Accessible Contextual Information for Urban Orientation

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ABSTRACT

We present Talking Points, an urban orientation system based on the idea that an individual's walking journey can be enhanced by providing contextual information about points of interest (POIs) along their route. Our formative research revealed numerous ways to provide serendipitous and task-critical information for both sighted and visually impaired users as they navigate through an urban environment on foot. Based on this, we developed a prototype system comprised of the following: an unobtrusive mobile device to present the user with contextual information; 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. This socially maintained urban orientation and contextual information system offers relevant, dynamic, and up-to-date information, a combination which may not otherwise be accessible.

Author Keywords

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

ACM Classification Keywords

H5.m. Information interfaces and presentation

INTRODUCTION

Providing context-specific information to mobile users has long been a central concern of Ubicomp research (e.g., [1, 7, 8]). In this paper we present a system called Talking Points, an urban orientation system, which seeks to deliver such information to a previously under-supported community of users: the visually impaired. The needs of the visually impaired differ from the needs of the sighted in significant ways. For example, individuals who are visually impaired navigate by memory. They identify and memorize a few points and, over time, construct a mental map by adding more points. In addition, Talking Points relies on community-generated content in order to maintain a database of location-based information that is as up-to-date and community-relevant as possible. This approach echoes previous systems (e.g., [8, 11]), while extending them to add authority controls in order to improve the reliability of data. Despite our focus on the visually impaired, we designed Talking Points to be universally accessible—that is, to provide support for both sighted and non-sighted users. By doing so, we substantially expand the pool of potential users[1], thus increasing the size of the community that can contribute (and benefit from) data contained in the Talking Points database.

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RELATED WORK

Previous research on urban orientation and contextual information was located in several areas: the navigation process of visually impaired individuals; alternative mobile navigation solutions for the visually impaired; 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 (e.g. Cyberguide [1], Lancaster Guide [7], Magitti [2]). These systems rely on static content associated with each location, preventing easy adjustment to changing or emerging user needs. To address this, a few systems have explored the generation of arbitrary annotations by users for physical locations (e.g., ActiveCampus [11], GeoNotes [8]), without taking the needs of visually impaired users into consideration.

How visually impaired individuals navigate within an urban environment is an important concern when considering methods of using contextual information 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], 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 have been developed which have

[1] According to the American Foundation for the Blind (http://www.afb.org), 3.8% of US residents are “visually impaired,” 0.5% are “legally blind,” and 0.05% are “totally blind.”

included: the Chatty Environment, consisting of tagged items audibly relayed to users [4]; Talking Signs, using a infrared wireless directional device to locate predesignated signage [18]; Loadstone Project, using GPS and open source software to create a collaborative database of virtual POIs [17]; Wayfinder Access, using GPS and a screen reader application on a cell phone to locate points of interest (POI) [21]; and SESAMONET, using RFID tags, a reader embedded cane and cell phone to navigate a designated pathway [20]. Each of these systems provides navigation specific to the visually impaired community; however most are using positional technologies that can become sporadic in their coverage due to interference when in urban or indoor settings.

Both visual and non-visual prefer using a device that fits in a pocket, leaving hands free to hold a cane or shopping bag. Some systems (e.g. Drishti [16]) require multiple pieces to be carried by the user, thus limiting the freedom of the user. For the disabled community, it is also essential that a device be inconspicuous while providing assistive technology to its user, thereby preventing stereotypes typically associated with the use of assistive technology devices [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 be dynamic in nature. The changing state of information can best be maintained by the collaborative effort of the community. The system needs to convey accurate information about a location in order to fully extend that individual's (particularly someone visually impaired) perception of their surroundings [5]. A system with "contextual augmentation" allows additional POI information accessible by multiple individuals using the same system [15] such as in GeoNotes [8].

VISUAL IMPAIRMENT REQUIREMENT FINDINGS

Methodology

In order to gather data regarding characteristics of a walking journey we undertook three studies: a "Wizard of Oz" (WOz) field simulation; observational interviews; and gathering qualitative information from a focus group.

Two WOz studies were conducted with sighted individuals to test possible applications of a contextual information system. For the first study, participants were equipped with a headset connected to a mobile phone and issued a "beep" when they walked by a 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.

Researchers also accompanied seven sighted and three visually impaired individuals on walking journeys to observe their actions. Journey characteristics such as attention, routing, and prioritizing were recorded. Questions were also developed to acquire details from both sighted and non-sighted on typical activities associated with a walking journey. Sighted and non-sighted people do 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 both as well. The questions were an additional means by which to extrapolate this information.

Finally, a focus group of sighted individuals were asked their preferences as to what information on POIs should be relayed. Quotes were recorded from this session and as well as common themes elicited by participants.

Findings

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

Of the three visually impaired participants interviewed, all expressed that familiarity of an area was accomplished by first identifying a few points, and then constructing a mental map by adding points over time For example, 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." The pressure to be independent and the necessity of remembering specific locations in order to get from one point to another cause the visually impaired to be less familiar with other POIs in their environment.

