

Trends in Engineering Surveying

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ÖSSZEFOGLALÁS

A tanulmány fő témái a következők: A mérnökgeodézia új lehetőségei. Modern integrált mérőműszerek és rendszerek. Az adatgyűjtés automatizált folyamata, magas frekvenciájú és folyamatos adatgyűjtés. Új adatfeldolgozási folyamatok, modern interpretációs lehetőségek.

A szerző vázolja a nemzetközi szervezetek (FIG, ISPRS, IAG) mérnökgeodéziával kapcsolatos aktivitását, az ezen a téren szervezett akciók tematikáját, és a publikált szakmai eredményeket.

1. INTRODUCTION

Engineering surveying is a part of surveying, which deals with local geodetic networks, setting-out, deformation measurement, measurement and control of civil engineering and industry structures. For this purpose are used modern and high level accuracy equipments. New technology enables automatic or high frequency data acquisition, processing and analysis. To complete the data acquisition by information about the surrounding conditions and the measured object are the systems completed by other sensors and new functionalities.

The high level of automation of the measurement process opens the way for new applications, new field of interest for engineering surveyors – permanent deformation measurement of bridges, dams and industry structures, laser scanning applications, high frequency dynamic measurements, etc. With new applications and usage of integrated measurement systems are connected new data processing methodologies – time series analysis, continuum mechanics theory in deformation analysis, model building, visualisation, etc.

2. ACTIVITIES OF PROFESSIONAL ORGANISATIONS

The worldwide largest professional organisation, which covers the complete application field of the surveying, is FIG. According the historical development, orientation and focus of professional

organisation the overall and bright coverage of the engineering surveying topics is possible in the FIG, only. Inside the FIG the field of interest of engineering surveying is covered by the Commission 6 (C6) and traditional includes acquisition, processing and management of data and all related information throughout the life cycle of a project (at construction site), quality control of civil engineering constructions and manufacturing of large objects, modern concepts for machine guidance, deformation monitoring, analysis and interpretation, measurement of dynamic loaded structures (general), deformation prediction in engineering projects, mines and areas of geological hazard, multi-sensor measuring system development. The C6 interest was focused to terrestrial laser systems testing and their usage in architecture, civil engineering and industry, also.

FIG C6 is cooperating with IAG, ISM mainly in the field of development of local geodetic networks, deformation measurement and analysis and their implementation together with geotechnical and geodynamic methodology (concept) in the areas of geological hazard, etc.). The cooperation with ISPRS is focused to application of laser scanning systems (TLS, InSAR, etc.) in the field of 3D (4D) model building, deformation measurement, high frequency data processing and analysis, model visualisation. The role of FIG C6 is to connect specialist and experts for all above mentioned topics, to build the umbrella for their effective cooperation.

The main topics of FIG C6 activities are covered by five working groups for:

- o deformation measurement,
- o industry surveying and large scale metrology application,
- o engineering survey data bases and facility management,
- o engineering surveys for construction works and structural engineering,
- o terrestrial laser scanning systems and applications.

In the field of **deformation measurement** the activities are focused on the automation of monitoring surveys, enhancement of geometrical modelling of deformations from integrate deformation surveys, physical interpretation of deformations including numerical modelling and prediction of deformations and back analysis. A main objective of the C6 is to propose or improve techniques to analyze long term measurement data in comparison with short-term ones, based on different sensors and its integration (GNSS, InSAR, etc.).

In the field of **industry measurement** the main goal is to provide the use of adapted survey techniques in industry & engineering, multidisciplinary collaboration between survey engineers, civil engineers, structural & mechanical engineers, R&D scientists - for a better approach of complex engineering survey problems, specific algorithms, instrumentation, equipment and techniques in engineering surveys, high precision measurements and special techniques for the **large scale metrology** of big equipment or structures, integration of survey & alignment sensors with actuators and/or tools for on-line monitoring and control of a given process (dynamic systems).

The working group for **engineering survey data bases and facility management** activity is focusing on the role of the surveying engineer as the responsible manager of spatially referenced information, support for the co-ordination of the activities of other disciplines, building concepts of data models for the mapping of relevant 4D or 5D project data, covering 3D geometry, time, and

descriptive attributes, exchange, provision and presentation of facility management data in computer networks, data integration for this subject, taking into account the presence of redundant data and different sources of information and automation and combination of feasible data acquisition techniques.

