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From Sit-Forward to Lean-Back: Using a Mobile Device to Vary Interactive Pace

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Abstract. Although *online*, handheld, mobile computers offer new possibilities in searching and retrieving information on the go, the fast-paced, "sit-forward" style of interaction may not be appropriate for all user search needs. In this paper, we explore how a handheld computer can be used to enable interactive search experiences that vary in pace from fast and immediate through to reflective and delayed. We describe a system that asynchronously combines an *offline* handheld computer and an online desktop Personal Computer, and discuss some results of an initial user evaluation.

1. Introduction

Almost all web searches are carried out while the user is sitting at a conventional, desktop Personal Computer (PC) connected to the Internet. It is likely, though, that search needs take shape away from the desktop, stimulated by activities a user is involved in, such as attending a meeting or listening to a presentation or lecture.

Mobile, handheld devices are beginning to be used to provide *online* search access. Clearly, these services will be useful, especially to meet specific, focused and urgent information needs. However, these approaches ask much of the user who has to engage in a cognitively demanding "foreground" information seeking process [13].

For some use-contexts and information needs, this burden is unhelpful and inappropriate. Sometimes search is a "background" user activity – the information need does not have to be satisfied immediately and the process of satisfying the need is not the user's main focus. For example, a seminar participant might be interested in discovering more about something mentioned by the speaker; however, if they began to search online immediately, they would quickly lose track of the rest of the talk.

In a diary-style study [4], Brown *et al* analyze the types of information people record and how they use this information subsequently. They found that participants often made notes for later use in some other task such as document preparation or as a reminder to pursue something of interest. Some of these notes will be written with the intention of using them as prompts for web searches. Brown *et al*, propose that capture tools (be they computerized or physical) should allow users to make sense of and organize their notes and to be reminded in some way to act on them.

In the light of their findings, the current paper-based approaches most people use to capture their potential queries seem inadequate. As a consequence, many such search inspirations are probably not acted upon. The bits of paper may be lost before the user gets back to their PC; they may be unable to read their own scrawling handwriting; they may not remember the significance or context of the search; or, they may simply lack the time to do, or use the results of, such "follow-up" searching, despite their best intentions

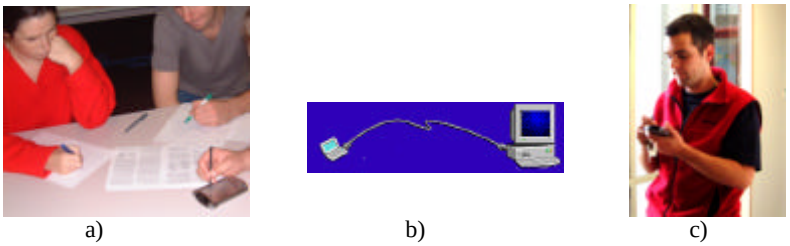
In this paper, we present a prototype system that aims to support background information seeking while still enabling more engaged, focused searching. The work explores how a mobile device can be combined asynchronously with a desktop PC to permit such shifts in the user's interactive pace.

The paper is organized as follows. In Section 2, we present the prototype set of tools we have built to further explore the notions of mobile interactive pace. This discussion includes a system description with example interactions, explanations of the range of interactive pace enabled and an initial user evaluation. In Section 3 we relate our work to other mobile developments and discuss how that work might further inform our efforts. Finally, in Section 4, we present our conclusions.

2. Background Information Seeking Tool

The tool enables users to capture background information needs *in situ* over time. It also provides them with facilities to use search results, later, in a number of ways both on the handheld and other interaction devices.

Our system asynchronously uses a mobile device in conjunction with a desktop PC. Myers and his group have successfully combined these two types of device, in synchronous ways, for other sorts of user needs such as lecture presentation and collaborative group work [16][17]. An illustration of the approach is seen in Figure 1.



a) b) c)

Figure 1: Laid-back searching in action: a) search requests recorded during a meeting (handheld is *offline*); b) when the user returns to their office, search is carried out via their desktop PC; and, c) results and associated pages are returned to the handheld for later *offline* or *online* use (results also available on desktop in several ways).

2.1 Interactive Pace and the Prototype System

Many mobile interactive applications and research prototypes run in "sit-forward" mode. That is, the user is wirelessly connected to some network, actively trying to satisfy some set of goals in a given (often short) time period, for example trying to contact work colleagues [10] or gain shopping assistance [3]. Although clearly important, "sit-forward" is not the only mode that mobile researchers should consider.

