a corresponding 2D-image position without modeling the physical properties of the sensor. These models are based on polynomial functions and on rational functions. These models are often used if the sensor model is classified and therefore not available to the application.

2.2 Levels

In order to merge with ideas well known to the remote sensing community, the ITS is structured in levels (0 - 4) which are related to the traditional photogrammetric workflow beginning from the raw image data up to an orthophoto.

Level 0, the lowest level, describes the original or raw data coming from the sensor without any geo reference and sensor information.

Level 1 contains unprocessed image data which have a known relation between image and object space. This may be a pushbroom image with the image row still in the original position and with orientation data.

Level 2 describes image data which have one closed form of functional relationship between sensor model and geo reference (oriented image).

Level 3 describes image data which originally have been acquired by a line sensor and which are processed to a common plane. This generates a readily visible image similar to an image taken by a frame camera.

Level 4, the highest level, describes processed image data which are directly related to the object coordinate system (orthophoto).

2.3 Image Sensor Model

It has proven to be impractical to design a generic sensor which could serve for the derivation of the geometrical properties of any existing imaging sensors. Instead several types of sensors with different physical models have been defined.

Generally the image sensor model has to describe the image geometry which is necessary to reconstruct the physical imaging process. The sensor model is specific for each class of sensors. The ITS has to accomodate all the parameters required to represent the sensor model.

For each sensor class a standard representation has to be defined. This standard representation has to contain the sensor specific geometry and all the parameters required to describe it.

Examples for different types of sensors are frame camera, CCD-line sensor (pushbroom) or radar.

2.4 Georeference of the Sensor

2.4.1 Rigorous Model

The rigorous model is based on the collinearity between an image point, the projection center of the sensor and an object point. This means that an image point, the projection center and the related object point lie exactly on a straight line if a geometrically ideal sensor and vacuum is assumed.

The rigorous model allows the exact solution of photogrammetric problems. Triangulation is possible, whereby bundles of collinear rays can be adjusted together to obtain a best fit to known control points. The

simple algorithms guarantee flexible use in all application environments. Online processing of data is possible with all modern computers.

2.4.2 Polynomial and Rational Functions

Polynomial and rational functions are used to directly model the geometric relation between the image and the ground. A 2D-image point is transformed into the 3D-ground system without consideration of the sensor geometry. A successful transformation requires the knowledge of a great number of polynomial coefficients (Dowman, 1999).

2.5 Raster Data Format

The ITS has two parallel representations. The internal storage keeps the data together with the image in one single file. The external storage keeps the data on a separate file in ASCII-format in combination with any image file format. The ITS is not exclusively bound to a particular image format. However, the use of TIFF 6.0 for the internal representation storing the image data and the ITS data in a TIFF-tag structure to be standardized is still planned.

The internal representation has obvious advantages in terms of consistency, while the external representation offers greater flexibility, i.e. it preserves the current variety of image file formats used by existing photogrammetric and geo-informationsystems, and preserves the individual character of an established production flow. Of course the conversion between these two representations is possible at any time. The conversion into an internal representation is a simple append function, i.e. there is no need to copy the image data.

3 COOPERATION WITH ISO/TC211, FGDC and OGC

Parallel to the efforts of WG II/7, other committees started efforts to standardize photogrammetric and remote sensing data formats. Among them are the ISO/Technical Committee 211 "Geographic Information / Geomatics" (ISO/TC211), the Standards Working Group of the U.S. Federal Geographic Data Committee (FGDC) and the standardization committee "Photogrammetrie und Fernerkundung" of the Deutsches Institut für Normung (German Institute for Standardization, DIN). The author is a member of these committees or works in close cooperation with them.

In the beginning of 1999 ISO/TC211 started to deal with the standardization of the storage and the exchange of image data within the framework of the new project 19124 "Imagery and Gridded Data Components". Many of the formats to be standardized had been collected in an overview prepared by the earlier project 16569 (19121) "Imagery and Gridded Data" (Fadaie, 1999).

ITS proved to be the framework most acceptable for the standization work started by the ISO/TC211 project 19124. Probably ITS did so well because it was designed independently of manufacturers and specific sensors. Furthermore it was built upon the mature model of central perspective long accepted as a standard in photogrammetry.

While working with ISO/TC211 project 19124, contacts were made to the Standards Working Group of the Federal Geographic Data Committee (FGDC). The FGDC coordinates the development of the U.S. National Data Infrastructure (NSDI). The NSDI encompasses policies, standards, and procedures for organizations to cooperatively produce and share geographic data (Standards Working Group of FGDC, 1999). The FGDC's "Content Standard for Remote Sensing Swath Data" is closely tied to the CCD-line sensor technique, thus its name. This standard already provides a software interface programmed for the image data format HDF (Hierarchical Data Format). HDF offers the definition of a fileheader for the storage of attribute data similar to TIFF though HDF allows a greater flexibility. HDF has been developed by the NCSA (National Center for Supercomputing Applications).

Contacts have been established with the Open GIS consortium (OGC) as well. ITS was presented at the OGC-meeting in Enschede, the Netherlands. In addition, Arliss Whiteside, the author of several of OGC's

requests for proposals, took part in a telephone conference with WG II/7 held in Stuttgart, Germany, in 1999 (Open GIS Consortium, 1999).

4 SUMMARY

The goal of the development of ITS continues to be the facilitation of work on the application level and the simplification of the data exchange between different types of systems in photogrammetry and remote sensing. The development of a software interface has not yet been realized because of the lack of financial support. The large system manufacturers do not seem to take a strong interest in encouraging theproject. A large spectrum of formats might not seem a disadvantage to the manufacturers. Indeed, it may have been helpful to proceed slowly and await further developments. The contacts to ISO and FGDC and their approach to the data format standardization might be helpful in the future.

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