TASclient: An accessible Application for Pedestrian Navigation

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Abstract: This paper describes an application for pedestrian navigation and its implementation using JAVA J2ME CDC Personal Profile. TASclient is one part of a distributed assistance system for mobility impaired persons.[1] Based on an user profile a personalised route planning can be used to find the best path to a certain goal or to find a way around the most interesting tourist locations.[2] The application described in this paper is designed to match the requirements of peoples with different kinds of impairments while offering not only navigation details but also information about points of interest. Special attention is turned on techniques to overcome the limitations of small hand-held devices.

Key–Words: User Interface, Hand-held Devices, Usability, Mobility Impairment, Location Based Services

1 Introduction

In recent publications a lot of approaches are presented to offer navigation systems to disabled persons. But most of these systems focus on just one group of disabled people. So there are systems designed either for wheelchair users [3] [4] or for blind and visually impaired users.[5] On the other hand most of these approaches either showed accessible user interfaces for the aimed user group or they developed a route planning adapted to the user groups needs. So far only a few systems are capable of guiding a considerably large user group by fulfilling the needs of route selection as well as user interface design for people with different disabilities.

As the route planning framework used in the proposed system is explained elsewhere [2] the focus of this paper is the user interface. While accessible user interface design for desktop computers mostly applies to blind users and the use of screen readers or other text-to-speech systems and Braille displays [6], the interface of a hand-held device is even more limited. The small touch screen of nowadays pocket computers and PDAs is hard to handle even for users without limitations. The goal is to create a simple and intuitively usable interface that allows handling even if the user lacks visual or auditive sense and may be limited in his physical abilities. While covering tourism the use of maps is essential. But again the size of the display limits the recognisability for the user.[7]

Another constraint when creating user interfaces for small devices is the limited computing power of nowadays pocket computers. Even if the speed of processors increased over the years, the operating systems for this devices still lack important features in terms of multi threading, multi tasking, scheduling, multimedia synchronization as well as stability. Current releases of Microsoft's mobile operating system WinCE – Windows Mobile 2005 – showed an improved stability, but due to the scheduling it is still hard to implement non stuttering sound output while simultaneously calculating a complex graphical interface.

2 Background

The structure of nowadays society is changing more and more. For example, in Germany the number of people older than 65 years will increase from 24 percent in 2000 to 35 percent in 2030. The number of people with mobility impairments is increasing as well. Mobility impairment does not only include bodily impaired persons but for example families with small children as well. Most communities, local institutions and public organisations put a lot of effort into making their facilities barrier free.

But in a lot of cases certain constraints disallow a complete barrier free access to buildings, historical sites, transport etc. These constraints might include financial budgets, protection of historical monuments or even contradictory rules and regulations.

The *Touristisches Assistenzsystem für barrierefreien Zugang zu Urlaubs-, Freizeit- und Bildungsaktivitäten* (TAS) is a project started in 2003 to provide a different approach to gain barrier free access to tourist and educational offers. Instead of changing the infrastructure of the tourist region it shows how to bypass or avoid the barriers.

The first impression of the systems capabilities can be found at a website representing the tourist region. Besides information about accessible accommodations and facilities, the user can plan individualised hiking routes based on an user profile. This profile contains information about the users medical history, available assistance gear and personal interests. Planned routes can be stored together with the user profile.

This profile is used again when the tourist comes into the holiday region, where he can lend a handheld device equipped with a GPS receiver. This device serves as a navigation system, tourist information guide and if necessary, as a medical monitoring system. To provide the device with up-to-date information and for sending emergency calls, it is connected to the main server via a VPN connection over GPRS.

Also included in the system is a service centre, which keeps all the data about geographical features, tourist attractions and other offers up-to-date and which is also responsible for initiating medical help in case of an emergency.

The described system is a highly distributed application which has to run on several hardware platforms. Thus it arose to use a technology that is available to all the different device configurations and ensures interoperability between them. This technology of choice was JAVA with its different editions. J2EE offers a platform for enterprise server applications including web services and database system management. The J2ME CDC Personal Profile is used on small devices.

