September 9th 2020 – 3DGeoInfo Day 1

Contents

Session 5 - Users and Use Cases 1 – Planning and Cadastral Systems – 8.30am – 10.00am

Paper #: 18 Indoor Localisation for 3D Mobile Cadastral Mapping using Machine Learning Techniques

Authors: Chryssy Potsiou, National Technical University of Athens, Greece; Nikolaos Doulamis, National Technical University of Athens, Greece; Nikolaos Bakalos, National Technical University of Athens, Greece; Maria Gkeli, National Technical University of Athens, Greece; Charalabos Ioannidis, National Technical University of Athens, Greece

With the rapid global urbanization, several multi-dimensional complex infrastructures have emerged, introducing new challenges in the management of the vertically stratified buildings spaces. 3D indoor cadastral spaces consist a zestful research topic as their complexity and geometry alterations during time, prevents the assignment of the corresponding Rights, Restrictions and Responsibilities (RRR). In the absence of the necessary horizontal spatial data infrastructure/floor plans their determination is weak. In this paper a fit-for-purpose technical framework and a crowdsourced methodology for the implementation of 3D cadastral surveys focused on indoor cadastral spaces, is proposed and presented. As indoor data capturing tool, an open-sourced cadastral mobile application for Android devices, is selected and presented. An Indoor Positioning System based on Bluetooth technology is established while an innovative machine learning architecture is developed, in order to explore its potentials to automatically provide the position of the mobile device within an indoor environment, aiming to add more intelligence to the proposed 3D crowdsourced cadastral framework. A practical experiment for testing the examined technical solution is conducted. The produced results are assessed to be quite promising.

Paper #: 25 3D Viewpoint Optimization of Topological Relationships: Application to 3D Cadastre for Visual Easement Validation

Authors: Romain Neuville, University of Liège - Geomatics Unit, Belgium; Jacynthe Pouliot, Laval University, Canada; Roland Billen, University of Liege, Belgium

Offering optimum 3D viewpoint to user can be attractive in relieving occlusion in 3D scene. This could be much relevant for the visualization of 3D cadastral systems since they constitute complex datasets including both physical and legal objects while users are operating a number of visual tasks that require precise outlook. However, 3D viewpoint usability has yet to be evaluated to demonstrate its relevance in accomplishing given end user's visual tasks. Hence, in this research project, the focus is set on visual identification of 3D topological relationships (disjoint and overlap) as it is one of the main users' requirements in 3D cadastre. To this end, this paper addresses this issue using a virtual 3D model of the Planetarium Rio Tinto Alcan (Montreal city) in which property issues take place, especially regarding the easement validation procedure. Empirical tests have then been administrated in the form of interviews using an online questionnaire with university students who will specifically address such issues in their professional career. The results show that a 3D viewpoint that maximizes 3D disjoined or overlapped geometric objects' view area within the viewport significantly outperforms traditional combined software points of view in visually identifying 3D topological relationship. This paper also suggests that user's inexperience in 3D cadastre reduces visual task efficiency when visually identifying 3D topological relationship among overlapped geometric objects. Eventually, this study opens up new perspectives on 3D topological relationships modeling and visualization.

Paper #: 51 Application of laser scanning in creating 3D cadastre UML model for underground historical objects – case study of Rzeszów (Poland)

Authors: Jarosław Bydłosz, AGH University of Science and Technology, Poland; Agnieszka Bieda, AGH University of Science and Technology, Poland; Artur Warchoł, PWSTE The Bronisław Markiewicz State University of Technology and Economics in Jarosław, ProGea 4D sp. z o.o., Poland; Monika Balawejder, PWSTE The Bronisław Markiewicz State University of Technology and Economics in Jarosław, Poland

The necessity for accurate registration of underground objects with various methods is becoming increasingly common throughout the world. Research studies conducted in this area mostly focus on objects related to transportation or public utilities and services. However, in settlements with a long history, apart from new objects, there are also various historical objects underground. Such places are not fully discovered, and sometimes they are not even fully inventoried with surveying methods. The aim of the presentation is to check terrestrial laser scanning as a method of measuring such objects. It was generally done in order to introduce them to the 3D cadastre.

Click here for full abstract.