At the other end of the pace spectrum is the "lean-back" style. Here, the interactive pace is much slower, with users interacting minimally, as information – such as m-commerce advertisements or museum exhibit descriptions [7] – is "pushed" to them.

Half-way between the "sit-forward" and "lean-back" is, what could be called, the "laid-back" pace. Here, the interaction is not as fast, time pressured and transient as the "sit-forward" mode but also it is not as slow, passive or minimally engaging as "lean-back".

The prototype search tools, presented here, support all three paces and allow the user to switch between modes as appropriate. Complementing the conventional, fast-paced style with a slower, more reflective approach, may bring additional benefits. For example, online, "sit-forward" web searching is a transient activity. The searches – the queries entered and the results returned – are generally not revisited in another session. Research in the digital library community has explored the potential of making the search a longer-term process. Twidale *et al* [21], for instance, suggest allowing a user to suspend and save an online search session if a user is having difficulties in finding the information they need. The saved information would include search results and queries which could be "debugged": "..the user can then reflect at leisure on what was done, without the pressure that she may feel during an online search".

2.2 Capturing Search Terms

The user enters search terms on an offline handheld computer using a familiar note-taking interface. They can record simple keyword searches and use the "advanced search" interface to restrict the scope of the search to a particular web site *etc.* (Figure 2). The handheld application performs a check for duplicate entries and allows the complete set of queries to be viewed and edited.

The handheld, then, gives the user greater support for query noting than when they simply use paper and pen. However, as with paper and pen, the user's main focus – such as listening to a talk – is not disrupted greatly while their search need is captured.

When the handheld is reconnected to the PC, the queries are automatically sent to a search engine (in our case Google ™), either via the handheld's cradle or wirelessly using Bluetooth. For each query, the search engine returns a result set and this, along with the web pages associated with each result, are copied to the handheld. In this way, the user's searches are guaranteed to be performed, even if the user has forgotten about the notes they made, or has no time to do the searches manually.

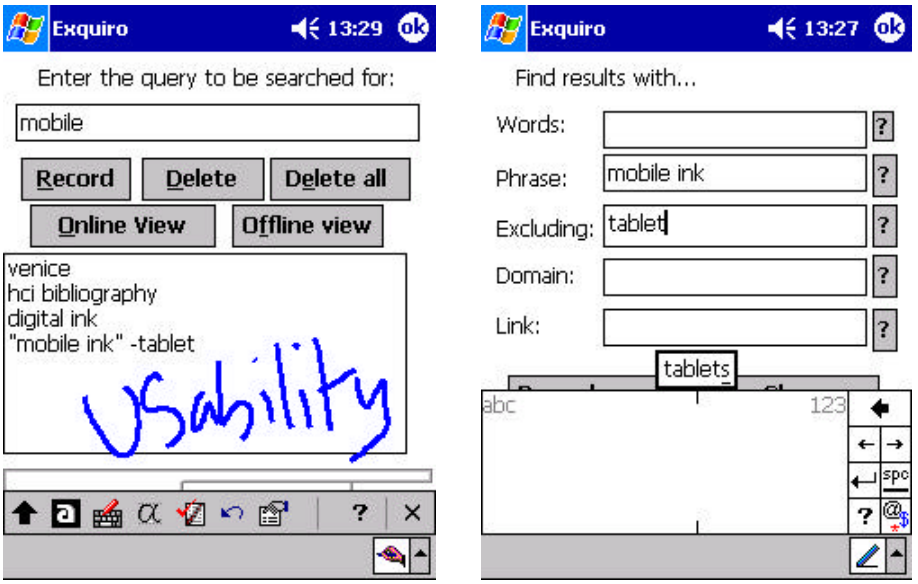


Figure 2 Handheld application for query capture. In the left-hand screenshot, the user is entering a new query ("mobile usability"), using handwriting recognition input, and a list of all previously entered queries is shown. One of the queries ("mobile ink" –tablet) was entered using the "Advanced Search" interface (see screenshot to the right).

2.3 Using the Search Results

Access on the handheld

After the search queries have been processed and the web pages copied to the handheld device, the user can browse the search results on the handheld offline. They can view a list of all the queries recorded – along with the date and time each was input – and access the downloaded result sets and associated web pages (see Figure 3). Millions of handheld users are already using asynchronous services, such as Avantgo (www.avantgo.com), to read web pages offline; our approach extends this popular activity to search.

