Building Augmented You-are-here Maps through Collaborative Annotations for the Visually Impaired

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Abstract. For the visually impaired it is important to learn about different kinds of spatial knowledge from non-visual maps, specifically while walking via mobile devices. In this article, we presented an augmented audio-haptic You-are-here map system based on a novel pin-matrix device. Through the proposed system, the users can acquire not only the basic geographic information and their location, but also augmented accessibility attributes of geographic features by user-contributed annotations. Furthermore, we at the first time discuss the annotation taxonomy on geographic accessibility, towards building a systemic methodology.

Keywords: haptic interaction, social interaction, annotation, taxonomy, you-are-here map, outdoor

1 Introduction

Apart from the geographic information, for the visually impaired they expect to know additional geographic accessibility information which is specific for them. For example, the blind prefers to know if there is a non-barrier sidewalk to the entrance of the nearby POI and where, or the types of doors (e.g., automatic or manual). However, it's time-consuming and cost-consuming to collect those kinds of accessibility geographic data over the world by one or several organizations.

Besides, due to lack of accessible location-aware YAH maps for the visually impaired, it is hard for them to explore the surrounding environments while walking outside, despite the mainstream GPS-based navigation systems would announce where users are, e.g. the name of the street or the nearby point of interest. In this paper, in addition to acquiring basic geographic information, we focus on investigating which other kinds of information would be acquired from the location-based YAH maps for the visually impaired, such as location and augmented accessibility information. We presented a tactile You-are-here map system on a portable pin-matrix device (PMD), and proposed a collaborative approach to gather accessibility information of geographic features from users' annotating. Furthermore, we discussed about users' annotation taxonomy systematically from its definition to the data model.

2 Acquisition of spatial knowledge from map exploration

2.1 Basic geographic knowledge

The basic geographic knowledge contains the spatial layout of map elements, names and categories of geographic features, and other map elements (e.g. scale, north direction). Although the swell-paper based maps have great touch perception, they only can represent a few of brief and static information, as well as related map legend in Braille. To present much more map elements and with detailed descriptions, the acoustic output has been employed in recent decades, from the auditory icons and sonification to text-to-speech (TTS) synthesis, like in [1, 2]. However, it is hard to learn about precise layout from the virtual maps. Aiming at obtaining explicit touch perception simultaneously, haptic-audio maps have been proposed on touch-screen tablet [3] and pin-matrix device [4].

2.2 Spatial relationship to users on location-aware maps

In addition to rendering basic geographic information, the location-aware maps state users' current position and the spatial relationship between them and the surrounding environments. TP3 [5] allows users to discover spatial relationship to nearby point of interests on mobile phones, e.g. distance and orientation. Specifically, the novel spatial tactile feedback in SpaceSence [6] represents explicitly the orientation from users' location to the destination. However, it is still challengeable to allow the users to explore the surroundings explicitly.

2.3 Augmented geographic accessibility

For people with special needs, the kind of geographic information stored in current map database is not enough, because they have their own additional requirements. For example, the online Wheelmap[1] and Access Together[2] collect the accessibility features of POIs in cities for wheelchair users, through user-contributed annotations. However, the visually impaired has much more special requirements than the disabled people who are sighted. In addition to avoiding various unaware obstacles, they expect to know accessibility information of geographic features while on the move. The "Look-and-Listen-Map"[3] is a project to prepare a free accessible geo-data for the visually impaired, such as traffic signals with or without sound. But due to lack of an accessible platform, the visually impaired is hard to benefit from the project currently. As one possible benefit from those collaborative accessible geo-data, it can improve the performance of involved applications, like a personalized route plan [7].

[1] www.wheelmap.org
[2] www.accesstogether.org
[3] http://www.blind.accessiblemaps.org/

3 Augmented tactile YAH maps through collaborative annotations

In this section, we described a tactile YAH maps on a mobile pin-matrix device. Through the proposed system, the users not only can explore maps and learn about their location context, but also can acquire knowledge on geographic accessibility in their cities by collaborative annotations.

3.1 The System Architecture

As shown in Figure 1, the system is a typical C/S (Client/Server) based system. Its server stores map data, annotation data and user information, and responses the map client, like sending map data. The ubiquitous mobile internet enables the client to connect the server at anywhere, and to present a tactile map with current location context. Additionally, it's convenient to read annotation on the go.

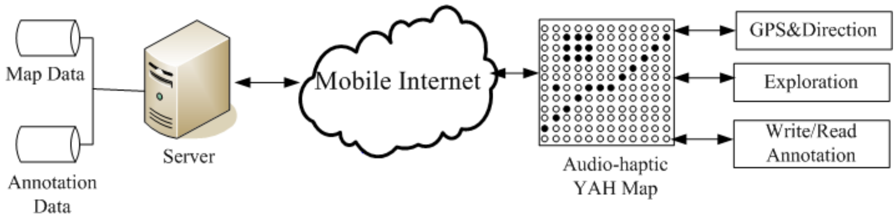

Fig. 1. The System Architecture

3.2 A Prototyped System

The Figure 2 (left) illustrates the overview of the prototype, consisting of a portable PMD, a WiiCane, a smart phone, an earphone with a microphone and a portable computer. The WiiCane is made by mounting a Wii remote controller on the top of a normal white cane. The smart phone is mounted on one shoulder, which has involved sensors like GPS, digital compass and Bluetooth. Users can listen to related annotations by the earphone. The computer in a backpack, runs the main application, and connects all of the other devices through Bluetooth or USB interface.

Besides, we design a set of tactile map symbols and YAH symbols through raised pins, to represent the YAH maps, see Figure 2 (right). In particular, the set of YAH symbols has eight symbols which point at one direction respectively, e.g. south, southwest, etc. Therefore, the YAH symbols would present users' location and heading orientation simultaneously on maps while walking or stopping.

