INSTITUT CARTOGRÀFIC DE CATALUNYA

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NEWSLETTER INSTITUT CARTOGRÀFIC DE CATALUNYA

CONTRIBUTION OF THE ICC TO THE XX CONGRESS OF THE ISPRS

On 12-23 July 2004 the XX Congress of the International Society for Photogrammetry and Remote Sensing (ISPRS) will be held in Istanbul. As at the previous congresses, the Institut Cartogràfic de Catalunya will be a very active participant, since it will present three papers and two posters. Each of these contributions is included in sumarized form in this edition of the ICC Newsletter, although once the Congress has been held, they will posted in greater detail at the ICC's website:

www.icc.es

On the Accuracy and Performance of the GEOMOBIL System

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The GEOMOBIL is a Land Based Mobile Mapping System (LBMMS) developed by the ICC. It is a modular system that allows the direct orientation of any sensor mounted on a roof platform. The GEOMOBIL system is composed by the following subsystems: orientation subsystem, image subsystem, laser ranging subsystem, synchronization subsystem, power and environmental control subsystem and the data extraction software subsystem.

Following a brief description of the GEOMOBIL system, this poster focuses on the calibration and performance of the GEOMOBIL image subsystem. It describes the calibration of the CCD (Coupled-Charged Device) cameras used (camera calibration) and the calibration of the boresight parameters (eccentricity and misalignment of the image sensors with reference to the GPS/IMU reference frame). The accuracy and stability of the boresight camera calibration are also discussed. In order to evaluate the accuracy and performance of the system, several missions have been carried out under different configurations and environments. An operator has measured elements on the images by using data extraction software developed by the ICC as part of the GEOMOBIL system. The results of the campaigns in terms of the accuracy and performance of the GEOMOBIL are discussed and conclusions are drawn.

Finally, the poster gives a brief description of the future developments related with the integration of new sensors into the GEOMOBIL platform. In particular, a terrestrial laser scanner has recently been installed and the first results are presented.

SUMMARY

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Semi-automatic Extraction on Line and Area Features from Aerial and Satellite Images

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The paper deals with the semi-automatic extraction of line and area features from aerial images and high resolution satellite imagery. In practice, the extraction of topographic objects from images for generating and updating GIS databases is carried out interactively based on mono or stereo plotting. Numerous efforts have been made in the past to automate the acquisition of point, line and area features in aerial imagery. However, to date fully automated (autonomous) systems have been in the research stage and they have only been used for limited purposes. Semi-automatic systems assisted by an operator would appear to be the best solution for the near future.

The aim of the project, which was undertaken by the two software companies ESG and Inpho, together with the Chair for Photogrammetry and Remote Sensing of the Technische Universität München and the Institut Cartogràfic de Catalunya, was to develop an operational system for the semi-automatic extraction of line and area features in 2D and 3D based on an existing software platform. The complete system was delivered to the Geo-Information Office of the German Federal Armed Forces and it has been in practical use since May 2003, updating VMap Level 1 data and generating the military basic vector database. The extraction tools for line and area features are fully integrated into Inpho's software platform inJECT, which was originally designed for the measurement of 3D building models in digital imagery. This software platform requires no special photogrammetric hardware (stereo glasses, emitter, 3D cursor) and is easy to use even for non-photogrammetrists, since no stereoscopic viewing is needed.

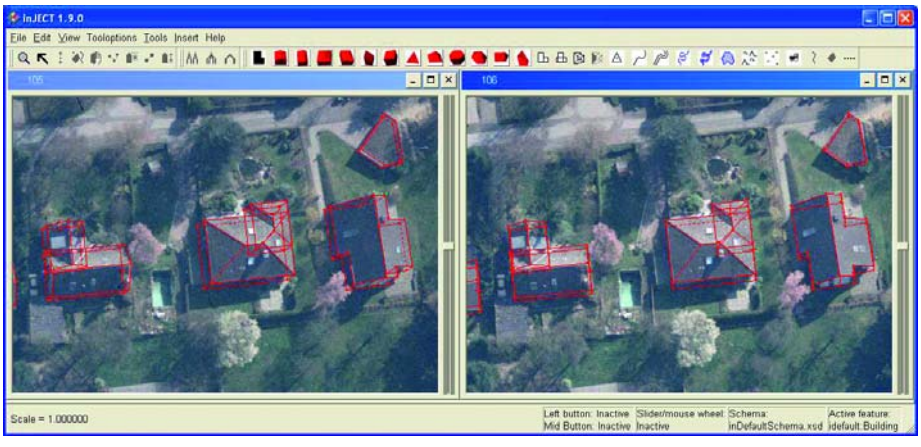
For the handling of the GIS vector data an interface between inJECT and Dynamo (Intergraph) has been developed, based on the GML2 format standard from the Open GIS Consortium (OGC). With this interface the vector data and the associated XML schemes can be automatically imported and exported. Imported features can be edited within inJECT.

