# Content Analysis Techniques to Ease Browsing with Handhelds

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## ABSTRACT

The Web is primarily designed for browsing with personal computers with large screens capable of fitting the content of most Web pages. On the contrary, browsing with handhelds, such as small-screen PDA's or cell phones, usually involves a lot of horizontal and vertical scrolling. The problem is worse when one is interested in Web transactions (e.g. buying books, paying utility bills), which typically involve a number of steps spanning several pages. Thus, browsing becomes time-consuming, strenuous, and causes significant information overload. But usually one needs only a small fragment of a Web page to perform a browsing task. We exploit this observation and alleviate the information overload by analyzing the content of Web pages and succinctly presenting the information to the users. In this paper, we briefly describe some of our content analysis techniques that ease browsing for mobile users. We also mention possible directions of future research.

## 1. INTRODUCTION

Browsing Web pages has become an essential part of our lives. With the expansion of wireless Internet, handhelds (e.g. cell phones and PDAs) are gaining popularity in Web browsing applications. Using personal computers with big screens, users can quickly scan through the rich engaging content of Web pages scripted for e-commerce and locate the objects of interest quite easily. Unfortunately, a major limitation of most mobile devices is their small screens unable to convey the richness of the Web content. Small displays offer narrow interaction bandwidths making it cumbersome and tedious to get to the pertinent content in a page. Depending on the design and layout of Web pages, they often do not fit on small screens, requiring intensive horizontal and vertical scrolling. This problem is further exacerbated when Web browsing spans several pages as in online transactions, e.g. shopping, registrations, bill payments, etc. In particular, the loss of spatially organized content makes it difficult for users to comprehend the sequence of transactional steps. While content summarization can somewhat compensate for this loss, it alone is inadequate for alleviating the information overload experienced by the users.

Thus, there is a need for developing techniques to improve Web browsing experience of mobile users. In this paper, we address this issue and discuss our solutions. We describe our prototype systems, Guide-O-Mobile [5] and CMo [1], that reduce information overload in Web browsing on handhelds. Guide-O-Mobile [5] uses an automata based process model and an ontology to deliver the relevant fragment of the Web page at each step of a Web transaction. CMo [1], uses the notion of context to identify and present the most relevant information to the mobile users, while preserving the richness of Web content. It segments Web pages into semantic clusters of information and allows its users access and easily navigate between these segments, starting with the most relevant segment and loading them on demand, one at a time. The paper also briefly describes our ongoing work on building a context-directed Web transactional system for mobile users and merchant-side process modeling for model-directed Web transactions on handheld.

The rest of the paper is organized as follows. The next section describes our content analysis techniques to ease browsing on handhelds. Section 3 discusses related works and we conclude the paper in section 4.

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## 2. APPROACH

Our approach is based on content analysis of Web pages. We observe that semantically related items exhibit spatial locality in Web pages [7] and share similar geometric alignment. Using this observation, we have developed a geometric Web page segmentation algorithm [1]. This algorithm identifies semantic blocks on a Web page. These semantic blocks are used by subsequent content analysis techniques (e.g. context analysis) which are described below.

### 2.1 Model-directed Web Transaction

We have developed a model-directed Web transactional system for handhelds [5]. We capture the two aspects of a transaction, namely its operation sequence and content identification by a process model and an ontology respectively. The ontology describes the set of semantic concepts occurring in Web pages, which are considered essential for conducting Web transactions in a particular domain. The automata-based process model succinctly captures the transactional steps delivering only the "relevant" page fragments at each step. We have realized this model by coupling techniques from content analysis of Web documents, automata learning, and statistical classification. The process model and the associated techniques have been incorporated into Guide-O-Mobile, a prototype system that facilitates online transactions with limited display size mobile device [5]. The prototype uses client-side process modeling technique, where

the Web page, loaded on the client browser, does not contain any information about the process model, which is learned and stored in client side. Next we describe our approach of merchant-side process modeling of Web transactions.

## 2.2 Merchant-Side Web Transaction

We are developing a Web transactional model for handhelds where content providers will label Web content with semantic annotations, allowing lightweight semantic inference that requires little processing. They will define their own elements, attributes, and content models that can be embedded within XHTML documents. Thus, content providers can easily use XHTML to label relevant content in their Web sites and describe process models specific to their sites. Then, mobile users will be able to use the system to easily identify all relevant information and quickly perform online transactions (e.g. buying a book) on such sites. Most online stores generate their Web pages automatically from templates. So we expect that labeling the content of templates will not require extensive effort on the part of content providers. At the same time, the use of XHTML for semantic labeling imposes no limitation, allowing merchants to define their own states and actions as they deem necessary. To demonstrate the effectiveness of this method, we have implemented a prototype system. Running the system on handhelds and a thorough evaluation is a work in progress.

## 2.3 Context Browsing with Mobile

To ease the browsing task on handhelds, we present only the relevant segment of a Web page on following a link. We observe that identification of relevant information on any distinct Web page is subjective until the user selects a link. But when the link is clicked, the subject of interest can be inferred from the link and its surrounding context. On following a link, our system captures the context of the link, employing a simple topic-boundary detection technique [1]. Then, the system uses the context and a Support Vector Machine (SVM), a statistical machine-learning model, to identify relevant information in the next page. Finally, it displays the most relevant segment of the Web page. In case when the relevant information is not identified correctly, the user is only one pen tap away from the beginning of the Web page. The prototype system and its evaluation are described in [1]. Next we describe our approach of using context for Web transaction.

## 2.4 Context-directed Web Transaction

We are currently developing a context-directed Web transactional system for handhelds. The system uses contextual browsing with a domain-dependent knowledge-base to facilitate Web transactions. The online shopping knowledge-base consists of the following few concepts: SearchForm, AddToCart, Taxonomy, ShoppingCart, Checkout. We have developed heuristics algorithms to identify each concept on a Web page. With the use of the contextual browsing, we will first present the geometric segment that is relevant to the context of the followed link. Our system will also identify and present the geometric segments, that contain any concept from our knowledge-base. This Web transactional system does not use a process model. However, it leverages contextual information to identify the relevant information on following a link, and presents it to the user. Currently we are developing the prototype system to accomplish such context-directed Web transactions. Next we will port the system on handhelds and conduct experimental evaluation.

# 3. RELATED WORK

Our work has broad connections to research in content adaptation for small-screen devices. The works described in [2, 3] focused on organizing Web pages into tree structures and summarizing their content. However, summary structures often cause needless navigational steps when a user is interested in some specific content. A number of research projects have tried to condense Web pages by displaying thumbnails and summarizing Web content [4, 6]. For example, SmartView [6] uses a page-splitting technique to group the elements of a Web page and present them together while allowing to zoom into the individual elements. Zooming and thumbnail presentation styles can facilitate the identification of relevant sections in Web pages, but they do not pinpoint the most relevant information in a page. These features, however, can further enhance the usability of our systems.

# 4. CONCLUSION

In this paper, we have described several approaches to ease browsing and Web transactions on handhelds. Using our context-directed browsing system, mobile Web surfers can potentially save their time by having to do fewer stylus taps to find and read relevant information while navigating from one Web page to another. We briefly described our process-model-based Web transactional system for mobile users. We also mentioned our ongoing work to develop context-directed Web transactional system and merchant-based process modeling solution for Web transactions on handhelds. Our system runs as a client-server application with the server doing the bulk of the processing. Currently we are working to port all the server steps to the handheld. We also plan to investigate the possibility of mining transactional models from contextual information.

# 5. REFERENCES


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