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ABSTRACT

We propose a new approach for mobile visualization and interaction of temporal information by integrating support for time with today's most prevalent visualization of spatial information, the map. Our approach allows for an easy and precise selection of the time that is of interest and provides immediate feedback to the users when interacting with it. It has been developed in an evolutionary process gaining formative feedback from end users.

Categories and Subject Descriptors

H.4 [**Information Systems Applications**]: Miscellaneous

General Terms

design, human factors, experimentation

Keywords

mobile interaction, visualization, events, POIs

1. INTRODUCTION

Today, we witness an explosion of applications available for GPS-enabled mobile devices to distribute one's current location with the world and to create and share points of interests (POIs) in a community of other mobile users. Examples of such applications are Layar, Wikitude World Browser, Foursquare, and Gowalla. Besides the spatial information of POIs, some applications also support sharing of temporal information, i.e., information on the time and duration of the POIs. In the context of this work, we consider events as entities that are build from POIs by adding temporal information to it.

Only a few mobile applications consider this temporal information explicitly and provide its users, e.g., a separate screen to set temporal filters when searching for events. These applications require the users to switch to a secondary screen in order to interact with the temporal information. In this paper, we present an integrated support for mobile visualization and interaction of events and POIs. With the time slider widget, we propose a new way for visualizing and interacting with temporal information on mobile devices. We have seamlessly integrated it with today's most prevalent visualization of spatial information, the map. The time slider widget allows for an easy and precise selection of the time that is of interest and provides immediate feedback to the users when interacting with it. It can be operated with one hand only and does not require both hands like pen-based mobile interaction. Our approach has been developed in an evolutionary process, starting with an initial paper-based prototype and two running user interface prototypes on the mobile phone. During the development, we have interviewed end users and received formative feedback to improve the application. An extensive evaluation of our application with end users is ongoing work.

The mobile visualization and interaction of collaboratively created and shared events and POIs is useful in various application scenarios. It is motivated from the use cases of the WeKnowIt project (`http://www.weknowit.eu/`) on emergency response and tourism.

2. RELATED WORK

Timelines are a common and helpful means to visualize chronological data [9]. Time is typically represented using a horizontal axis whereas the vertical axis is used to display entities that are related in time. This can be found in many of today's applications such as the British History Timeline (`http://www.bbc.co.uk/history/`), the SIMILE timeline widget (`http://www.simile-widgets.org/`), the TimeZoom approach [5], and many others. The vertical axis is also often used to distinguish different levels of granularity when browsing time such as a few hours up to years and centuries. Although very effective and useful for temporal information, spatial information is not considered here.

PhotoBrowser [6] is a mobile application that visualizes clusters of photos along their timeline in a vertical manner. Hertzog and Torrens present a mobile system that represents meetings and work days of a business traveler as a vertical list [7]. While the users can browse through time, spatial information is not integrated in this visualization. Luz and Masoodian present a mobile system for the non-linear access to temporal information [8]. It allows browsing through structured multimedia recordings along specific features of the content. The visualization of the data is quite complex and it requires pen-based interaction bounding both hands of the users to the device.

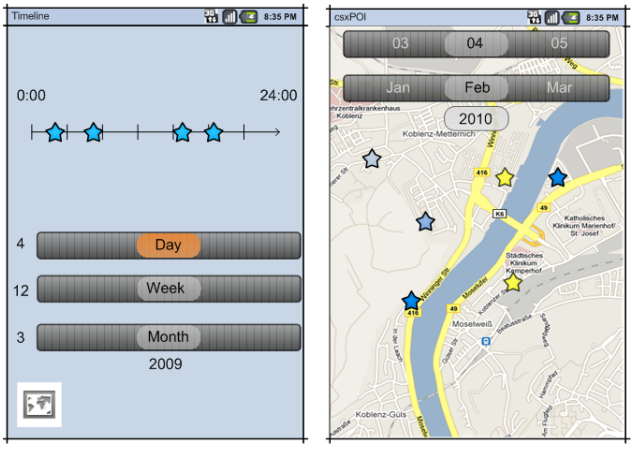
One of today's most sophisticated mobile, context-aware applications is IYOUIT [2]. It supports social relationships, location records, and weather conditions. With DBpedia Mobile [1], users can explore structured information extracted from Wikipedia. In addition, there are several other commercial applications for mobile creation and sharing of POIs such as Layar (http://layar.com), Wikitude (http://wikitude.org), Foursquare (http://foursquare.com), and Gowalla (http://gowalla.com). Although the applications allow for creating and sharing POIs, they do not explicitly support creating

and sharing events. Thus, they do not provide an integrated visualization and interaction of events and POIs. Some applications like Layar provide a separate screen for setting temporal filters when searching for POIs.

