AccessibleMap

Web-Based City Maps for Blind and Visually Impaired

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Abstract. Today cities can be discovered easily with the help of web-based maps. They assist to discover streets, squares and districts by supporting orientation, mobility and feeling of safety. Nevertheless do online maps still belong to those elements of the web which are hardly or even not accessible for partially sighted people. Therefore the main objective of the AccessibleMap project is to develop methods to design web-based city maps in a way that they can be better used by people affected with limited sight or blindness in several application areas of daily life.

Keywords: Accessible Maps, Semantic description of maps, Web Map Services, Styled Layer Description.

1 Towards Accessibility of Maps

1.1 Background

Web-based city maps are crucial means in terms of helping people to orientate themselves in physical space. Their purpose is to assist users with discovery of new cities, mobility, orientation, and can therefore support the overall feeling of safety. Further they are a supportive tool to get a better overall image of the city or a district, or to discover streets, squares and crossings in detail by receiving information about existing points of interest, street types (e. g. pedestrian area, bicycle lane, main road), lengths of street, type of crossings (e. g. X-crossing, T-crossing, etc.), footprint of building blocks, street names and house numbers, tactile systems, acoustic traffic lights, and many more data and attributes. Fig. 1 shows an extract from a web-based map as an example for the great variety and amount of map content.

So far comprehensive research and development activities exist in the field of navigation for blind people. Several visual aids have been developed such as Electronic Travel Aids and Personal Guidance Systems [2], [5] often in combination with tactile, haptic, sound components [4]. Example projects working on the development of navigation or guidance systems for visually impaired pedestrians are Ways4all, Nav4blind, Loadstone, Poptis and Argus. [14], [9], [7], [11], [1]

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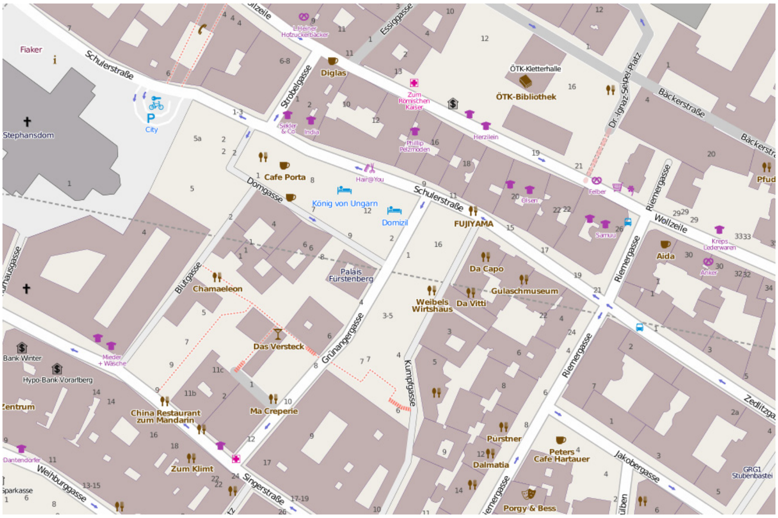

Fig. 1. Example of broad web-map content. Source: OpenStreetMap.

However, even though different types of assistive technology and visual aids (e. g. screen reader, Braille display, text to speech technology) as well as guidelines and standards of accessible web design (e.g. WCAG – Web Content Accessibility Guidelines, [15]) have been developed, it is currently difficult or even impossible for people with vision deficiency to fully discover web-based city maps.

1.2 The AccessibleMap Project

The aim of the AccessibleMap project – funded by the Federal Ministry for Transport, Innovation and Technology in the benefit programme – is to develop methods which can make web-based maps accessible for visually impaired people. The target group is specified into detail and divided into three sub-groups. These are (1) visually impaired (caused by different eye disorders), (2) colour blind and (3) blind persons, and are characterised and analysed with methods from empirical social research and statistic procedures. An online survey tool was developed and distributed in autumn 2011 for the definition of the requirements of the target group, the determination of their mobility and orientation patterns as well the specification of preferred representation modes of visual information.

Based on the user requirements analysis methods are developed to (1) automatically generate a textual description of a web-based map (map in words) as well as (2) an optimised cartographic design/layout. Hence, the AccessibleMap user interface is developed as a multi-sensory interface. As presented in Fig. 2 it contains the map component with an optimised cartographic design (visual user interface) and the voice output of the textual description (acoustic user interface).

Fig. 2. AccessibleMap User Interfaces

The textual description of the map relates attribute and geometric (spatial) information and is provided in written form to the user who can access it with the help of existing visual aid technology that supports accessibility of text, such as screenreaders and Braille displays. What needs to be stressed is the automatic generation of the spatial description out of vector data so that a large area can be covered. The automatic approach reduces costs as there is no need for extensive manual and time consuming updates. Furthermore, this method makes the accessible map flexible so that it can be easily applied in different cities and regions.

