Technische Universität Dresden – Fakultät Informatik
Professur für Multimediatechnik, Privat-Dozentur für Angewandte Informatik

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GeNeMe '10

Gemeinschaften in Neuen Medien

an der
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am 07. und 08. Oktober 2010 in Dresden

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C.7 COACH: Collaborative Accessibility Approach in Mobile Navigation System for the Visually Impaired

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Abstract:

Due to the shortage of geographical information suitable for the visually impaired, the current navigation systems fail to provide high quality performance. The results of an international survey on the user needs are discussed in this article. A collaborative accessibility approach (COACH) is proposed to not only extend accessible geo-information, but also offer an opportunity to share experiences among peers. Related topics are addressed, like map data, multimodal annotation, and privacy.

1 Introduction

The term accessibility describes the ability to access a product (e.g., facilities, device, and software) by as many people as possible, specifically for persons with disabilities. Even if computer-based assistive technologies play a significant role to enhance their abilities, such as living independently and participating in social activities, various problems are created in novel Web-based services at the same time. These problems concern content, user interface and participation.

Due to lack of accessible resources and accessible interfaces to applications, most of current Web 2.0 systems fail to provide services for users with a disability. For example, E-Mail is still the preferred exchange method for many blind people and there are few communication platforms for them allowing gathering feedback on questions and issues [PW10]. In this case, accessibility not only impacts their bad impression of current products, but also reduces their exploration of new and future services. Furthermore, the disabled are unable to share their practical experiences which are useful to peers. In a similar manner, because of shortage of communication platforms, able-bodied people loose opportunities to make a contribution, in order to assist persons with disabilities as best as they can. As a consequence, in addition to provision of accessible information, another significant issue is how to establish a collaborative platform.

In this article, we discuss an approach how to improve the performance of mobile navigation systems for the visually impaired by introducing the concept of a

COllaborative ACcessibility approacH (COACH). We analyze the limitations of an existing, well advanced system and presented core problems based on a survey. A universal framework of COACH is proposed, in which by establishing a collaborative platform among users and volunteers, it is possible to resolve existing problems through user-contributed data. Naturally, this approach will be suitable to others with different capabilities, if applied accordingly. Additionally, related topics are discussed, like map data, multimodal annotation, and privacy.

2 Accessible navigation services

Introduction of navigation system for the visual impaired

Since the introduction of Global Positioning System (GPS) into navigation-assistance system for the persons with low vision and blind from the late of 1980s, this field has evolved into a new era. Already the introduction of the long white cane or guide dogs, has helped a considerable number of blind people to stay independent and manage their daily routes. With the help of satellite navigation and digital maps, the users not only obtain their real-time geographic location, but a dynamic guidance, e.g. where to turn left or right. Thereby, a growing number of blind people can go to where they want to also in unknown locations independently.

In 1985, Loomis proposed a concept for a personal guidance system integrating GPS-based navigation for people with visual impairment, and a detailed spatial database [GLKFY91], in which the geographic information system (GIS) managed the map data. The map database is essential in many ways, from finding the name of location and near points of interest to calculating dynamic instructions of a route.

While being late adopters in general, almost all of the visually impaired always carry with them a mobile phone when going out [KJWL09]. Specifically, in Japan one report lists about 94.4% visually impaired persons, ranged from 14 to 80 years old, make use of a mobile phone. Since its introduction, GPS navigation on mobile phones was a high priority request [WMMN08]. Fortunately, there are several available products on the market, such as Trekker[1], BrailleNote GPS[2], Wayfinder Access[3] and Loadstone GPS[4], and all of them enable navigation functions. It is necessary to highlight Loadstone, a free navigation system on mobile phones, with free map data requiring manual import of a database. Its GIS data may be edited freely and inspires the users to carry out improvements.

1 Trekker: http://www.humanware.com/

2 BrailleNote GPS: http://www.senderogroup.com/

3 Wayfinder Access: http://www.wayfinderaccess.com/

4 Loadstone GPS: http://www.loadstone-gps.com/

Questionnaire for blind pedestrians

In order to analyze experiences and requirements of blind users for mobile navigation services, an international questionnaire has been conducted. There are 9 users (8 blind and 1 severe low vision) taking part in the initial processing, in which 6 participants finished via email feedback, and other 3 joined with the first author by telephone interview or face-to-face interview. All of them are users of Loadstone GPS. Among of the participants, most of them are 20-40 years-old and European, detailed demographic information is described in Table 1. Seven of them have experiences of GPS navigation system more than one year. Therefore, their feedback is significant to figure out issues of current systems and acquire their special demand.

