Customizing Digital Libraries for Small Screen Devices.

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In this paper we present a system that allows users to access digital libraries using small screen devices. Instead of providing users with a single hard-coded solution, we allow them to customize how the content is structured, formatted and viewed on the small display. The centre of our system is a tool that can be used to customize Greenstone Digital Library collections for small displays. To lower the entry level, this tool has been designed to provide an abstraction from Greenstone's low level architecture and other computing technologies, such as HTML and Java Script. We also place a strong emphasis on evaluation and incorporate users throughout the software development cycle. Lastly in the discussion, we speculate that by designing usable and customizable systems, there is the potential of breaking down the open source revenue model, which relies on providing services for systems that are hard to use and configure.

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1. INTRODUCTION

Digital Libraries provide a structured way of displaying information over digital media such as the Internet. Unlike the web, which is typically clogged with irrelevant and unhelpful information [Marsden 2001], digital libraries provide access to edited and categorized content. Not only does this make it easier to locate content, but it also reduces cost incurred in printing and distribution [Witten 2001].

Digital library collections are typically accessed using a PC connected to the Internet. However, the expensive, bulky, fragile, large power consuming PC does not seem like an ideal device for providing universal access [Marsden 2001]. An alternative, more portable and less power "hungry" client that can be used is the mobile phone.

However, using mobile phones presents new challenges, as they have limited screen sizes, computation resources, bandwidth and interaction. While the last three issues are being improved constantly, the constrained display size is more "fixed" and hence problematic. This is because information often needs to be formatted, structured and translated, before it can be displayed on the device.

In this paper we present a system that provides small screen access to digital libraries. Unlike previous research which has provided a single hard-coded solution for formatting, translating and viewing content on small displays, we provide users with a more flexible WYSIWYG tool that allows them to customize the content appropriately for the small screens.

2. BACKGROUND AND RELATED LITERATURE

The problem of formatting, translating and viewing web and digital library content has been investigated in numerous research papers [Buyukkokten 2000] [Schilit 2001][Buchanan 2003][Jones 1999][Marsden 2001].

One paper that is of particular interest to us, proposes a solution for small screen access to digital libraries. This solution enables users to access digital library content served as HTML (hypertext markup language) on devices that support WAP. To achieve this, the authors install a proxy server to translate the HTML content to WML (wireless markup language). However, this system is plagued by the inadequacies of WAP [Nielsen 2000] and the different interpretations of the WML standard. User tests also show that people struggle to retrieve information. According to the authors, this is attributed to the usability issues that lie with the digital library and also the inexperience of users with digital library systems. This system is also unable to recreate a similar desktop web browsing experience. This is partly due to WAP's inability to create a "killer app" [Nielsen 2000]. As a result, it more difficult for users to use their prior knowledge when using the mobile solution.

Another notable solution is LibTwig [Buchanan 2003]. This system allows users to access and search Greenstone digital library collections on small screen displays. It does this by communicating to Greenstone via a CORBA protocol.

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It presents users with an HTML interface. The home page has the name of the collection and a keyword search box beneath it. Search results are displayed in two ways: a reduced outline hierarchy containing only items and branches which match the search; or a traditional ranked list. In the case of the hierarchical index, users can expand a category to reveal its component documents and subcategories, or close it to leave the title visible [Buchanan 2003]. Alternatively, in the outline mode, the ordering of documents within categories is done alphabetically. An evaluation of these two methods showed that there is statistically no significant difference between them. The authors conclude that a possible reason for this is that the cultural incomprehensibility and learned expectations (in the context of searching), may limit or eliminate the benefits of hierarchies.

Light-weight browsers, such as Pocket Internet Explorer found on Windows CE devices, can also be used to browse digital library content served as HTML. Users can either view the content as is, or can use the "fit to screen" feature which attempts to format the content appropriately for the small display. Both solutions are problematic. With the former solution, users struggle to see the overall context of the page at a glance as the small screens can only ever display a portion of the HTML content. This means that users have to scroll horizontally and vertically to view the content. Excessive scrolling within pages can be very disorientating [Buyukkokten 2000]. A common solution to this problem is to format these pages appropriately for small screen devices. The latter solution attempts to format the HTML content by ensuring the HTML pages are restructured to fit the screen width. This restricts scrolling to a single dimension. However this solution does not take advantage of the inherent structure of digital libraries.