While interacting with the YAH map, users can press the buttons on the WiiCane to panning or zooming. Due to the touch-sensitive feature of the PMD, users can obtain auditory descriptions by one finger contacting involved map symbols. To inquire "Where I AM", the YAH symbol will present in the center of the display automatically. With the help of the YAH symbols, users would explore the surroundings and discover the spatial relationship between themselves and nearby geographic features, such as the orientation and distance to a bus stop or a building.

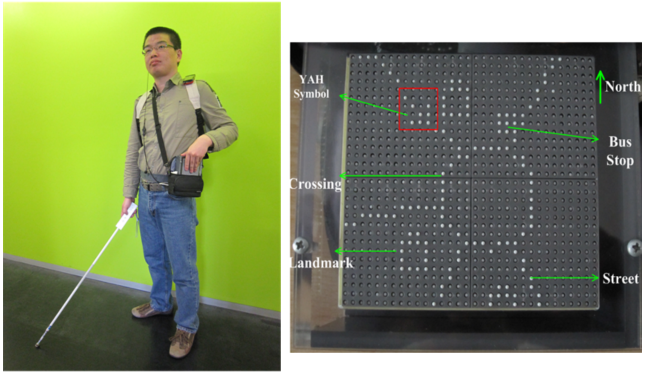

Fig. 2. The prototype of the audio-haptic location-aware YAH maps. (left: the overview of the system; right: a screenshot of YAH maps with various symbols)

4 Taxonomy of Augmented Geo-accessibility (AGa) Annotation

Although there are a couple of systems to collect enhanced accessible geo-information for the people with special needs via user-contributed annotation data, from the perspective of scientific research it is still lack of a comprehensive investigation of annotation taxonomy. Thus, in this section we focus on systematically discussing how to utilize collaborative annotated data to enhance accessibility of geographic features in real world, from its definition to data model and involved applications.

4.1 AGa Annotation Definition

"*An AGa annotation is virtual information to describe additional accessibility information of geographic features for people with special needs*."

The above definition contains several important points, which are stated as following:

At first, the focus of the annotation is about the accessibility features of geographic features in physical world. Thus, it will cover an array of items which dependent on different special user requirements and categories of existing geographic features, like auditory output of traffic signals for the visually impaired, and elevators in underground stations for the mobility impaired.

Secondly, the definition is general and simply to include a broad range of end users, who can be disabled people, but also can be temporal users like people having leg injures or wheeling a baby car.

Thirdly, the virtual information is linked to geographic referencing objects in physical world, and the descriptions of virtual information would be in a number of methods, from text, audio media, videos and pictures to haptic/tactile feedback, which can help end users to learn about involved accessibility features.

Fourthly, towards a stricter range of the term of geographic feature in the definition, it contains various existing geographic referenced objects which can be digitalized and stored in digital world, rather than all of the components on the Earth. In addition, the annotations are made not only by the end users, but also from the volunteer community who concerns about accessibility.

4.2 AGa Annotation Data Model

Different to the ubiquitous annotation systems [8] for general requirements by linking virtual information and existing objects in both physical and digital space, the dimensions of AGa annotation focus on accessibility features while reading, writing, and sharing the annotations. We list 9 dimensions to learn about AGa annotations.

1. Categories of Geographic Features: different accessibility features for different categories;
2. Location Dimension: the annotation's location in physical world;
3. Temporal Dimension: the creating/editing time;
4. Content Dimension: annotation's body is about objective mapping information or about subjective users' experiences;
5. Structure Dimension: structured accessible attributes and users' quantify annotations, e.g. rating, or an unstructured description;
6. Source Dimension: explicit annotations from users' descriptions directly and implicit annotations from digital sensors data;
7. Presentation Dimension: accessible user interfaces;
8. Editing & Sharing: annotation can be edited and shared between user groups;
9. Privacy Dimension: involved personal data;

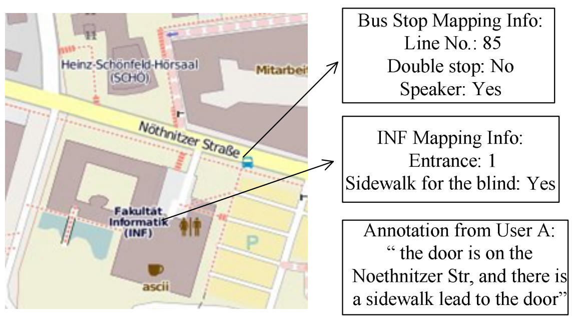

Fig. 3. An example of AGa annotations for the visually impaired

As illustrated in Figure 3, the visually impaired users would access the accessibility map information (e.g. bus stops, entrances) and annotations from others. Even if the 9 dimensions are described respectively, the relationship of them is correlative, and will impact each other in the practical applications.

5 Discussion & Conclusion

Different to rendering color-enabled maps for the sighted through the visual channel, the 2D PMD doesn't allow overlapping map symbols by the raising pins. Thus, it's important to find a suitable strategy to rendering the YAH maps on a limited portable PMD. For the visually impaired the cognitive mental maps generated while reading location-aware maps on the move might be different from a desktop-based map for pre-journey. However, what are their differences exactly is not clear yet. Besides, excepting the above mentioned 9 dimensions, which dimensions else are useful for the visually impaired?

In order to let the visually impaired acquire much more spatial knowledge on the move, the paper introduces an overview proposal how to build an augmented non-visual you-are-here maps through collaborative annotation via a portable PMD. For future work, the prototype should be evaluated with end users who are visually impaired.

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