As one result of the investigation, the subjects indicated the most necessary improvement functions in Loadstone are: insufficient map data, difficult import and translation of map data, and incomplete route plans. Specifically, in developing countries and Africa the lack of map data has been a huge barrier preventing to introduce Loadstone [Load10].

Table 1: Participants' basic profile

#	Age	Country	Experience	Frequency of usage GPS Navigator
1	20-40	Austria	1-3 years	each time when going to an unfamiliar or large open space/place
2	20-40	Germany	1-3 years	most of time when going to an unfamiliar place
3	20-40	South Africa	3-5 years	more than 50% of times
4	20-40	Serbia	< 1 year	20 % – 50 % of times
5	20-40	India	1-3 years	under 20 % of times
6	20-40	UK	>5 years	more than 50% of times
7	20-40	USA	1-3 years	each time when going out
8	40-60	Germany	< 1 year	under 20 % of times
9	<20	Czech	1-3 years	each time when going to an unfamiliar or large open space/place

Furthermore, points of interests corresponding to their special needs e.g. a traffic light with/without sound, a lift or stairs in a building, are uncommon in current maps. These specific POIs were missed by 8 responses (89%). Such additional information in the map database is useful when being outside. In case the navigation system fails, all of the subjects keep walking and try to get help from a passerby, their family and friends if necessary. Participants report, beyond making a call, or sending SMS (short message service), they were able to take a photo, access internet-based applications (e.g. email, bus timetable) through their mobile devices at hand. In addition, 8 persons were interested in remote guidance from friends or even unfamiliar persons via mobile phone while she/he was in trouble.

The social network is not unfamiliar to the participants. Six of nine participants make use of this kind of applications (e.g. Facebook, Twitter) frequently, even each day. Sharing is one of the most important features of social network applications. Figure 1 summarizes their attitude on sharing information of accessible POI.

Sharing accessible POI information is a real-time report of accessibility issues about the current situation where the participant is. For instance, at a bus stop several bus lines may be canceled due to a traffic accident, or a traffic light doesn't work including its audio-haptic signal. In contrast, annotation is a suggestion for the user himself or for others. It describes relevant experience for some navigation tasks, for example, how to go through one complex crossing or what should be done in a big bus station. The difference between sharing and annotating is, the former focuses on where the person is and what the participant suffers from presently, the later one concerns practical experiences and may be acquired from an earlier visit or even other sources.

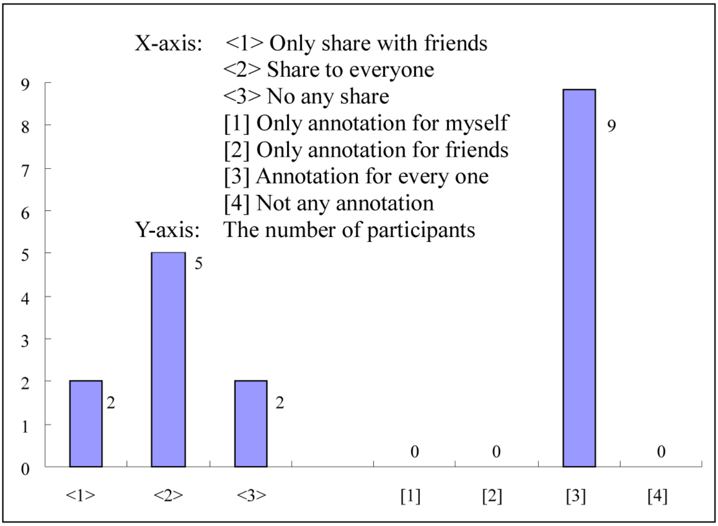

Figure 1: Share and Annotate Accessible Information.

Figure 1 illustrates imbalanced views among participants. Only 5 persons supported sharing with every one, while 9 persons (100%) are willing to provide annotations for everyone. Besides, there were 2 persons who didn't want to share to anyone. Being worried about their privacy, some of the subjects refused sharing even with their trusted friends. In contrast, all of them completely agreed to annotate geo-information if this is critical information for the visually impaired. Thereby, acquiring large number of annotations from different people is more significant than creating trust, if the procedure ensures anonymity.

