Klaus-Georg and Sigrid Hengstberger Prize 2010.
Three Klaus-Georg and Sigrid Hengstberger Prizes are awarded annually to young scientists and researchers at the Heidelberg Ruprecht-Karls University. The prizes are intended to enable the recipients to present a scientific symposion on the theme of "The Ruperto Carola Symposion at the IWH: A Sponsorship Award for Young Scientists" at the Internationales Wissenschaftsforum Heidelberg (IWH).

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HENGSTBERGER SYMPOSION

Towards Digital Earth – 3D Spatial Data Infrastructures

September 7 – 8, 2011

Convened by

Jun.-Prof. Dr. Bernhard Höfle · University of Heidelberg · Institute of Geography · Chair of GIScience

Dear colleagues,

we would like to cordially welcome you in Heidelberg to the Hengstberger Symposium "Towards Digital Earth – 3D Spatial Data Infrastructures".

Three-dimensional (3D) mapping and characterization of the Earth using sensor technology is increasingly gaining importance. Detailed 3D topographic information is essential in a great variety of research fields aiming at mapping, modeling, exploiting and increasing the understanding of phenomena located on the Earth surface, such as for modeling natural hazards and environmental change monitoring. New remote sensors allow highly detailed 3D topographic mapping with sub-meter accuracy such as the Laser Scanning technology.

In contrast to these high quality but costly sensor data, the last years have witnessed a compelling advent of collaborative Web 2.0 projects (e.g. wikis and social networks) collecting freely available user-generated geographic content such as the OpenStreetMap (OSM). Each contributor in these communities represents a "human sensor" in a world-wide network adding new geographic observations. Therefore, it is essential to integrate aspects from engineering and natural science (sensor technology) with Human and Social aspects of Web communities. This interdisciplinary symposium aims at identifying possibilities and limitations of combining the best of both worlds by fusing 3D remote and (2D) human sensor data. Furthermore, new research impulses for the extension of 3D Spatial Data Infrastructures (3D-SDIs) and next steps towards the 3D Digital Earth "by and for people" are expected. Further detailed information can be found on the website http://3dde.uni-hd.de.

We are looking forward to compelling presentations and fruitful scientific discussions and would like to kindly thank you for your active participation.

Bernhard Höfle, Kristina König

Wednesday, 7 September 2011

09:00-09:15	WELCOME ADDRESS: *Klaus-Georg Hengstberger* *(Sponsor-Hengstberger Foundation, DE),*
	Peter Comba *(Director IWH, University of Heidelberg, DE)*
09:15-09:30	MISSION STATEMENT: *Bernhard Höfle (University of Heidelberg, DE)*
09:30-12:00	**SESSION:** DIGITAL EARTH: HUMAN AND 3D REMOTE SENSORS CHAIR: *Yola Georgiadou (University Twente, NL)*
09:30-10:00	**Digital Earth: Inventory and Prospect** *Michael Goodchild (UC Santa Barbara, US)*
10:00-10:30	COFFEE/TEA BREAK
10:30-11:00	**Crowdsourcing Digital Earth –** **From Data Fusion to Knowledge Generation?** *Alexander Zipf (University of Heidelberg, DE)*
11:00-11:30	**3D Remote Sensing Sensors – Mapping the Earth in 3D** *Gottfried Mandlburger (Vienna University of Technology, AT)*
11:30-12:00	**DISCUSSION**
12:00-13:30	LUNCH
13:30-15:00	**SESSION:** VOLUNTEERED/CROWDSOURCED GEOGRAPHIC INFORMATION CHAIR: *Michael Goodchild (UC Santa Barbara, US)*
13:30-13:50	**The Evolution and Spatial Volatility of VGI in OpenStreetMap** *Peter Mooney (National University of Ireland Maynooth, IE)*
13:50-14:10	**Persuading Non-GI Specialists to Capture Metadata –** **Is it Possible?** *Claire Ellul (University College London, UK)*