Paper #: 71 Modelling Land-Use Regulation Conflicts with 3D Components to support Issuing a Building Permit

Authors: Saeid Emamgholian, Dept. of Geomatics, Université Laval, Québec, Canada, Canada; Jacynthe Pouliot, Dept. of Geomatics, Université Laval, Québec, Canada, Canada; Davood Shojaei, Centre for SDIs and Land Administration, Department of Infrastructure Engineering, The University of Melbourne, Australia

Cities are facing important challenges due to population growth and massive development of high-rises and complex structures above and below the ground surface. In that respect, having an efficient land-use regulation framework in force is necessary for cities. In investigating current practices for processing spatial data when issuing building permits, in many cases, the planned building is drawn on 2D plans with cross-sections to represent their 3D dimensions. In complex multilevel developments, this method has significant shortcomings like the requirement of managing numerous plans and sections and uncertainty in decisions more specifically when checking land-use regulations comprising 3D components (e.g. height limits, overhanging objects, solar rights). In order to support issuing a building permit and moving towards the establishment of 3D smart cities, this paper presents an inventory for land-use regulations with 3D components and functional classification of their possible conflicts. Two functional classifications of possible conflicts in a building permit process from two points of view (i.e. data integration process, and magnitude of land-use regulation conflicts) are proposed. These results are placed in the context of having 3D city models that integrate landuse regulation information.

Session 6 – Keynote, Users and Use Cases 2 – Applications – 10.30am - midday

Paper #: 9 Combined modelling of multiple transportation infrastructures within 3D city models

Authors: Christof Beil, Technical University of Munich, Germany; Thomas H. Kolbe, Technical University of Munich, Germany

The development of digital urban twins has led to efforts of multiple cities to gather detailed and highly accurate data on many parts of urban environments, including road and railway infrastructure as well as areas used by pedestrians. This paper presents concepts for representing and segmenting this data semantically, geometrically and topologically ensuring usability for various multimodal applications in the context of digital 3D city models. First, methods for modelling multiple transportation types of several standards such as OpenDRIVE, GDF and INSPIRE are examined, including a discussion of different types of information integration such as functional and topographical representations. Then, concepts proposed to the CityGML Standards Working Group for the CityGML 3.0 Transportation model are presented. This includes detailed methods for modelling multiple transportation modes within a common city model while avoiding redundant geometric representations. A section / intersection concept in combination with links used to model these relations is described. Linear as well as areal models of level crossings, pedestrian crosswalks or areas shared by multiple transportation infrastructure at the same time (e.g. a tramway within a road) are presented. Subsequently, examples and applications that benefit from accurate representations of multiple transportation types are described

Paper #: 13 Life Cycle Assessment of Technical Building Services of Large Residential Building Stocks using Semantic 3D City Models

Authors: Hannes Harter, Technical University of Munich - Institute of Energy Efficient and Sustainable Design and Building, Germany; Bruno Willenborg, Technical University of Munich - Chair of Geoinformatics, Germany; Werner Lang, Technical University of Munich - Institute of Energy Efficient and Sustainable Design and Building, Germany; Thomas H. Kolbe, Technical University of Munich - Chair of Geoinformatics, Germany

Reducing the demand for non-renewable resources and the resulting environmental impact is an objective of sustainable development, to which buildings contribute significantly. In order to realize the goal to reach a climate-neutral building stock, it must first be analyzed and evaluated in order to develop optimization strategies. The life cycle based consideration and assessment of buildings plays a key role in this process. Approaches and tools already exist for this purpose, but they do mostly only take the operational energy demand of buildings and no life cycle based approach into account, especially when assessing technical building services (TBS). Therefore, this paper presents and applies a methodical approach for the life cycle based assessment of the TBS of large residential building stocks, based on semantic 3D city models (CityGML). The methodical approach developed for this purpose describes the procedure for calculating the operational energy demand (already validated) and the heating load of the building, the dimensioning of the TBS components and the calculation of the life cycle assessment. The application of the methodology is illustrated in a case study with more than 115,000 residential buildings from Munich, Germany. The study shows that the methodology calculates reliable results and that a significant reduction of the life cycle based energy demand can

be achieved by refurbishment measures/scenarios. However, the goal of achieving a climate-neutral building stock is a challenge from a life cycle perspective.