The working group members manage different research teams and projects, which are resulting in information systems of large constructions, industry companies and business centres, also. There are developed tools for effective management of large data sets, enabling very high frequency of operation over these data. The results of data analysis and acceptance of decisions during the actual process are used for daily process management connected with usage of developed building information systems.

The members of the working group for **engineering surveys for construction works and structural engineering** are focused their activities on sensor and measurement system development for kinematic application. They are studying the use of embedded sensor arrays and the role of advanced surveying techniques for structural monitoring, creating an awareness of surveyors through a study group "Fibre optic sensors" of the rapidly emerging technology of fibre optic sensors as "non-geodetic" sensors, interferometric sensors, to measure deformations (strain) and temperatures in civil engineering structures.

The working group for **terrestrial laser scanning** is promoting the usage of TLS for geometric documentation in a variety of environments, particularly high risk and environments which benefit from remote measurements (e.g. structures, slopes, underground surveys, structural deformations of cultural heritage monuments), investigate existing and developing terrestrial laser scanner instrumentation for engineering applications, evaluate and compare algorithms for processing terrestrial laser scanner data (e.g. registration, surface modelling, etc.), investigate and document metrological and quality control issues for laser scanning measurements, investigate the integration of laser scanning measurements with other measuring techniques, such as conventional geodetic systems and photogrammetric techniques.

The special and actual topics in focus of C6 were covered by six study groups, which activities were oriented to:

- o SG 1 - Continuum Mechanics as a Support for Deformation Monitoring, Analysis and Interpretation,
- o SG 2 - Optimal Use of Interferometric Synthetic Aperture Radar (InSAR),
- o SG 3 - Crustal Deformation Monitoring,
- o SG 4 - Monitoring and Analysis of Cyclic Deformations and Structural Vibrations,
- o SG 5 - Fibre Optic Sensors,
- o SG 6 - Terrestrial-Based RF Positioning Technologies.

3.

TRENDS AND NEW APPLICATIONS

The actual application of new developments, theory and methodology are traditionally reflected in a big number of conferences covered by C6 members. Parallel to the traditionally organised series of conferences, last two years started conferences oriented to continual deformation measurement, including integrated sensor system development and usage, to navigation of construction and agricultural machines. The newest activity is dated to September 2010 and was oriented to indoor navigation.

International Course for Engineering Surveying is held traditionally in Germany speaking countries, is well known between the engineering surveying community and is attended by high number of participants. These events are focused through many years to machine-, computer- and robot- vision, to discuss recent scientific and technical advancements and applications for optical static and kinematic 3D measurement techniques. Emphasis was placed in last year at new and emerging technically in precision laser scanning, tunnel construction and the topic fibre optic sensors and their usage in civil engineering structure monitoring.

The longest tradition has between the series of conferences the **International Symposium on Deformation Measurements** which is traditionally organised by the WG6.1 of C6. The last conference of this series was held in Lisbon (Portugal) in 2008 and the next will be prepared for 2011 in Hong Kong. The topic of these series is covered by more working groups of C6 and for study groups, which deals with the bright field of deformation measurement.

WG6.4 and SG4 participated with the joint session at the international conference organised by UK's Institution of Civil Engineers and the 5th **International Conference on Current and Future Trends in Bridge Design, Construction and Maintenance** held in Beijing in China 2007. The purpose of this series of conferences was to provide a forum for not only bridge design and construction, but also for measurement of dynamic loaded structures. For surveyors is very important this cooperation and open new contacts and opportunities of application of the new geodetic technology (mainly for kinematic application).

In Novosibirsk (Russia) was started the series of conferences and exhibition, **International Exhibition and Scientific Congress GEO-SIBERIA**, which is organised by the Siberian State Geodetic Academy and co-sponsored by FIG C6, namely by WG6.3. The congress is organised every year with big interest of Russian surveyors (more than 400 participants), in the field of engineering surveying, information system and surveying technology development.

In 2007 started the series of **International Conference on Machine Control & Guidance** prepared by Uni Bonn (Germany), with participation of the WG6.2 and WG6.5 members, cosponsored by C5. The last conference was held in 2010 and was oriented to the newest development and application in the field of machine guidance. The series of these events is oriented more to guidance of construction and agricultural machines (large scale and outdoor application).