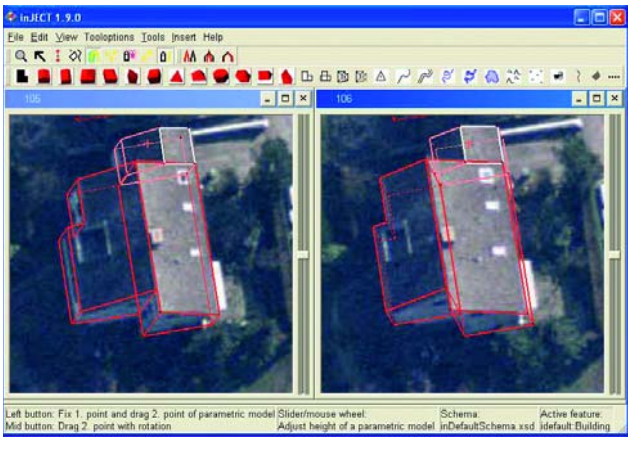
The tool for the measurement of linear features (e.g. road networks) is based on a line tracking algorithm, where the user first defines a starting point and the measurement direction in the image. Following this, the procedure starts and automatically measures points along the middle axis of the particular line. Existing lines and crossings are snapped and nodes are generated, leading to a topologically connected network, which is very important in the case of road network extraction, for example. The lines are smoothed and the average width of the line segments is also computed automatically. Finally, the resulting topologically connected road network is smoothed and the operator can key in the missing GIS attribute values.

The tool for the measurement of area features (e.g. parcels, vegetation areas) extracts the contours of radiometrically homogeneous areas. The user first defines a rough initial model by at least three points within an area, and then a region growing competition algorithm deforms it to obtain the contour of the particular area, which is modelled as a snake. The algorithm takes automatically extracted line features along the contour into account during the region growing the process. Automatic simplification –in order to obtain a Minimum Description Contour– and then thinning and smoothing is performed, before the geometry of the area feature is stored and the operator can key in the attribute values of the feature.

The semi-automatic extraction is preferably performed using digital orthophotos to capture 2D GIS vector data. Furthermore, the software is available for the capture of 3D features using aerial imagery. Here, the automation part currently consists of the on-line z measurement functionality, which automatically derives the height of each vertex point of a line feature or the contour of an area feature. Both 2D and 3D, the algorithms have been extensively tested with IKONOS 2 and IRS satellite imagery, as well as with orthophotos with a pixel size of 50 cm.

The well-known handling of buildings within inJECT is currently being extended to irregular shapes and to the GML3 standard for the import and export of 3D building data.