14:10-14:30	**The conflation of authoritative and crowd-sourced data for future development of spatial data infrastructures in comparison to normal anatomy** *Mike Jackson (University of Nottingham, UK)*
14:30-15:00	**DISCUSSION**
15:00-15:30	COFFEE/TEA BREAK
15:30-17:00	**SESSION:** CASE STUDIES – CROWDSOURCED GEOGRAPHIC INFORMATION CHAIR: *Mike Jackson (University of Nottingham, UK)*
15:30-15:50	**Fahrradies: A Bicycle Routing System Based on Open Source Software and Free 2D and 3D Geodata** *Manfred Ehlers, Kai Behnke (University of Osnabrück, DE)*
15:50-16:10	**Learning from Geographic Information on the Web** *Christian Sengstock, Michael Gertz (University of Heidelberg, DE)*
16:10-16:30	**Human Sensors, Empowerment, and Accountability in Africa** *Yola Georgiadou (University Twente, NL)*
16:30-17:00	**DISCUSSION**
17:00	**REMARKS** *Convenors*
19:00	DINNER: RESTAURANT ”OSKAR“ (HASPELGASSE 5)

Thursday, 8 September 2011

09:00-10:30	**SESSION:** (3D) SPATIAL DATA INFRASTRUCTURE (SDI) CHAIR: *Bernhard Höfle (University of Heidelberg, DE)*
09:00-09:20	**3D-SDI contribution to energy-efficient cities** *Volker Coors (Hochschule für Technik Stuttgart, DE)*
09:20-09:40	**Managed Objects Can Solve Some of the Interoperability Issues for 3D City Models** *Lars Bodum (Aalborg University, DK)*
09:40-10:00	**Deriving Standardized 3D City Models from Crowdsourced Geodata** *Marcus Goetz (University of Heidelberg, DE)*
10:00-10:30	**DISCUSSION**
10:30-11:00	COFFEE/TEA BREAK
11:00-12:30	**SESSION:** SENSOR DATA INTEGRATION AND FUSION CHAIR: *Gottfried Mandlburger (Vienna University of Technology, AT)*
11:00-11:20	**The OpenEarth Framework and 3D data integration** *Chaitan Baru (AC San Diego, US)*
11:20-11:40	**Introduction to georeferenced managed objects and their potential for sensor data** *Jan Kolar (Grifinor Project, DK)*
11:40-12:00	**3D spatial data extraction for crowd sourcing and volunteered geographic information mapping of natural environments** *Martin Rutzinger (University of Innsbruck, AT)*
12:00-12:30	**DISCUSSION**
12:30-13:45	LUNCH
13:45-14:45	**PLENARY DISCUSSION:** BEYOND THE CURRENT 3D DIGITAL EARTH: POSSIBILITIES AND LIMITATIONS CHAIR: *Manfred Ehlers (University of Osnabrück, DE)*
14:45	**CONCLUDING REMARKS** *Convenors*
15:00	END OF WORKSHOP WITH COFFEE/TEA
20:00	OPTIONAL: NIGHT TOUR OLD TOWN OF HEIDELBERG *Meeting point: fountain in the marketplace (prior registration required: hoefle@uni-heidelberg.de)*

► **SESSION:** DIGITAL EARTH: HUMAN AND 3D REMOTE SENSORS

Digital Earth: Inventory and Prospect

With Google Earth and various other virtual globes providing a first generation of Digital Earth implementations, based on the vision outlined by Gore in 1998, it is appropriate to consider what the next generation might be like. On the one hand, one might conduct a traditional waterfall analysis by identifying use cases and then functionality and architecture. On the other one might echo the early developers at Keyhole and speculate on how the next generation might push the technical envelope. The presentation outlines discussions that have taken place in Florence in 2008 under the auspices of the Vespucci Initiative, and in Beijing in 2011 under the auspices of the Chinese Academy of Sciences, aimed at revisioning Digital Earth for the next decade, and provides a personal interpretation and perspective. The presentation explores the relationships between Digital Earth and other cutting-edge topics in geographic information science, including cyberGIS and volunteered geographic information.