3 User Interface

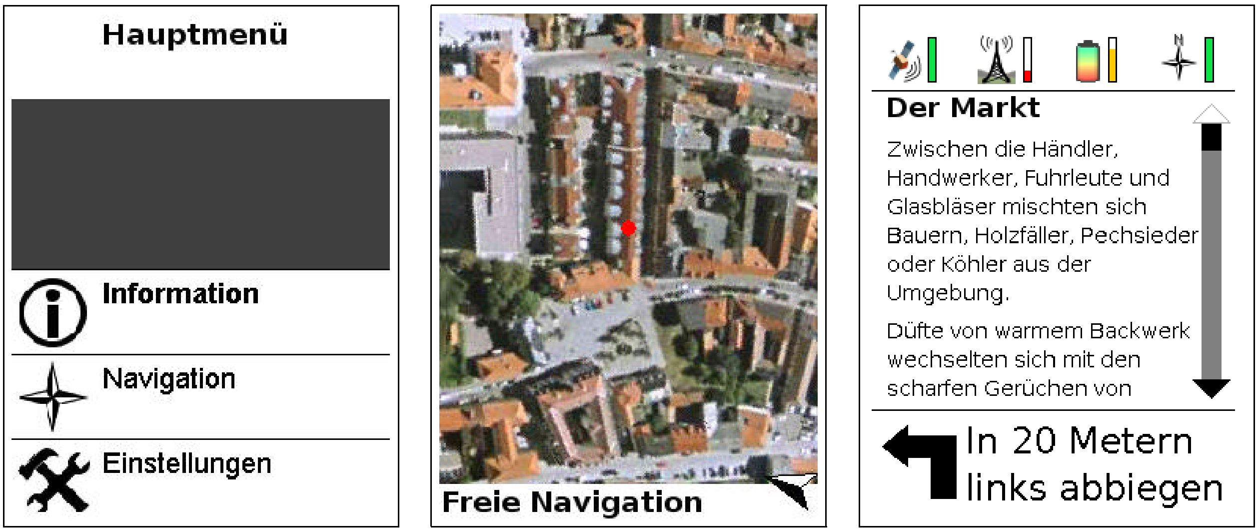
In earlier publications we presented a user interface based on a simple 3×3 matrix. This was done by splitting the PDAs touch screen in nine rather large buttons that could be used for user input.[8] Follow up user tests have shown that this interface was prone to maloperation. Many blind and visual impaired users accidentally touched the display while orienting at the corners of the device to find the correct button. Another disadvantage for blind and visual impaired users was the missing haptic behaviour of hardware buttons. But also seeing users experienced a lot of maloperations while carrying the device in their pockets. To prevent this a rather complicated screen lock had to be implemented. This on the other hand is hard to handle by users with limited tactile abilities.

Therefore another interface operation concept was implemented. Instead of certain regions of the display pictured as buttons, the navigation now is controlled by simple gestures on the touch screen. Just one of the hardware buttons of the PDA is used to switch between different views. Depending on the complexity of the devices usage a certain set of gestures can be used. Basic navigation within a tree-like menu structure, as well as navigation on a map is implemented as simple movements into four directions, controlling audio playback is done by clockwise or counter clockwise circular movements for skipping forwards or backwards, the gesture for stop and play is just pressing the touch screen for a longer time (default value is about 2 seconds).

3.1 Audio user interface

To ensure the user receives the information in a suitable way, at least two senses are used to display the feedback from the device. The audio channel always gives feedback if an user action was successful or not. This feedback does not only include reading the current menu item when navigating through the menu. It also gives auditive feedback as soon as a gesture was started by the user and again when it is properly detected by the device.

As there might be many situations where different parts of the application want to access the audio channel for output, a priority based resource handling was developed. The gesture detection described above has the highest priority, its sound output can not be interrupted by any other resource requests. It is even allowed to use the resource simultaneously while other parts of the application use the audio output. Those outputs on the other hand can only interrupt themselves and have no effect on other audio output currently playing. The priority thereunder is assigned to all navigation messages, including directions, warnings and situation descriptions. They can only be stopped by messages of their own priority. This however should be a very rare case, as the navigation messages are held as short as possible or are consolidated when landmarks are close together. The audio feed-



a) b) c)

Figure 1: Screenshots of TASclient. a) Menu view, b) Map view, c) Info view

back of the user interface itself, including the speech output of menu items, is assigned to the next priority. They can be interrupted by navigation messages or by messages of their own priority. Other than before this case occurs quite often, for instance when quickly browsing through the menu or switching between the different views of the application. If a message is interrupted by a message of its own priority it is cancelled immediately. If the interrupting message has a higher priority it is tried to play the message again until a time-out has been reached. Lowest priority is assigned to tourist guide messages, which include all additional information about tourist attractions. They are triggered by the current position and user actions. The messages can not interrupt messages of their own priority, only higher priority messages are able to do that. Tourist guide messages on the other hand never time out, they can only be stopped by user action.