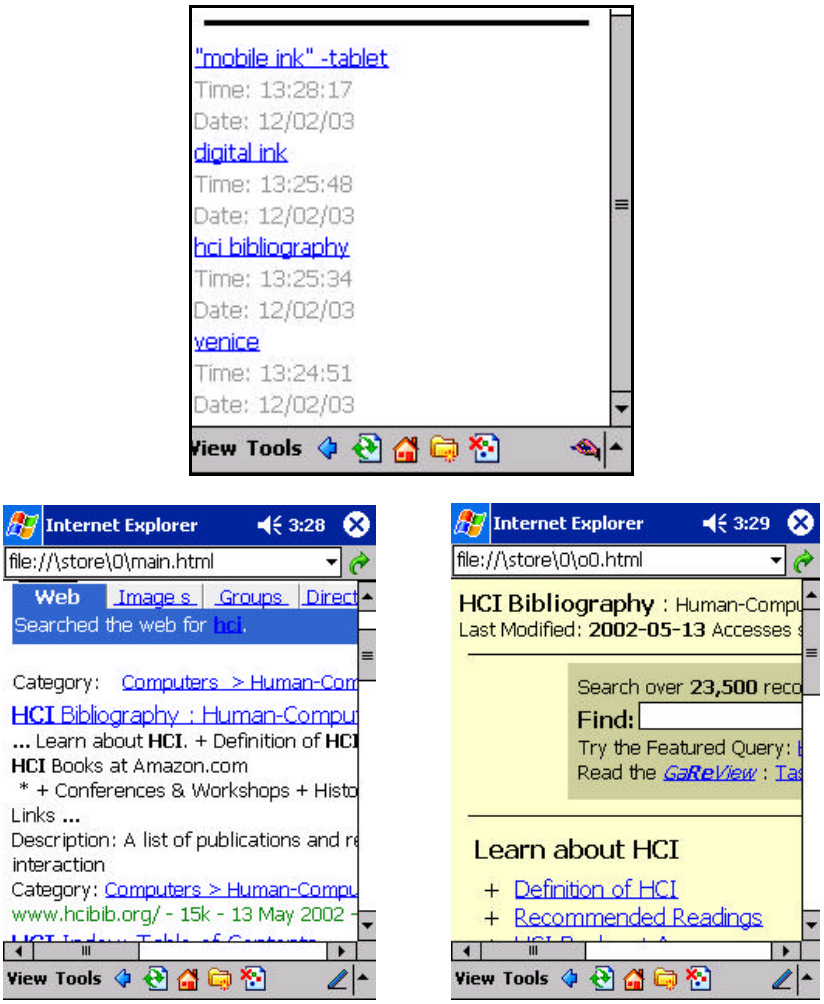


Figure 3: Viewing the search results, offline, on a handheld computer. User views a list of queries captured over time (see top screen shot). After selecting a query, e.g., "hci bibliography", a search result list is then available (see bottom left-hand screenshot). For each result, a set of web pages (to a depth specified by the user) are accessible offline: the bottom right-hand screenshot shows the top-level page for the first search engine result; clicking on further links (e.g. "Definition of HCI") will retrieve further cached pages.

Access on the desktop PC

As well as accessing queries and results on the handheld, this information is also available on the desktop PC via a custom browse/search tool (see Figure 4). This tool also allows the user to carry out further searches online, thereby interactively refining

the results of the initial, handheld captured queries (an important requirement for effective searching [18]).

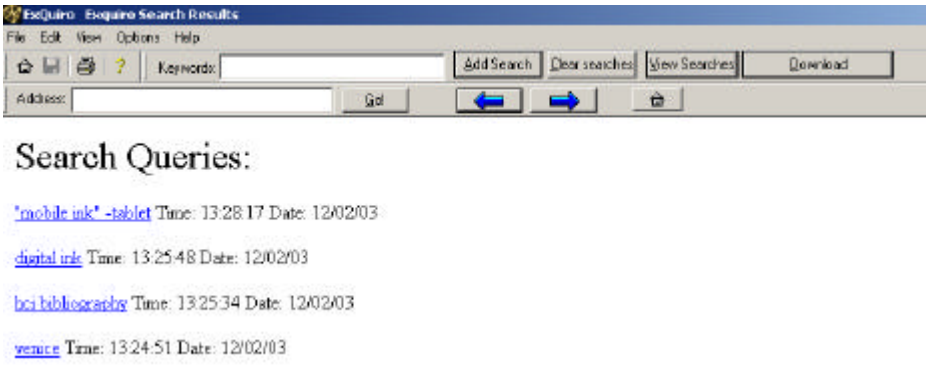


Figure 4: screenshot of desktop PC tool interface. Search queries are loaded from the handheld device when the user reconnects the mobile with the PC. User can click on search results links to view web pages online. They may also carry out additional, online searches to further explore their information needs.