Commonality on how sighted and non-sighted individuals experience a walking journey was revealed. The use of known points to navigate is utilized by both groups. By utilizing known locations, further locations can be found and utilized for future exploration.

Interviews with the visually impaired revealed the importance to have access to information regarding the location of restrooms, information centers or police stations, blind materials (e.g. Braille menus) availability, physical barriers (e.g. construction sites), and public transportation. Access to information about the "type" or "category" of each point, to construct a mental map of locations through verbal directions also proved to be helpful [18]. Additionally, all of the visually impaired interviewees 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].

Both user groups expressed interest in information about changes in their surroundings (e.g. construction or new location) that may affect the route used and time it takes them to get from one point to another. Sighted users thought it important to know about other related consumer options nearby.

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

The culmination of data from both sighted and non-sighted individuals revealed a high general interest in an orientation device, both stressing the importance of a small device with accurate location detection and updated information. Interviewees suggested that user access to information such as hours, menu, customer feedback, or location type they are passing would be 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.

TALKING POINTS PROTOTYPE

The data and findings aforementioned substantially informed the design of the Talking Points system. Our prototype system consists of 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.

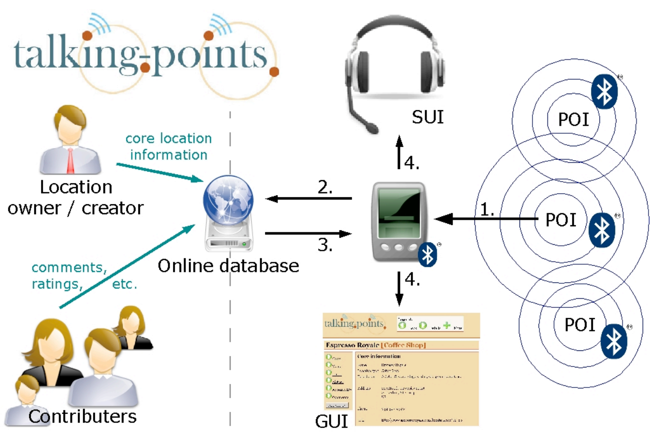

Figure 1: System & interaction diagram

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).

Content Server

The website component of this prototype allows users to contribute information about POIs based on the fact that all interviewees claimed the use of social sources to gain location information. The focus group discussion demonstrated that people have different ideas of what type of content to contribute. To address this issue, rather than use pre-defined templates, users are able to create different types of information (e.g. accessibility information) appropriate given the variability of taggable locations. This architecture allows users to update location information at any time and emphasis placed on the social connection between individual users and a diverse community. In addition to direct contribution from users, we also plan to support importation of annotations from established location-based information sources, such as Wikimapia.

Focus group participants expressed concern over information quality within a user contributed content environment. To address this, location tag ownership policies were implemented: Only the tag creator 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.

Client Software

The Talking Points client was developed in Java and supports two user interfaces: a SUI, incorporating the CMU Sphinx library[2] for voice recognition and FreeTTS[3] for the TTS engine. To address the issue of information bombardment when encountering a POI, users were initially only given the "POI name" and "POI type." Once that information has been audibly presented they have the option to issue a number of speech commands to navigate through the categories available for the POI. A Java swing-based GUI was also implemented for use by sighted and deaf users. The SUI and GUI content and functionality are identical, except the GUI displays a list of nearby POIs ("name" and "type") whereas the SUI renders one at a time.

Hardware

Influenced by the concern voiced by sighted and non-sighted participants over carrying obtrusive hardware, the OQO Model 02 mobile computer, a palm-sized full performance PC, was chosen as the unobtrusive mobile device for our prototype. Afforded with Bluetooth capability and potentially other technologies using added

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[2] http://cmusphinx.sourceforge.net/html/cmusphinx.php
[3] http://freetts.sourceforge.net

hardware the device is able to detect POIs in an 8-10 meter range. Coupled with cellular data connectivity, this device can retrieve information from the remote information database when a POI is passed. The delay of information from the database to the device is less than a second, yet, the delay between the device and the Bluetooth beacon is usually 5-12 seconds, which we are working to improve.

Bluetooth beacons were chosen as POI tags over other technologies, such as Wi-Fi, GPS, and RFID, for their combination of low cost (Bluetooth is available in most cell phones), range detection, and degree of position detection precision. As previously stated, Bluetooth was chosen over GPS due to the lack of available signal in many urban and indoor settings. Despite this issue, GPS also provides a low cost alternative requiring no hardware. A hybrid of technologies is the best solution, as it allows coverage for all environments and represents future work. To embrace this idea of combined technologies, GPS coordinates are entered in the record of each POI established.

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) information; annotations for barriers and obstruction markers; porting the client to a mobile phone platform (such as Google Android); and support for 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 demonstrates that users, both sighted and visually impaired, could benefit from contextual information systems by having access to location specific user-generated content. A socially maintained 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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