Michael Goodchild
(Department of Geography, University of California, Santa Barbara)

Crowdsourcing Digital Earth – From data fusion to knowledge generation?

Recently we have seen an explosion of data being generated both by technical as well as human sensors. Together they give an increasingly comprehensive digital representation of our planet covering both physical and social aspects. While we see attempts to harvest and integrate those data with respect to its geographic context, most of the approaches do cover only a single or very few data sources, they keep the concept of flat maps and they focus on data management, fusion and visualisation (rather than analysis). I conclude that more research is needed on: a) integrated approaches combining multiple data sources for generating data for the Digital Earth covering different crowdsourcing approaches and technical sensors. b) We need to think about ways to derive information in all three spatial dimensions both for natural objects as well as man-made structures. Further we need to handle also moving and dynamic objects, i.e. their ”behaviour“ and even social interactions. c) Finally we do not only need to generate, fusion, manage and visualize this data in its ”Earth“ context, but also think about ways how to empower the crowd with analytical capabilities, i.e. tools that generate new information (or even knowledge) from the data being available. Current approaches focus on providing analysis tools for domain experts, but there is the question if – and how – we can democratize not only geographic data generation and visualization, but even some aspects of spatial analysis.

Alexander Zipf
(University of Heidelberg, Institute of Geography, Chair of GIScience)

3D Remote Sensing Sensors – Mapping the Earth in 3D

Capturing and reconstructing the Earth's surface and artificial objects is of prime importance for many applications in our everyday world; from transport infrastructure to telecommunication, from disaster management to ecological issues, from agricultural measures to city planning and many more. The magic triangle is: Sensors – Algorithms – Applications. In other words, the raw sensor data is transformed using a set of algorithms to a final model, be it a 1D cross section, a 2D map, a 3D virtual reality computer model. Capturing 3D data was long restricted to a handful of mapping experts. Today however, with the tremendous progress in sensor (GPS, UMTS, digital consumer cameras) as well as computer (mobile devices) and internet technology (Google, Virtual globe), this field is also open to a wider community of non-experts (i.e., collaborative crowdsourcing). This contribution, therefore, reviews well established and uprising 3D remote sensing sensors. Instruments enabling high geometric and radiometric quality will be equally discussed along with low price consumer devices. The principles of both, passive sensors (photometric frame cameras, line scanners, hyperspectral scanners) and active systems like RADAR, LIDAR and range cameras are introduced and their pros and cons are confronted. As 3D data capturing is, nowadays, often carried out in a multi-sensor environment, fusion of data from different sources becomes more and more important. This applies to specific sensor systems like full waveform Airborne Laser Scanning (ALS), where precise point clouds are obtained by combining data from Global Navigation Satellite System (sensor position), inertial measurement units (sensor alignment), the laser scanner (range and beam deflection) and a waveform processing unit as well as for the integration of models with different levels of detail. Embedding local Google SketchUp 3D photo models into precise, countrywide 2.5D ALS DTMs may serve as an example of the latter. One of the challenges of tomorrows geo-data infrastructure is to combine the high accuracy level of modern 3D sensors with the potentially high up-to-dateness of crowd source data.

Gottfried Mandlburger
(Vienna University of Technology, Institute of Photogrammetry and Remote Sensing)

The Evolution and Spatial Volatility of VGI in OpenStreetMap
Volunteered Geographic Information (VGI), and in particular OpenStreetMap (OSM), is being used for many real-world applications such as: building 3-D city models, automobile/cycle/pedestrian navigation applications, gazeteer development, etc). One of the most exciting characteristics of VGI, while potentially being the most controversial, is the dynamic nature of contributions to projects such as OSM coupled with the GIS/spatial data handling abilities of OSM contributors. In this paper I shall discuss ongoing research and development towards understanding the dynamic and evolutionary nature of the spatial data "inside" OSM. Case study examples and analysis are presented. Accessing the edit history of features in OSM is a complicated process, compounded by the ever increasing volume of the spatial data within OSM. Subsequently, little research is being conducted on the historical evolution of the spatial data in OSM up to the current version of the globally accessible OSM database. Unlike National Mapping Agency data products the "current version" of OSM may not be the "best available" or "highest quality" for certain applications. The results of my work indicate that researchers, commercial companies, etc developing applications or services using OSM must be cognizant of the potential problems caused by the volatile nature of the underlying spatial data and its attributes/metadata. I explore the effects of this volatility in terms of VGI integration into iniativies such as Spatial Data Infrastructures (SDI) and Digital Earth.

