A Novel, User-Friendly Indoor Mapping Approach for OpenStreetMap

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Abstract

The community project OpenStreetMap (OSM), which is well-known for its open geographic data, still lacks a commonly accepted mapping scheme for indoor data. Most of the previous approaches show inconveniences in their mapping workflow and affect the mapper's motivation. In our paper an easy to use data scheme for OSM indoor mapping is presented. Finally, by means of several rendering examples from our Android application, we show that the new data scheme is capable for real world scenarios.

Keywords

OpenStreetMap, Indoor Maps, Data Scheme, Mapping

1 Introduction

The vast amount of projects and applications of the OpenStreetMap (OSM) has shown that Volunteered Geographic Information (VGI) is able to compete with proprietary and commercial solutions, such as Google Maps, in outdoor environments. Especially in sparsely inhabited regions, commercial, non-open maps show a lack of a good coverage, mainly due to the limited prospect of profit for their providers. At this point, community projects are evolving their full advantage by providing free and open mapping methods. Moreover, even such regions are mapped because of the huge OSM community. Consequently, OSM maps have an extensive and detailed coverage of relevant features for the most parts of the world.

Unfortunately, the map quality for interiors of buildings is not as high as for outdoor maps in OSM. The OSM project community has still not agreed on an unified data scheme for indoor maps, while global players, such as Google and Microsoft, have already mapped the indoor environment of a vast amount of shopping malls, airports and other public buildings.

In order to achieve a coverage level for OSM indoor maps that is comparable to the high quality of the outdoor maps and to develop a real alternative to existing commercial solutions, it is absolutely necessary to establish a mapping scheme for indoor components and objects that is easy to use and to understand.

Therefore, we describe the principles and practical application problems of existing indoor mapping schemes (*2. Related Work*) and propose a novel approach for mapping indoor environments for OSM (*3. Indoor Data Scheme*). Finally we present various rendering examples of our Android map application and give an outlook on our future work (*4. Conclusions and Further Work*).

2 Related Work

A precondition for mapping building interiors and explaining the existing approaches is the understanding of the basic OSM mapping. Map data can be stored in XML format and is comprised of three basic data elements: nodes, ways and relations. The purpose of nodes is to describe geometrical points in the world in the WGS84 projection and provide, if available, additional information with so-called tags. A tag always consists of one key-value pair. In Figure 1, an example of such a node with one tag in XML format is given.

```
<node id='340188031' timestamp='2013-03-18T09:16:11Z' lat='50.8138432' lon='12.9305845'>
    <tag k='bus' v='yes' />
</node>
```

Figure 1: Snippet of a simplified OSM node in XML format

By connecting nodes to ways, it is possible to describe lines (unclosed way) and polygons (closed way). This connection is expressed by a sequence of references to nodes or the corresponding identification numbers (IDs) respectively. Furthermore, the usage of tags for these ways enables the declaration of their purposes. For example, a polygon is declared as a building with the tag "building=yes". Figure 2 shows the XML example of a way.
Relations are the most recent of the OSM basic data elements. They are used to group nodes and ways to one semantic meaning. The grouping is expressed by a sequence of references to the IDs of ways and nodes, whereas the semantic is defined by tags (see Figure 3). An example for relations are bus routes, which consist of several streets (ways) and bus stops (nodes).

```
<way id='30742862' timestamp='2014-02-19T17:14:51Z'>
    <nd ref='340010531' />
    <nd ref='2212115051' />
    <nd ref='2212115052' />
    ...
    <nd ref='...' ... />
    <nd ref='340010531' />
    <tag k='building' v='yes' />
</way>
```

Figure 2: Snippet of a simplified OSM way in XML format

```
<relation id='2826912' timestamp='2015-01-05T12:12:32Z'>
    <member type='way' ref='4681387' role='' />
    <member type='way' ref='4544839' role='' />
    ...
    <member type='way' ref='3016.3679' role='platform' />
    <member type='node' ref='1512603261' role='stop_exit_only' />
    <member type='way' ref='231126448' role='' />
    <tag k='route' v='bus' />
    <tag k='type' v='route' />
</relation>
```

Figure 3: Snippet of a simplified OSM relation in XML format

All these data elements are used by one of the best known and most used mapping schemes for indoor data, the IndoorOSM proposal (Goetz, 2011 & 2012). The concept of this approach is the construction of a hierarchical data structure (see Figure 4), which is able to represent the 3-D structure of

buildings.

