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Map Requirements and Attainable Public Policy for an Installation-free Worldwide Navigation and Information System for the Blind

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Abstract. The aim of this work is to demonstrate that safe and independent mobility is feasible for blind pedestrians worldwide, requiring only adequate mapping and attainable public policy. A basic map format and an installation-free guidance and information system are presented. The developed map format can be used as the basis for a worldwide navigation system for the blind. In order to achieve such expanded accessibility, however, certain public policy changes are necessary. National and local organizations of blind and deafblind people must educate themselves and their supporters about the need for, and benefits of, detailed mapping of buildings and cities. They must take the lead in raising public awareness and in lobbying institutions and cities to offer maps in formats which support safe and independent navigation.

Keywords: Navigation & Orientation Technology; Safety; Social Participation; Universal Design; Wayfinding

1. Introduction

Various products exist to provide navigational help for the blind in specific locations. Most common, perhaps, are Braille markers on doors, elevators, and bank machines. Less common are tactile environmental maps at building or park entrances. Although helpful, such aids cannot announce their presence, and blind navigators must depend upon others to direct them to the Braille information. More technical devices provide auditory cues, such as announcing building floors or traffic light changes, but these are unavailable in many areas.

Fig. 1: The current TANIA system with guiding grids and segments for precise navigation of visually impaired users both indoors and outdoors. Blind and deafblind people can access the map information using the tactile overlay of TANIA's touch screen, its audible output or a connected Braille display.

To support more independent ambulation by blind people, complex indoor location and navigation systems have been developed. Most require installation of a special infrastructure, such as optical beacons or Radio

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Frequency Identification (RFID) tags. The impressive accuracy achieved by some of these systems is offset by several disadvantages. Installation is time-consuming and costly. Beacons can be occluded by environmental changes, like door position, and signals impeded by weather conditions, like temperature and humidity. Outdoor navigation systems based on the Global Positioning System (GPS) have proven similarly unsatisfactory. Maps used in such systems are made for car navigation, resulting in low accuracy and low resolution. Further, as with most indoor applications, signals can be blocked or unavailable.

In previous work we have presented a navigation system, based on tactile-acoustical interface, which can both locate blind users and provide integrated information relevant to current position (Hub, 2007a). The TANIA (Tactile-Acoustical Navigation and Information Assistant) system encompasses augmented maps in which all significant points or objects are named (Figure 1). By tapping on a touch screen, the blind or deafblind user can access information acoustically or on a connected Braille display (Hub, 2007b).

2. Methods

At the University of Stuttgart a map format was developed that supports precise guidance of blind and visually impaired people both indoors and outdoors. Maps include special grids and segments with location information to orient the user in open areas, large rooms, or long streets where physical markers are absent (Hub, 2008). In contrast to conventional maps used in Global Positioning Systems, these maps include data relative to the needs of blind people, such as specifics about sidewalks, traffic lights, etc. Further, text information can be added to the maps at any location, providing public transportation schedules at bus stops, product locations in stores, menus at restaurants, etc. Based on the eXtensible Markup Language (XML), map entries can be edited by blind users themselves, so information can remain current and individualized. All information can be presented on a small connected Braille display. Pilot studies were conducted using the new map format in large conference environments and defined urban districts.

Because of distance and time constraints, it was not always possible to make exact measurements of pilot study environments on site. One of the most time-consuming challenges of this project proved to be obtaining adequate rough maps of desired areas. Available maps were frequently not digitalized. Sometimes the absolute scale was missing. Often maps were incomplete and/or incorrect.

When maps provided were not digitalized, hardcopies had to be scanned and redrawn. For this purpose drawing or modeling programs (Map 3D and 3D Studio Max, by Autodesk), frequently used by architects, were used. The same programs were utilized to name map regions and objects. When maps were received in a digitized vector format, considerable time was saved, however, it was occasionally necessary to re-measure certain distances using a distancemeter (Disto^{TM} pro^{4}a, by Leica).

The extended version of our assistant system, which includes a camera-based sensor module and additional hardware, was first developed for the 3D model of a research institute at the University of Stuttgart (Hub, 2004). Detailed 3D environmental models in the *OpenSenceGraph* format were produced (OSG, 2008), and could be easily augmented by tapping on a software button to create areas for additional information. Textual information, descriptions and/or safety warnings could be entered via keyboard. Subsequent changes can be accomplished very easily in this format by adding or editing the structure elements (“nodes”) of the scene graph. When the changes are complete, the updated map can be saved by the user (Hub, 2006).

