Accessible Contextual Information for Urban Orientation

ABSTRACT
The conceptualization of an urban orientation system was based on the idea that an individual's walking journey could be enhanced by providing contextual information about points of interest (POIs) along their route. Research revealed a number of ways in which to provide serendipitous as well as task-critical information for both sighted and visually impaired users as they navigate through an urban environment on foot. Thus, a prototype system was developed to meet the following criteria: provide the user with an unobtrusive mobile device to facilitate contextual information presentation; a socially maintained online database containing information about POIs ; software that is accessible via both a graphical and a speech user interface; and location "tags" to be detected by the unobtrusive device. A socially maintained urban orientation and contextual information system such as this offers relevant, dynamic, and up-to-date information, the combination of which may not otherwise be accessible.

Author Keywords
Accessibility, Urban Orientation, Contextual Information System, Blind, Mobile Computing.

ACM Classification Keywords
H5 Information interfaces and presentation

INTRODUCTION

Objects in the physical world all have associated information not intuitively known through initial examination. This associative information can enhance an individual's understanding, especially an individual who is visually impaired, by understanding the object in its context. However, presenting relevant information to those who need or want it at an appropriate time can be challenging, especially if the object is not of consensus interest. Technological solutions that provide contextual information about objects have been introduced in such settings as museums, however the experience enrichment stops when the patron leaves the premises. The goal of this study is to inform the design of a multi-faceted location-based information system to provide serendipitous as well as task-critical information for both sighted and visually impaired users as they navigate through an urban environment on foot.

RELATED WORK

Previous research on urban orientation and contextual information was located in several areas: alternative mobile navigation solutions for the visually impaired; the navigation process of visually impaired individuals; the social implications of cell phone use versus an "assistive" device; and collaboration and use of community driven data.

A number of systems have been developed to provide location-specific information about predefined landmarks for mobile users, such as Cyberguide [1], Lancaster Guide [7], Magitti [2]. These systems rely on static content associated with each location, and thus could not adapt to changing or emerging user needs. To address this, a handful of systems have explored the viability of allowing users to generate arbitrary annotations for physical locations (e.g., ActiveCampus [11], GeoNotes [8]), however these systems have not taken into consideration the needs of visually impaired users.

The way in which visually impaired individuals navigate within an urban environment is an important consideration when considering methods of using contextual information systems to enhance an individual's walking journey. Documentation states that "Most training for the blind traveler focuses on learning routes to get from point A to B." [18], which is a skill utilized in orientation and mobility training. To follow a route, "Visually impaired travelers also break their journey into shorter stages and orient themselves within the journey a greater number of times..." [12]. Taking visually impaired navigational habits into consideration, alternative mobile navigation systems specific for visually impaired individuals have been developed which have included the Chatty Environment [4], Talking Signs [18], Loadstone Project [17], Wayfinder Access [21], and SESAMONET [20]. Each of these systems provides a method of navigation specific to the visually impaired community, however most are using positional technologies that are not precise enough to provide the user with immediately relevant contextual information exactly when he or she is passing a POI.

In terms of both sighted and visually impaired individuals, carrying a device in a pocket leaves hands free for other actions, such as carrying a cane or shopping bags [16]. For the disabled community, it is also essential that a device be inconspicuous while providing assistive technology to its user [17]. In addition to its small size, cell phones also contain various functions that can be utilized to gather information about locations. In one instance, a cell phone camera takes a picture of QR codes to produce information about the location without having to step into the business [14]. Although this system was specific to sighted individuals, the same concept has been used for the visually impaired [6].

With regard to the conception of utilizing collaborative data provided by a community, an observation was made that typically, "...users are seen as passive information consumers" [13]. This creates a static environment for the users and decreases the interest and use of the application. The development of a system that accumulates information about a community needs to allow the information in the system to be dynamic. The changing state of information is possible through community collaboration efforts and the users of the system. The system needs to convey to the individual accurate information about a location in order to fully extend that individual's (specifically someone who is visually impaired) perception of their surroundings [5]. A system with "contextual augmentation" allows additional information about a location to be accessed by multiple individuals using the same system [15] such as in GeoNotes [8]. These geonotes could consist of information directed personally or to the community.

