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Location and navigation system for visually impaired

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Abstract

The proposed location and navigation system for visually impaired people is a portable audio-based system to help blind and visually impaired to orientate themselves and detect the place or street at which they are currently walking in the cities. The position of this person is obtained using Global Positioning System (GPS) forwarded to a PC system, which compares the positional information with its internal data containing locations of all street intersections using cartographic software. Information where the person is currently standing is presented by the synthesised speech.

Introduction

The most important sense whereby people receive information is the visual perception. For people without the benefit of sight it is hard to orientate and travel autonomously. There are two basic classical ways how blind people can get around without the help of other person and without bumping into things or not to be disorientated – they use tactile information from their white cane to keep them on the sidewalk, and their seeing-eye dog to guide and keep them safe. The location and navigation system for visually impaired (LNS), which is shaped now and presented here, can be a new way to relieve them. LNS is a device that will allow people without benefit of sight to determine where they are located in a city during their outdoor trips. LNS can accurately determine their own position and hopefully help them to get around a little easier in our visually based world.

Parts of the system

There are many technologies today which can be used for the project: a system for localisation by GPS satellites, an inside building localisation system, a mobile communication systems (GSM, UMTS), WLAN (wireless local area network), a portable computer (PC, PDA, etc.), a cartographic software, a user-friendly man-machine interface and a vocal interface.

We have decided to use in our device the following components:

Hardware components

A kernel of our device is a PC system; we have decided to use the *Mobile Assistant Cappuccino G1* from the Saint Song Corporation. This computer is a full-featured Mini-Book PC that is lightweight and compact and runs on a whole wide range of general business and personal productivity applications and is fully compatible with an entire library of PC software based on several operating systems especially Windows and Linux.

Another important device is a GPS receiver: we have worked in our project with a personal navigator Garmin eTrex. It is 150 grams, 12 channels, with a built-in GPS antenna receiver. In addition to determining our position, the eTrex can create, name and save a location (as an electronic waypoint) in its memory, allowing us to navigate back to this point any time we want. And once we start moving, the GPS provides other data, like speed, direction of movement, time and distance to the destination, and more.

We are now evaluating the interest of the association of different sensors to the GPS (an electronic compass, a pedometer, and an altimeter). All in one device includes system DRM (*Dead Reckoning Module*) from Point Research Corporation described in [2]. It provides critical position information when GPS positioning is unavailable or unreliable. Above all in the cities, GPS is not always available, because the signal may be blocked indoors or by buildings, trees, or heavy foliage. Dead reckoning can be coupled with GPS to provide continuous high-quality position estimates when travelling through these challenging environments.

For user interface there is used a headset consisting of a microphone and an earphone. We wanted to connect the headset to the PC by the technology Bluetooth. For future it is possible also to connect GPS and DRM by Bluetooth technology as well as user keyboard, which is equipped by 5 keys and should be situated at the top of the user’s white cane.

Software components

The software components view on LNS is presented in Figure 1. The user communicate with the system by the speech interface as well as by the dedicated keyboard.

