INFORMATION SERVER CONCEPT for SPECIAL USER GROUPS

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ABSTRACT

The presented information server concept, developed at VTT, is a user-centred and task oriented client-server approach for solving informational needs of special user groups. This paper describes application of the concept for producing an unbroken trip chain for the visually impaired. The goal of the study was to build a navigational aid for the visually impaired using commercial passenger information and personal navigation services without laborious and expensive changes in the current infrastructure.

Visually impaired persons do not have any specific information needs. Information needed either exists but is not accessible, or would be useful for all passengers. Passenger information systems should be equipped with a standard XML interface, which is accessible via Internet. This would make it easier to serve special user groups, whose means to reach the information is different.

INTRODUCTION

Generic travelling difficulties for the visually impaired are localisation and environment perception, selecting and maintaining correct heading, and detecting obstacles above waist and unexpected road works.

There have been numerous research projects about creating electronic travel aids (ETA) for visually impaired persons. These projects usually have concentrated on solving one specific problem. The result has been usually technically simple device, which may be difficult to use. Because the visually impaired have several problems, they would have to acquire a wheelbarrow to take with all these devices to carry off everyday life.

Development of travelling aids based on positioning has a long history, the use of GPS has been researched since the late 80's and since then there have been many research projects like Mobic [1], Drishti [2] and Brunel Navigation System for The Blind [3], and commercial products like Sendero Groups BrailleNote GPS [4] and VisuAide's Trekker [5] addressing GPS based ETA for the visually impaired. Navigation systems have usually worked well in small-scale implementations, but a large-scale implementation will be extremely expensive (especially with beacon based navigation systems). Percentage of visually impaired persons of the whole population is less than 1.5 % in developed countries; therefore large investments to the infrastructure are not reasonable. Still, visually impaired persons have equal rights to achieve the same services as all other citizens. Despite intensive research and development, electronic travelling aids for the visually impaired have not yet become common. This indicates that the problems at hand are not easy to solve.

The most important guidance aids for the visually impaired are still the **white cane** and **guide dog**. Electronic travelling aids should be considered as supplementary equipment. What we need is a travelling aid that produces a small amount of navigational information and does not disturb other information perceived from the environment. Further, the evaluation of the device should be based on the benefits it produces not the amount of information it generates.

NOPPA ARCHITECTURE

VTT's Information server concept aims to utilise commercial services and devices for improving public transport accessibility with creating access to passenger information with a personal mobile device rather than building physical infrastructure.

Research and development of the concept was done in a research project NOPPA (Navigation and guidance for the visually impaired) [6], which started at June 2002 and ends of the year 2004. Project pilots a personal navigation system for the visually impaired, which produces a unbroken trip chain for the visually impaired.

The most important building blocks of the system are mobile Internet, mobile phones and personal navigation systems and services. For unbroken trip chain for the visually impaired there are requirements for continuous, general use positioning techniques, continuous (Internet) access to passenger information and availability of map data accurate enough for users' needs. For example there aren't generally maps available, which would include pavement information or information about large public premises either. Door-to-door guidance would require map data including entrances and continuous guidance would even require indoor maps and indoor positioning, which are generally unavailable.

Design goals of the NOPPA -guidance system were:

- Easy and fast to use
- Flexibility
- Affordable to the user
- Access to public transportation and passenger information systems
- Applicable both indoors and outdoors
- Integration of products and services for personal navigation
- Modular, easy to update, easy to add functions
- Speech user interface.

To fulfil these requirements, we created an architecture presented in Figure 1. Because of low processing capacity of the mobile terminal and a low bandwidth wireless data connection, most of the work is done in the Information server. Data flow between mobile client and Information server is minimized, which keeps the communication costs low and shortens response time.