The top level element of this data structure is a relation, which represents the *building* itself and contains the *levels* and the outer shell of the building. Levels are modelled as relations as well and contain so-called *building parts*. These building parts are spatial elements that represent rooms, floors, stairways, etc. They are mapped as ways and describe the geometrical layout. Furthermore, Points of Interest (POI), such as entrances, doors, etc., are represented as nodes and may be members of buildings, levels or building parts. Another proposal (Hubel, 2014) uses a similar data scheme.
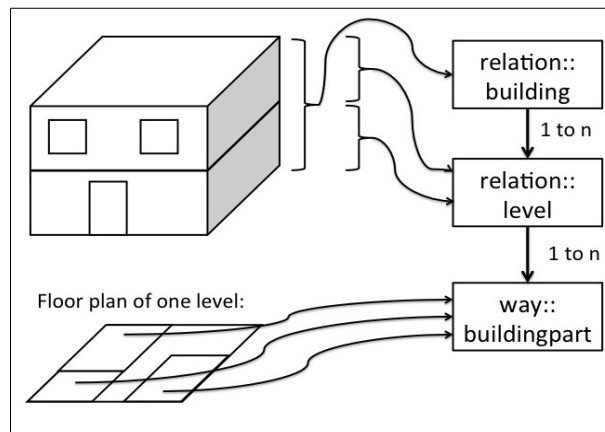

Figure 4: IndoorOSM proposed data scheme (simplified visualisation)

However, both approaches have one drawback: They are based on a high number of necessary relations for the description of a building. Therefor it proves difficult for the mapper to handle the data with the available editors, such as JOSM. For those reasons, both approaches are rarely used in the community.

In the following part of the paper, a way of obtaining a structured description without such a number of relations is introduced.

3 Indoor Data Scheme

The goal of the presented data scheme is to avoid as much mapping overhead as possible and to reduce the barriers for new indoor mappers. Therefore, the usage of relations must be rigorously reduced.

3.1 Proposed Data Scheme

The basic question is wether relations are really needed for the description of buildings. The top level relation of the previously named approaches (see Figure 4, building relation) is used to describe the building and its inner elements, but this could also be achieved by a geometrical analysis of the outer shell of a building and all inner elements. This analysis may be performed by clipping of polygons (O'Brien, 2005). By discarding the top level relation, a preprocessing step for the assignment of rooms to buildings is now required for rendering and searching applications.

The second relation, i.e. the relationship between levels and building parts, can also be expressed by a simple level tag for each level element (ways and POIs). With this approach, it is possible to avoid all relations and provide a much easier mapping approach (see Figure 5) at the expense of more complex processing steps in rendering and searching algorithms.

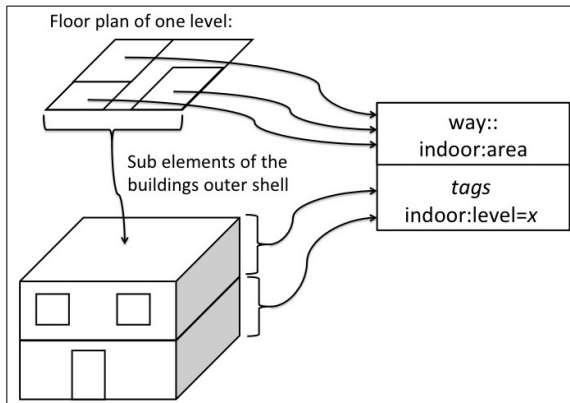A short example of this new approach, applied to an indoor area, such as a room, is given by the following XML snippet (Figure 6).

Figure 5: Visualisation of the novel indoor mapping scheme

Figure 6: An example way, which describes a room at level 0 in the novel data scheme syntax (highlighted line marks the level tag)

As shown in the XML example, only few additional tags for a simple mapping of building interiors are needed. The following table gives an overview about the defined indoor tags. Please note, that these tags only represent the current state of work and have to be extended depending on the requirements of new applications.

Tag: Key	Tag: Value	Purpose	Applies To
indoor:level	-2, -1, 0, 1, 2, etc.	membership to level	indoor ways and POIs
indoor:area	room, wall, stairway, etc.	area usage	ways
indoor:door	yes	room entrance	nodes
indoor:entrance	yes	building entrance	nodes
indoor:highway	service, footway	indoor routing	ways

3.2 Rendered Map Examples

The new scheme was used to map several buildings of the Chemnitz University of Technology and an underground car park with the editor JOSM. With a specially defined MapCSS file ((OpenStreetMap-Wiki, 2015) and appropriate data filters, the rendering of the indoor data was tested in JOSM. Thereby the MapCSS file was used to control the rendering, i.e. by specifying the colour a room is filled with. The filter was applied so that only the desired level is shown. Figure 7 shows such a JOSM rendering for one university building.

