Creating a worldwide 3D globe from user-generated data

Matthias UDEN , Arne SCHILLING, Ming LI, Marcus GÖTZ, Alexander ZIPF

Abstract

Recent years have witnessed a paradigm shift in collaboratively created geographic data on the internet. The amount of Volunteered Geographic Information (VGI) [1] steadily increases and maps from projects like OpenStreetMap[1] (OSM) are being recognised and used more and more. Investigations on its completeness and quality have shown, that in particular urban areas in Central Europe have already been mapped by volunteers with an impressive level of detail (cf. [2, 3]). In those areas, OSM is meanwhile well ahead of only mapping the street network and points of interests and a certain level of saturation is about to be reached. This progress in user-generated maps, however, is mainly limited to 2D. In order to utilise the potential of the "mapping crowd" even better, it has to be investigated, to what extent such a project like OSM could be extended into the next dimension. The idea of letting the crowd assemble not only 2D maps but also comprehensive 3D city models is very promising.

3D-related mapping in VGI projects is currently very limited. In OSM for instance, only few 3D information exists due to data structures which are inappropriate for complex 3D content as well as missing editing tools, mapping conventions and widespread 3D viewers. Nevertheless, the OSM-3D project [4-6] shows, how the data can already be used for creating 3D city and landscape models at present. Based on the 2D data and the little amount of available 3D information, 3D scenes are created and provided in a standards-based manner as a Web 3D Service (W3DS) [7]. In a regular update process, the meanwhile over 50 million building ground plans [8] in OSM are being extruded. Together with additionally available information like POIs and labels, up-to-date 3D city models are being created. The OSM-based data is enhanced with public domain terrain data from the SRTM[2] mission.

Only recently, this process has been expanded to a worldwide extent. The OSM-3D W3DS now provides 3D models of arbitrary places all over the world (cf. Figure 1), whose quality and completeness mainly depend on the underlying OSM data. This can potentially have a motivating effect for people outside Europe to map their environment in 3D, because they can now see the results in our 3D globe. In general, many different applications are made possible with this user-generated 3D model of the world. Our W3DS client software, the XNavigator [9], allows for the integration of several OGC Web Services and OpenLS [10]. Therefore, applications like 3D (pedestrian) routing, analyses of disaster impacts or urban planning based on volunteered geographic data are possible (e.g. [11-13]). While changing the extent of OSM-3D from Europe to global we have made some experiences which show that the European workflow cannot in all cases be naively transferred to the rest of the world. New challenges arise which we would like to present and discuss at the workshop.

Crowdsourced 3D city modelling is still in its very early stages and the level of detail has to be improved in the future. In order to achieve this, several efforts are to be carried out, which are supposed to ease direct 3D mapping and inspire the volunteers for this new dimension. One first step towards more detailed crowdsourced city models is the OpenBuildingModels prototype [14]. This web-based platform will allow to upload entire architectural 3D building models into a free-to-use

[1] http://www.openstreetmap.org
[2] Shuttle Radar Topography Mission - http://srtm.csi.cgiar.org/

repository in the future. These models can then be referenced from within OSM and subsequently displayed in a viewer like OSM-3D (cf. Figure 2), which significantly increases the level of detail. Apart from this platform, several other challenges in the context of crowdsourced 3D city modelling have to be tackled. For instance, data structures, modelling and editing methods which are most suitable for volunteered 3D mapping have to be investigated. While a lot of research already exists about accurate 3D *reconstruction* of buildings (e.g. [15-17]), all this has to be examined in an altogether different light for the approach of crowdsourced data *generation*, where little to nothing related research exists. By pushing forward both, research and community efforts, we can make a huge step towards a user-generated "Digital Earth" [18] in the future.

Acknowledgments

The authors would like to thank all contributors to the OSM-3D project. This research has been partially funded by the Klaus-Tschira Foundation (KTS) Heidelberg.