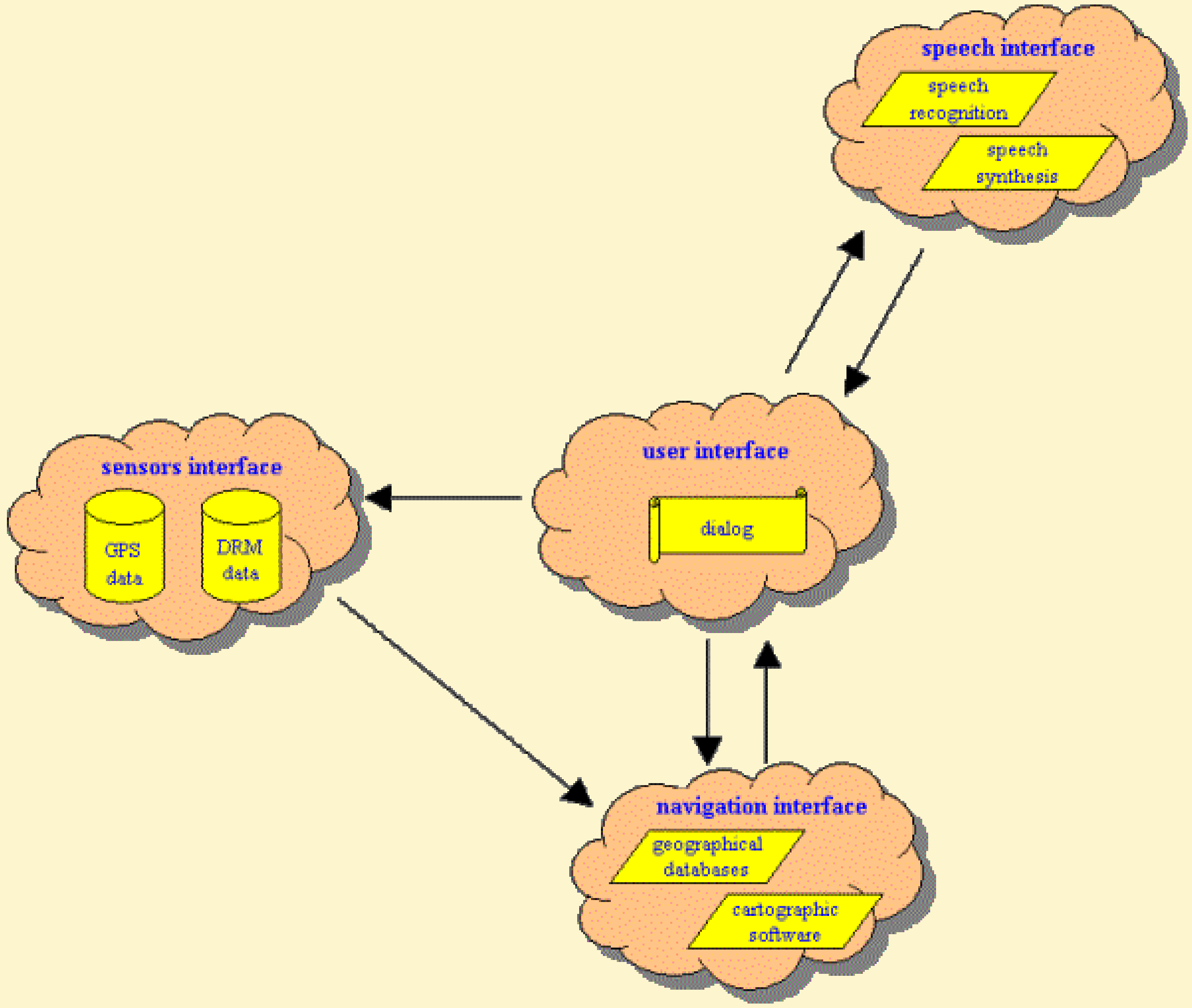

Figure 1: The location and navigation system - software view

The scattered software equipment consists of:

- Text to speech software from *ELAN speech engine*
- *IBM ViaVoice* for speech recognition
- *IGN Géoroute* - a geographical database for Paris and around Marne La Vallée
- *ArcView* - GIS (*Geographical Information System*), a software to present and exploit cartographic data
- *Network Analyst* – a software for recomputing a position

How the system works

The main task consists in mapping a location obtained from the GPS receiver to the maps databases, in another words in integrating GPS and GIS systems to work together correctly. After the asking request for the location or the description of how to go to some chosen destination, the following steps are done:

- Download data from the GPS receiver and extract from them information about current latitude and longitude.

- Transform point location from spherical coordinates to the Cartesian coordinates used in the maps.
- Set and display this point in the “map” – situate the position in the geographical database using the software ArcView.
- Get information where the person is, what is around and how to get somewhere.
- Prepare information for navigation, which should be convenient for reading by the text-to-speech machine.

Examples of the navigation

The basic message, which the user can listen at, is information about his current location. The following types of example messages can be generated:

You are on the intersection of Avenue Ampere and Boulevard Newton.

You are on Avenue Ampere near Boulevard Newton and Mail Descartes.

The nearest route Boulevard Newton is 19 meters far.