METHODOLOGY

In order to gather data regarding characteristics of a walking journey research was conducted using four data collection methods: a "Wizard of Oz" (WOz) situation and system simulations; surveys; observations; and gathering qualitative information from a focus group.

Two WOz studies were conducted to test possible applications of a contextual information system with potential users. For the first study, participants were equipped with a headset connected to a mobile phone and issued a "beep" when they walked by a point of interest (POI). They were then instructed to use voice commands, from a list of accepted inputs, to obtain more information about the POI. Information about each location was audibly presented in a hierarchical menu of which selections were made in order to hear content pertaining to the selected menu item. The second WOz study utilized the same POI menu hierarchy but the command issuing method was changed from voice input to phone keypad input.

A survey with three different types of survey questions was developed, each question type to address the journey characteristic of the following types of people: sighted; non-sighted; and undifferentiated. Sighted and non-sighted people have different walking journey characteristics, especially in respect to techniques for orientation and informational questions [12], but it was suspected that there might be commonalities between the two types as well. The surveys were a means by which to extrapolate this information.

Researchers also accompanied seven sighted and two visually impaired individuals on walking journeys to observe their actions. Journey characteristics such as attention, routing, and prioritizing were recorded as well as answers to survey questions that were posed during the journey.

Finally, a focus group of roughly twenty sighted individuals answered questions about what they would like to know about locations they pass while walking. Quotes were recorded from this session and as well as common themes elicited by participants.

FINDINGS

The data gathered from interviews, observations and WOz studies revealed that both sighted and visually impaired individuals could benefit from using contextual information systems in an urban environment in different ways.

Of the three visually impaired participants interviewed, all of them expressed that they become familiar with an area by first identifying a few points, and a mental map is constructed by adding points over time as one interviewee pointed out: "The way [blind] people travel is different than the way sighted people travel: when [sighted people] look at a map you see the whole map, you see the total; [people with blindness] take only pieces from a total."

There is also a great amount of pressure on the blind to be independent on their journeys, and they frequently do not like to seek outside help: "I was trained to seek aid from a human as a last resort, [which] was an oppressive approach. Although a high level of independence is important, it is unrealistic to go into a situation thinking you will know everything." Because of this pressure, and the importance of remembering particular places to get from one point to another, the visually impaired are not always familiar with points of interest in their environment: "If [the visually impaired] walk by a donut shop and the door isn’t open, and they don’t smell it, they don’t know its there" one interview stated.

Interviews with the visually impaired revealed that it is important for them to have access to information regarding restroom locations, information centers or police stations, blind materials (such as brail menus) availability, physical barriers (such as trees and construction sites), historically relevant information, and public transportation. Giving users access to information about the "type" or "category" of each point, to construct a mental map of locations through verbal directions has also proved to be helpful [18]. Additionally, of the three visually impaired individuals interviewed, all expressed the need of any device to be carried in addition to their typical items be small enough as to not impose supplemental burden [19].

Sighted users expressed interest in information about how their surroundings have changed, such as a new store location, or construction that may affect the route used and time it takes them to get from one point to another. All of the sighted users also expressed that they usually call someone if they need more information about a particular place, or if they are lost and need directions. It was also important for sighted users in this study to know about other related consumer options near them.

Users can easily be bombarded with too much information. During the exercises users were read strings of text about each location as soon as they came within range of the POI. These strings of text included "POI name," "POI type," and "POI description." Both of the WOz participants provided feedback which indicated that only the "POI name" and "POI type" were important to hear initially; anything beyond that took too long to hear and was not relevant if they did not want to know more about that POI.

The culmination of data from both sighted and visually impaired individuals revealed that there was high general interest in an orientation device and both demographics stressed the importance of having a small device with accurate location detection and updated information. The survey results suggested that giving the user access to information such as hours, menu, prices, customer feedback, or the type of location they are passing would be the most beneficial. There was also interest in creating a personalized device, where the user can update information regarding the kind of journey they want to take and the ability to filter information about POIs they have passed.