Integration of a Terrestrial Laser Scanner with GPS/IMU Orientation Sensors

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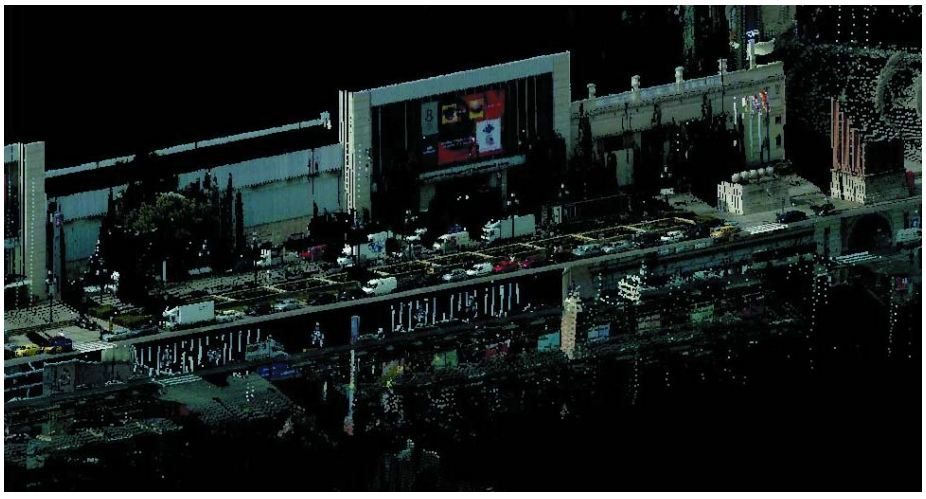
Direct orientation of laser systems has been widely used in airborne laser sensors but not with the terrestrial laser systems. The usual way to operate a terrestrial laser is by scanning a scene while the sensor remains static. In order to cover the whole scene, different scans can be combined by matching several common points, finally the orientation of the scene is performed by identifying and providing coordinates for a minimum of 3 points. This procedure is very time-consuming, leading to very low productivity. In order to increase productivity, the ICC has integrated a terrestrial laser scanner in a mobile vehicle with the aim to operating the laser while the vehicle is moving.

This paper describes the integration of a terrestrial laser scanner with the GPS/IMU orientation sensors of a Land Based Mobile Mapping System. The laser pulses are synchronized to the GPS time by using a modified PPS (Pulse Per Second) signal from a GPS receiver. In order to transfer the reference frame from the GPS/IMU sensors to the laser sensor, a number of calibration scans and control points are used, and the offset and misalignment between the laser and GPS/IMU sensors is determined. The results of the calibration procedures, as well as the accuracies and performance obtained by the integrated GPS/IMU/terrestrial laser system are presented in the paper.



Terrain Modeling in an Extreme Mountainous Area: A Combination of Airborne and Terrestrial LIDAR

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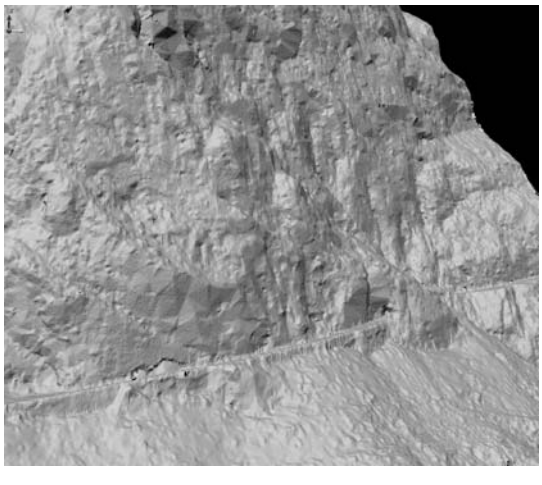
A combination of airborne and terrestrial LIDAR data has been used to model extremely steep mountains that are crossed by the Núria cog railway. This cog train is the only means of terrestrial transportation available to reach the Núria Valley in the Spanish Pyrenees. The purpose of this digital elevations model is the modeling of rocks that fall over the railway track in order to implement protection measures to mitigate this risk.

The airborne LIDAR system was an Optech ALTM 3025. Special parameter settings were selected to improve the coverage of the area, but as the mountains contain many overhangs and vertical walls, some occlusions appeared in the airborne LIDAR data. A terrestrial survey was also carried out in order to improve the terrain modeling. The terrestrial campaign consisted of 5 scenes observed with a Riegl LMS-Z210 mounted on a tripod in 5 static positions in front of the problematic vertical areas. Terrestrial laser scenes were oriented identifying previously surveyed reflectors.

A dynamic survey was carried out with the terrestrial laser to acquire some additional information about the rail path. Data was captured with the terrestrial LIDAR instrument integrated into the GEOMOBIL, a Land Based Mobile Mapping System. The GEOMOBIL was mounted in a train platform that was driven by the train. In order to collect different parts of the track, various paths were completed with the scanner mounted in different orientations. The GEOMOBIL system includes GPS/IMU sensors for the direct orientation of the terrestrial laser scanner and of two digital frame cameras.