The first **International Conference on Indoor Positioning and Indoor Navigation (IPIN)** was

held 2010 in Zurich (Switzerland), with co-operation of FIG C6, C5, IAG and other organisations. The successful conference was attended by 400 participants (250 IT specialists and 150 surveyors) discussed methodology of indoor navigation, possible technology based on WIFI, LAN, terrestrial RF sensors, GSM, etc. According the very positive response of participants was decided to start the new series of conferences (next in 2011, Lisbon, Portugal).

Between the engineering surveying community is well know the series of conferences on **Optical 3D Measurement Techniques**, which is organised in co-operation with of ISPRS and FIG C6 and C5. The series of these events is traditionally focused to machine-, computer- and robot- vision, model building, image matching with many applications from a variety of working areas. The conference discusses recent scientific and technical advancements and applications for optical static and kinematic 3D measurement techniques. The last conference held 2009 in Vienna (Austria) were devoted to step-motor-driven and servo-controlled electronic theodolites and total stations, high resolution, low cost and smart digital cameras, capabilities for very fast or even real-time processing, visualization, animation and VR techniques are some developments leading to new procedures in photogrammetry and surveying. The next conference will organised by ETH Zurich (Switzerland) this year.

The traditional seminar on **Terrestrial Laser Scanning** in Fulda (Germany) is organised annually by FIG C5 and C6 together with the DVW and ISPRS. This seminar serves to show the stage of development of the sensors, processing as well as application, furthermore a view of future developments.

The latest news in theory, methodology, technology, research and application are reflected at conferences which are annually organised on **FIG Working Weeks and Congresses**. The total number of papers on these conferences achieved 800, from which about 20% is devoted to different topics of engineering surveying. These papers are accepted for technical sessions managed by FIG C6 or C5.

Commission 6 was represented at the FIG WW in **Eilat (Israel, 2009)** by 6 sessions devoted to deformation and land slide monitoring and special engineering applications. It was organised 3 joint TSs of C6 and C5 devoted to terrestrial laser scanning, LIDAR and network and data analysis. Two TSs are organised in cooperation with ISM and ISPRS. Traditional annual meeting of the commission was held during the WW, during this were discussed actual topics of deformation monitoring, analysis and interpretation using continuum mechanics, monitoring and analysis of crustal deformations, optimal use of InSAR technology, terrestrial-based RF positioning technologies, methods and equipment of terrestrial laser scanning for engineering surveying procedures, analysis of cyclic deformations and structural vibrations, monitoring of dynamic loaded structures, application of automatic measuring systems multidisciplinary expertise and co-operation, which lead to integrated survey methods and systems.

C6 was prepared for the FIG Congress held in **Sydney (Australia, 2010)** 16 technical sessions devoted to the engineering survey topics – deformation using GNSS, terrestrial scanning, subsidence and landslides, quality, management and standards, LiDAR and INSAR applications, remote sensing

and data processing, machine guidance and integrated systems, building measurement and modelling, engineering survey. The commission annual meeting build space for presentation of the progress made by the commission WGs and study groups.

4. CONCLUSION

The high number of prepared events and papers underlines, that C6 is one of the most active and very important in FIG. The effort included to all this events and their preparation will transform to results, which are important not only for FIG commission members, but member of other professional organisations and all specialists dealing with engineering surveying around the world.

Concluding the discussed and presented topics in years 2008-2010 are remarkable new field of interest in engineering surveying. Parallel to the traditional topics (deformation measurement, setting-out, large scale metrology) are discussed new topics (laser scanning, model building, image matching, visualisation, fibre optic sensors, usage of InSAR, RF positioning, indoor navigation, etc.). In many fields are decided that results is needed in real time or with frequency at 0.1 kHz level. Very positive is the active participation of surveyors on this process and development also the bright co-operation together with specialist from other professions.

Papers of all events (conferences, seminars) organised in co-operation are included to the FIG Library, which is e-library positioned at FIG servers (<http://www.fig.net>). This ways are all this papers and the information achievable for all who is interesting in pdf files. The library offers the users searching and analyzing tools, also.

LITERATURE

1. FIG Commission 6 Annual Report 2008, 2009, www.fig.net.
2. FIG Annual Review 2008, 20009, www.fig.net.
3. FIG Library, www.fig.net.

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