To explore an alternative use of the handheld gathered queries, we are adapting the Collage Machine [14], developed by Kerne. The approach involves extracting images and key text from each search result web page. As the analysis proceeds, for each handheld captured query, a composite collage of this information is built (Figure 5). The aim is to investigate the benefits of a calmer approach to search.

Figure 5: collage created by the Collage Machine [14] given search queries captured by the handheld device. This collage is made up of images extracted from web pages that match the query terms shown in Figure 2 – for example, there are graphics from Nokia (the logo is on the "mobile hci" website), Venice tourist sites and digital ink screenshots from Microsoft.

As well as displaying the collage on a desktop PC we can also use a much larger interactive display which is the size of an office whiteboard (Figure 6) [1].

Figure 6: the Waikato Large Interactive Display System (LIDS). This large screen technology is being used to display handheld query search results as a collage.

Google™ has recently begun to offer a search result "viewer"[1]: this displays results for a *single* query as a continuously scrolling slide show (Figure 7). The user can "lean-back" and watch as the results are automatically presented. We are investigating how *sets* of search queries captured by the handheld, over time, could be presented using this sort of viewer to further provide a "relaxed" form of information discovery.

Figure 7: the Google™ Slideshow interface. Results for a query (in this case "mobile HCI") are automatically scrolled in the top pane; with a preview of the page relating to the result visible in the lower pane. The user can control the pace of scrolling and intervene to skip through results or stop the process.

2.4 Review of the Interactive Paces Supported

Having illustrated the use of the tool in some detail, we step back to consider how the spectrum of interactive pace, outlined earlier, is supported by the tool.

[1] http://labs.google.com/gviewer.html

Sit-Forward Search:

- When using the PC tool, users can carry out conventional, sit-forward, iterative, online searches to further refine the search results arising from the handheld capture.
- While accessing the offline results on the handheld, the user can, at anytime, connect to the web and begin iteratively and interactively searching.
- While passively viewing the Collage or SlideShow, the user can interrupt, selecting an item for interactive browsing.

Lean-back Search:

- When using Google SlideShow and Collage machine presentations, the user operates in "lean-back" mode – they can gaze, passively, as the results are scrolled or collaged. If something of interest is spotted, they can select the item and further browse or search interactively, moving the pace towards "sit-forward".

Laid-back Search:

- When the user is capturing queries on the handheld, the aim is to provide a way for them to actively formulate a request without distracting them from the actual tasks – such as attending a seminar – they are engaged in.
- When browsing the cached, offline search results on the handheld.
- Both via the handheld and the desktop tool, the user also gets integrated access to all their search requests (possibly generated over a day or more) and associated results. The system, then, provides a level of persistence that is often missing in the web search process.
- Czerwinksi and Horvitz [8] find that users have difficulty in recalling and resuming previously suspended computer-based tasks. From their work they suggest the need for automated reminder tools that will help users re-focus on their important computing events. Our system provides such a support for search type tasks.

2.5 Initial User Evaluation

Three experienced handheld computer users were given the prototype system for a two-week initial user study. We asked them to record observations about the system each day in a diary. At the end of the trial, we interviewed each user individually.

An analysis of their diaries and the interview transcripts showed that the subjects used the handheld system in a range of contexts: e.g., while watching television; during meetings; while on the telephone; and, at their desk when planning their daily

tasks. Although they all noted the potential benefits of the system, they also encountered some interesting problems:

- the users saw their handheld device as a medium to make "rough" notes. For example, they said they paid less attention to spelling when they used their device. For the search application, such "inaccuracies" caused problems.
- All three users regularly used other handheld applications like the notepad during meetings. They indicated a preference for a search capture tool that integrated better with these other applications. The XLibris digital library appliance [19] illustrates a possible approach. It is a handheld device that enables users to read and manipulate documents. Readers can highlight terms and make annotations. The system generates hypertext links to related documents based on these user interactions.
- In common with many other systems, they also reported frustrations in trying to read web pages designed for the large screen on the handheld device [11].

