Visualization Techniques for Personal Tasks on Mobile Computers

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Abstract

Mobile computers support users to achieve their personal goals. An important task for digital assistance is to represent a user's personal agenda. This has to be done in an intuitive way. In this paper we describe how interactive visualization can be used to reach this goal. Therefore, we describe how spatial-temporal aspects of personal tasks can be represented visually considering the limitations of mobile devices. Furthermore, the personal task management and visualization system *eGuide* is introduced.

1 Introduction

The ubiquitous digital assistance (e.g. PDAs, PalmPilots, PocketPCs, Smartphones etc.) helps users to manage and optimize activity sequences for personal tasks. However, there is a large amount of personal data a user somehow must be informed of. This has to be done in an intuitive way to make it easy for users to get all relevant information from their data.

An adequate way to display a personal agenda is the use of visualization techniques, i.e. mapping abstract data to visually perceptible representations. The capabilities of the human visual system allow the simultaneous recognition of an enormous amount of visual information. Thus, much information can be encoded in one single picture and therefore, visualization is an adequate way for representing a user's personal agenda.

In the field of mobile computing limited resources (especially limited display capabilities) of mobile devices must be taken into account. On the other hand, mobile devices can be used to collect information of the current situation (e.g. location tracking, current time, bio sensors etc.). In doing so, situation aware visualizations can be realized. Thus, the amount of data to be displayed can be reduced and rare display-space can be saved.

In this paper we describe how visualization can be used for personal task management. Section 2 addresses visualization of personal tasks under the limitations of mobile devices. Furthermore, we present a system for personal task management and visualization developed for CeBIT in section 3 and give a conclusion and a perspective on future work in the final section.

2 Personal task visualization on mobile computers

A personal task management system running on an ultra mobile device (e.g. PalmPilot or PocketPC) supports users to optimize execution of their tasks and activities by providing an interactive agenda. It needs input of user tasks, the present situation, and user preferences before an analyzing unit can calculate a schedule. Furthermore, an efficient visualization engine is needed as well. Basic techniques for visualizing personal activities can be classified as follows:

- representation of spatial aspects to visualize where activity occurs,
- representation of temporal aspects to visualize when tasks have to be performed,
- alphanumerical representations like list, text, and hierarchy views,
- representation of task priority, e.g. by varying intensity of colors of graphical objects,
- other representations.

Nowadays, personal tasks are often represented alphanumerically. Most applications only provide text views and simple list views; in few cases there is limited support for hierarchically structured data. A user has to scroll through the data to find relevant information. Thus, searching for information often takes longer than completing tasks. A few special techniques address the visualization of personal tasks on mobile computers. One example is DateLens (Benderson, Czerwinski, & Robertson, 2002). It is based on Table Lens (Rao & Card, 1994) and provides a calendar interface for representation of a schedule. The technique DateLens makes use of the Focus & Context approach (Keahey, 1998) and thus, is also eligible for large data sets. DateLens shows that adaptation of known visualization techniques is a successful way for creating lightweight visualizations for mobile computers.

Although several visualization techniques exist, they are all designed for one specific purpose only. Thus, it was our aim to integrate techniques that address temporal, spatial and personal aspects of tasks in a new visual personal task management system. An additional design goal was to create a system where all information representations are linked together.

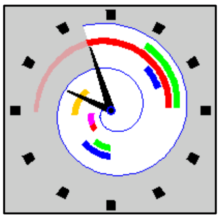

Figure 1: SpiraClock's watch hands are representing the current time. Tasks are visualized by curved shapes placed at the spiral according to their beginning and finishing time. Tasks of the current hour are at the outer cycle of the spiral; farther tasks are placed at the inner cycles. The status of task performance is represented by a change of color intensity.

One technique we found eligible for visualizing temporal aspects of personal data is SpiraClock (Dragicevic and Huo, 2002); but the support for spatial aspects is limited. Though SpiraClock is already implemented, we had to re-implement it. Our implementation of SpiraClock (see Figure 1) considers the requirements of mobile devices. Thus, graphical effects have been omitted and the interface now meets the special needs of pen-based input. Furthermore, it had to be designed as a modular component to allow an easy integration into our system. In order to realize linking, tasks are represented as curved shapes within the shape of the spiral. These task shapes are input sensitive and can be clicked to open a selection of possible links (e.g. to get further information about a task or the get a map view centered at the location where the task has to be performed).