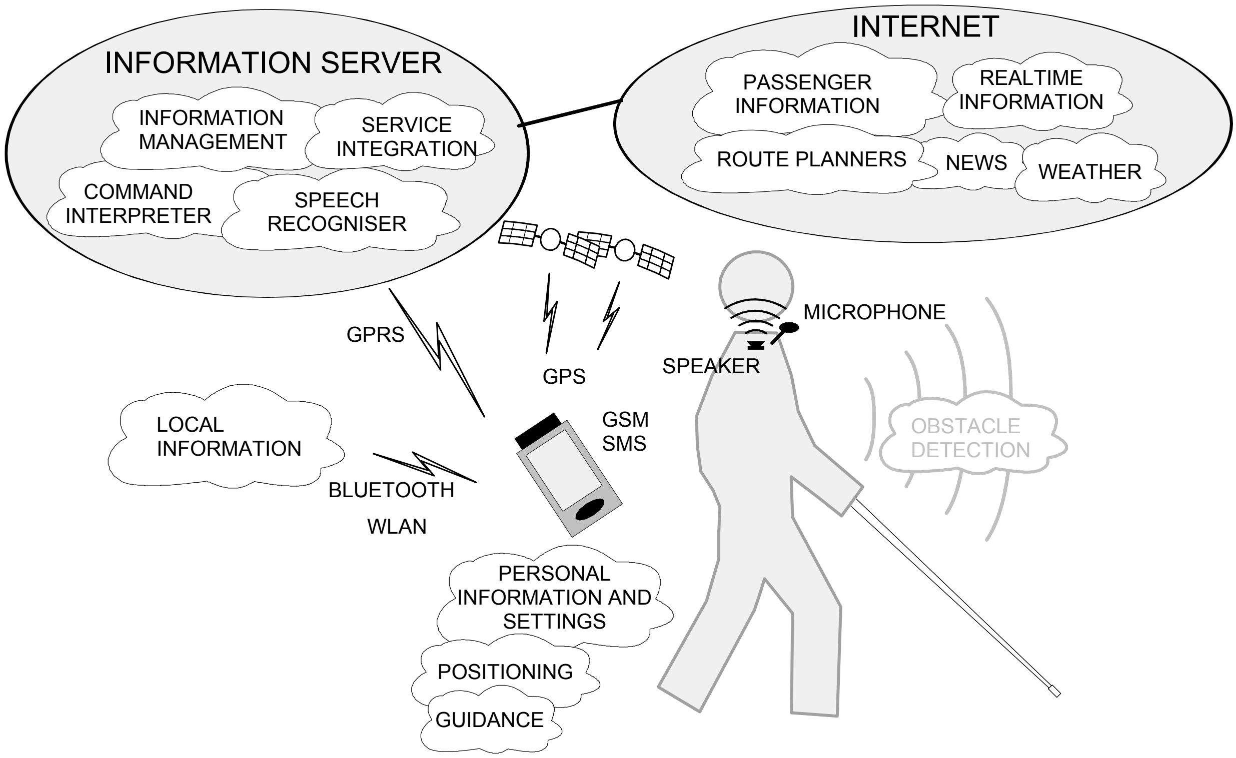

Figure 1. Architecture of the NOPPA guidance system.

INFORMATION SERVER

The Information Server in the architecture is an interpreter between the user and information systems. It collects, filters and integrates information from different sources and delivers only the results to the user. For the visually impaired speech user interface is a natural choice. If the users are deaf, user interface based on text and visual information is used instead.

The server constructs a route plan, which is transferred to the terminal. Terminal is responsible for route following and guidance functions. It however reports its coordinates periodically to the server which could follow the progress of the journey and possible changes and disturbances concerning the rest of the journey. Real time information plays an important role through the unbroken trip chain [7].

Route following and guidance is done in the terminal, because these are time critical functions and because of unreliable wireless connection. Although GPRS connection is often considered continuous, in practise it is not. Implementation of guidance in the terminal makes it available even when the connection to the server is temporarily off.

THE PROTOTYPE

The prototype of the terminal is built on a commercial mobile phone. The system carries out following characteristics

- Speech user interface (Finnish)
- Route planner (commuter and intercity traffic both bus and train)
- Access to bus and train real time information

- Guidance and route following during a trip
- Personal stop announcements in-vehicle
- Roadwork information
- Airport departures (domestic flights), real time information
- News, watch, local weather, memo
- GSM phone and SMS services
- GPS, GSM positioning, pedometer, compass
- Bluetooth, GPRS (WLAN) connectivity
- Indoor navigation system based on Bluetooth or WLAN positioning
- Own recorded walking routes with location based comments

User evaluation tests are planned for autumn 2004. In the tests the value of the information provided is under evaluation not usability of the device.

