

Visualization of Travel Itinerary Information on PDAs

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Abstract

Conventional travel itineraries list travel related information, such as flights and hotel bookings, in a chronological order of date and time. As such the only observable relationship between different activities listed on a conventional itinerary is that the activities follow one another sequentially in time. Various graphical travel itinerary visualization systems have recently been developed to allow making references between different events on an itinerary easier. These systems rely on large computer displays for visualization of itinerary information during the pre-travel planning and preparation phase, and allow access to such information using mobile phones during the actual trip when access to a computer with large display may not be possible. We have developed a system called PATI, which allows not only access but also modification of personal travel itinerary information using Personal Digital Assistant type devices. This paper describes PATI and introduces techniques used for visualization of complex itinerary information on small displays.

Keywords: Handheld computing, mobile computing, travel itinerary, PDA, visualization.

1 Introduction

Travellers often carry an itinerary of their trip which may range from a simple trip to a complicated one spanning over several weeks or months. Although the itinerary is usually created before the trip starts, it may be modified during the trip to include changes to plans, events and so on. A conventional travel itinerary is often in tabular form, and lists related travel events in a chronological order.

These tabular itineraries are generally less than satisfactory to carry, use, or modify and update. The main problem with them is that they do not always provide an overview of the relationship between various events of a trip. Perhaps the only relationship which can be viewed in a standard travel itinerary is that events follow one another chronologically in time. For instance, although it might be easy to check whether Washington is going to be visited before London, it would be difficult to find out

the arrival time in Washington based on the local time of London after a long flight from London to Washington. Information such as this is often needed by travellers when for instance they have to contact someone at a city which is in a different time-zone than the one they are currently in.

Although several graphical visualization techniques have previously been devised to represent the concept of passage of time (Plaisant, Milash, Rose, Widoff, and Shneiderman 1996), train timetables (Tufte 1983) or air travel (Tufte 1990, Pu, and Faltings 2000), most of these visualizations either do not address the issue of travel over different time-zones, or only deal with travel between two locations, without the possibility of including other intermediate locations.

A novel system has been developed to allow graphical visualization of travel itinerary information as part of a collaborative travel-planning software (Apperley, Fletcher, Rogers, and Thomson 2000). Despite the fact that this system addresses the problems associated with conventional itineraries during the planning phase, its use remains rather limited during the course of travel as it requires large screen display and access to the Internet.

As an extension to the above mentioned system, a software prototype called MATI (Masoodian, and Lane 2002) was developed to allow access to travel itinerary information using WAP-enabled (Weiss 2002) mobile phones. However, due to the limitations of the WAP technology, and that of mobile phones in terms of their input, output, and processing capabilities, MATI only provided facilities for accessing personal travel itineraries without the possibility of modifying them.

This paper describes a prototype system designed to provide means of accessing and modifying travel itinerary information using Personal Digital Assistants (PDAs). This paper also discusses the graphical itinerary visualizations which have been tailored to suit the limitations and capabilities of the PDA type devices.

2 Graphical Itinerary Visualization

A Collaborative Information Gathering (CIG) tool has previously been developed to assist travel agents with the process of creating travel itineraries with their clients collaboratively over the Internet (Apperley, Fletcher, Rogers, and Thomson 2000). The CIG software provides a graphical travel itinerary visualization for creating, viewing, and modifying travel itineraries remotely.

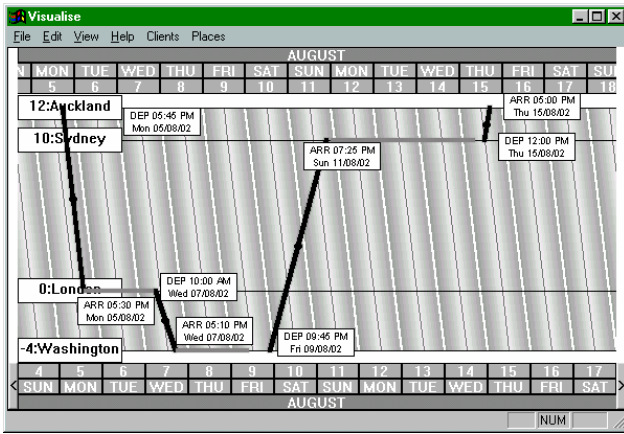


Figure 1: CIG graphical travel itinerary visualization

Figure 1 shows the CIG itinerary visualization software, depicting an example round-trip between Auckland, New Zealand, and Washington, USA, with stops in Sydney and London. The vertical axis is in time-zone units, showing the time differences between various locations which are either destinations or transit points along the way. The horizontal axis, on the other hand, shows the normal progression of time at a particular location. From this axis it is possible to see for instance how long a flight or a hotel stay is.