The poster presents the behavior of airborne LIDAR data in steep terrain through comparison with the data captured with the terrestrial scanner, while the accuracy of the scene orientation and the alternatives for combining the terrestrial and aerial scenes are also discussed.



BRIEF NOTES

1ST TECHNICAL SYMPOSIUM ON SNOW AND AVALANCHES

On 16 June 2004 the *1a Jornada Tècnica de Neu i Allaus* (1st Technical Symposium on Snow and Avalanches) was held at the headquarters of the ICC.

The ever greater occupation of high mountain areas as a result of building development and infrastructures, as well as the growing availability of recreational activities there, has considerably increased the risk of damage to people and materials caused by avalanches. In response to this, over the last few years more and more institutions, organizations and companies have devoted their attention to the study of this phenomenon.

This has been the background to the decision to stage the *1a Jornada Tècnica de Neu i Allaus*, the aim of which has been to create a meeting point for those who wish to learn about the work currently in progress. The event also offers the opportunity for an exchange of experiences and it will serve to establish links between the professionals working in this field.

The Symposium took the form of various 15-minute papers grouped into 6 subject areas (meteorology, prediction, cartography, safety, civil engineering, legislation and risk) and a final lecture.

THE OFFICIAL GAZETTEER OF THE MAIN TOPONYMS OF CATALONIA IS NOW AVAILABLE ON DVD

In May 2004 the ICC published the *Nomenclàtor oficial de toponímia major de Catalunya* (Official Gazetteer of the Main Toponyms of Catalonia) on DVD in PDF format.

Based on the Gazetter in paper form (see ICC Newsletter No. 18), the ICC has developed its own application to search for and view (electronic index) a specific toponym on the corresponding page. The toponym can also be viewed by clicking on the PDF file (one file per municipality).

Following the entry of all or part of a toponym, the electronic index supports searches by *comarca* (administrative division of Catalonia) or by municipality, and/or by types of toponym.

Once the toponym has been selected, the information is presented as a table indicating the toponym selected, the *comarca* and the municipality to which it belongs, the type of toponym and the page where it can be found. By clicking on the grey column on the left side of the table, the Gazetter page on which the toponym appears is displayed.

Furthermore, the search results can be ordered alphabetically by toponym, comarca, municipality, or type of toponym.

The application also includes instructions for use.

The PDF files are high quality (300 dpi), so that the user may print the pages or the entire Gazetteer by means of a quality printer. The search result can also be printed as a list of toponyms.

Assessment of Digital Elevations Model Accuracy Derived from SPOT-5 High Resolution Stereoscopic Imagery

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This paper describes the derivation of Digital Surface Models (DSMs) from 3-fold along-track stereoscopic SPOT-5 imagery within the scope of the High Resolution Stereoscopic (HRS) study, organized by the International Society of Photogrammetry and Remote Sensing (ISPRS) and the Centre Nacional d'Études Spatiales (CNES). The orientation of SPOT-5 is reconstructed by bundle adjustment using a functional model based on correction polynomials. As observations enter automatically derived tie-points as well as stereoscopically measured control and check points. Orientation data and look angles supplied with the SPOT-5 auxiliary data are treated as constants. The adjustment resulted in an RMS (Root Mean Squared)-error of 2 m in Easting, Northing and Height at 17 check points. DSMs are produced for 4 test sites, which are located in different terrain types (mountainous, moderate and urban). An automatic region growing image matching process generates a dense point cloud in image space, which subsequently it is rigorously transformed into the object space and converted into a regular spaced DSM. The comparison with a digital terrain model (DTM) of superior accuracy yields standard deviations better than 5 m (1 σ) in flat and moderate terrain, and better than 10 m (1 σ) in mountainous regions. An additional DSM covering the entire image scene (approx. 60 km x 80 km) is produced with a standard deviation of better than 9 m using the commercial software ISAE and rational functions. The sigma values include all errors of the automatic matching process as well as the differences between the surface and the terrain model, and therefore must be regarded as very conservative. Finally, all results are summarized and conclusions are drawn from the study.

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