Figure 2. Noppa prototype terminal.

VISUALLY IMPAIRED PERSONS AND UNBROKEN TRIP CHAIN

If we examine problems a visually impaired person meets when using public transport, we recognize the following list (depends slightly of the transportation mean):

trip planning, finding a stop/station, finding an entrance to the station, navigating inside the station, finding the right platform and waiting place, knowing when the right vehicle arrives, finding a vehicle entrance, payment, finding a seat, depart on right stop, navigating inside the station, finding the exit of the station and finding the destination.

Most of these tasks are trivial for the sighted, but very difficult for the visually impaired. There are cases when a blind person has spent several hours on the bus stop, because he couldn't recognise arrival of the right vehicle.

Nevertheless, in our studies we couldn't find any specific information needs for the visually impaired. Information needed is either available for the sighted, existing but not accessible, or would be useful for all passengers. However, the means for a visually impaired person to reach the information is different. This is an important factor to take into account when new passenger information services are designed.

To produce unbroken trip chain for visually impaired, we have to switch seamlessly between different modes of operation during the trip (see Figure 3). This requires that system must be context aware to recognise transition points and change automatically its mode of operation accordingly.

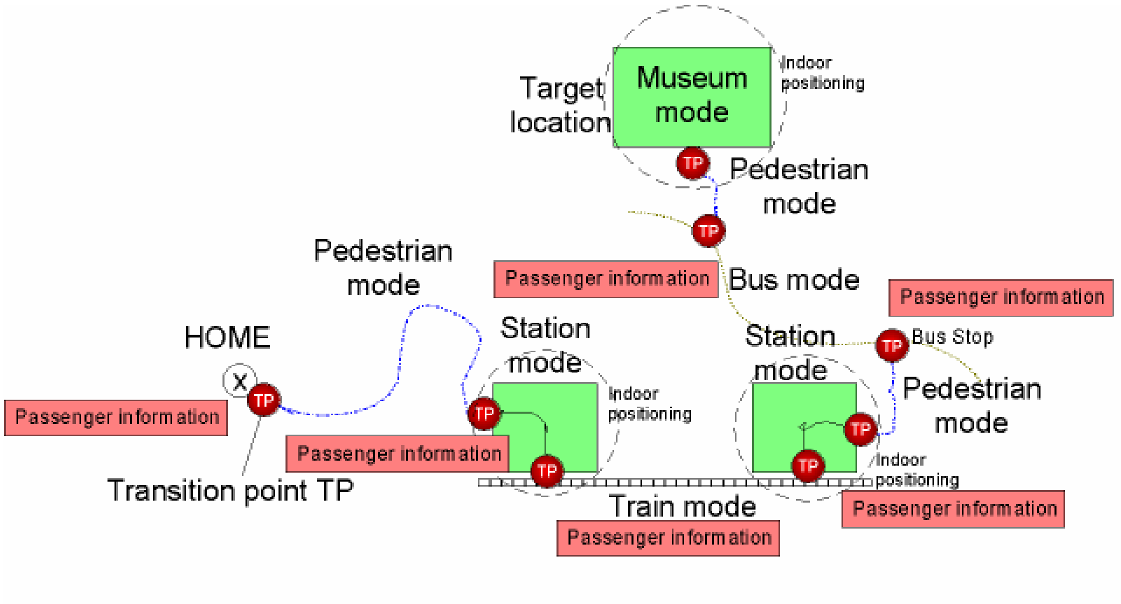

Figure 3. Unbroken trip chain and different operation modes.

TRIP PLANNING

All planning is based on commercial journey planners. Helsinki metropolitan area (Helsinki, Vantaa, Espoo and Kauniainen) is covered by one planner [8], which covers local bus, tram, metro and local train traffic. A speech user interface for the journey planner was constructed in the server. Speech recognition software is speaker independent and requires street names from these cities to accomplish recognition. List of 10 000 street names is acquired from the journey planner and automatically compiled to recogniser grammar.