When a travel crosses the international dateline, the difference between days on different hemispheres is shown along the top and bottom lines of the visualization. Using these two different time scales it is possible to compare the time of various events across different time-zones. A horizontal black line depicts a stay event in a location, while the upward and downward lines show travel eastward, or westward respectively. The dark and light shaded stripes show the 12-hour night and day periods while midnights and mid-days are marked with a dark grey or a white diagonal line.

3 Mobile Phone Access to Travel Itinerary

A major limiting factor in using the CIG system is its lack of support for remote mobile access. A tool called MATI (Mobile Access to Travel Itinerary) was developed to provide access to the CIG system using WAP-enabled mobile phones (Masoodian, and Lane 2002).

MATI includes a mixture of textual and graphical visualizations. The textual visualization provides access to specific details of the events, while the graphical visualization gives an overview of the travel itinerary.

In textual view, as shown in Figure 2, MATI allows access to the list of all the destinations (2a), from which a particular destination can be selected (2b) to find out information related to that destination (2c), for instance all the hotel bookings relating to that city (2d) or details of a particular hotel (2e).

The graphical travel itinerary visualization of CIG is too complex to be displayed effectively on the small display of a typical mobile phone. It was, therefore, necessary to modify the visualization by making it less complex, while at the same time keeping its most essential features.



Figure 2: Textual visualization of MATI

The graphical visualization of MATI, which is shown in Figure 3, allows users to select different levels of zooming for viewing an itinerary (3a), which may be an overview of the entire itinerary or a specific time period (3b). The user can then access previous or next consecutive time periods (3c, 3d), or change from navigation mode to selection mode, to find and view information relating to an event (3c, 3e, 3f).

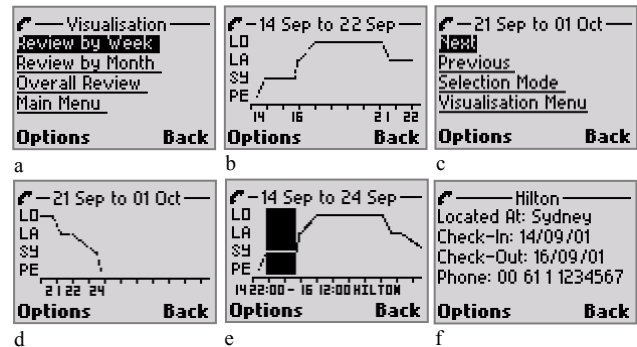


Figure 3: Graphical visualization of MATI

An empirical study was conducted to investigate the effectiveness of the graphical and textual visualizations of MATI (Masoodian, and Lane 2003). The results of this study demonstrated that the textual style generally outperforms the graphical style when each of them is used on their own. However, when both of these visualizations of MATI are used together in real-world settings, they are likely to provide the users with effective access to their itinerary information.

Although these results are certainly encouraging, and show the effectiveness of MATI in providing access to itinerary information, at present the mobile phone technology along with WAP are not very suitable for providing facilities which can be used to allow modification of itineraries remotely.

4 PDA Access to Travel Itinerary

Modern PDA devices are powerful computing tools with fast processors, good quality small-sized screens, and wireless networking capabilities through a range of mechanisms such as LAN, infrared, Bluetooth (Weiss 2002), and IEEE 802.11 (Lough, Blankenship, and Krizman 1997).

These capabilities make PDA devices ideal tools for a range of applications, particularly for mobile users such as travellers. PDAs have already been used for delivery of

context-aware information to users (Cheverst, Davies, Mitchell, Friday, and Efstratiou 2000, Marti, Pucci, and Rizzo 2001).

It was therefore decided to develop a prototype system for PDAs which would allow not only access to travel itinerary information but also provide means of modifying and updating itinerary events when changes such as flight delays, cancellations, and so on occur.

Clearly the capabilities of even the most powerful PDAs in terms of their input and output fall somewhere between those of standard desktop or laptop computers and average mobile phones. Hence it is not possible to directly translate and adapt software technology developed for PCs or mobile phones to PDAs. It is often necessary to completely redesign existing software to make them suitable for PDAs.