3.2 Graphical user interface

While for blind users the audio interface is the main channel for feedback from the device, other users might more depend on the graphical interface. Due to the use of the touch screen, the graphic device acts as input as well as output device at the same time.

So far three different modes or views are included in the interface, all of which can be controlled by the gestures described above. The menu view offers control over all features to the user, from selecting the route to changing the look and feel of the interface. Figure 1 a) shows a possible screenshot of the menu: At the uppermost part the current menu level is depicted, the greyed out parts beneath show that the current selection is at the upper end of the menu level. The label in bold letters (information) is the currently selected menu item, the two menu items below show the following possibilities in the menu tree.

Figure 1 b) is an example of the map view. Here aerial pictures are used to show the current surroundings, but schematic maps or a mixture of both can be used as well. The map will turn orientation with the direction the user walks, a compass in the lower right corner depicts the north direction.

The last view, shown in figure 1 c) is the info view, which is only available with the tourist guide messages. It repeats the spoken text of the audio guide and augments it with pictures.

Note that all screenshots shown in figure 1 are made with default settings for font size, colour scheme and screen orientation. If necessary these and other settings can be changed by the users to fulfil the needs especially for seeing impaired users.

4 Monitoring features

When creating an assistance system for a user-group with different kinds of limitations, one has to keep in mind that the users might have a wide range of medical needs. To be able to react in a case of emergency, it is possible to transmit the current position of the device to a service centre. Therewith it is possible to send any needed help to the user. In a simple case this would be a taxi if a user reached his physical limits, but it might also be an ambulance.

But sending a manually invoked emergency call via the device is only sufficient as long as the user is still able to operate the device. For more severe cases a self-controlled emergency system is necessary. Therefore auxiliary measuring devices can be connected to the device via BlueTooth. One device in use is a chest-belt measuring pulse and electrocardiogram. In case of any abnormality it sends an event to the PDA, which in turn transmits the electrocardiogram-data to the service centre. There any further actions can be initiated.

5 Optimisation

The power consumption of the devices is a problem not solved in a sufficient way so far by just relying on operating system features. By now off-the-shelf PDAs might work only for a few hours. Complex calculations and unnecessary use of resources might drop the running time extensively. External power sources might bypass this problem but it is as well important to keep the device small and handy.

Sophisticated use of the resources, like the display, any modules connected by BlueTooth or integrated into the device like GPS, GPRS or medical sensors, help to reduce the power consumption and therefore increase the time the system can be used without external power supply.

As the J2ME JAVA edition is most commonly used on smaller devices like mobile phones together with the CLDC/MIDP profile, there is a lack of good JVM supporting CDC/Personal Profile, which is adapted to devices like PDAs. So far IBMs J9 is one of the few virtual machines for such devices. It might be due to the lesser propagation on such devices that this virtual machine lacks some optimisation.

Therefore some of this optimisation was done by overriding the functionality of the JVM, for instance when handling the images used to display maps. Just as J2SE profiles, the J2ME Personal Profile offers different colour models for images or devices. When displaying image files on a display the images colour model should be transformed into the colour model of the device. IBMs J9 works quite well as soon as the image is loaded into the memory. But as soon as you transform (i.e. rotate) the picture, the systems performance drops immediately. If you ensure, all images and devices work in the same colour model you can drop the transformation of the colour model and therewith increase the systems performance.

To lower the processor time needed for painting the map furthermore, the map is not repainted every time the system gets a new GPS position, which is usually once a second. Instead a repaint is only triggered if the change to the currently painted map exceeds a significant value, depending on the zoom level of the map.

Besides runtime optimisation some functionality not included in the J2ME Personal Profile were implemented natively in C++ using JNI JAVA Native Interface. This includes for instance sound playback or simple features as accessing the charge level of the battery.

6 Conclusion

This paper presented a mobile application for navigation of users with physical limitations. It was shown how information can be displayed in several ways to increase the usability to users lacking sensory abilities.

However this is just a small part of what is necessary to implement a serviceable navigation and assistance system to this user group. The handling of complex geographical data is another significant issue, that has to considered be as well.

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