Images

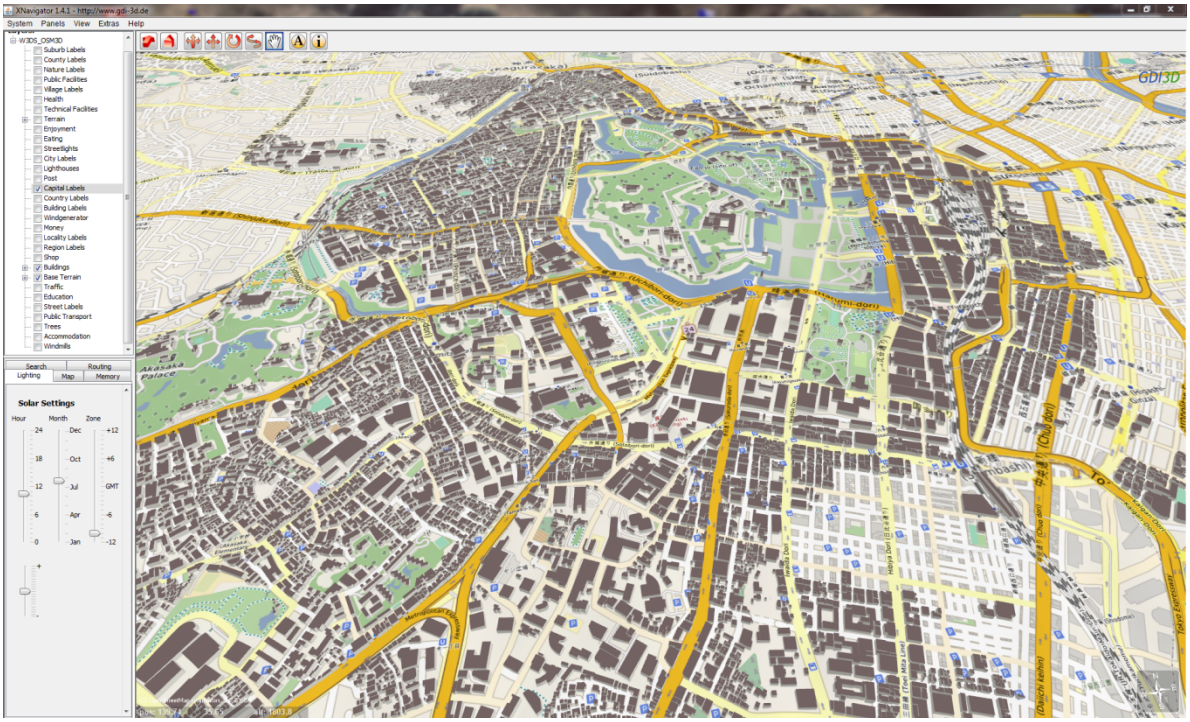

Figure 1: OSM-3D is now available worldwide. This picture shows Central Tokyo with 3D buildings derived from OSM.

Figure 2: The OpenBuildingModels approach enables users to upload and share their 3D architectural building models in a free repository. The models can be displayed in OSM-3D and therefore greatly enhance 3D city models.

References

1. Goodchild, M., *Citizens as sensors: the world of volunteered geography.* GeoJournal, 2007. **69**: p. 211-221.

2. Haklay, M., *How good is volunteered geographical information? A comparative study of OpenStreetMap and Ordnance Survey datasets.* Environment and Planning B: Planning and Design, 2010. **37**(4): p. 682-703.

3. Neis, P., D. Zielstra, and A. Zipf, *The Street Network Evolution of Crowdsourced Maps: OpenStreetMap in Germany 2007-2011.* Future Internet, 2012. **2012**(4): p. 1-21.

4. Over, M., et al., *Generating web-based 3D City Models from OpenStreetMap: The current situation in Germany.* Computers, Environments and Urban Systems, 2010. **34**(6): p. 496-507.

5. OSM-3D. *The OpenStreetMap 3D project*. 27/03/2012]; Available from: http://www.osm-3d.org/home.en.htm.

6. Goetz, M. and A. Zipf, *The Evolution of Geo-Crowdsourcing: Bringing Volunteered Geographic Information to the Third Dimension*, in *Volunteered Geographic Information, Public Participation, and Crowdsourced Production of Geographic Knowledge*, D. Sui, S. Elwood, and M. Goodchild, Editors. 2012 in press, Springer: Berlin.

7. W3DS. *The Web 3D Service Wiki*. 27/03/2012]; Available from: http://www.w3ds.org.

8. Taginfo. *Usage of OSM building key*. 27/03/2012]; Available from: http://taginfo.openstreetmap.org/keys/building.

9. XNavigator. *The W3DS Client & 3D Navigation Tool*. 27/03/2012]; Available from: http://xnavigator.sourceforge.net.

10. Open Geospatial Consortium Inc., *OpenGIS Location Services (OpenLS): Core Services*. 2008, Mabrouk, M.

11. Walenciak, G., et al., *Extending Spatial Data Infrastructures 3D by Geoprocessing Functionality*, in *The International Conference on Advanced Geographic Information Systems & Web Services. GEOWS 2009*. 2009: Cancun, Mexico.

12. Schilling, A., et al., *Interoperable Location Based Services for 3D cities on the Web using user generated content from OpenStreetMap*, in *27th Urban Data Management Symposium (UDMS 2009)*. 2009: Ljubljana, Slovenia.

13. Lanig, S., et al., *Geodateninfrastrukturen im historisch-geographischen Kontext - Buddhistische Steinschriften in der Provinz Sichuan/China*, in *AGIT 2011, Symposium Angewandte Geoinformatik*. 2011: Salzburg, Austria.

14. Uden, M. and A. Zipf, *OpenBuildingModels - Towards a platform for crowdsourcing virtual 3D cities*, in *Paper accepted for the 7th International 3D GeoInfo Conference*. 2012: Quebec City, Canada.

15. Wonka, P., et al., *Instant Architecture.* ACM Transactions on Graphics (TOG) - Proceedings of ACM SIGGRAPH 2003, 2003. **22**(3): p. 669-677.

16. Ripperda, N. and C. Brenner. *Data driven rule proposal for grammar based facade reconstruction*. in *Photogrammetric Image Analysis - PIA07*. 2007. München, Germany.

17. Sampath, A. and J. Shan, *Segmentation and Reconstruction of Polyhedral Building Roofs From Aerial Lidar Point Clouds.* IEEE Transactions on Geoscience and Remote Sensing, 2010. **48**(3): p. 1554-1567.

18. Gore, A., *The Digital Earth: Understanding our Planet in the 21st Century.* Australian surveyor, 1998. **43**(2): p. 89-91.