This process of redesign is not just concerned with graphical layout of the interface components but also includes modification of styles of interaction which are used in a standard PC environment but are less than satisfactory for PDAs. There are in fact some applications which are very useful on PCs but translate very poorly to handheld devices (Weiss 2002).

5 PATI Prototype

A prototype system called PATI (PDA Access to Travel Itinerary) was developed to allow retrieval and modification of travel itinerary information using a PDA device. PATI provides a graphical itinerary visualization, referred to as the linear visualization, which closely relates to the CIG and MATI graphical visualizations.

Figure 4 shows the interface of PATI, which is divided into two components, the main view, and the radar view. The main view which is shown in the top area of the screen is reserved for displaying a detailed view of a segment of the itinerary, while the radar view (shown in the bottom part of the screen) displays the overview of the entire itinerary.

PATI retains the basic form of the CIG visualization, with locations on the vertical axis and the time on the

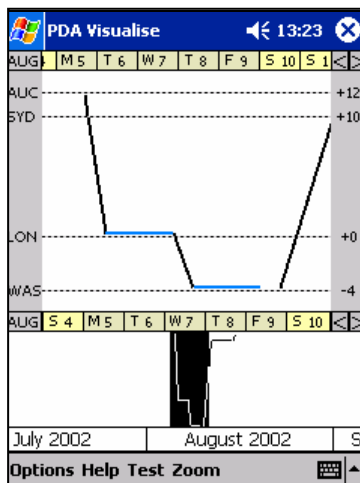


Figure 4: The main and radar view of PATI

horizontal axis. The spacing between locations on the vertical axis is calculated in the same way as in CIG, where time-zone differences are used. The order in which locations appear is also maintained. The location with the greatest Greenwich Mean Time (GMT) value is at the top, then progressively moving through intermediate locations, displaying the location with the lowest GMT value at the bottom.

Because of the restrictions of the screen size of the PDAs, the CIG visualization had to be simplified to make it more suitable for the PDAs. For instance, the city names are abbreviated and only the first three characters are shown at the left hand side of the visualization. Also, the time-zone values have been moved to the right hand side, allowing easier comparison of the local time differences.

The number of visible datelines is restricted to two, with one which corresponds to the location at the top and another one that corresponds to the location at the bottom. From these datelines the time corresponding to a position along a location line can be determined, as depicted in Figure 5.

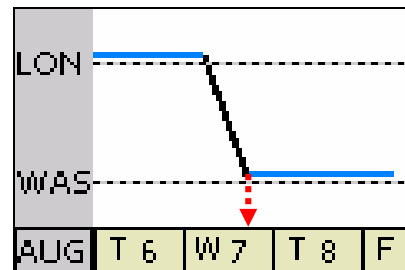


Figure 5: The flight from London arrives during the afternoon of Wednesday 7 August, Washington time

The length of the itinerary segment shown in the main view can be modified either by selecting a period from the zoom menu of PATI, or by selecting a portion of the itinerary from the radar view. The maximum length of time shown in the main view is 60 days, while the minimum is a single day. The limit is set to 60 days because if a wider view is used events that occur close together are increasingly compressed together, making the visualization of individual events impossible. The form of the datelines shown at the top and bottom of the main view change automatically as the length of the selected itinerary period is modified. Figure 6 shows three different forms of a dateline.

An important feature of the CIG visualization is its overview of the entire itinerary. However, as the screen size of a PDA is much smaller than that of a standard computer display, it is necessary to provide a simplified overview of the itinerary, from which the users can select to view smaller segments in more detail. PATI provides

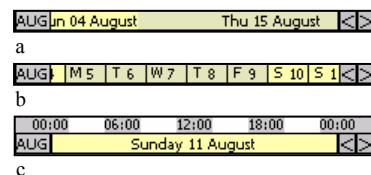


Figure 6: Dateline forms showing a segment a) greater than a week, b) a week, and c) a single day

this facility through its radar view. The black rectangular area shown in the radar view of Figure 4 corresponds to the selected region shown in the main view. The radar view can be used to change the zoom level of the main view. The users can simply swipe the stylus across a desired section to bring it into the main view.

The graphical visualization of the itinerary provides a useful overview of the entire itinerary in the radar view, or a particular segment of the itinerary in the main view. However, the users also need to be able to access the exact details of events when such information is needed. The simplest form of accessing information relating to an event is by selecting it using the stylus and then choosing to view its details from a pop-up menu (Figure 7a). This brings up an event information window showing all the details in a non-editable textual form (Figure 7b). If the user wants to modify the details of a particular event this has to be done in an edit event dialog box (Figure 8a) which can be accessed by selecting an event and then choosing to edit it (Figure 7a).

