A Collaborative Environment for Enhanced Information Access on Small-Form-Factor Devices

Zhigang Hua[1], Yutaka Kidawara[2], Hanqing Lu[1], Katsumi Tanaka[2]

[1]Institute of Automation
Chinese Academy of Sciences
No.95 East Road, Zhong-Guancun
Beijing, 100080, China

[2]National Institute of Information and
Communications Technology
3-5 Hikaridai, Seikacho, Sorakugun
Kyoto, Japan

zghua@nlpr.ia.ac.cn, luhq@nlpr.ia.ac.cn kidawara@nict.go.jp, tanaka@dl.kuis.kyotou.ac.jp

ABSTRACT
This paper proposes to establish a collaborative environment to achieve enhanced information access on the small-form-factor devices. We designed a distributed user interface that crosses devices to cooperatively present information adaptable to the small displays. Moreover, we apply our system to the common documents and web pages that are ubiquitous media contents on mobile devices.

Categories and Subject Descriptors
H.4.3 [**Communications Applications**] Information browsers

Keywords
Information access, collaborative computing environment, small form factors

1. INTRODUCTION
As mobile devices such as Personal Digital Assistant (PDA), Internet-capable phones, and consumer appliances continue to flourish, it becomes a significant challenge to provide more tailored and adaptable services for this diverse group. To make people really enjoy the ease of information access and manipulation on the small-form-factor mobile devices, there exist many hurdles to be crossed [3]. Among them, major crucial challenges include the limited accessing bandwidth and display sizes of mobile devices. Thanks to the galloping development of both hardware and software, the bandwidth condition is expected to be greatly improved in the near future. However, in the foreseeable future, the display, i.e. the form factor, will continue to be the major constraint on the small mobile devices such as cell-phones and handheld PCs. In this paper, we focus on facilitating information access on small devices.

Generally, current applications or documents are mainly designed with desktop computers in mind. When browsing the documents through these mobile devices with small display areas, users' experiences will be greatly degraded. However, as users acquire or gain access to an increasingly diverse range of portable devices, the display area will not be limited to a single device any more, but extended to the display areas on all available devices [2]. When the user's experience is enhanced by the cooperative work of multiple devices then interaction will uniformly transacted among a set of devices.

MobileHCI'05, September 19?2, 2005, Salzburg, Austria.
ACM 1-59593-089-2/05/0009.

Based on the beneficial evidence that cooperative browsing can increase users' experiences, we propose a collaborative system for cooperative sharing and browsing among different devices. By utilizing the cooperation of multiple displays, we set out to overcome the display constraint that is limited in a single device. Such a novel scheme is characterized as: 1) a communication mechanism to maintain cooperative browsing across devices; and 2) distributed user interface across devices to cooperatively present information.

2. RELATED WORKS
To let people really enjoy the ease from information browsing on small-form-factor devices, there is a crucial need to develop effective and efficient methods for mobile users. As shown in Fig. 1, the original Yahoo! page (a) is too large to display on a Pocket PC device with a 240x320 display resolution (b).

Many studies have been carried out to improve web content readability on small displays. Su et al [4] has proposed a method to present a thumbnail view for web content (e.g. Fig. 1 c). Although this display style helps users easily access a page overview, the panning and scrolling interactions are still largely required in the browsing course and are also difficult to be done on these small devices. Many methods have been proposed for adapting various media on small display areas. In Chen's work [1], a novel approach is devised to adapt large web pages for tailored display on mobile device, where a page is organized into a two level hierarchy with a thumbnail representation at the top level for providing a global view and index to a set of sub-pages at the bottom level for detail information.

However, these methods have not considered to utilize the available multiple display areas in various devices to help information browsing. This paper proposes to construct a collaborative environment to facilitate information access in a pervasive environment.

Figure 1. The original display (b) and the thumbnail display (c) of the Yahoo! page (a) on a small-screen PocketPC.

3. SYSTEM DESIGN

In our system, we designed a distributed cross-device interface to cooperatively present information access for mobile users.

3.1 Collaborative Information Access

We construct the distributed UI by uniting the multiple displays on the available devices to overcome the display constraint on a single small device. In the collaborative environment, we design a browsing scheme that enables information to be cooperatively browsed across various devices. The basic idea is to analyze the content structure of the information and segment into a series of sub-sized content blocks, and then deliver the content blocks to various devices for collaborative presentation.