The second aspect that is tackled is how to optimise cartographic design (choice of colours, object size, etc.) according to the needs of visually impaired. Different eye diseases like colour blindness, retinitis pigmentosa, macula degeneration just to mention some, require that the representation of visual information of web-based maps must be adapted to the needs of different users. It is therefore necessary to investigate the needs of the user group according to the specific eye conditions.

Functionalities are implemented which allow (1) to configure, i. e. select the cartographic design depending on user abilities and preferences, (2) to access verbal descriptions (text and speech output), and (3) to perform basic map operations such as search, zoom, and pan. The result will be a prototype of the web-based map which will be tested intensively by the target group.

1.3 Semantic Description of Space

The basic geographic data is open data, i.e. open government data and OpenStreetMap (OSM) data. The latter has been created by its community, is free to download, contains a great variety of attributes and is kept up-to-date in a satisfying way. Besides the use of OSM data, the AccessibleMap geodatabase is prepared to add additional data, for example data provided by the local community governments. As a first sample the City of Vienna provides data for a test region. These data is published under the Creative Commons license which targets at promoting open and shared data access and use via web services for the public. Due to the great variety of data and their attributes, the described data sources provide a wide range of information, which meets data demanded by the target group. Therefore, most general information (street names etc.), tactile information (surface of roads), useful landmarks, etc. is available for the users.

Description of maps in words and provision of meaningful information to the user require a lot of efforts on semantics. Data, i.e. spatial database content, need to be related and linked to each other in a meaningful way to create information, knowledge, and therefore better understanding of (urban) space (Fig. 3).

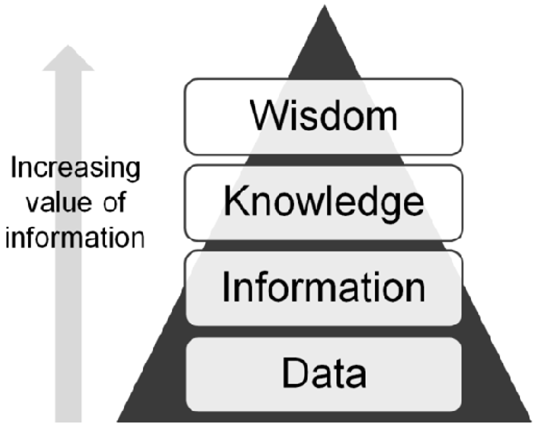

Fig. 3. From data to better understanding of space. Source: based on Laurini 1991 [6].

The following gives an example for the semantic description of crossroads. Mathematically a crossroad consists of two or more intersecting lines and a specific angle in between. Nevertheless do most users prefer a semantic description Instead of receiving figures of angles users prefer a more semantic description of crossroads using hour system instead of receiving angular dimensions (e. g. [12]). Hence, the verbal description of the directions of a street or crossroad could be designed as follows (Fig. 4): „Street B diverges at 1 o'clock (respectively 20 degree); street A at 11 o'clock (respectively 340 degree) from street C." In other words the shape of the crossroad can be described as a "Y-crossroad" or a "triple-trace crossroad".

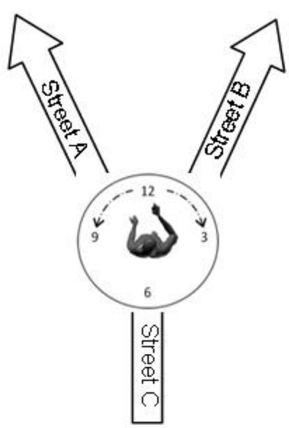

Fig. 4. Description of crossroad based on hour system, Sánchez & Torre 2010 [12]

2 Technical Implementation

The AccessibleMap prototype is developed to be used either with PC or by mobile devices (e. g. smartphone, tablet PC, etc.). The software architecture is made up of open source technology, i.e. a PostgreSQL/PostGIS database, Geoserver, Open Layers and PHP Application Server. The accessible map is based on geographic information systems (GIS) extended with algorithms that can create semantic spatial descriptions automatically. The technologies chosen to access the textual output are screenreaders or Braille displays for blind and high visually impaired people. Screenreaders are available commercially or open source.

For the map layout Styled Layer Description (SLD) technology is used. SLD allows creating a map rendering style according to the user requirements which includes e. g. the configuration of colour design and labelling as well as colour contrast between the different objects. The data, i. e. the maps, are provided via Web Map Services (WMS) to the user.

In this context WCAG 2.0 Guidelines (Web Content Accessibility Guidelines) are of high importance.

3 Analysis and Specification of User Requirements

Within the AccessibleMap project constructive co-operations between users and target group experts as well as developers are principally seen as a fundamental precondition for and a central aspect of the application development process.

The project analysis and specification of user requirement is based on a literature review as well as on a user survey, focusing on the above outlined target user groups. Therefore an online questionnaire was designed using the internet survey tool SurveyMonkey according to the principles of empirical social research. The survey was developed in close co-operation between the different project partners (ICT-experts, GI-experts, target user group experts).