3. PRELIMINARY EVALUATION

We decided to use an open source digital library system called Greenstone. In order to uncover any usability issues with Greenstone, we decided to use two usability evaluation techniques: Think Aloud and Conceptual Model Extraction [Nielsen 94]. We chose to evaluate the Demo collection which comes standard with a Greenstone Digital Library (GSDL) installation. Twenty undergraduate students were asked to perform tasks to test the main functionality.

Four types of usability issues were identified: Search and Navigation Issues (e.g. Users only used the keyword search and A-to-Z title listing. Some users would have also liked the ability to search from the home page); Conceptual Model Issues (e.g. The icons were not intuitive and were poorly understood); Information Structure Issues (e.g. Users would have liked to be able to restructure the document format and layout) and Aesthetic Issues (e.g. Users generally commented negatively on Greenstone's 'look and feel,' and would have liked the ability to apply skins or even better redesign the site).

The study concluded that the only way to effectively address these issues would be to allow customization, as users have varying backgrounds, interests, motivation, levels of experience and physical ability. Customization allows the user to view the information that is relevant to them and appropriate for the access device. Also users do not have to bare the overhead of carrying unused features and content, which can increase the response time and wastes resources such as bandwidth and memory.

4. SYSTEM DESIGN AND ARCHITECTURE

Based on the conclusions of the preliminary study, we decided to develop a system that allows users to customize Greenstone digital library collections for small displays. We made use of Greenstone's visualization framework which enables users to customize the entire digital library website (e.g. home page, help page, collection etc...). It uses a unique macro language consisting of macros, JavaScript and HTML to specify the layout of all elements that make up the site. Its also uses collection configuration files to specify the structure of a collection (e.g. collection logos, how search results are displayed, how the documents are displayed, what search and browsing facilities are available etc…).

However, to do any of this customization users are required to understand Greenstone's underlying architecture, as well as all the underlying technologies that are used to format, structure and translate the content. To reduce the entry level and avoid such a steep learning curve, we decided to develop a high level tool that provides an abstraction from Greenstones architecture and the underlying technologies used by the visualization framework, such as Macros, JavaScript and HTML.

4.1 Overview of the System Architecture

Using an iterative design process [BOEHM 1988] we developed a system (see Figure 1) that consists of 3 main components: Greenstone Digital Library Installation serving Greenstone collections, Customization Tool, and a PDA.

The Greenstone Digital Library system serves all content as HTML. This HTML is generated on the fly by the visualization module. The visualization module is responsible for dictating how the entire Greenstone site is displayed. When initialized, the visualization module reads in all configuration files (i.e. macro files and collection configuration files) which dictate the structure of the interface.

This Customization tool (see Figure 2) is responsible for automatically generating these configuration files. It provides a high- level WYSIWYG graphical editor that enables users to customize the Greenstone site. Users can select

an HTML page to customize (e.g. home page, search page, results page, document page etc…). The tool displays all available functions for a page on the left and the current page as viewed on the PDA on the right. The visualization pane on the right also allows users to view the results as different functions are applied.

The tool consists of three components: front-end, back-end and the transfer module. The front-end is responsible for the visualization. The back-end maintains an abstract representation of the Greenstone user interface. This representation is used to generate configuration files which are then transported to the Greenstone server via the transfer module. The transfer module supports FTP so users can customize remotely.