New travel events can also be added in a similar fashion by selecting the new event item from the pop-up menu (Figure 7a) and then editing the new event dialog box, shown in Figure 8b. Furthermore it is possible to draw a new event directly on the main view area and then modify its details.

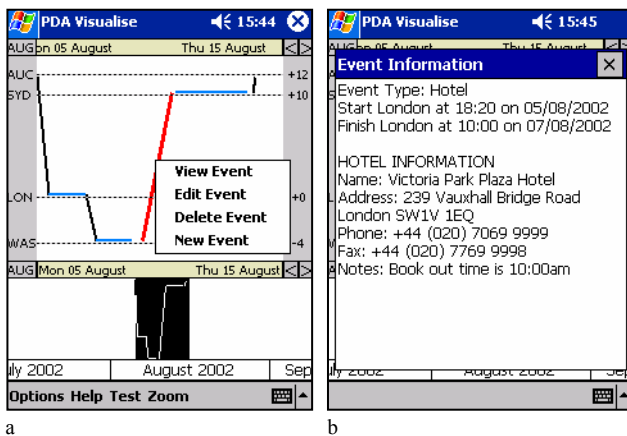


Figure 7: Selection of an event to view its details in the textual event information window

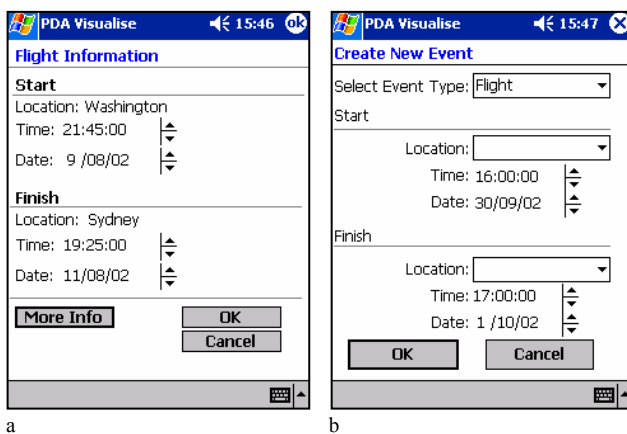


Figure 8: Dialog boxes showing editing a) an existing event, b) a new event

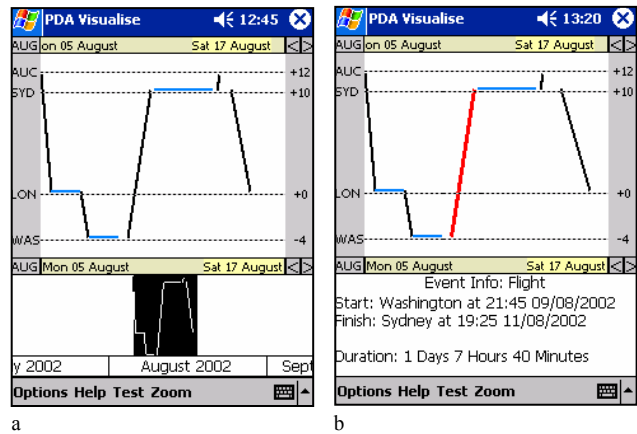


Figure 9: The main view and a) the radar view, or b) the selected event details

Another quick way of accessing the details of an event is by simply tapping on it using the stylus. This replaces the radar view with a summary of the textual information related to the selected event (Figure 9). The radar view reappears after a few second, or when the event is deselected, whichever occurs first.

6 System Architecture

The CIG software is based on client-server style architecture (Apperley, Fletcher, Rogers, and Thomson 2000) in which the components communicate with one another through a central hub (Figure 10). The system supports several different types of visualization tools, one of which is the graphical visualization described earlier. These visualization tools interact with one another by sending and receiving data in the form of 'travel events', which are single itinerary components such as a flight or hotel stay. The travel events are also stored at a central database which can be queried by the visualization tools through the central hub.

