

Smart Point Clouds in Virtual Globes – a New Paradigm in 3D City Modelling ?

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Vision and Goals

New Application Areas for highly detailed 3D Landscape and City Models

- automatic generation of **reality-based simulation environments**
- generation and updating of **traffic infrastructures**

Requirements and Challenges

- largely **automated acquisition & production** of 3D (city) models
- frequent / automated **updates**
- **geometric and semantic** information extraction and change detection
- integration into an interactive, collaborative environment

Motivation – Current City Modelling Paradigm

Prevailing Modelling Approach

- vector-based / 3D boundary representations
- automated texturing based on oblique airborne imagery

Problems / Shortcomings

- discrepancy of perspectives: airborne acquisition vs. ground-based **use**
- 'exploding' production effort with increasing level of detail
- photorealism as a dead-end !? (what happened to cartographic principles ?)
- traditional 3D models poorly represent nearby environment

Recent Alternatives

- image-based city models (e.g. Google StreetView)

Motivation – Mobile Laser Scanners as promising new 3D Geosensors



Mobile LS System (TopScan / Optech)

Typical Characteristics

- 100'000 3D points/sec
- at up to 100 km/h
- multi-sensor systems
- largely automated data acquisition and processing
- data acquisition at 'eye level' (!)

Future Characteristics

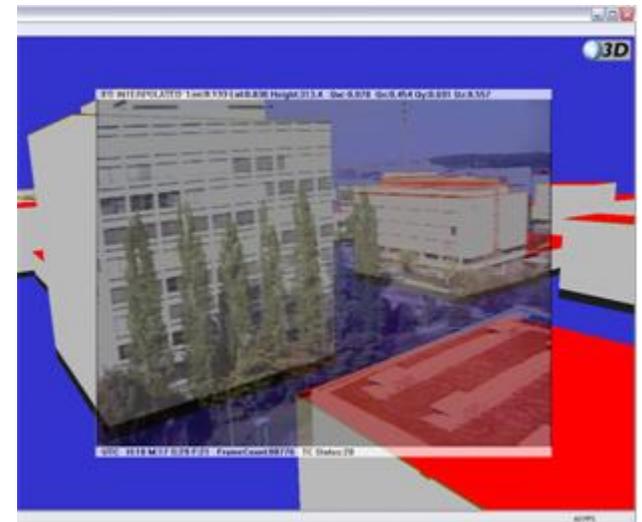
- (multi-)spectral 3D point properties
- acquisition geometry for 3D points

Integration of 3D Point Clouds into Virtual Globe Technology i3D (Video)



Why using Virtual Globes?

- **Interactive 3D Environment for 3D Geodata**
- **Web-Streaming for TB of Imagery and Terrain Data**
- **Geodetic Reference**
- **Geospatial Collaboration**
- **Geosensor Integration**
- **Mixed-Reality Applications**
 - Augmented Geo-Monitoring combining micro UAV-based video imagery with a Virtual Globe



State of Research / Related Work – (Geo-)Spatial 3D Point Clouds

Number of
publications (trend)

Data Acquisition / Collection of 3D Point Clouds

- Barber, D., Mills, J. and Smith-Voysey, S., 2008. Geometric validation of a ground-based mobile laser scanning system. *ISPRS Journal of Photogrammetry and Remote Sensing*, 63(1): 128-141.
- Haala, N., Petera, M., Kremerb, J. and Hunterc, G., 2008. Mobile LIDAR mapping for 3D Point collection in Urban Areas - a Performance Test, XXI ISPRS Congress, Beijing.

Processing (Triangulation, Simplification)

- Pauly, M., Gross, M. and Kobbelt, L.P., 2002. Efficient simplification of point-sampled surfaces, *Visualization, 2002. VIS 2002. IEEE*, pp. 163-170.