The questionnaire design is based on the results of the comprehensive literature review which covers literature from e. g. Web Cartography, Modern Cartography, Special Needs Cartography, and Cybercartography [3]. From reviewing the literature available on the topic, it became obvious that detailed information on design and implementation of web map applications for visually impaired is mostly missing. Thus the questionnaire was particularly designed to get response on open questions regarding user interface design and functionalities, map design, and map content.

The questionnaire consisted of 55 open and closed questions addressing the different types of visual impairment. The questions referred to:

1. Demographic issues (sex, age, education, profession, place of residence etc.);
2. Aspects regarding the visual impairment of the participants (type, extent and timing of the visual impairment etc.);
3. General characterization of internet user behavior (extent of internet use, use of digital devices, use of assistive technology and visual aids etc.);

4. General characterization of web map user behavior (extent of use, problems, purposes etc.);
5. User needs on map content (user group specific information, supplementary links, etc.);
6. User preferences on the graphical and non-graphical user interface design (access and use) including functionalities;
7. User preferences on the (carto-)graphical and non-(carto-)graphical map design (cartographic means of design, use of additional information media like photos, audio signals, verbal description etc.).

The AccessibleMap user survey resulted in 199 returned and 158 valid questionnaires. The valid questionnaires are grouped under three subgroups of target users as follows:

- people with reduced and limited vision: 59 %,
- colour blind: 4 %, and
- blind: 37 %.

Even though the interviewed persons show a high level of internet usage, only 56 % point out to use web maps. Respondents mentioned different reasons therefore:

1. Web map applications are not (easily) operable, i. e. not (easily) usable.
2. Web map applications do not provide verbal descriptions of their content.
3. Web map applications cannot be interpreted by screen reader, Braille display or voice output.
4. Users lack knowledge on the existence of web-based maps.
5. Users make use of voice-operated navigation devices instead of web map applications.

Hence, the provision of voice output and textual, i. e. readable descriptions is a fundamental requirement to enable usage of computer applications including web map applications to these users.

4 Accessible Map in Practice

AccessibleMaps aims to make web-based maps accessible to blind people. A direct advantage for the target group could result in its increased mobility.

Anyone who has ever had to find its way around in unfamiliar surroundings will know just how valuable a good orientation system can be. If a blind person does not know where the next bus stop is, how many intersections need to be crossed before reaching the side street she/he is looking for, or she/he has not a clue about how to get to the desired destination, it is essential to provide a save guiding system. This type of situation is very challenging and stressful for people with impaired vision.

Improving the accessibility of maps will therefore not only enable blind and partially sighted people to access them but also enable their use within other way finding and orientation solutions that rely on the availability and accessibility of maps.

In this respect it is worth to mention a few examples of possible integration of AccessibleMap within existing way finding projects.

POPTIS (Pre–On–Post–Trip–Information–System) is an acoustic orientation system offered by the transport operator “Wiener Linien” in the underground network of Vienna. All possible footpaths in stations of the underground are explained to visually impaired people. POPTIS is used among others to support the trip preparation.

AccessibleMap could support a blind person in the preparation of his/her journey through the availability of accessible maps that can be explored also in terms of spatial relations to determine for example the position of a bus or metro station.

As a further development of POPTIS the project Ways4All envisages the conception of a barrier-free total system for orientation and movement in public space for people with special needs. The concept includes components which allow for navigation both indoors and outdoors, communication with public transport and public infrastructure to ensure a safe travel. With navigation system persons with special needs should have access to up-to-date traffic information.

Ways4All strives to integrate various components in the mobility chain of a blind persons (visual, tactile guidance systems, POPTIS, electronic passenger information, barrier-free internet pages). The availability of accessible maps is pivotal for the achievement of an integrated approach in the mobility chain of visually impaired persons. AccessibleMap will therefore be essential in the environment and mobility discovery of urban settings.

Mobile services Quando and Scotty respectively of the Vienna Public Transport and the Austrian Federal Railways offer besides timetables also informations about delays, public traffic interruptions, different kinds of online service and a route planner. The use of maps is an integral part of these and similar mobile applications that at the current stage can not be accessed by visually impaired persons.

The accessibility of web-based maps is a very important factor for the mobility and orientation of visually impaired persons and must be viewed as a necessary component to be considered in the development of different guiding systems.

5 Outlook

The presented methodology to make easier the access to web-based maps for visually and blind people can be integrated into other existing web-based maps and web-mapping technologies. Further the automatic textual description, with focus on semantics, can be an added-value for pedestrian navigation. Instead of navigating the user in a linear way from A to B (e.g. “turn right after 300 meters”), as it is the case for most traditional navigation systems, another option is to describe the route with the help of landmarks (e.g. “turn right after the second street, in front of the park”).

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