3. Related research and future directions

Having motivated and outlined the new scheme, we review other mobile research and show how we might integrate the findings into our approach.

3.1 Adapting search presentations for mobile access

Much of the HCI research work related to our scheme has addressed the problem of adapting online search interfaces to the small screen.

Users of online search services on small screens find it difficult to cope with the large number of potentially useful results returned to their handheld device [13]. A number of approaches have been suggested to overcome this sort of problem.

The PowerBrowser [6] leads the user through a filtering process: with each new search keyword entered, the user is shown the number of pages in the Web site that contain the term(s). Individual page details are only shown when the user feels the number of pages in the retrieval set is small enough to deal with on the small space of the screen. The danger, of course, is that relevant and important pages may be overlooked while the user focuses on reducing the number of pages retrieved.

WebTwig [12] attempts to reduce a user's feeling of information overload by applying an outline view to search results: instead of showing each Web page result, the system groups them into higher level categories. The user can expand and contract the view to see more or less detail (in a similar way to the familiar folder-file presentations seen on desktop interfaces).

Our prototype does not adapt search results or associated web pages, yet. However we plan to present overviews of search result sets and the pages. We will extend existing schemes to deal with multiple search result sets relating to queries carried out over an extended period of time. However, it should be noted that as our system

integrates with a desktop machine, the user at least has a seamless way of reviewing their searches on a large screen.

3.2 Context aware searching

Another set of refinements involves adaptive search engines that personalize results [5]. Use of context information about the location of a mobile device is also seen as important in providing richly appropriate assistance to users [9].

A handheld computer is a very "personal" device. They have applications to enter notes, to-do lists and memos. We plan to explore the use of such context and data to enhance the search – for example, if a user enters a search query "experimental methods" during a lecture on CHI (as noted as an event in their handheld computer diary) the system might suggest a search term of "CHI experimental methods".

As well as carrying out "explicit" search term capture, we will look at ways of automatically extracting potential searches from the data held in the handheld and thereby provide an implicit search mechanism as seen in the Xlibris system [19].

3.3 Mobile assistants

Most researchers in mobile search interaction have addressed online exploration of web content. Aridor *et al* [2], though, tackle the overload problem with a "focused search" approach that combines both online and offline access. Users define a number of "knowledge-agent bases" for topics of interest. A conventional PC system then attempts, over time, to learn more about that topic and extracts related Web pages that are transferred to the handheld computer. These sets of information can be searched offline and the key pages can be viewed in full; less relevant pages can be accessed if the user has a wireless connection to the Web.

The approach exemplifies what could be described as a "lean-back" search scheme – the user is much less active than both the conventional (online) "sit-forward" approach and our laid-back approach. Our system is a support tool to explore embedding Web search into everyday activities; their approach is more of an intelligent assistant that pushes potentially useful information to the user.

Aridor's system compiles and aggregates information for the user. In contrast, in our scheme, search results are processed in a minimal way; we will look at providing facilities for the system to analyse sets of results to provide more useful groupings. For example, a clustering approach could be applied to the results produced by all the individual search requests entered over time and pages regrouped in terms of topics.

3.4 Embedding search into everyday life

Other researchers have looked at linking physical contexts, while mobile, with later online information access. The InfoPoint [15], for instance, is a hand-held device that

allows users to capture information from objects tagged with a visual code. One of the applications discussed by the researchers is a conference aid that allows users to grab web URLs from research posters. On return from the conference, the data is transferred from the InfoPoint and the associated information viewed on a Web browser. This is clearly another "laid-back" search mechanism.

4. Conclusions

In this paper we have challenged the notion of the fully connected "eager" mobile computer user whom many mobile HCI researchers focus on. We wish to put forward the notion that this type of interaction is not always appropriate and that mobile users have a range of tasks with varying degrees of urgency. The design goal for our system was to present a tool which supports a variety of urgencies (sit-forward, laid-back & lean-back) for a common task (searching). Our hope is that other interaction designers will not become lured into supporting only sit-forward tasks, simply because the technology now allows it, but will remember that being laid-back is also a noble goal.

Acknowledgements

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