Session 7 – Users and Use Cases 3 – Underground – 1.00pm – 2.30pm

Paper #: 3 Data Modelling for Operation and Maintenance of Utility Networks: Implementation and Testing

Authors: Federico Fossatti, University of Twente, Netherlands; Giorgio Agugiaro, TU Delft, Netherlands; Léon Olde Scholtenhuis, University of Twente, Netherlands; André Dorée, University of Twente, Netherlands

The organisational data models that support the information needs of utility network managers are proprietary and domain-specific, while the emerging national standards in this field often lack lifecycle data representation capabilities. However, multiple types of utility networks can be comprehensively represented with the free and open-source Utility Network Application Domain Extension (ADE) of the international standard CityGML. The Operation & Maintenance (O&M) Domain Ontology is a proposed extended version of the Utility Network ADE that allows for consistent and comprehensive processing, storage and exchange of O&M related utility network data. So far, this ontology has not yet been implemented in a spatial-relational database. Consequently, the support it offers during routine utility asset management tasks has remained untested. This paper, therefore, tests the support of the O&M domain ontology for asset management and proposes a database implementation of this data model. To this end, it models and loads two utility networks from the campus of the University of Twente, the Netherlands. It tests the ontology's support for asset management by simulating a street reconstruction project and retrieving necessary project information in relation to a utility's (a) maintenance history and performance, and (b) site conditions and valve locations. Results show that the implemented model supports projects with rapid, comprehensive, and consistent information about semantic details of utilities. Such data needs yet to be collected and registered systematically to enable future data-driven asset management practices.

Paper #: 50 U-Route - Leading Edge Network Utility Design

Authors: Joseph Kearney, Costain, United Kingdom

U-Route calculates routes based on client and stakeholder priorities, transforming how utilities networks are planned, designed and delivered by programming engineering rules to read environmental and socio-economic data. It quickly identifies the optimal path (be that CapEx, OpEx, whole-life or a combination) leading to the most favourable routing outcomes, and an estimated design programme saving of 45% against traditional methods. U-Route replaces manual methods for generating corridors, traditionally based on limited insight. By digitally analysing study areas thousands of potential routes are appraised against a flexible set of criteria, returning the optimal design at the earliest stage of the project.

Click here for full abstract.

Paper #: 55 Ontology-Based Rule Compliance Checking for Subsurface Objects

Authors: Claudine Metral, University of Geneva, Switzerland; Vincenzo Daponte, University of Geneva, Switzerland; Ashley Caselli, University of Geneva, Switzerland; Giovanna Di Marzo, University of Geneva, Switzerland; Gilles Falquet, University of Geneva, Switzerland

This paper presents a model for representing compliance rules related to subsurface objects. Rules expressed in this model can be automatically evaluated (using SHACL or SPARQL) on existing 3D city models expressed in RDF. The main characteristics of the proposed model are (1) its expressiveness, that comes from the use of formal ontologies for representing the rules and the objects they refer to, (2) its integrative nature, given by the interconnection among the proposed ontologies and the connection of these ontologies with CityGML and IFC (in an ontological form), and (3) its multi-geometry aspect. Preliminary results allow to automatically evaluate formally expressed compliance rules for underground objects in a 3D city model, that will considerably ease the task of professionals of the field.

Paper #: 79 Modular Approach to 3D Representation of Underground Infrastructure in the Model for Underground Data Definition and Integration (MUDDI)

Authors: Joshua Lieberman, Open Geospatial Consortium, United States; Carsten Roensdorf, UK Ordnance Survey, United Kingdom