Related work

Over the past years, collaborative social network make cyberspace become more energetic and powerful. The netizen can share various experiences, thoughts, actions, etc., with their friends or unknown persons with the same taste. Those leading social networks such as Facebook, twitter, etc., have been in a rapid development recently, not only the increment of active users and relevant applications, but also expanding into mobile devices, which carry our communication everywhere at any time. On the other side, collaboration between sighted persons and the visually impaired is emerging via collaborative networks, aiming at improving accessibility of contents.

In the Social Accessibility Project [TKKIA08], an approach to collaborative accessibility is described in order to improve web accessibility through collaboration among end users, designers, developers, and anyone who care about the issue of accessibility. Inside its current process model, end users identify and report problems, meanwhile, supporters choose and fix problems by adding accessibility metadata. There is a social accessibility server in charge of saving all data and communication. According to this study there is no lack of volunteers.

Similar to the Social Accessibility Project, the We-LCoME project [FMMRS08] developed a tool to create accessible multimedia e-learning materials and recourses for the students via a collaborative community, which includes lecturers, the student support services and the learners.

Collaborative multimodal annotation of geographic data has been proposed for RouteCheckr [VW08]. Users are able to make geo-annotations through one central server. However they cannot add geo-data nor share these data. Use of existing GIS is not foreseen. Still, the authors could show in a number of field trials, there is a unique collaborative strategy in place.

In a word, the approach of collaborative accessibility inspired from the user contributed content systems, makes use of a vast amount of potential volunteers in cyberspace community to enhance accessibility of nearly every type of service. Specifically, the current ubiquitous computing networks provide new possibilities for multimodal annotations for geo-spatial service.

3 A universal framework of collaborative accessibility approach (COACH)

By summarizing existing projects and analyzing the characteristics of accessibility, a universal framework of collaborative accessibility is illustrated in Figure 2. There are two basic participator groups: user group and volunteer group. Members from the user group provide their awareness metadata explicitly or implicitly. The awareness metadata from user group contain user profile, available accessible interfaces, assistance information and context including location, surroundings, and other implicit data. Sometimes the boundaries of the participator groups are not fixed, because a disabled user also could be a volunteer when she/he contributes what she/he knows into community.

In the framework, there are 4 basic components: central servers, mobile accessibility interface, desktop accessibility interface, and volunteer platform. The role of the central servers (e.g. map database server, annotation server) is important, not only providing communication of the whole system, but also managing essential databases, including geographic database and user-contributed annotation data.

The users access the services in two modes, mobile mode and desktop mode. In the mobile mode, users make use of their mobile devices equipped with various sensors to carry out navigation services, as well as share and annotate geo-information. The context-awareness is bound to the sensors, e.g. GPS tracking location, digital compass recording orientation, etc. Moreover, it is a possible to implement multimodality and fuse for example annotations in auditory recording, vision recording via a camera and other modalities into one compound object. For instance, a user makes a spoken annotation to describe the structure of a complex crossing, which is clearer than a simple text annotation. In addition to explicit annotations initiated by users themselves, the implicit ones will be generated when interaction with the environment takes place (asking for directions, following a guide, or activating traffic light acoustics announcement).