Information Extraction

- Schnabel, R., Wahl, R., Wessel, R. and Klein, R., 2007. Shape Recognition in 3D Point Clouds, Institut für Informatik II, Universität Bonn, Bonn.

Visualisation, Use, Interaction

- Kreylos, O., Bawden, G.W. and Kellogg, L.H., 2008. Immersive Visualization and Analysis of LiDAR Data *Advances in Visual Computing. Lecture Notes in Computer Science. Springer, Berlin / Heidelberg*, pp. 846-855.

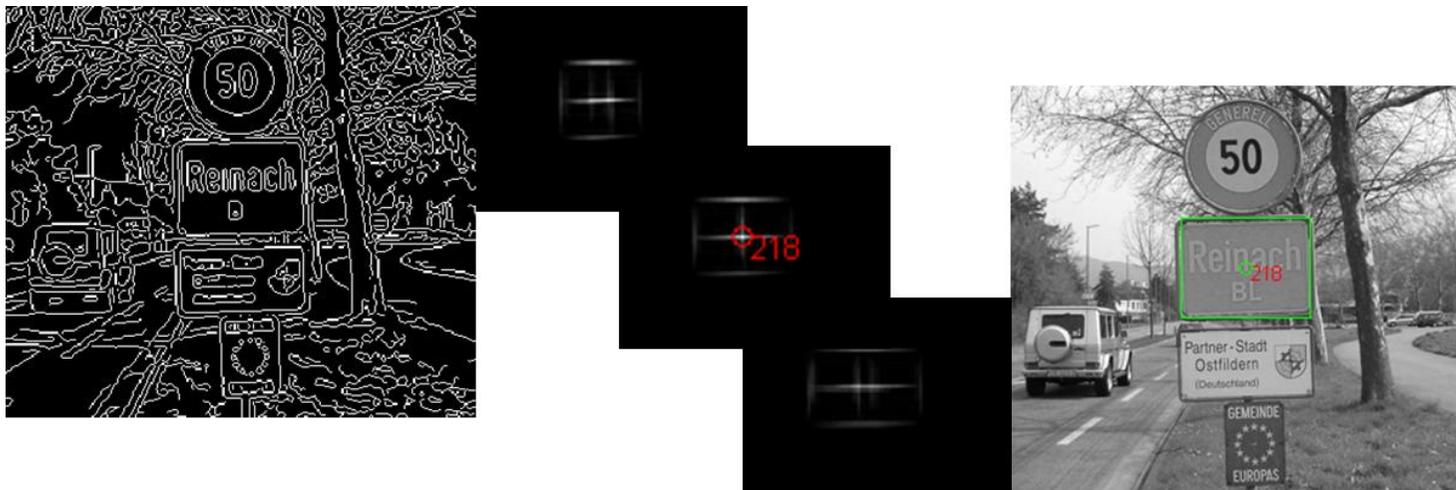
Turning 3D Point Clouds into Smart Point Clouds – Research Issues

Geometric and Semantic Information Extraction

- e.g. automatic extraction of road signs (multi-sensor approaches)
- replacement / symbolisation of extracted objects or 'tagging' of point clouds

Change Detection

- e.g. for maintaining / updating infrastructure databases



Automated road sign extraction from still imagery [Burkhard, 2008] (MSc semester project)

Supporting 3D Point Clouds in Virtual Globes – Research Issues

Algorithmic Foundations

- generation of multi-resolution, streaming representations of 3D point clouds
- handling of occlusions / point visibility
- texturing of 3D point clouds / use of texture patches (?)

Visualisation & Interaction

- comparison of the usefulness of different city model representations
- perspective 3D views vs. stereoscopic views
- methods and tools for the **interaction** with 3D point clouds

Summary

Combination of ...

- Mobile Laserscanning
- 3D Point Clouds
- Virtual Globes

... with an enormous Potential

Numerous Research Issues on (Smart) 3D Point Clouds

- Object Extraction
- Geospatial Data Mining
- Visualisation
- Interaction