Positioning makes route planning easier, because the current address can be searched with reverse geocoding. Often used target addresses can be saved to a list, but if the start or target address is unknown, terminal asks for an address. Voice response is recorded and transferred to the server for recognition. Recognition result is then transferred back to the terminal for certifying. All personal parameters like walking speed are also transferred to the server. When we have all the information needed for route planning, the server generates a route request and sends it to the journey planner.

Route plan is based on journey planner's response. It is augmented with road work information, Point of interest (POI) -information and Area of interest (AOI) -information. Road works on the route are gathered from WINKKI-database from Helsinki Public Works Department. User listens the route plan and if he/she considers it acceptable, the next step is to start route guidance.

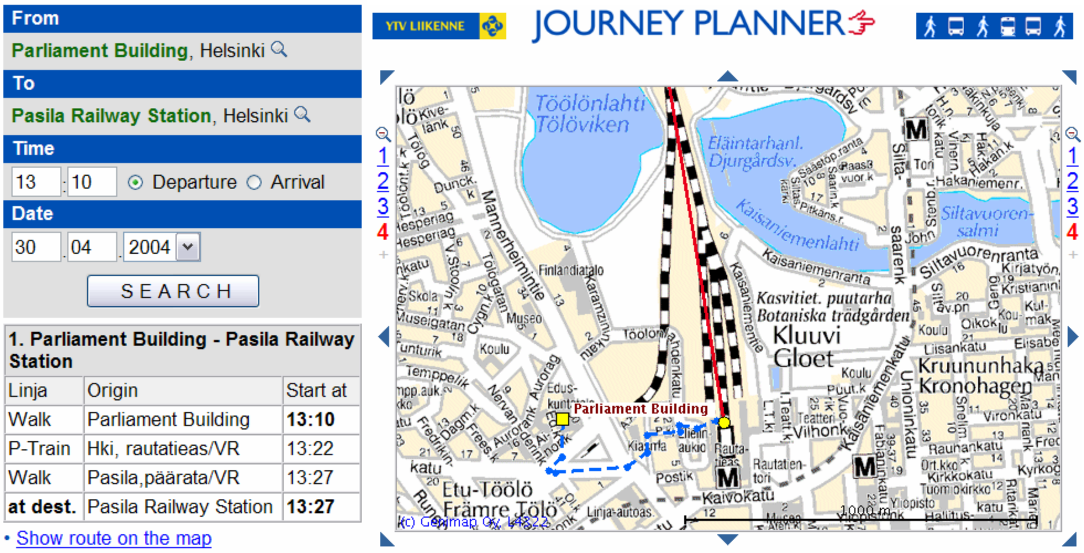

Figure 4. Example route planned by Helsinki metropolitan area journey planner [8].

PEDESTRIAN NAVIGATION

In pedestrian mode we have to navigate using mostly the same map data than in car navigation. Map data used in navigation systems today is collected for car navigation purposes. The map usually includes only street centre line, street name and class, no pavement information. Example of this can be seen in Figure 4, where walking route is marked (on) with blue dashed line. This is not adequate for pedestrians, because pedestrians use pavements, zebra crossings and footpaths. Required accuracy of the maps would be about 2-5 meters and routing should include pavements, zebra crossings and traffic lights. Result information should include coordinates and form points of the route.

Map quality is an important factor in navigation, because navigation systems can't recognize map errors without environment perception sensors. Correct route is more essential for the blind persons, because they can't see if the route proposed by the navigator is dangerous or unusable.

Positioning errors are easier, because for example GPS receiver delivers error estimate. Therefore, although we can't correct the error, we can warn the user of the operation defect. Navigation systems must always take into account that the maps are not accurate and have errors and positioning accuracy varies sporadically.

Guidance methods change according to possible inaccuracies in positioning. If the positioning accuracy is 1 m, you can give guidance to a target, which is for example 10 meters away, but not if the positioning accuracy is 100 m. Guidance in the case of low positioning accuracy is telling the big picture of the route and resembles asking for another person for guidance.