Figure 7: Rendering of indoor environments in JOSM

Furthermore, an Android application was developed to display both outdoor and indoor maps. The rendering of outdoor data was realized by the Android library *mapsforge* (Mapsforge Project, 2015), whereas the indoor data rendering was realized by an own developed rendering library (Graichen, 2014). Figures 8, 9 and 10 show rendering examples of this Android application.
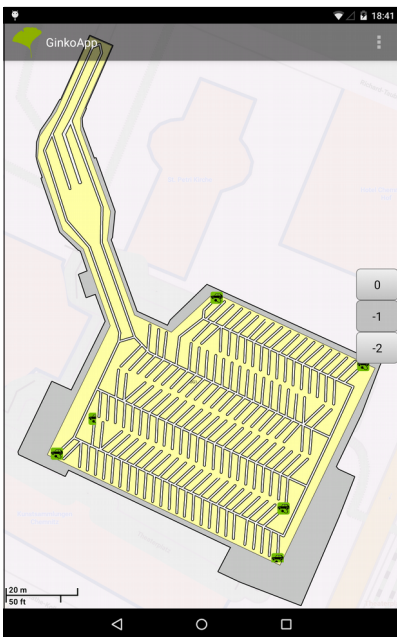

Figure 8: Rendering example of the underground car park

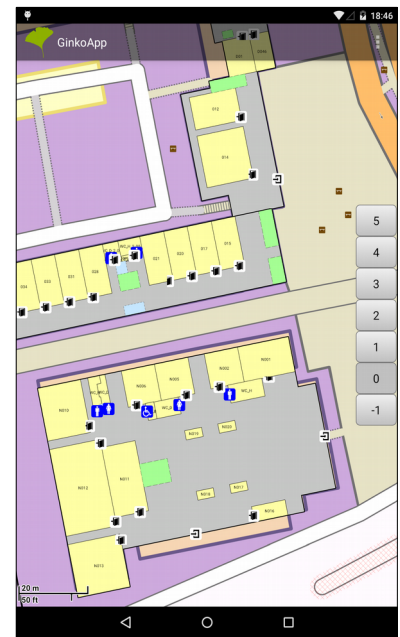*Figure 9: Rendering examples of two campus buildings*

Figure 10: Lower part of Figure 9 at higher zoom level

4 Conclusions and Further Work

In this paper, a novel approach for mapping indoor environments is presented. Compared to previous proposals, this new mapping scheme renounces the use of relations and therefore is easy to understand and to use with available OSM editors. However, the simplification of the indoor mapping requires additional preprocessing steps in rendering, routing or searching applications in order to reconstruct the structure in buildings (building → level → room).

By means of an own developed Android map rendering application, it has been shown that such a preprocessing step is feasible and that our approach is suitable for real word scenarios.

In the future, our work will focus on the research and development of indoor mapping support software. One part of this planned work, for example, will be a JOSM plugin, which assists the mapper with automatic level tagging and validates the created indoor data.

5 Acknowledgements

References

✔ Goetz, M., & Zipf, A. (2011). *Extending OpenStreetMap to indoor environments: bringing volunteered geographic information to the next level*. CRC Press: Delft, The Netherlands.
✔ Goetz, M. (2012). IndoorOSM. Retrieved March 9, 2015, from https://wiki.openstreetmap.org/wiki/IndoorOSMReference
✔ Graichen, T. (2014). *A Combined In- and Outdoor Map for Android.* State of the Map EU 2014. 13 to 14. June 2014, Karlsruhe, Germany.
✔ Hubel, A. (2014). Proposed features/indoor. Retrieved March 9, 2014, from https://wiki.openstreetmap.org/wiki/Proposed_features/indoor
✔ Mapsforge Project. (2015). Rendering of OpenStreetMap data. Retrieved March 9, 2015, from https://github.com/mapsforge/mapsforge
✔ O'Brien, J., (2005). Clipping and Hidden Surfaces. Retrieved March 9, 2015, from http://www-inst.eecs.berkeley.edu/~cs184/fa05/lectures/lecture-06.pdf
✔ OpenStreetMap-Wiki. (2015). MapCSS Implementation. Retrieved March 9, 2015, from https://josm.openstreetmap.de/wiki/Help/Styles/MapCSSImplementation