Google Earth (`http://earth.google.com/`) provides an integrated visualization and interaction of time and space. It renders a vertical timeline widget at the top of a map view and allows the users to interact with the timeline while at the same time observing changes on the map. The widget offers various parameters to browse in time, which is suitable for mouse-based interaction on a desktop computer but is too complicated for interaction on a mobile device. Finally, the mobile application developed by Church and Smyth visualizes mobile search queries and their corresponding results on a map [4]. By the use of a time slider, the users browse back to earlier queries and results. Here, the temporal and spatial information is connected with the queries of the users but is not related to when and where the entities happened that are found via the queries.

3. DESIGN

In order to provide support for sharing events and providing an integrated visualization and interaction of events and POIs, we have extended our csxPOI application for the collaborative creation and sharing of semantic POIs [3]. We have followed an evolutionary design process, starting with an initial paper-based prototype and two running user interface prototypes on a mobile phone. During the development, we have interviewed four end users of medium and high expertise and received formative feedback to improve the application. In the first paper-based prototype, we used three time slider widgets for month, week, and day as shown in Figure 1a. The time slider widgets can be turned arbitrarily to the left and right to set the current date. This design adapts the idea of the TimeZoom application [5] (and other applications) as discussed in Section 2. The time slider widgets can be operated with a single hand. However, the visualization of the temporal information of events is still separated from the spatial information.



(a) First Design (b) Second Design

Figure 1: Initial prototypes experimenting with the time slider widget

Figure 2: Browsing events and POIs with the thumb on a mobile device in the final design

Inspired by the related work that integrates the visualization of time and space into one view like Google Earth, we decided to place two time slider widgets for month and day at the top of the already existing map view of our csxPOI application as depicted in Figure 1b and implemented a working prototype. When the user touches the upper part of the application, the time slider widget appears and allows for selecting the point in time the user is interest in. The time slider widget fades out after some time such that the users have full view of the map again. Although the placement of the time slider widgets at the top of the screen is applicable for a desktop application like Google Earth, it turned out to be not useful for the mobile context. When the users interact with the time slider widgets, their thumbs obstruct the immediate visual feedback that is provided when spinning the wheels. However, providing immediate feedback is one of the essential principles when designing interactive applications. In addition, users easily slipped off a time slider widget when spinning it. For example, when spinning the upper time slider widget one accidentally often also hits the lower one.

Thus, we have finally decided to use a single time slider widget only and have placed it at the lower part of the screen as depicted in Figure 2. Here, the time slider widget is better accessible with the thumb of the users and operating the time slider widget does not obstruct the users' view onto the map. The time slider widget appears when the users tap on the screen and fades out after a while. By this innovative and simple design, we are able to provide an integrated visualization and interaction of events and POIs on a mobile device. While the users can conveniently pan and zoom the

map as usual, they can additionally browse in time using the time slider widget with their thumb.

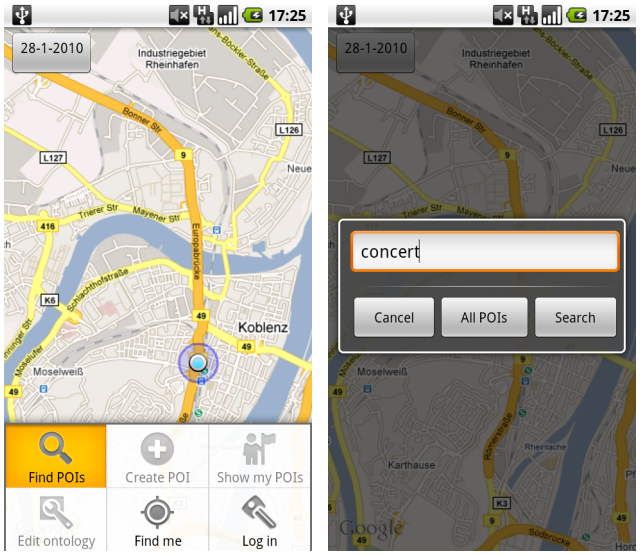
4. APPLICATION

The time slider widget and support for sharing events is an extension of our csxPOI application for the collaborative creation and sharing of POIs [3]. The csxPOI application has been developed for Android-based mobile phones. Users can create, modify, and delete POIs and events in a Wikipedia style manner. Although existing applications allow for creating and sharing POIs as well, they do not explicitly support creating and sharing events and the users are not allowed to collaborative modify or even delete other users' events and POIs. Delete operations on the events and POIs of our csxPOI application do not remove them permanently from the database but can be reverted if required. This protects the application from users who delete arbitrary data.

