TANIA – A Tactile-Acoustical Navigation and Information Assistant for the 2007 CSUN Conference

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Summary
A navigation assistant based on a tactile-acoustical interface and augmented map information is presented, affording blind people real and virtual explorations of the 2007 CSUN Conference environment. By tapping on a touch screen, hotel layout and conference-related data are provided.

Introduction
Negotiating new environments can be challenging for all of us, but blind people face far greater navigation and orientation difficulties in such situations. At conferences, for example, the environment must be learned quickly and may even change from day to day. Information about the location of meeting rooms, restrooms, lunch and break areas, booths, company representatives, and products is especially difficult to obtain. This author's experience at the last CSUN Conference stimulated the development of a specialized application of our electronic Tactile-Acoustical Navigation and Information Assistant (TANIA) system to this year's meeting. Unlike commercially available navigation systems, which are usually inoperable indoors without installation of a time and/or cost intensive signal or marker infrastructure, the TANIA system does not require infrastructure. It provides indoor navigation support for blind and visually-impaired people based on a step-recognition method and simple building maps. These maps have been augmented with additional information supplied by hotel management, conference organizers, and exhibitors.

Related Work
There are several approaches for tracking people within buildings. Some of them use conventional infrastructure, like WiFi or Bluetooth connections, with mapped signal strength data to calculate current position. One example of such a system was presented at the 2006 CSUN Conference by Bowen [1]. An advantage of these systems is that necessary infrastructure already exists in many public and government buildings. However, localization accuracy can be impeded by electromagnetic disturbances, ferro-concrete, and especially by environmental alterations, such as the opening of doors, the appearance of people, or changing weather conditions.

Another approach is to install RFID tags [7,8] or optical beacons [10] throughout the building, linking text information to specific locations, like doors and hallway intersections. Accuracy resulting from these systems can be quite good, however extensive installations are necessary, and the system hardware may have to be regularly updated to reflect changes in the environment.

Self localization and tracking are also possible using a combination of stereo cameras and 3D environment models. In previous work we have shown that objects can be recognized interactively [3], even when these objects are moved [4], based on local sensor information and simultaneous processing of 3D environment models. However, these systems require additional hardware and extended computing power, as well as a detailed 3D model.

System Setup

The TANIA system consists of a lightweight, portable tablet PC suspended from a strap worn around the neck. An inertial sensor (MTx, by Xsens) is fixed at the center of the strap and connected by cable to the tablet PC. Once the initial position is entered, e.g. the main entrance of a building, the user's current position is determined by the inertial sensor, which consists of a 3D compass, a 3D gyroscope, and a 3D acceleration sensor. Related positional data, such as room or booth numbers, or distance covered along a specific route, can be presented acoustically and visually on the touch screen of the tablet PC. Additionally, TANIA can be connected and adapted to commercially available portable Braille displays. Given software specifications, connection can be made to standard computer ports or interfaces, like USB or Bluetooth. This not only allows deafblind people to use the assistant system, but facilitates its use in situations when acoustical output must be avoided or cannot be heard.

Real and Virtual Explorations of Environment

Tracking support is based on a step recognition method originally developed by Kourogi and Kurata [6]. We adapted their algorithm to our inertial sensor, and, in deference to feedback from users and signal characteristic analyses, mounted it behind the neck on the tablet PC strap. Accuracy of one step can be achieved when walking in areas without interfering electromagnetic fields. By synchronizing map information with collision and corner detection methodology, accuracy is maintained at reasonable levels even in the presence of interference, or for long walks in large buildings [5].

Moving one's finger on the map presented on the touch screen provides a spatial impression of the current environment, or of any other area where adequate digital mapping has been done. Stored text information can be accessed via tactile-acoustical switches or by tapping on the map, allowing the user to address navigational tasks and virtually explore alternative routes. The touch screen includes four tactile orientation strips, providing perceivable orientation cues for forward, backward, left and right movement. The user's position is automatically centered in the middle of the touch screen, where the strips intersect. By tapping in this spot the user can receive information about his of her current position.