Peter Mooney
(National University of Ireland Maynooth)

Persuading Non-GI Specialists to Capture Metadata – Is it Possible?
Metadata, and how it is captured, maintained and used, is fundamental to any Spatial Data Infrastructure. This is possibly even more the case in a 3D context, where the types of errors in the 3D geometry may vary widely depending on the source and capture method for the data itself. Issues relating to data quality, described by metadata in the context of terms such as completeness, currency, positional accuracy and coverage, apply in 3D as much as they do in 2D. The presentation will give an overview of the use of metadata in a multi-national Coastal Environmental Science research project, presenting the differing views about the importance of various metadata elements expressed by the producers and the users of this metadata. Issues relating to metadata capture and motivating team members to undertake this task will also be examined, in the context of a multidisciplinary team whose expertise ranges from environmental science to population migration, and whose familiarity with GIS and metadata is limited.

Claire Ellul
(University College London (UCL), Civil, Environmental & Geomatic Engineering)

The conflation of authoritative and crowd-sourced data for future development of spatial data infrastructures
Spatial data infrastructures (SDI) have moved from the concept stage to being accepted policy and an increasingly essential component of the environmental and economic planning programmes of most countries. They have been defined and built from a top-down perspective, harmonising and making interoperable the spatial data holdings, particularly map-based data, of government ministries and related governmental bodies. At the time of their inception this was compatible with the reality that most of the relevant data were collected and mapped by such agencies. Over the last decade, however, we have experienced a situation where the ability to accurately locate an objects position, boundary or trajectory no longer requires expensive survey equipment operated by highly trained professionals. Such a capability is now within the scope of the general public most notably through the technology which is part of the almost ubiquitous mobile phone. This has led to an explosion in people positioning themselves, the places that they visit, the photographs that they take and the digital trails that they create as part of their day-to-day work and social activity. The value of this data in aggregated form, for social and commercial application, has been recognised but it has as yet produced more of a parallel path towards spatial data acquisition and utilisation than an integrated contribution to "governmental" SDI. This presentation will discuss this situation, compare the nature of the two sources of data and present some research results aiming to achieve conflation of the two to achieve the best of both worlds.

Mike Jackson
(Centre for Geospatial Science, The University of Nottingham)

Fahrradies: A Bicycle Routing System Based on Open Source Software and Free 2D and 3D Geodata

Nowadays the world market is overloaded with routing applications. Those routing services are mostly designed for the usage with motorized vehicles, for this purpose they are well-engineered. However, the requirements of cyclists often differ from those of motorists. Cyclists are typically not interested in finding the shortest way to their destination; they prefer choosing paths where they can enjoy nature without interfering with motorized traffic. In view of the fact that digital geographic material for bicycles is rare, the project Farradies.net was developed to offer new possibilities by using solely open source software (e.g. OpenLayers, MapServer) and free geodata (e.g. OpenStreetMap and SRTM global digital elevation data). This project provides a routing service which is particularly designed for cyclists and for the region around the city of Osnabrück. Based on free geodata from OpenStreetMap.org, Fahrradies.net uses pgRouting, which enables users to plan their tracking routes more individually. For using pgRouting in the Web, a special algorithm was developed (written in PL/pgSQL). Furthermore, users can choose from several routing profiles. The offroad-profil, for example, is optimized for mountain bikers and will prefer ways through rough terrain, like paths or tracks with cobblestone pavement and appropriate slopes that are derived from SRTM elevation data. In addition, Fahrradies.net offers information about many points of interest along the calculated routes. Interactively designed tracks can be downloaded for mobile devices. Another important innovation is that the routing service offers functions referring to the Web 2.0 definition. For example, it is possible for users to rank routes, based on various evaluation criteria. These ratings can also be taken into account when planning individual biking excursions. The main idea behind that is that people can actively interact with the system, in contrast to only use a given service. Bicyclists, for example, can either avoid certain steep slopes when crossing mountainous landscapes. Mountain bikers, on the other hand, can select tracks with maximum altitude differences for their workout. Fahrradies is designed to give cyclists the tools to plan their routes as individually as possible.