The menu of our csxPOI application is depicted in Figure 3a. For searching events and POIs, the users click on the menu option "Search POIs" and type in a query term as depicted in Figure 3b. We have decided to call the menu item "Search POIs" as from a user perspective events are only POIs with some additional temporal information, namely a start date and duration. All events and POIs within the current map excerpt can be retrieved by clicking on the "All POIs" button. The retrieved events and POIs are shown on the map as depicted in Figure 4a. The currently selected date is shown at the top-left corner of the screen. POIs (without temporal information) are depicted as yellow stars on the map. Their visualization does not change when spinning the time slider widget. Events are depicted as blue stars if they are within a period of 30 days beginning from the currently selected date. Those events that are close to the currently selected date are shown in dark blue whereas events farer away from the current date are depicted in an increasingly transparent manner. Events that happen at the same day are shown shaded in half blue and half red. Events that occurred before the currently selected date or after 30 days beginning from this date are not shown to the users. When the users spin the time slider widget, the visualization of the events on the map immediately changes and reflects the change in the selected date as depicted in Figure 4b. Several of the events that are shown in Figure 4a disappeared in Figure 4b whereas new ones emerged. With such an interface, the users get a feeling of how far away a certain event is with respect to the current date. They can easily browse the events and receive details on them by clicking onto the stars.

If a user wants to jump to a farer away date, he can click on the currently selected date at the top-left corner of the screen. By this, a standard date picker widget opens that allows the user to select a specific year, month, and day. A help button on the top-right of the screen opens a legend as shown in Figure 5a explaining the different kinds of stars shown on the screen.

In order to create an event or a POI, the user selects the menu option "Create POI". It opens a screen as shown in Figure 5b. First, the users type in a name for the event and POI, respectively. By checking the "with date / time" box, temporal information is added to the POI and it becomes an event. By clicking the pencil buttons next to start and end, the users select the begin and end date and time of the event. In addition, there are also shortcut buttons provided

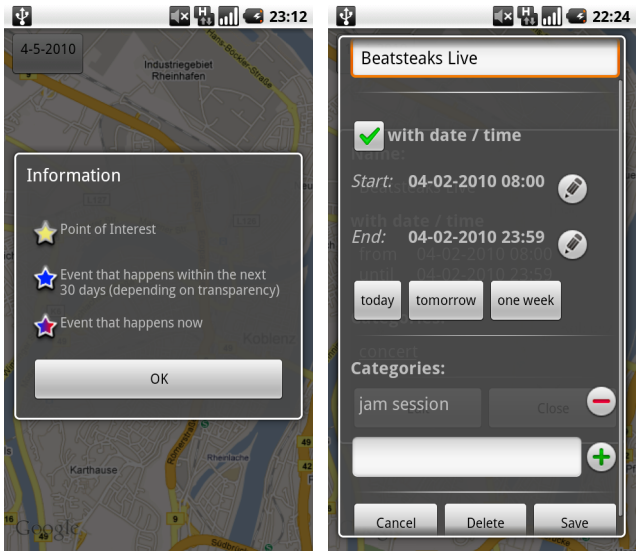


(a) Main menu (b) Search results

Figure 3: Searching for POIs and events

(a) Displaying the search results (b) Spinned the time slider widget

Figure 4: Integrated visualization and interaction of events and POIs



(a) Help screen (b) Creating an event

Figure 5: Legend and user interaction to create events

to select the current day, tomorrow, and next week. The events and POIs are annotated with semantic concepts such as jam session in Figure 5b that are taken from a collaboratively created and modifiable ontology [3]. Using semantic annotations allows to search for events and POIs through the subclass hierarchy of the collaborative ontology. For example, jam sessions can be found through the search string *concert* as a concert is a superclass of jam session.

5. CONCLUSIONS

We have presented a novel and intuitive approach for visualizing and interacting with events and POIs on a mobile phone. Our application provides an integrated map-based view of POIs with a time slider widget for browsing events. An extensive evaluation of our application in a field study is ongoing work. Videos documenting our application and the application itself is available for download from the Web: http://west.uni-koblenz.de/Research/systeme/csxPOI. It will also be made available through Google's Marketplace.

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