Marked-up Maps: exploring mixed media for group navigation and information gathering

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ABSTRACT
Mobile devices have been used as tools for navigation and geographic information retrieval with some success. However, screen size, glare, and attentional requirements of the interface are often cited as weaknesses when compared with traditional tools such as paper maps and guidebooks. In this position paper, a simple mixed media approach is presented which addresses some of these concerns and may also aid in co-located group navigation and information gathering.

Categories and Subject Descriptors
H5.2. Information interfaces and presentation (e.g., HCI): User Interfaces: Interaction Styles.

General Terms
Design, Experimentation, Human Factors.

Keywords
Mixed media interfaces, Geographic Maps, Collaboration.

1. INTRODUCTION
Information retrieval in mobile environments can utilize context such as the current location to help frame queries and present results. The use of context can also extend to the interface itself. Real world artifacts can be used to express queries either concretely (e.g. tell me about that building *there*), or abstractly (e.g. by manipulating physical objects to represent an information need) [9]. Augmented reality [2], actuators [4] and peripheral displays [7] can be used to extend the presentation of information into or onto the real world. In this paper, the use of paper maps as artifacts for mobile information retrieval is discussed, and our related research work is presented.

Paper maps are interesting real world artifacts to augment in part because they are themselves an information resource. Like books [3], we can use the information presented on a map as a launching point for queries by connecting the paper map to digital information. People already know how to use paper maps for navigation, planning and discovery. Additionally, and unlike many books, paper maps are readily used when mobile. That paper maps present static views is often advantageous, by allowing an individual to become familiar with a particular representation of a city or region, which he/she can then refer to with confidence. However, paper maps, as static views, are limited in the scope of information presented, the level of detail available, and the way in which information is presented. They also rely heavily on spatial search, which brings with it innate limitations in the perception and management of visual complexity [5].

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2. PAPER VS. ELECTRONIC MAPS
As part of a previous study, 111 individuals were asked simply whether they preferred paper or electronic maps, and to give reasons for their preference. Respondents were predominantly Computer Science students, and so might be expected to exhibit a higher than average preference for electronic maps. 65 of these respondents were given the option of saying that they "liked both equally". Of these 65, 17 stated a preference for paper maps, 22 for electronic maps, and the remaining 26 said they had no clear preference. An additional 46 respondents were forced to choose between paper or electronic maps. Of these, 24 stated a preference for paper maps, and 22 for electronic maps.

Reasons given in support for paper maps were varied. The most often cited reason was portability. While maps on a handheld or laptop are portable in some sense, they lack the ready availability of a paper map folded up and stuck between seats in an automobile, for example. Paper maps were also seen by some as providing a clearer, more accessible view that displays a wider region and is easier to study and manipulate (by rotating, folding). Others liked being able to write on paper maps, and several respondents cited the tangible nature of paper as a benefit.

Those who stated a preference for electronic maps also gave a variety of reasons. Most prevalent were that electronic maps can provide greater coverage and control over level of detail (via overlays, zoom and pan), and provide the ability to search for locations.

When respondents indicated that they had no clear preference for paper or electronic maps, they overwhelmingly indicated that paper maps were more useful when traveling, and electronic maps before or after the fact.

We have developed a mixed media prototype that recognizes the advantages of paper maps for way finding en route, but attempts to augment the maps with location-specific information accessible via a handheld computer. This approach contrasts with other

research considering the use of maps for information retrieval in public spaces involving mounted, digital map displays [7,8,9].

3. MARKED UP MAPS

In our prototype, map locations are identified using small, flat RFID labels affixed to the back of the map. Labels can be arranged in a regular grid, or used to mark specific locations of interest. An RFID reader is attached to the back of a PDA, such that locations are queried by holding the PDA display-side up in front of a map region. Details about that region appear on the PDA screen when the user presses a physical button on the device (Figure 1).

By identifying location only, we can augment the map in many ways, as with electronic maps. Our current implementation focus is to allow different categories of information to be linked to the same locations, and be accessed on user request. However, virtual overlays could be generated in a continuous, lens-like fashion on a PDA screen [1], and some seamlessness might be achieved by analyzing RFID read sequences and time intervals. Marked-up maps provide a static overview that can also be used as an aid for zooming and panning with a small screen device.