Manfred Ehlers, Kai Behncke
(Institute for Geoinformatics and Remote Sensing, University of Osnabrück)

Learning from Geographic Information on the Web

The rapidly increasing amount of Volunteered Geographic Information (VGI) on the Web provides a rich resource for describing and exploring locations and regions in geographic space. Popular sources managing large numbers of geographic features (VGI-features) include geo-tagged media, like Flickr, Twitter, or Wikipedia articles, and dedicated open geographic information sources like OpenStreetMap. Learning tasks based on the representation of locations and regions using VGI include, among others, the prediction of events at a given location based on event observations in other regions, or the segmentation of geographic space into meaningful regions to automatically generate maps or extract vector representations. But how can VGI be used to build a generalized, meaningful, and structured representation of arbitrary locations and regions in geographic space that can be input to learning tasks? We assume that locations and regions can be represented by VGI-features that are close in spatial proximity, inspired by the process how people get a sense of their environment based on surrounding real-world phenomena. A major challenge in developing and using such a representation is that existing data sources manage a high dimensional, noisy, sparse, and highly clustered feature space, which is difficult to handle by learning tasks. To overcome some of these problems, feature selection and extraction methods tailored to the characteristics of VGI are needed. In this talk, a general approach to represent arbitrary locations by VGI-features and a model to define a structured VGI-feature space are introduced. Feature selection and extraction algorithms and example learning tasks are proposed that demonstrate the benefits and the generality of the approach. Finally, we outline future research topics related to VGI-feature spaces.

Christian Sengstock, Michael Gertz
(Institute of Computer Science, Heidelberg University)

Human Sensors, Empowerment, and Accountability in Africa

Reports of citizens as voluntary sensors can go beyond the geometric primitives of point, line, or polygon. Empowered citizens can report failures in the delivery of local government services – e.g., water, health, education – via text messages on standard mobile phones. The public disclosure of these reports on the web and other mass media may pressure local authorities to take remedial action. The voice of ordinary citizens can be amplified, and citizens' capacity to directly influence public service delivery and hold local government accountable can be improved. With mobile phone coverage and ownership expanding rapidly in Africa more and more initiatives are developed for citizens to make innovative use of mobile telephony and SMS-based services in Africa. In this paper, we outline the challenges pertaining to citizen sensing for domestic accountability, based on a pilot 'human sensor web' in Zanzibar, with UN Habitat and Google funding between 2009 and 2010. A human sensor web is an assembly of geographic web services, citizens with mobile phones ('human sensors') reporting & publicizing water and health problems in traditional mass media and Google Maps, public water points & clinics, and stakeholders & users. The lessons we learned during the pilot form the backbone of a research agenda to advance an African contribution to Digital Earth.