No route was found in the specified searching distance.

No point. (An error is occurred, e.g. GPS is switched off, or the signal is missing.)

Example below shows real solved "finding the best route" problem. It finds the shortest route between two points: ESIEE (2, boulevard Blaise Pascal, 93 162 Noisy le Grand) and the church Saint-Loup de Sens in Champs sur Marne. Directions report (a set of instructions on how to get from one location to another) and corresponding map (only for the illustration) are shown below.

Starting from the church.

Turn right onto rue DE LA MAIRIE.

Travel on rue DE LA MAIRIE for 30 m.

Turn right onto rue DE PARIS.

Travel on rue DE PARIS for 161 m.

Continue straight onto avenue DU GENERAL DE GAULLE.

Travel on avenue DU GENERAL DE GAULLE for 1135 m.

Turn left onto boulevard DU BOIS DE GRACE.

Travel on boulevard DU BOIS DE GRACE for 550 m.

Continue straight onto boulevard COPERNIC.

Travel on boulevard COPERNIC for

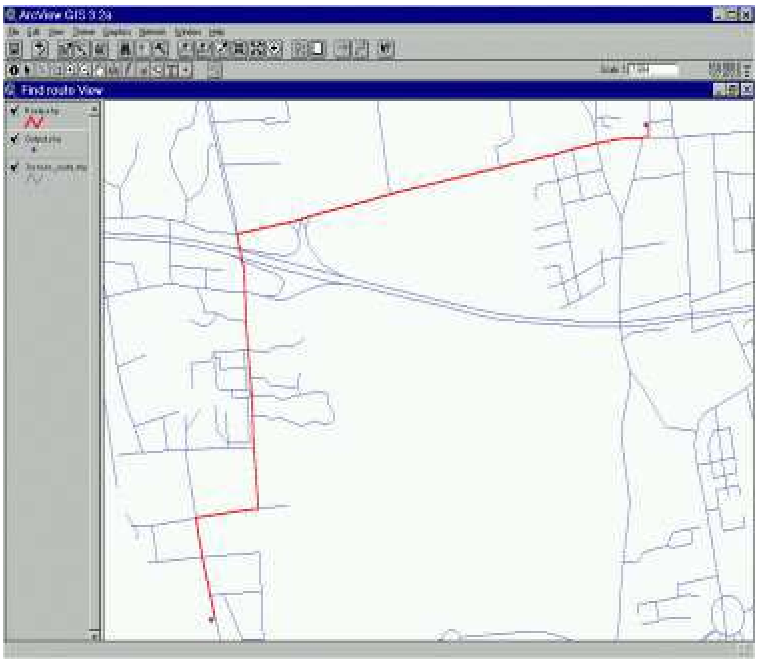

Figure 2: The best route between ESIEE and the church

158 m.

Turn left onto avenue AMPERE.

Travel on avenue AMPERE for 268 m.

Turn right into ESIEE.

Total distance travelled is 2497 m.

The third feature of the system is to find the closest facility. Closest facility refers to anything providing a certain type of service that is closest to a given location, known as an event. It can be the closest post office, the closest bus stop, the closest drug store to our house etc.

This part of the system is still under development and especially the following tasks of future development are:

- The ccuracy of the system is about 10 meters, which is caused by the precision of the GPS. 10 meters is pretty much for crossing the road on the proper side for example, so we are trying to integrate DRM to the LNS
- Think out and create a concept of saving waypoints (points were the person has already visited) to one corporate database file.
- Finish a concept of users interface on which we are cooperating with an ergonom and blind people.
- Use better databases, which contain useful information about e.g. underground and bus stations and inform the user about connections and timetables.

Conclusion

This system LNS is developing in ESIEE (*École Supérieure d'Ingénieurs en Électronique et Électrotechnique*) Paris. In June 2002 we were able to do first experiments with the system: The software was installed and verified on laptop PC connected to the GPS receiver. Whenever during a walking tour this software was able to "say" us where we are – the name of the street we were walking on and names of the nearest intersection streets. The work will continue, nevertheless this is the prototype, which should help visually impaired to orientate easier and feel a little more independently.

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