PATI consists of two main components, a small server which is a minimized version of the CIG server, and a client visualization component. In most cases where the PDA is used in a standalone mode, the visualization client

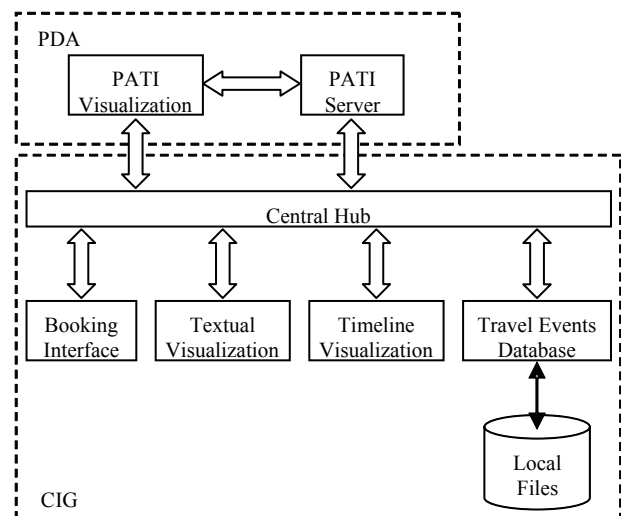


Figure 10: PATI and CIG system architecture

communicates with the minimized server that runs on the PDA. However, when the PDA is connected to the Internet either through a PC and a cradle, or some wireless technology such as Bluetooth, then the client can also interact with the main CIG server by bypassing the server on the PDA.

In keeping with the modularity of the CIG software, the PATI server was implemented as a separate program. This enables other travel itinerary tools to be easily written for the PDA. In addition, multiple clients can connect to the PATI server simultaneously. This means that any number of travel itinerary tools, such as different visualizations, can run on the same PDA and all have shared access to the travel itinerary data.

Both the CIG and PATI servers store their own travel itinerary data in a separate database. It is therefore necessary to synchronize these databases as soon as the PDA is connected to the Internet.

During the process of synchronization the PATI server communicates with the CIG system server via TCP/IP. As far as these servers are concerned there is no difference between being connected through the Internet or a local area network. Furthermore, to the CIG server, PATI server is just a temporary client.

Itineraries created by the CIG and PATI are fully compatible to allow sharing of data between the two systems. The first stage in loading an itinerary in PATI is to specify the name and port of a CIG server. Upon acceptance of these details PATI queries the server for the names of the itineraries that it has available. This leads to the second stage where the user selects which itinerary to load from the list displayed by PATI. The selected itinerary is then copied into PATI and becomes available for use.

6.1 Synchronization

To make it possible for PATI to be used on a PDA without continuous Internet connection, it was necessary to allow PATI server to store its own travel itinerary database on the PDA. However, as mentioned before, this creates two copies of the events database which can both be modified and updated independently. Therefore there is a need for synchronizing these databases whenever an Internet connection can be made.

During the synchronization process, the events on both the CIG and PATI server databases are compared. If an event is found in the CIG database that does not exist in PATI database, a prompt appears on the PDA screen asking the user whether the event should be added to the PATI itinerary or not. If on the other hand an event is found in PATI that does not exist in the CIG itinerary, a prompt appears on the PDA screen asking whether the event should be added to the CIG itinerary.

This process not only allows new events to be added to the outdated itinerary, which could be either of the CIG or PATI itineraries, but it also allows deletion of events from the outdated itinerary when no similar event can be found on the modified itinerary (because it was deleted

by the user). For instance consider the following itinerary:

1. Flight from Auckland to London
Departing Auckland at 17:45 on 5/8/2003
Arriving London at 18:10 on 5/8/2003
2. Hotel stay in London
Starting at 18:10 on 5/8/2003
Finishing at 10:00 on 7/8/2003
3. Flight from London to Washington
Departing London at 10:00 on 7/8/2003
Arriving Washington at 17:10 on 7/8/2003

Now imagine that after this itinerary has been entered into the CIG system and downloaded from there into PATI, a change is made to the flight from Auckland to London on the CIG system so that now arrives at 19:30 on the same day. The itinerary stored in PATI is still in its original state, as synchronization has not yet occurred.

When synchronization is attempted, the process will find that there is no match for the original event in PATI arriving at 18:10, and the event in the CIG system arriving at 19:30. PATI will prompt the user asking if the outdated event should be added to the CIG system (Figure 11a), effectively bringing the outdated event back which is not desired. The responsibility is put on the user to answer “no”, which in addition to not adding the event to the CIG system, removes the event from PATI. PATI will then ask if the updated event should be added to PATI (Figure 11b). Again it is up to the user to answer “yes”, adding the event to the itinerary stored in PATI and completing the synchronization process.