Yola Georgiadou
(Chair Geo-information for Governance, Faculty of Geo-information Science and Earth Observation (ITC), University Twente)

3D-SDI contribution to energy-efficient cities

Climate change, the limitations of fossil fuels and sustainable energy production are some of the biggest challenges of the 21st Century. Heating and cooling of buildings is one of the largest sources of energy consumption in the European Union. In Germany, we have about 18 million residential buildings, 75% of these have been build 30 years ago. How can 3D spatial data infrastructure (SDI) contribute to the energy-efficiency of our cities? Unfortunately, a SDI has no direct impact on energy consumption. However, a 3D city model available and usable by professional energy managers as well as private building owners will have a significant impact to reduce the energy consumption of a city and in addition to raise the local energy production such as PV. A 3D SDI enables energy managers to get an overview of the expected future energy demand due to improved simulation methods. In addition, the performance of a building can be improved by optimized building control due to online access of current energy consumption and predicted / simulation. To achieve this, we need to (i) be able to share multipurpose 3D city models, which requires a mapping between domain specific ontologies, (ii) enable energy simulation tools to deal with 3D city models to improve simulation results at city level (Strzalka et al. 2011), (iii) enhance the quality of existing city models, (iv) support crowd sourcing to capture detailed models of building including interior. For instance, the availability of simple web-based modeling tools (such as Google SketchUp) will enable every owner of a building to prepare a suitable model for energy simulation. Currently, semantic modeling is lacking, and (v) ensure privacy issues.

Volker Coors
(Hochschule für Technik Stuttgart)

Managed Objects Can Solve Some of the Interoperability Issues for 3D City Models

The road towards interoperability within the domain of 3D city modelling is long and despite the strong technological progress there are still many decisions to make and a lot of specific implementations to do before the situation could be described as satisfying. 3D city models must adapt to a spatial data infrastructure and they also have to advance from simple geometric models to more complex information models. A big step in the right direction has been taken with the introduction of CityGML. The OGC specification allows exchange of 3D city models and furthermore there are numerous possibilities to define semantic properties together with the geometry. But introducing CityGML as the preferred information model and data exchange format for the future will not solve all problems. A further enrichment of the information model is suggested by the use of Managed Objects (MO) in a conceptual model on the application level. MO refers to a pure object-oriented and platform-independent binary representation that carries both the executable behaviours and attribute data regarding an object. The MO's allow having not only properties (attributes) for the objects in the 3D city model but also operations (methods). This will make the 3D city model much more interesting for simulation purposes or other applications that are demanding functionality and intelligence.

Lars Bodum
(Aalborg University, Department of Development and Planning)

Deriving Standardized 3D City Models from Crowdsourced Geodata

Professional tasks such as urban planning more often require precise 3D models for computation and visualization. Moreover, applications for the broad public such as Google Earth do also allow a three-dimensional visualization of a virtual globe. Thereby, professional applications and enterprises mainly utilize proprietary data obtained by public authorities or commercial providers. In contrast, research institutes or small companies always seek alternative (and cheap) data sources, which are capable for their requirements. One type of such alternative data sources has evolved in the last couple of years, namely Volunteered Geographic Information or Crowdsourced Geodata. Thereby, both terms describe the collaborative collection of different types of spatial and geographic data. That is, both layman and professionals collect such data and share it in a Web 2.0 community platform with other users at no charge. One very popular example for this trend is OpenStreetMap (OSM) – a project aiming at providing a massive data source of spatial information. It began as an online map, but soon evolved to a source of various types of information. That is, OSM not only contains information about streets, but currently also details about roughly 36 million buildings. Projects such as OSM-3D (www.osm-3d.de) already demonstrated, how OSM data can be utilized for visualizing urban areas, but it mainly focuses on visualization and not on semantics. If it is possible to create standardized 3D city models containing both geometric and semantic information, OSM and other crowdsourced geodata could be considered as a real alternative data source for diverse applications. This paper discusses how 3D models could be created from OSM and furthermore it investigates how the current data situation looks like (referring to buildings).