The tool operates in three phases: initialization phase, customization phase and export phase. In the initialization phase the tool is either started up in a normal or restricted mode. In the restricted mode, configuration files from the Greenstone server are not downloaded, so no information regarding the current structure is available and not all operations are available. The customization phase allows the user to customize the interface. Once the user is satisfied, they can select the export function. During the export phase, configuration files are generated to reflect the changes made during the customization phase (i.e. they encode the structure and layout of the Greenstone site). These configuration files are then exported to the Greenstone server. The Greenstone server has to be restarted for the changes to be applied. If a user skips the customization phase by selecting the export function after the initialization phase, a predefined default template is applied. Users are also able to save and load. A single level undo operation is also available.

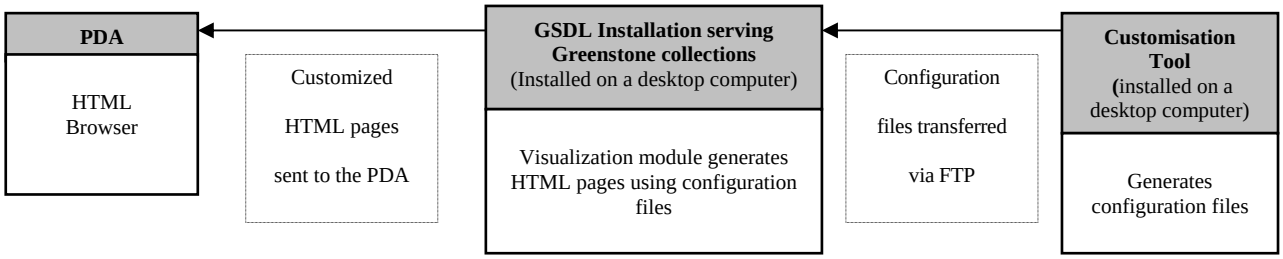


Figure. 1. *Overview of the system architecture.*

The PDA is a thin client which connects to the Greenstone server and receives the requested HTML pages. We make use of wireless TCP technology which allows HTTP to run over mobile networks. HTML pages from the Greenstone server are rendered in an HTML browser on the PDA. All the formatting is applied by the Greenstone Visualization module.

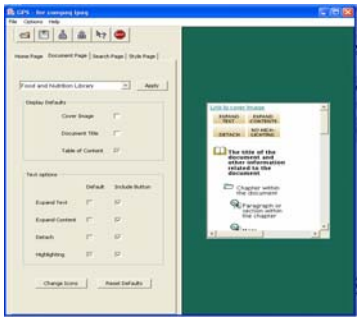


Figure. 2. *The high-level WYSIWYG graphical customization tool.*

4.2 Search and Navigation Issues

For all available collections, users are able to choose which search and browsing facilities should be used on the mobile device. By default, only the keyword search and A-to-Z title listing are enabled. This is done to ensure the most frequently used functions are easy to access. It also reduces the amount of cluttering on the screen that is caused by displaying all the search facilities. However, users are not restricted to these search and browsing options. They can include other options if required. One work-around for reducing the amount of cluttering involves displaying all the search and browsing facilities in a drop down menu listing.

4.3 Conceptual Model Issues

The tool also allows users to replace all Greenstone images (e.g. banners, icons, background images, images links etc.) with other images, text or links. When the default template is applied, custom Greenstone icons are used. Although this

solution may not be ideal, it allows Greenstone users to use previous knowledge when migrating to the small screen interface.