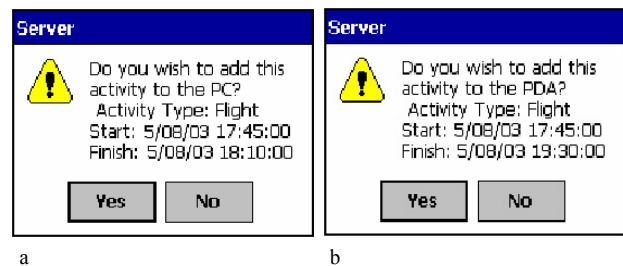


Figure 11: PATI synchronization prompts

The current synchronization process requires the user to decide how the itinerary events should be modified and updated on the CIG and PATI databases. This synchronization strategy is rather simplistic, and perhaps more intelligent automatic synchronization processes can be devised.

However, since the number of updates on an itinerary is often small and manageable by the user, an automatic synchronization mechanism has not yet been developed for PATI. Furthermore updating events manually allows the user to monitor what changes have been made to the itinerary, particularly if they have been made by the travel agent on the CIG system database.

7 Evaluation

A user study of PATI has also been conducted. During this study twelve subjects used PATI to find answers to 11 questions relating to a fictional travel itinerary of an

international trip to multiple countries. Responding to these questions required the users to interact with the interface, and interpret graphical and textual information displayed by PATI.

Although the users found PATI generally easy to use, the study identified several usability issues relating to itinerary navigation, zoom and search mechanisms provided by PATI.

Some participants had difficulty in understanding where they were currently located in the itinerary. This was either due to the fact that they were not reading the datelines or did not quite understand them fully.

Most participants preferred to move through the itinerary in a step-by-step manner, by using the onscreen arrow buttons instead of the pop-up calendar that moves the itinerary directly to a given date. This was especially noticeable in questions that required the movement to a date in the itinerary one month forward from the main section of the itinerary. This is perhaps because tapping the stylus is a very quick action, requiring little movement of the hand, particularly if the buttons that the user is clicking are next to one another. It was however evident that as users got more familiar with the system they started to use the pop-up calendar when necessary.

The users also had difficulty in selecting the best level of zoom to do certain tasks, particularly during the early stages of the study. The users initially would zoom to a level they liked and then attempt to do the activity required of them. Most of the time any zoom level was sufficient to complete an activity, but occasionally zooming in was required to be able to complete an activity. The users generally took a few minutes to get used to the radar view and utilize it effectively for selecting an appropriate zoom level for viewing the details of particular segments of the itinerary.

A few of the participants that did not fully understand the relationship between the dateline and the main section of the visualisation were not able to directly find events. These participants would frequently tap on all visible events in an effort to find the correct one. Some participants also did not recognize that events were drawn in a style that directly described their type, and therefore they would tap on the events that were different to the type of event they were searching for.

8 Conclusions

This paper has described a prototype system called PATI which can be used for accessing and modifying personal travel itinerary information using a PDA type handheld device.

A usability evaluation of this system has indicated that although the users generally found the linear visualization of PATI easy to understand and interpret, there are interface design issues which need to be addressed.

It is also important to note that even though the basic visualization of itinerary information used by the CIG, MATI, and PATI systems is essentially the same, the way users interact with each of these systems to access the

underlying textual information seems to be different. Therefore, it might be interesting to conduct a comparative user evaluation of the three systems to find out if the users' expectation of a graphical travel itinerary visualization system differs across these different types of devices, depending on the physical limitations or capabilities of the devices used.

Furthermore, our experience from developing systems for visualization of complex graphical information on PDA types devices in other application areas such as meeting content visualization (Luz, and Masoodian 2003) seems to indicate that certain user behaviour such as successive tapping on screen buttons rather than using more effective navigation methods (e.g. selecting from a dialog box or popup menu) remains consistent across different applications.

Empirical studies of PDA user behaviour are needed to identify general interaction techniques which are preferred by users regardless of the application area. It is likely that these interaction techniques are rather different from those which have been established and accepted by standard personal computer users.

Other researchers (Bederson, Czerwinski, and Robertson 2002) are also suggesting that the use of small handheld devices with pens and touch-screens, rather than personal computers with mice and keyboards, might affect usage patterns, and therefore further research is needed in this area.

9 Acknowledgments

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