Marcus Goetz
(University of Heidelberg, Institute of Geography, Chair of GIScience)

The OpenEarth Framework and 3D data integration

In an age where scientists and the general public have access to free software such as Google Earth that permit whole-Earth data visualization, the scientific community still struggles to fuse and visualize heterogeneous, multidimensional data products. At a time when raw data archives and derived products are growing rapidly, the pathways to integrate and visualize these data are limited. New approaches must be developed to maximize the utility of a broad range of community data products, and to enable intuitive data integration and visualization for research and education and outreach. One such effort is the OpenEarth Framework (OEF), initially developed as part of the Geosciences Network project (GEON, www.geongrid.org). Beyond supporting the myriad file formats, data types, and metadata associated with such data, a system like OEF also needs to explore the ability to scale to large data, for example, via data partitioning algorithms to tackle the underlying challenges of managing large individual and integrated data sets that exceed computer memory capacities. OEF provides a visual analytics environment. The goal of such environments is to provide users an interactive experience, as much as possible. We will discuss experiences with different data types including, for example, tomography, 3D orthophotography, high-resolution topography, and terrestrial laser scans. Integration of 3D data has broad applications not only in the solid earth sciences but across a broad range of domains from surface and ground water hydrology, to petroleum reservoir characterization, urban modeling, emergency response, and the atmospheric sciences.

Chaitan Baru
(San Diego Supercomputer Center, UC San Diego)

Introduction to georeferenced managed objects and their potential for sensor data

This contribution is about experimental research on georeferenced managed objects that can provide possibly highly specialized data representations. These representations can be tailored for a very concrete type of data, information and actions related to the real world. Delivering data in a traditional way is also possible, but the main strength of the concept is that the specialization in data representation does not hamper technical interoperability. This is useful especially for large and highly heterogenous information systems, such as SDI for cities, countries or entire world. This talk will introduce how managed objects can allow for this flexibility in terms of data representation. How to empower data and information creators in devising new representation of any feature related to our planet, publishing the result, and how clients can instantly start using the content without changing the client's software. These properties of georeferenced managed objects have a great potential for being associated with broad variety of sensor data ranging from satellite data systematically covering entire globe to specialized *in-situ* data. Even individuals collecting data manually can use managed objects directly using simple user interfaces, because the design supports GUI, 3d visualization and time at many levels of resolution. Outlined concepts will be supported by an experimental implementation called GRIVIN. Several ideas will be given for merging various georeferenced data, being it from connected sensor devices, data from databases, Web services, or raw data, and turning it into a specific, accessible information.

Jan Kolar
(Grifinor Project)

3D spatial data extraction for crowd sourcing and volunteered geographic information mapping of natural environments

The availability of spatial data has strongly increased in the last decade due to freely accessible remote sensing data, integration of sensors in user devices (e.g. Global Positioning Systems in mobile phones), and the development of online globes, mapping, and spatial data management platforms (e.g. Open Street Map). Spatial data description, collection and modification by users i.e. volunteers is increasing. This phenomenon has led to a "wikification" of geographical information, which is known as Crowd Sourcing and Volunteered Geographic Information (VGI). So far major user activities focus on urban area and infrastructure mapping such as adding streets and buildings and tagging locations such as restaurants and meeting points. However, there is increasing interest in using VGI describing natural phenomena and surfaces such as geomorphologic structures, water bodies, mapping of vegetation, and sighting sites of specific species of fauna. Current examples exist where VGI is used for biodiversity mapping, updating of land use and land cover maps, mapping of water extent, etc. We propose a concept integrating data derivatives, which were automatically extracted from existing 3D topographic LIDAR data, which was for example collected within research projects. The idea is to upload and collect 3D vector data such as extracted crevasses of glaciers, current glacier extent, geologic faults, erosion scraps, etc. Crowd sourced and volunteered mapped spatial data plays already significant role in many applications. VGI for mapping the natural environment will help to distribute new data sets among diverse scientific, public, and private user communities, which highly benefit by this kind of interaction, information and knowledge sharing.