Software and hardware keys support basic map functions, like selecting different floors, zooming, and scrolling. More advanced options give current directional orientation, measure the distance and orientation to selected destinations, and synchronize to the next architectural object. An information key provides an overview of current system status.

Implementing Conference Information

In the initial stages of this project we utilized a very simple map format that consisted only of named lines representing room walls and doors. This was adequate for the first usability tests with blind subjects. In order to flesh out the system, we now utilize the Geography Markup Language (GML) format [2]. This format increases map complexity by supporting inclusion of environmental structures, text information, and links to related data. Using it we have derived a scheme to guide blind and visually impaired people, and for this application data relevant to the 2007 CSUN Conference has been incorporated. Included are floor maps, rooms, lecture and exhibition halls, booths, products and company contact names. With the GML-based format all features can be listed, categorized, and retrieved. Users can, for example, access location information about a single item, such as company, or about groups of objects, such as all Braille displays. Even three dimensional descriptions of objects, when available, can be included within this format. However, current speed limitations of the tablet PC's processor impede the interactive use of 3D models.

The aim of this project is to provide blind and visually-impaired CSUN Conference attendees with up-to-date information about room locations, events, exhibitors and products. Besides enhancing accessibility and facilitating conference navigation, our project will provide blind and visually impaired attendees an opportunity to try our TANIA system and provide us with welcome usability feedback. However, it should be noted that we cannot guarantee the accuracy of information provided us by third parties and used in the preparation of our maps.

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References

[1] Bowen CL III. Using Wireless Networks To Assist Navigation For Individuals With Disabilities. California State University, Northridge Center on Disabilities' 21st Annual International Technology and Persons with Disabilities Conference (CSUN 2006), 2006 March 20-25, Los Angeles, CA, USA. Available from: http://www.csun.edu/cod/conf/2006/proceedings/2931.htm

[2] Geography Markup Language. Available from: http://www.opengeospatial.org/standards/gml

[3] Hub A, Hartter T, Ertl T. Interactive Localization and Recognition of Objects for the Blind. California State University, Northridge Center on Disabilities' 21st Annual International Technology and Persons with Disabilities Conference (CSUN 2006), 2006 March 20-25, Los Angeles, CA, USA. Available from: http://www.csun.edu/cod/conf/2006/proceedings/2661.htm

[4] Hub A, Hartter T, Ertl T. Interactive Tracking of Movable Objects for the Blind on the Basis of Environment Models and Perception-Oriented Object Recognition Methods. To appear in: Conference Proceedings of The Eight International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS 2006), 2006 Oct 23-25, Portland, OR, USA.

[5] Hub A, Kombrink S, Ertl T. Tactile-Acoustical Navigation Assistant for Real and Virtual Explorations of the Environment. Envision Conference 06, 2006 Sept 21-24, Kansas City, MO, USA, 48.

[6] Kourogi M, Kurata T. Personal Positioning based on Walking Locomotion Analysis with Self-Contained Sensors and a Wearable Camera. 2nd IEEE and ACM International Symposium on Mixed and Augmented Reality (ISMAR 2003), 2003 Oct 7-10, Tokyo, Japan, 103-112.

[7] Kulykukin V, Gharpure C, Nicholson J, Osborne G. Robot-assisted wayfinding for the visually impaired in structured indoor environments, Autonomous Robots 2006, 21(1), 29-41.

[8] Naviwalk. Available from: http://www.idfone.co.kr

[9] Nexus. http://www.nexus.uni-stuttgart.de/index.en.html

[10] Ran L, Helal S, Moore S. Drishti: An Integrated Indoor/Outdoor Blind Navigation System and Service. 2nd IEEE International Conference on Pervasive Computing and Communications (PerCom 2004), 2004 March 14-17, Orlando, FL, USA, 23-32.