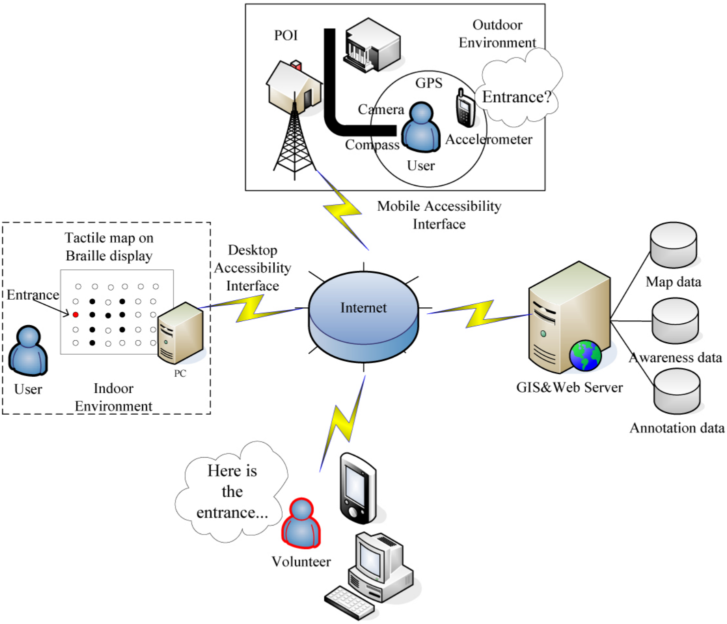

Fig.2: A framework of collaborative accessibility in mobile navigation system

In the desktop mode, the geographic information could be represented on a tactile-audio map [ZW10] through a large-scale Braille display [VWBL08]. On the tactile map, users are able to study annotations more easily. Through exploring a complex crossing on the map, users could touch the exact structure of the crossing, in X-type crossing, Y-type crossing or central island-type crossing, which has been recorded in the related annotation by others previously. Meantime, users can share and annotate accessible geographic information on the tactile map directly with the help of multimodal interaction.

The task of the volunteer platform is to assist one who needs a special help via collaboration. Most of the volunteers are sighted people, who obtain inaccessible geo-information without problems. Thus, they are capable of assisting the users to resolve problems with their knowledge and experience. For example, a remote guidance is possible for the visually impaired when related context has been provided, such as location, destination, current situation, etc. On the other hand, at times a person with low vision or blind is even a better volunteer, offering assistance via her/his practical experience.

4 Discussion

The approach of COACH introduces many challenges. We discuss in the following core issues raised including the map data need, the required ICT, the collaboration foreseen, the multimodality of annotations and privacy.

Map data resource: map data is the foundation of every navigation system. Because of shortage of map databases in Loadstone, specifically in developing countries, its user experience has been highly reduced, although there are several converter tools, all of which consist of many difficult processes. On the other hand, current commercial map data providers offer more professorial services but don't see a business model in accessible POI data. Fortunately, there exists a free worldwide map data provider, OpenMapStreet [HW08] [Open10], which supports to use and edit all of geographical data in a collaborative way for every one. It is a suitable candidate that makes use of OpenStreetMap as data resource for free navigation system.

Information and communication technologies (ICTs): in a ubiquitous computing world, the integration of Internet network, mobile network and sensor network allows to communicate anywhere at any time. While various new hardware is introduced into mobile phone platforms, the interaction is a challenge for the visually impaired due to lack of accessible features, e.g. touch screen phone. Consequently, the acceptance of mobile phones is to be improved to provide different kinds of services, by increasing accessibility of interfaces for people with special needs.

Collaborative accessibility: although the current ICTs and powerful mobile devices provide the necessary technologies, there will be still challenges to establish the platform through collaborations, specifically for the visually impaired. At first, inaccessible user interfaces of the platform might cause failures. Maps are in particular inaccessible to blind people due to their graphical nature. Another concern is the quality and quantity of sharing and annotating information. For instance, how to encourage and attract users and volunteers as soon as possible and how to manage the wrong annotations which mislead users should be considered.

Multimodal annotations: due to the special needs of the visually impaired, in order to implement multimodal annotations, interactions has to become accessible both in the mobile mode and desktop mode. The explicit annotations originated by users are easy to obtain via users' interaction directly. However, by comparison the implicit annotations are collected by a more complex and difficult analysis, as they depend on uses' movement, experience, context, and so on. On the other hand, those implicit annotations are more rich and helpful to improve the performance if obtained correctly.

Privacy: the users are aware of their data. As indicated from our subjects of questionnaire, some of them refused to share information or choose only trusted friends and family to guide them remotely when in trouble. On the contrary, all of them agree to annotate their experiences contained less relevant privacy to every one. For this reason, a multi-faceted strategy of protecting privacy should be considered in collaborative approaches, not only to resolve users' problems, but also to encourage their contributions actively. For instance, it is possible to keep important personal data in user's phones, or ask permission to publish.

5 Conclusion and Future Work

For the visually impaired, even if mobile navigation systems provide opportunities to improve mobility, there exist various issues. Based on an interactional survey we identified limitations of current systems and their requirements. As main result, participants indicated their passion to contribute their annotation for routes and POI to others. Through a collaborative accessibility approach (COACH), it is possible to both enlarge accessible information and share experiences among users and volunteers. In addition, several other significant issues were discussed, which were map database, multimodal annotations, privacy, with the aim of adapting COACH in a mobile navigation system.

Applying COACH within a collaborative personal navigated platform will require an organizing institution. Future work will have to investigate the role of commercial and public bodies and matching their interests.

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