PUBLIC TRANSPORT TERMINALS

Stations and terminals are usually indoor environments, where satellite positioning is unavailable. There are several possible technologies available for indoor positioning, but none of these methods has the same standard position than GPS has for outdoors. Moreover we must be able to utilize the positioning with our terminal device. The most promising candidates for indoor positioning are wireless LAN and Bluetooth based systems [9], but positioning methods are still at early stages and not commonly accepted. Both of them need also infrastructure investments, but these investments concern all passengers. Cell phone based positioning is too coarse for navigation purposes. Cell ID based systems give usually coordinates that are not inside building's area but the coordinates of closest GSM antenna.

Besides of no feasible indoor positioning, lack of standardized indoor maps or data models is the second barrier for indoor navigation. Often there already exists a suitable guide map of the area or building. This is the case with museums, fairgrounds and airports for example. These maps need to be modified into navigational form, where it is possible to plan simple routes and search location based data.

For public transport terminals and similar areas we use Area of Interest (AOI) information. These are detailed descriptions of target locations. Proximity of the AOI is detected from position coordinates. In NOPPA project, orientation and mobility specialists made speech descriptions of two railway stations for the visually impaired. Visually impaired listen the description and produce a mental map of the terminal.

Terminals have acoustic announcement systems. Information is not available for example deaf persons. Usually announcements are generated by automatic systems, where information is already in text form. Also this information should be made available through suitable public interface. Then it would be possible to serve for example minor language groups as well as disabled persons.

PERSONAL ANNOUNCEMENTS

Personal announcements are possible to produce trough a navigation system in a station and in a vehicle. There are cases where for unknown reasons, that acoustic announcement system is turned off in a station or in a vehicle. Also there are some user groups that cannot hear or understand acoustic announcements at all.

The main idea of the personal announcements is to pick up only those announcements that have meaning for the passenger.

In a vehicle it is possible to produce personal stop announcements. From the route plan we know names, passing times and coordinates of the start and end stops and all stops between them. GPS positioning is usually available in a bus and our tests show that method works quite nicely. Another way to produce personal announcements is to request the vehicles position from an operator's real time tracking system, if available.

CONCLUSIONS

Our prototype fulfils the requirements we set at the beginning of the project. The main goal was to show that a guidance system for the visually impaired person is possible to build without laborious and expensive changes in the current infrastructure. This is possible with utilising common Internet services for passenger information and personal navigation.

Passenger information systems should be equipped with a standard Internet interface (XML). Through this interface it would be possible to deliver static information (timetables), real time information and disturbance information in such way that it is accessible to the special user groups. These interfaces are needed for example when developing mobile applications for all passengers.

Development of public transport route planners should be focused on pedestrian use, because pedestrians use public transport. Required accuracy of the maps would be about 2-5 meters and routing should include pavements, crosswalks and traffic lights. Result information should include coordinates and form points of the route.

ACKNOWLEDGEMENT

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REFERENCES

[1] Gill, J., Mobility of Blind and Elderly People Interacting with Computers. http://www.tiresias.org/reports/mobicf.htm. (27.2.2004)

[2] Garaj, V., "The Brunel Navigation System for Blind: Determination of the Appropriate Position to Mount the External GPS Antenna on the User's Body", *In Proceedings of the U.S. Institute of Navigation - GPS 2001 Technical Meeting*, Salt Lake City, Utah, USA.

[3] A. Helal, S. Moore, and B. Ramachandran, "Drishti: An Integrated Navigation System for Visually Impaired and Disabled," *Proceedings of the 5th International Symposium on Wearable Computer*, October 2001, Zurich, Switzerland

[4] http://www.senderogroup.com (27.2.2004)

[5] http://www.visuaide.com (27.2.2004)

[6] http://www.vtt.fi/tuo/53/projektit/noppa/noppaeng.htm

[7] Koskinen Sami & Virtanen Ari. Public transport real time information in Personal navigation systems for special user groups. *In Proceedings of 11th World Congress on ITS.* 18 - 24 October 2004, Nagoya, Aichi, Japan.

[8] http://www.reittiopas.fi (27.6.2204)

[9] Virtanen Ari & Koskinen Sami, Towards Seamless Navigation. *In proceedings of the MobileVenue'04.* 27-28.5.2004 Athens, Greece. 6 p.

[10] Ministry of Traffic and Communications Finland, Passenger information programme - HEILI. http://www.heili.info