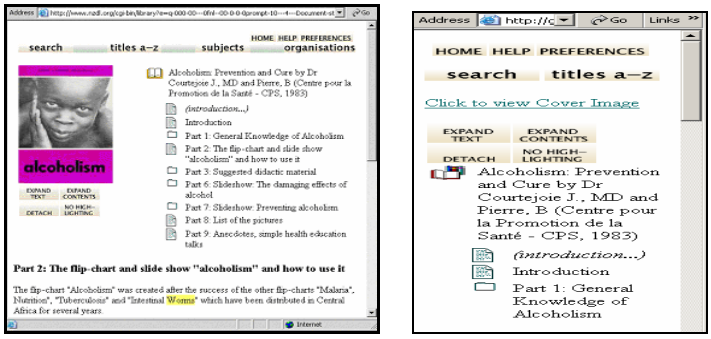
4.4 Information Structure Issues

One of the problems with viewing Greenstone collections on small displays is the excessive amount of scrolling that is required. For example, Figure 3 shows a Greenstone home page when viewed using a desktop browser (see Figure 3a) and a PDA browser (see Figure 3b). Navigating the home page on the PDA requires a lot of horizontal and vertical scrolling, which can be very disorientating. [Buyukkokten 2000]. In this case we provide two solutions. Firstly users can select a collection from a drop down menu listing. This reduces the amount of screen space required and hence the amount of scrolling too. Secondly, instead of displaying all available collections in a grid (see Figure 3a), collections logos are rather placed in a vertical listing. Although this increases the amount of vertical scrolling, it constrains the scrolling to one dimension. Hence, users only have to scroll up and down.

(a) (b)

Figure. 3. *Viewing the home page on a desktop computer (a) and on a PDA (b).*

The tool also lets users customize the structure of documents within collections to make them more appropriate for viewing on the small screen. For example, Figure 4a shows document consisting of a table of contents (TOC), cover image, document buttons and text. Users can arrange these document elements by customizing the default template. They can also remove or replace document elements. For example, Figure 4b shows a customized Greenstone document where the cover image has been replaced with a link to it and the TOC has been placed beneath the document buttons.



(a) (b)

Figure. 4. *An example of a standard Greenstone document (a) and a customized Greenstone document (b).*

4.5 Aesthetic Issues

The customization tool allows users to design the look and feel of entire Greenstone site. Users can structure the page header and footer, banner, logo, text colors, link colors, background and can also replace all images. In addition to this, they can also insert text, links, and images.

4.6 Feedback, Help and Documentation

In order to make the tool easier to use and learn we decided to incorporate two types of help. Firstly, we provide a step-by-step annotated tutorial. Secondly we have also implemented context sensitive help. We have also made all our project resources available via the following URL: http://www.cs.uct.ac.za/Research/CVC/Projects/past/digitalLibrary/.

5. PRERELEASE EVALUATION

After developing the prototype system we decided to evaluate its user interface to try and identify any potential difficulties or unexpected states. We conducted a heuristic evaluation. Three participants, as recommended by Nielsen [Nielsen 1992] were used in total. All participants were expert Greenstone users (i.e. they had an in-depth understanding of Greenstones low-level architecture) and had also attended a postgraduate course in usability. The evaluation consisted of two parts. In the first section, participants were given a list of tasks to perform. These tasks were designed to represent the most common usage scenarios. In the second section, participants were required to investigate each panel (i.e. each of the customisable components of Greenstone) for usability problems. This section was not highly structured, as we wanted to give participants the freedom to explore the system and come up with their own tasks. We also had an observer whose role was to provide assistance to the participants and also to interpret how any user actions or comments were related to issues in the design of the interface. Following the heuristic evaluation we conducted a severity rating to rank the usability problems. The usability problems identified were minor issues that were addressed before the final release.

6. DISCUSSION AND CONCLUSION

In this paper we have presented a system that provides small screen access to digital libraries. Instead of providing users with a single hard-coded solution, we allow them to customize how the content is structured, formatted and viewed on the small display. The centre of our system is a tool that can be used to customize Greenstone Digital Library collections for small displays. In order to lower the entry level, this tool has been designed to provide an abstraction from Greenstone's low level architecture and other computing technologies, such as HTML and Java Script.

In designing this system we have also addressed issues of access, content, training and customization. These issues have been highlighted by various researchers as being important requirements that need to be considered when designing software for developing countries [Marsden 2003] [Norton 2003]. In this paper we also focused on developing a usable system by incorporating users throughout the software development cycle (i.e. we conducted a preliminary evaluation, during the design phase we used paper prototyping and tested the prototype by conducting a heuristic evaluation).

A consequence of designing usable and customizable systems is that they have the potential to break down the open source revenue model, which relies on providing services for systems that are hard to use and configure. Not only will this empower users, but it will allow them to deploy these systems at a lower cost.

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