After getting content blocks that can fit into small displays, it is necessary for us to adopt a well-built interface to display them among the available mobile devices. There exist various styles to represent these tailored blocks on small screens. In Chen's work [1], two various methods are identified, namely single-subject splitting and multi-subject splitting. Single-subject splitting is suitable for a web page which contains the content of a particular topic, such as a news story in the BBC news site. Multi-subject splitting is more appropriate for the homepage of a web site. Our system adopts the multi-subject splitting. In this case, a page is organized into a two level hierarchy. A thumbnail representation at the top level provides a global view and index to tailored blocks at the bottom level for detailed content.

Thus, we adopted a two-level representation pattern to present the segmented information: 1) presenting on the operated device an index view on the top level with each index pointing to detailed content portion; and 2) a click in each index leads to automatic display updates of the corresponding detailed content on the other devices. We believe such an approach can help users browse documents on small devices easily. For example, users can easily access the interesting content portions without many scrolling operations except for a click on the index view.

3.2 USAGE SCENARIOS

We apply our system to several kinds of documents that are ubiquitous in mobile devices, including text document (e.g. PDF, MSDOC, PPT) and web page.

3.2.1 Collaborative Browsing of Documents

Document readability is greatly degraded due to the small display areas on current mobile devices. Commonly, users have to continually scroll through the content to browse each portion detailedly. In this case, we believe our solution is capable of solving this problem: 1) partitioning a document into a series of content sections according to the paragraph or passage info; 2) extracting a summarization description from each portion using a title or sub-title (summarization instead if no titles); and 3) generating an index view for the document and each index points to the detailed content portion in a large document. Figure 2 (a) and (b) show an example for our solution, where an MSWord document is represented through its outline index, and a click on the phone (a) leads to the display of detailed content on the PocketPC device (b). The design for slides is really useful in practice (e.g. report, presentation, etc).

For instance, the speaker of a presentation often move around to keep close with audiences, it's necessary to design a mechanism to facilitate the interaction with his slides when moving around.

Figure 2. Examples for the collaborative information access

Thus, we present the indexed view on a small device such as a phone which can be taken by users, and the interaction with this phone will automatically generate the corresponding display updates in the main screen in which the slides is presented.

3.2.2 Collaborative Browsing of Web Pages

Due to the pervasive wireless access, it's common case that users visit Web pages through these devices. However, Web pages are mostly designed for desktop computers, and the small display areas in mobile devices are consequently too small to display them. We apply our system to generate a cooperative way for a tailored view of large web pages on mobile devices.

Different from other documents, web pages include explicit content structure. There exist studies on page segmentation to partition web pages into a set of tailored blocks. Here, we adopt the methods by [1], in which each page is represented through an indexed thumbnail with multiple segments and each of them points to a detailed content unit. Figure 2 (c) and (d) shows an example for this case. A click in the index thumbnail on the PDA device (c) will lead to a detailed content display on the PocketPC device (d). Moreover, we deliver the detailed content blocks to various devices according to a simple principle, that is, match the block size and the display area. As a result, a selected detailed content block is displayed on a suitable display area.

4. CONCLUSIONS

This paper described a novel collaborative environment to facilitate information access for mobile users. We construct a communication mechanism to maintain cooperative browsing across devices. We apply the system to the documents and web pages ubiquitously available on mobile devices. In future work, we will devise more advanced distributed interfaces to facilitate users' information browsing tasks across various devices.

5. REFERENCES

[1] Y. Chen, W.Y. Ma and H.J. Zhang, Detecting Web Page Structure for Adaptive Viewing on Small Form Factor Devices, *Proc. of the twelfth International World Wide Web Conference*, May, 2003, Budapest, Hungary.

[2] A. Coles, E. Deliot and T. Melamed. (2003). A Framework for Coordinated Multi-Modal Browsing with Multiple Clients. *Proc. of the 13th International Conference on World Wide Web*, Budapest, Hungary.

[3] W.Y. Ma, I. Bedner, G. Chang, etc. A framework for adaptive content delivery in heterogeneous network environments. MMCN 2000, Jan. 2000, San Jose, USA.

[4] N. M. Su, Yutaka Sakane, M. Tsukamoto and S. Nishio. (2002). "Rajicon: Remote PC GUI Operations via Constricted Mobile Interfaces". The 8th Annual International Conference on Mobile Computing and Networking, Atlanta, USA.