Martin Rutzinger
(Institute of Geography, University of Innsbruck)

Improving the fitness for use of OpenStreetMap for planning tasks

One important task in spatial planning is to delimit urban regions. For this purpose actual and detailed data are needed. Volunteered geographic information (VGI) like OpenStreetMap (OSM) fulfills both aspects. Nevertheless, a limitation of crowd-sourced spatial data are their spatial data quality, in particular their completeness, which affects their fitness for use. The presentation proposes a methodological framework to delimit urban regions in Europe that are currently not mapped or only partially mapped in OSM. By predicting such areas, completeness of OSM can be enhanced considerably, and thus its fitness for use can be improved. For this purpose machine learning methods, i.e. artificial neural networks and genetic algorithms are applied. The resulting model estimates urban regions, under the premise of existing OSM data, comparably well. The model shows spatial heterogeneity of its performance across different European regions. These results indicate that the potential for improving the fitness for use is related to location. Finally, potential research areas are identified whereas VGI can enhance traditional data sources.

Julian Hagenauer, Marco Helbich
(University of Heidelberg, Institute of Geography, Chair of GIScience)

Fusion of VGI and highly accurate laser scanning data for 3D city modeling

In recent years Airborne Laser Scanning (ALS) has evolved as a standard technology for highly accurate three dimensional topographic mapping. These high quality and expensive sensor data is increasingly gaining importance in many research fields such as 3D city modeling. Besides remote sensing data collaborative Web 2.0 projects such as Open Street Map (OSM) aim at collecting and providing freely available user generated geographic data of e.g. streets and buildings. These data is less accurate but in general more up to date, meaning that there is a spatio-temporal shift between ALS data and Volunteered Geographic Information (VGI). However, both datasets have already been used for 3D city modeling. By fusing datasets from both worlds existing 3D city models can be improved and new methods can be developed updating both remote sensing and user generated geographic data. Furthermore, quality assessment of VGI in areas matching with ALS data is possible.

Andreas Jochem, Bernhard Höfle, Marcus Goetz
(University of Heidelberg, Institute of Geography, Chair of GIScience)

Combined 3D Acquisition of Inscriptions and Terrain of the Worms Medieval Jewish Cemetery ‚Heiliger Sand'

Inscriptions on medieval tombstones made from sandstone become extremely weathered leading to characters hardly visible and partly lost. Digitally capturing the geometric information is to preserve the today's state and to analyze it with tailored algorithms. Simple light models can be used to simulate a neutral material without shadowing, and virtual light sources can be moved by the user making him independent from the once fixed setting up of a photographer. Additionally, curvature based analysis using Multi-Scale Integral Invariants (MSII) allows for enhancement of script and elimination of noise due to weathered surfaces. We will show exemplary results of the 30 most endangered tombstone acquired with a close-range 3D-scanner. An outlook is given concerning the embedding of high resolution scans in midrange area scans of the terrain, a big challenge for level-of-detail methods across several orders of magnitude.

Susanne Krömker, Hubert Mara
(Interdisciplinary Center for Scientific Computing (IWR), University of Heidelberg)

DSMs validation and merging methods and procedures

The work consists in two parts: in the former original DSM (Digital Surface Model) validation approaches are presented. The validation consists of different steps: an inner outlier detection computed by means of a command developed within GRASS (an open source and free GIS software); an external 3-dimensional bias detection computed by means of a MATLAB ad hoc developed software; the analysis of the DSM quality dependent on the slope and on the aspect (using a two way analysis of variance ANOVA) and on the terrain coverage using GRASS. The latter part of the work, still in progress, has as target the creation of a multi-resolution digital model rigorously obtained from the different DSM sources available. For such an aim, the statistical analysis and comparisons of the models to be merged is a pre-condition to define the optimal procedure. The DSMs taken into account as examples refer to a morphological complex area in the North of Italy (the region around the Como lake). They were obtained from different techniques: the SRTM (step of 90 m) from SAR, the ASTER (step of 30 m) from aerial photogrammmetry and the Regione Lombardia DSM (step of 2m) from photogrammetry. The data used to validate these DSMs are GPS ground spread points taken with RTK surveying modality and the LIDAR filtered point cloud from which the DSM (step of 2m) was computed using GRASS GIS. Finally the terrain coverage considered is that obtained from the Regione Lombardia DUSAF land use database at scale 1:10000.

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