TALKING POINTS PROTOTYPE

The data and findings described above substantially informed the design of this urban orientation and contextual information system. A prototype system was developed to meet the following criteria: unobtrusive mobile device to facilitate contextual information presentation; a socially maintained online database containing information about POIs; software that is accessible via both a graphical and a speech user interface; and location "tags" to be detected by the unobtrusive device.

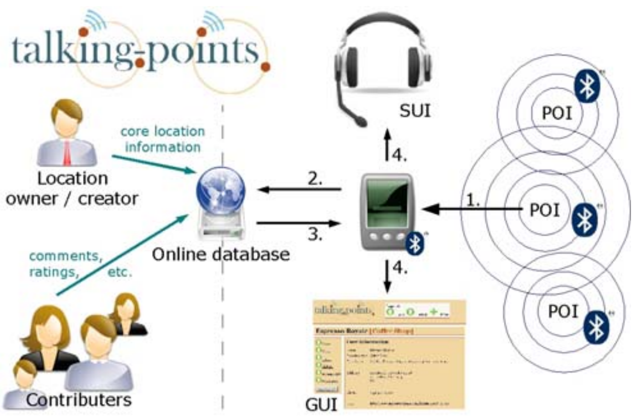

Figure 1: System & interaction diagram

The "Talking Points" system consists of two components (see Figure 1): a social online database that facilitates user-generated content creation and storage of the POI information; and a mobile device that detects POIs and presents the contextual information through either a Speech User Interface (SUI) or a Graphical User Interface (GUI).

Software

Given that all survey participants cited social sources of information for data gathering about a location, the website component of this prototype was developed to allow users to contribute information about such locations. Contribution is open to anyone and data from focus group discussion demonstrated that people have different ideas of what type of content to contribute. To address this issue, users are able to create categories of information; here, location templates would not be appropriate given the variability of taggable locations. Prior literature in the area of categorization would seem to agree [22]. This architecture allows users to update location information at anytime and places emphasis on the social connectivity between individual users and a diverse community.

Focus group participants expressed concerns of the quality of information presented in a user contributed content environment. To address this concern, location tag ownership policies were implemented: only the creator of the tag can change the "POI name" and "POI type." This authority measure was adopted to ensure the integrity of the information that system users would be accessing the most often.

A graphical user interface (GUI) was implemented for sighted users in addition to a speech user interface (SUI) which has the same functionality as the GUI but with options presented to the user via a Text-to-Speech (TTS) engine. To address the issue of information bombardment when the user encounters a POI, they are initially only read the "POI name" and the "POI type." Once that information has been audibly presented they have the option to issue any of a number of speech commands to navigate through the categories available for the POI.

Hardware

Given that both the sighted and visually impaired participants voiced concern over carrying obtrusive hardware, the OQO Model 02 mobile computer was chosen as the unobtrusive mobile device to facilitate contextual information presentation. Coupled with cellular data connectivity, this device is able to retrieve information from the remote location information database when a POI is passed.

Bluetooth beacons were chosen as POI tags over other technologies, such as WIFI, GPS, and RFID, for their combination of low cost, range detection, and position detection precision. Further, since all of the study participants carried Bluetooth enabled mobile phones, future iterations of the current device software could be ported to a mobile platform in which case users would not have to carry and extra device at all.

FUTURE IMPLEMENTATIONS

During the development of the Talking Points prototype, a number of areas for system enhancement were uncovered. Future iterations will include: orientational (left, right, ahead, behind, above, below) information; ability to "discover" nearby POIs; use as barrier or obstruction markers (visually impaired application); "virtual" POI tags requiring no physical hardware; porting software to open source mobile phone platform (such as Google Android) to eliminate need for additional device; and on-the-go user contributed content directly from the mobile device.

CONCLUSION

The goal of this study was to investigate methods of using contextual information systems to enhance the walking journey of both sighted and visually impaired individuals. Information from the research conducted here demonstrates that users, both sighted and visually impaired, could benefit from contextual information systems by having access to location specific user generated content. An urban orientation and contextual system such as this offers relevant, dynamic, and up-to-date information, the combination of which may not otherwise be accessible.

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