3.1 Relating back to the map

There will be times when the information presented on the handheld display becomes disassociated in the user's mind from the map. Additionally, keyword search on the handheld would retrieve information that may then need to be related to the map. Because a paper map is used, it is challenging to relate back to it. This is facilitated by requiring all retrieved information to refer back to map quadrants on the paper map. It is also possible to provide on the handheld a map view of the relevant location. It is less clear how useful this approach would be: in our experience (using both electronic and paper maps during a city scavenger hunt), it is difficult to relate a handheld map view and a larger paper map view. This may be addressed by displaying the relevant region in the same way and at the same scale as the paper map. Providing these cues in combination may allow the user to readily locate positions on the paper map.

Figure 1: A Marked up Map providing access to tourist information using the Montreal subway map.

3.2 Occluding the paper map

Our prototype retrieves information as the handheld is positioned over the relevant map position. This is a straightforward interaction, and less cumbersome than a pointer-style RFID reader and handheld combination when used in a mobile context. However, this also hides the portion of the map the user is enquiring about. A lens view mirroring the paper map below will likely address this issue, and allow for more precise geographic queries by tapping or outlining smaller map regions as shown on the handheld screen.

4. EVALUATION

4.1 Preliminary Field Trial

The prototype will undergo an iterative design and evaluative field trial while attending upcoming conferences. Maps of two cities are marked up with information relevant to ourselves as conference attendees and sightseers. By evaluating the prototype in context, we will begin to understand the nature of queries that sightseers might like to perform using a typical paper map, the impact of occluding the paper map with the handheld, and how effective cues in the retrieved information are when relating back to the relevant map position.

4.2 Exploring Group Use

While the interface permits interaction by a single user, holding a map and a PDA device at the same time may prove cumbersome when mobile. In the single user case, a stationary, wall-mounted map (such as a route map provided in a subway station) might be easier to use. We believe the interface is well suited for use by a group of people, however. When navigating a city or traveling in groups, it is normal for one person to carry a paper map, and do the majority of work with the map. Others can request a turn looking at the map, or work with the map holder by peering over his/her shoulder. At times, maps are truly shared, with each person holding a different end of the map. In a prior study, it was observed that even in this case individuals tended to shy away from regions in the other person's 'territory' (as bounded by their personal space), unless very comfortable with each other [6]. Our interface permits collaborative navigation by allowing the map holder to maintain the high level view, while others focus on regions and topics of interest.

It is hypothesized in our current research that the marked-up map serves as an overarching context from which group members can pose questions and into which they can relate their findings. In other words, the common view facilitates communication with each other as well as access to the electronic information resources.

In order to begin to examine this hypothesis, we have designed an exploratory field study. The study employs a within-groups, counterbalanced design to examine how different sets of tools impact group navigation and information gathering activities in a real-life example (sightseeing), and in particular how marked-up maps impact these activities. Small groups of three or four will conduct group navigation activities over the course of three days. Participants are new graduate students at Dalhousie University. Each day they will use a different set of tools, and each group member will record their experiences in a semi-structured diary format at the end of the day. The first condition involves the use of the marked-up paper map and two handheld computers, used as

described above. The second condition employs two handhelds only, additionally loaded with an equivalent electronic map with three levels of zoom and search functionality. The third condition uses the paper map and two paper guidebooks, containing the same information as is available in the electronic guides, and with table of contents, index, and a simple hierarchical organization based first on region then information category. In all conditions guide information will refer back to the map using quadrants and an image displaying the relevant map portion as previously described.

The participant groups will be given a brief training session with each interface prior to any sightseeing. At the end of the three days, each group will be interviewed to elicit evaluative comments and shared experiences.

5. FUTURE WORK

Results from the group study will guide future research, however we plan to explore a wider range of interaction techniques to query the space represented by the map. Many of the techniques carry over from electronic map interfaces, however each may benefit from the use of a large, tangible paper map. We are particularly interested in whether a technique is appropriate for shared and/or personal use in a mobile context. For example, swiping the length of a street could mean a request for a directory of that street. Circling a broad region could indicate a desire for an overview of that region. A route request could be made by clicking the starting point and dragging to the desired destination. Distance from the physical map could translate as the zoom level of the view provided in an overlay lens.

6. ACKNOWLEDGMENTS

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