Given time and cost constraints some environments had to be modeled in 2D. For these maps the XML format was used. This format makes it easy to augment the map with information like tables. Therefore, we have configured our special XML map format (Augmented World Modeling Language) in such a manner that it is compatible with the OSG format. This will support use of 3D models when available. Regular 2D mapping was done for large exhibition halls in conference hotels, where products for the blind were presented. Mapping was also done outside between two conference hotels in Los Angeles, and in specific areas of two German cities. This allowed us to investigate TANIA’s usability under indoor and outdoor conditions. We integrated significant objects and architectural detail into these maps, showing elevators, stairways, and even toilets and sinks in the restrooms (Hub, 2008). The current map format includes guiding grids comparable to a checkerboard for the guidance of blind people when physical guidelines as walls or sidewalks are absent. Segments in hallways and sections within streets allow precise location determination both indoors and outdoors. Navigational advice can be added to these map elements, such as warnings about an upcoming driveway, or the direction in which elevators are oriented.

3. Results

Building and site maps are available from many public and private institutions, and laws which guarantee equal accessibility can facilitate their acquisition. However, these maps must be converted to the new format, and augmented with information for the blind and visually impaired. Blind people can augment the maps with additional text information, and share them with other users. Using detailed maps in the new format and our navigation system, blind and deafblind people are able to determine their position indoors and outdoors with accuracy of approximately one large step.

Trials with the TANIA system thus far demonstrate that this system offers some significant advantages over comparable systems. First, basic functions can be learned in five to twenty minutes, even by people with limited computer experience. Second, changes in the environment can be easily incorporated by loading new maps or changing details on existing maps. These upgrades can be accomplished by institutions, by blind users, or by others familiar with the system. Third, when walking parameters are set correctly, system accuracy is more precise than that of GPS systems. If location errors occur, they can be easily corrected by the user. Fourth, the TANIA system functions when GPS signals are too weak or unavailable.

Perhaps the most important advantage is that TANIA can potentially be used everywhere where adequate mapping has been done. And, because the system encompasses a complete computer with a large hard drive and multiple interfaces, information can be accessed, as needed, from the World Wide Web. Users have the potential to achieve unlimited independent mobility. No longer must those who lack willing sighted assistants remain isolated.

5. Discussion and Future Work

Laws passed recently in many countries mandate equal accessibility for all citizens to public buildings and transportation systems. While necessary adaptations have been made to accommodate people in wheelchairs – ramps, renovated toilet stalls, wider doorways, e.g. – adaptations for blind and visually impaired citizens are not as prevalent. Even when Braille descriptions exist on doors, elevators, teller machines, or signs, they cannot announce their presence. Visually impaired navigators often remain dependent upon sighted others to plan walking routes and explore unfamiliar environments. The TANIA system represents one attempt to develop a technological solution to the independent mobility problems faced daily by visually impaired, blind, and deafblind individuals.

In order to achieve significant functional improvement in accessibility for these people, several technical developments must be realized, and several political challenges overcome. First, funding for devices such as TANIA must be provided by government agencies or social services organizations. This would necessitate improved public awareness of handicapping conditions, and a sincere commitment to the right of accessibility for all citizens. Additionally, in order to use such devices, all public buildings should be equipped with at least one WiFi access point. Maps of streets and buildings should be provided and updated by public institutions or local governments. Maps of the interior environments of public buildings should be available, as well, allowing blind people with navigation devices to download them via WiFi access points. To solicit business from blind and deafblind customers, businesses and shops might map their interiors as well, providing this information over the world wide web. These ideas are no more farfetched than was the idea, years ago, that every household should have a telephone, and more recently, that every home and business should have a computer.

Currently it is possible to obtain direct and actual distances to a target destination online, but mobility maps of greater resolution, with a degree of detail necessary to adequate route planning (showing sidewalks and walls, e.g.) must be created. Again, this takes awareness of and commitment, in time, money, and energy, to accessibility issues. Barriers due to funding issues can be minimized with an accelerated campaign of public awareness, including the passage of laws which mandate accessibility. More difficult to overcome are barriers which involve security and privacy issues. Given today’s climate of fear and terrorism, mapping public buildings and outdoor public areas can be perceived as enhancing mobility for a few while jeopardizing the safety of many. Such objections are not logical, however, since the availability of building maps also enhances fire fighting, law enforcement response speed and efficiency during emergencies. Mapping in private houses could be done by anyone who is able to. Often architectural maps can be located. In order to support worldwide navigation a network of map servers should be created to integrate all map and augmented information.

This project will need the help of sponsors to cover the planning, funding, and execution of its goals. To bring together all interested groups a non-profit organization was founded (BNI, 2008) to coordinate the project and to make the system available to sensory handicapped people in developing countries.

6. Conclusion

Assistant systems based on detailed and augmented maps offer blind people increased navigational independence and facilitate equal access and social interaction. With coordinated effort from many interested groups, a worldwide navigation and information system can be realized. Trials at pilot locations have shown that users can be trained within a minimal time period, and with reasonable expenditure of financial resources. It has only to be done.

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