As mentioned before, by using SpiraClock it is difficult to visualize a larger number of locations. Thus, we needed a technique to represent spatial aspects of the personal agenda. Maps are commonly used for this purpose. There are two possibilities when using maps:

- raster maps, based on raster images or
- vector maps, based on a geometrical description of locations.

The advantage of raster images is that they are easy to handle and fast to display. However, they are not as flexible to meet the requirements of a dynamic task management system. Thus, we decided to use a vector map. An eligible base for the development of a map visualization engine has been found in the Scalable Vector Graphics (SVG) specification of the World Wide Web Consortium, more exactly, in the SVG Mobile Profiles: SVG Tiny and SVG Basic (W3C, 2003). An advantage of SVG is that it is a standardized file format based on XML grammar. Thus, it is easier to acquire and integrate customer specific map content, and even the automatic generation of map content from databases is possible by using new technologies like XSLT. Furthermore, SVG content can be dynamically changed when the Document Object Model is used as internal data structure. By doing so, we can react to arbitrary changes of a user's environment by adapting the SVG data structure. This can be realized by changing attributes of SVG nodes. Furthermore, using SVG gives us the opportunity to realize transformation of the map content (e.g. for rotating the map according to a user's heading), as well as rendering the map content to different regions of the display (e.g. for realizing an overview map). Another argument for the use of SVG is that the desired linking capabilities are an essential part of the SVG specification. Since our system is intended to link all information, we implemented an SVG viewer for SVG Tiny that fulfills our special needs. Thus, we are able to display graphical map content. Additionally a linkage of graphical map objects with further object specific information can be realized by simply clicking an object.

Nevertheless, we especially had to consider the limited display space of mobile devices. Personal task data depends on resources like location and time. To give an example, one might imagine a manager at a trade fair listening to a presentation. After finishing the presentation the manager's next task will mainly depend on where he is located and the current time. Fixed dates of the manager's schedule must be considered too. Thus, our intention was to show a user relevant information only and to focus the visualization on possible next task, i.e. spatial-temporal nearby information such as presentations starting during the next minutes, booths of companies saved in the managers contact file and so forth.

We found the approach of situation awareness suitable for our needs. One important task for a situation aware application is location tracking, i.e. determining where a user is located. According to the availability of location information we differentiate between:

- continuous location tracking and
- discrete location tracking.

While continuous location tracking permanently provides a system with data about a user's coordinates in space (e.g. by calculating WLAN field strength), discrete location tracking means getting information about the location of a user at specific positions in space only.

Nearly every today's mobile computer is equipped with an IrDA sensor. Thus, we are using special IrDA beacons to realize a discrete location tracking. These beacons can be easily mounted at doors, information booths or other places of interest. The positions where the beacons are located are stored in a small database on the mobile computer. Thus, when getting a signal from a specific beacon, we know the position of the user. Furthermore, the internal clock of mobile computers provides us with current timestamps. Aware of current location and time we are able to search within an activity database for relevant information, e.g. presentations shortly starting behind a nearby door. Additionally, with the information we found, we are able to dynamically calculate a route through a user's tasks. In connection with the route a representation of the relevant information is presented. Now the capabilities of our map engine get involved. By altering the transformation matrix of the map view a zoom and pan according to the users location is realized. By adding and removing nodes of the SVG data structure relevant information becomes visible while irrelevant information is hided. Another important feature of the map engine is the intuitive representation of the personal route. Since, the route is calculated not only by considering space, but also time, we can provide a user with temporal aspects of the route as well. Therefore, we developed a color scaled route representation that can be enhanced by placing annotations at certain points of the route (see Figure 2). In doing so, users are always informed about where they have to go and when they will be at a desired location. This eases a user's personal task planning significantly. Additionally, priority of tasks and status of task performance can be visualized be changing color intensity or saturation. This can be realized again by altering attributes of nodes of the SVG data structure.

For future development the integration of further sensors is planned; new sensor technologies for location tracking have been already investigated (e.g. WLAN navigation and motion sensors). Interesting sensors might be acceleration or velocity sensors to dynamically change font size while a user is in motion, compass sensors to realize an automatic map rotation according to a user's heading and biosensors to track current personal body situation.