Data and models of the built environment enable urban systems to serve their inhabitants and adapt to ever increasing rates of change in society, climate, and. Models of the built environment at or above the ground surface need to be 3 dimensional to best fill that role, but the subsurface also has critical 3-dimensional properties that are even more difficult to characterize being hidden from view. There are many compelling use cases for high quality data on the underground environment at varying levels of detail, from which a list of 6 critical use cases are presented here. Data on the location and disposition of buried utility are difficult to collect and maintain, but the value of avoiding damage, delay, injury and cost with good underground data in all these cases far outstrips the cost and difficult of obtaining it. Effective management and utilization of underground data also depend on models and schemas to organize them. Sharing and exchange of such data require standard models that are agreed between data providers and consumers. There are presently a number of applicable models and standards, but they often reflect a specific perspective, focus, and priorities that make it difficult for any one of them to provide a holistic awareness of the entire underground built environment at the multiple levels of complexity required by the use cases. The draft Model for Underground Data Definition and Integration (MUDDI), a comprehensive integration model for underground information takes a modular approach, with a conceptual core that covers basic geometric representations of underground assets, and a number of extension modules that add more specialized capabilities as well as interfaces with existing models. Several prototyping efforts have generated physical implementations of the MUDDI conceptual model and application deployments populated by operational utilities data, in particular the NUAR and LUAR pilot projects sponsored by the UK Geospatial Commission. An Open Geospatial Consortium Standards Working Group (SWG) is being formed to build on the draft MUDDI model as well as the experiences gained in pilot projects, in order to publish a full specification of the model at the conceptual, logical, and physical levels. Another SWG objective will be to create a roadmap of critical extension modules, particularly those which support upcoming 3D-4D digital twin technologies for visualization, operation, and simulation. Other advanced use cases for these extensions, such as mixed reality visualization and navigation, are expected to become common as both the demands on our built environment and the data available to manage it continue to expand.

Session 8 – Users and Use Cases 4 – Applications, Panel Session 'Users and Use Cases' – 3.00pm – 4.30pm

Paper #: 16 A Semantically enriched and Web-based 3D energy model visualization and retrieval for smart building implementation using CityGML and Dynamizer ADE

Authors: Efi Chatzinikolaou, National Technical University of Athens, Greece; Ioannis Pispidikis, National Technical University of Athens, Greece; Efi Dimopoulou, National Technical University of Athens, Greece

Smart Cities are complex distributed systems which may involve services, applications, sensors and IoT devices. In order to be able to link and use such heterogeneous data, spatial data infrastructures for Smart Cities can play an important role in establishing interoperability between systems and platforms. Semantic 3D city models describe spatial, graphical and thematic aspects of the city objects according to the CityGML international standard, issued by the Open Geospatial Consortium (OGC). The requirement to support energy time-dynamic properties within CityGML objects arises from the fact that cities yield great potential in terms of energy consumption reduction and efficiency increase. In order to support such time-varying energy properties concerning city objects, recent extensions of the CityGML in the form of Application Domain Extensions (ADEs) are researched and developed, such as the Energy ADE and the Dynamizer ADE. Starting from a Building Information Model (BIM) and evaluating energy use of the building though the created Building Energy Model (BEM), the objective of this study is to integrate and visualize the time-based energy simulation results with the 3D building model in a 3D semantic city model. Using the latter ADE, the highly detailed static 3D Building (LOD 4) is extended to support those energy variations of individual feature properties and associations over time. Also, the web-based visualization approaches and data retrieval were further researched and an interoperable web-based application was developed in order to accomplish an integrated knowledge on how time-series data can be distributed in a virtual 3D environment.

Paper #: 20 A spatio-temporal web application for the understanding of the formation of the Parisian Metropolis

Authors: Emile Blettery, Institut National de l'Information Géographique et Forestière, France; Paul Lecat, Université Gustave Eiffel, France; Alexandre Devaux, Institut National de l'Information Géographique et Forestière, France; Valérie Gouet-Brunet, Institut National de l'Information Géographique et Forestière, France; Frédéric Saly-Giocanti, Université Gustave Eiffel, France Mathieu Bredif, Institut National de l'Information Géographique et Forestière, France; Laetitia Delavoipière, Université Paris 13, France; Sylvaine Conord, Université Paris Nanterre, France; Frédéric Moret, Université Gustave Eiffel, France;

This article presents a spatio-temporal web application dedicated to the co-exploitation of heterogeneous data spatialized in a common 3D environment, providing several paradigms for supporting their co-visualization and interactions within the 3D environment and across time. The relevance of this tool is demonstrated here with two use cases involving historians and sociologists with the common objective of better understanding the formation of the Parisian metropolis. The study focuses on the evolution of the city of Nanterre (Paris area), which underwent many changes in the 1950s, and in particular on shantytown areas. Through census as statistical data and aerial imagery as visual data, a group of historians and sociologists experimented the relevance of the joint exploitation of those heterogeneous data within the proposed spatio-temporal web application.