Chapter 13
Generation of a Data Model for Indoor Navigation Based on Volunteered Geospatial Information (VGI)

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ABSTRACT

Navigation has been an inseparable part of human life especially in modern days, when the structures of cities and their buildings' indoor environments have been more complex. More than 80% of routine life of a typical citizen is spent in indoor and the indoor environment are getting highly complex due to the increase in sizes of the buildings. An important factor to a successful indoor navigation is the precise suitable map for the inside of the buildings. Collection and generation of indoor geospatial data is very time consuming and costly for a building. Using the concept of volunteered geospatial information might be a suitable solution to deal with this problem. This chapter addresses the extraction of a data model for indoor navigation from VGI. An efficient methodology is proposed and evaluated to extract the navigation data model from OpenStreetMap automatically to use in indoor navigation applications.

INTRODUCTION

Navigation and route finding have been an inseparable part of human life especially in modern days, where the structures of cities and their buildings' indoor environments have been more complex. Navigation can be generally divided into two broad classes of indoor and outdoor according to the nature of the embedding space. While the navigation in outdoor is a most studied class from different perspectives such as positioning methods, application areas, and algorithms (Chatila, Devy, Lacroix, & Herrb, 1994; Langer, Rosenblatt, & Hebert, 1994; Levinson et al., 2011; Makri, Zlatanova, & Verbree, 2015;

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Massidda, Bülthoff, & Stegagno, 2015; Urmson et al., 2008), the navigation and wayfinding in indoor environment is newer and more challenging.

More than 80% of the routine life of a typical citizen is spent in indoor environments. These are getting highly complex due to the increase in sizes of the buildings such as hospitals, airports, megamalls, and universities (Li & Lee, 2013). On the other hand, the progress in indoor positioning systems facilitates serving and using the location-based services (LBS) such as navigation and recommender systems. Therefore, the indoor navigation is one of the main applicable and useful services for citizens (Han, Jung, Lee, & Yoon, 2014; Möller, Kranz, Huitl, Diewald, & Roalter, 2012; Nakajima & Haruyama, 2013; Zheng et al., 2014). However, the indoor navigation has been a challenging research topic recently (Mortari, 2013; Karimi, 2015). The main challenges in this field are the lack of high precision in indoor navigation, possibility to free movements of agents, and difficulty to build a navigation network structure (Werner, 2014; Karimi, 2015). Moreover, collection and generation of indoor geospatial data are very time-consuming and costly. The main focus of the maps and geospatial data providers is on the production of formal outdoor maps. Using the concept of volunteered geographic information (VGI) might be a suitable solution to deal with this problem (Mortari, 2013). Using VGI greatly reduces time of data collecting and saves the costs related to it. On the other hand, accuracy of VGI data in most cases is acceptable for indoor navigation. Furthermore, important areas such as points of interest (POIs) and semantic information exist in many sources of VGI data such as OSM and Google Maps.

Most of the existing VGI projects such as Google Maps and Wikimapia have focused on the collection and enrichment of outdoor geospatial data. This functionality is similar to the elaboration of the traditional mapping agencies. Some of them even provide both 2D and 3D view of information. But, the number of projects which provide the users with functions to add or view the indoor environment is rare. Moreover, the usage of existing volunteered indoor datasets for navigation in the existing projects in the current form has some barriers. For example, the interior environments of buildings are not supported completely and the semantic information used for buildings is of heterogeneous formats in different countries due to the lack of standards for key values. Adding routines for supervised automatic entrance of indoor spatial data and assigning the existing or loaded semantic information to them in an acceptable standard format may be a feasible solution to this issue, which is also addressed in this paper.

An important factor to a successful indoor navigation is the precise suitable map for the inside of the buildings. The main characteristic of an indoor map, which separates it from a common outdoor map, is the difference in data model. A data model, which also is called location model, defines the structure of representation of location information (Werner, 2014). There is several buildings' indoor navigation software, which uses different data models. This heterogeneity results in impossibility or at least presents difficulty to share the data. The IndoorGML standard, which is proposed by Open Geospatial Consortium (OGC), is a useful format for indoor navigation applications (OGC, 2012). The main advantages of this standard are that it facilitates data exchange between different navigation software and supports the building modeling in 2D and 3D format.

One of the most popular projects in VGI is OpenStreetMap (OSM). The easy way of adding geospatial data to this project as well as access to the history of data are among the reasons which make this project more applicable rather than the other VGI-based projects. The OSM is generally used for outdoor wayfinding and navigation, but we present a methodology to add the indoor data model automatically to this site in order to enrich the project and facilitate the pervasive navigations.

This chapter addresses the extraction of a practical, standard data model for indoor navigation using VGI. The advantages and disadvantages of using each data model in indoor navigation based on geo-