3 eGuide – task visualization for the CeBIT

A lot of fair guides do already exist; Fraunhofer IGD implemented the first official mobile electronic guide for the computer show CeBIT (Bieber & Giersich, 2001). The problem is that task management is missing in the known solutions and visualization techniques are rarely used. The scope of our research is dynamic personal assistance for visitors of trade shows or conventions under consideration of a users current situation integrating task management and spatial-temporal aspects of visualization. Thus, a new system called *eGuide* has been created for such in-house scenarios considering the stated aspects. To realize a platform independent system we are developing our application according to the PersonalJava™ Application Environment Specification (Sun Inc., 2000).

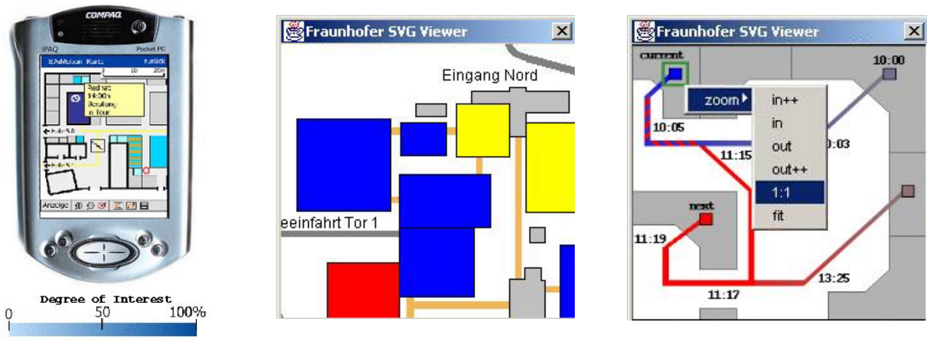

Figure 2: Map view including importance information encoded by using color intensity (left); SVG map, simple but meaningful figures of convention halls (graphical abstraction) (middle); Personal tour planning and representation using the SVG map engine (right).

Following our aim to integrate intuitive representations, the system *eGuide* provides list views, text views and hierarchical views, as well as an agenda view (e.g. SpiraClock, see Figure 1), and a map view (adapted SVG map engine, see Figure 2). An important feature of our representations is that they are all linked together. In order to realize the linking concept a user's preferences (e.g. the aim to visit specific exhibitors or to listen to certain presentations), as well as present situation of a convention (e.g. hall and booth locations, opening hours, schedule of presentations etc.) are considered. Thus, if the map shows a booth of an exhibitor the user is interested in, via click on the booth's representation a link to further information is opened. Additionally, by selecting an exhibitor form an offered list a user can be linked to detailed company information in an extra text view or to the map view, while the map is centered at the exhibitor's booth.

The intention for scheduling is to dynamically calculate a personal and individual plan (for the complete duration of a convention) and to create a visual representation of this plan a user can interact with. Since we have to find an optimized way through the different aims, tasks, and user preferences, a fast heuristic task-scheduling algorithm has been implemented. In doing so, not only a personal route through the exhibition can be calculated, but also an estimation of length and duration of the entire journey can be given. The use of color scales to represent task priority and task performance status allows a user to determine the possible next task easily. This is even increased by using the color scaled route representation.
The approach of the Fraunhofer Institute is to represent personal tasks in an intuitive way. To reach this goal, we use an iterative process of application development. Requirements for this iterative approach are the constant use of the application and it's easily adaptable software architecture; both requirements are met by *eGuide*. Within our research we plan to evaluate the results of personal activity scheduling and graphical representation at the booth of Fraunhofer at CeBIT 2003, at International Workshop on Mobile Computing (IMC, 2003) in Rostock and other related events. The user feedback enables us to realize the iterative approach and thus, to successively design a more and more user friendly and intuitive application.

4 Conclusions and future work

A convention or trade fair visitor has to perform various different tasks under the consideration of space, time, and personal preferences. We described how a system that integrates personal task management and visualization can be used to help users optimizing their tasks and thus, achieving a better navigation and support within personal schedules. We presented how a dynamic spatial-temporal representation of the personal agenda can be realized in connection with input of several sensory components. Furthermore, we described the electronic trade fair and convention guide *eGuide* and that an iterative user feedback based approach for application development can be used to create a user-friendly application.
Further research will address the improvement of the used data structures and scheduling algorithms and the enhancement of the visualization to realize an even more user-friendly application. One of our main interests is the integration of further sensory components.

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