ATTENUATOR: TOWARDS PRESERVING THE ORIGINAL APPEARANCE OF LARGE DOCUMENTS WHEN RENDERED ON SMALL SCREEN MOBILE DEVICES

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ABSTRACT
Although compact mobile devices are convenient and have many advantages, their small screens can present problems. A significant proportion of HTML documents are optimally designed to look best when rendered on high-resolution displays of desktop and laptop computers - not small screen mobile devices. Transcoding solutions exist that can intercept HTML pages and transform them for small screen devices, but as consequence the original visual layout and structure of the page is barely recognizable. Described in this paper is the Mobile Page Attenuator, a proxy-based framework that preserves the view of the document as it was originally intended for the desktop in a form renderable on a small screen device. A scheme for region-based interactivity is also introduced, further ameliorating the need for excessive scrolling in either direction.

1. INTRODUCTION
In recent years we have witnessed the remarkable commercial success of small screen devices, such as cellular phones and Personal Digital Assistants (PDAs). Technology continues to evolve, allowing an increasingly peripatetic society to remain connected without any reliance upon wires. Mobile computing heralds exciting new applications and services for information access, communication and collaboration across a diverse range of environments.

Typically, popular mobile devices are sized appropriately to fit conveniently into a pocket. While factors such as processors, networks, protocols and content are likely to evolve, the physical limitation of the display size is likely to remain constant for a longer period. This observation is coupled with the unfortunate fact that the preponderance of popular HTML content is optimally formatted for rendering on the high resolution displays of desktop and laptop computers - not small screen mobile devices.

Almost every user of the World Wide Web is familiar with famous portals of Yahoo!, Excite, AltaVista, Google, and others. As with traditional products, these famous portal sites have a familiar product branding, which is their unique visual identity that distinguishes them from the competition. Many users of the WWW rely on these portals every day for common services including searching, news, stocks, etc. This reliance breeds familiarity to the extent where users know the precise locations on pages where they can find specific information efficiently. Although a number of sites now serve their content to mobile devices, the structure and experience is usually inferior to the equivalent desktop versions. One disadvantage being that the original structure and layout (visual identity) is diminished, but perhaps more importantly desktop users of these sites now have to adjust to a new visual layout and structure for each web site viewed on their mobile devices. Transcoding solutions exist that can intercept HTML pages and transform them for small screen devices, but as a consequence the original visual layout and structure of the pages are barely recognizable.

Described in this paper is the Mobile Page Attenuator, a proxy-based framework that preserves the view of the document as it was originally intended for the desktop in a form renderable on a small screen device. A scheme for region-based interactivity is also introduced, further ameliorating the need for excessive scrolling in either direction.

A brief survey of the related work is discussed in section 2. The concepts and interaction flow of the Mobile Page Attenuator is presented in section 3. A description of the system architecture is offered in section 4. Section 5 proposes areas for further research and concluding remarks.

2. RELATED WORK
From an architectural perspective, there are three conventional positions at which content adaption can be performed: at the origin server, at the proxy or at the browser. Content providers may select a web server-based content management solution [1, 10] able to serve the content in a suitable format. Frameworks such as Microsoft .NET provide a device abstraction, allowing developers to focus upon the application logic.

If the content is not delivered from the server in a suitable format then various strategies for imbuing a proxy with the ability to perform an appropriate dynamic transcoding have been proposed [3, 4, 11], with some systems also able to adapt to the varying network.
conditions [7, 12]. Proposals have also been made to standardize proxy transcoding architectures [6, 8].

Alternatively, the browser can offer transcoding schemes or novel user interface mechanisms [13]. Pocket Internet Explorer offers *Fit to Screen*, which simply reduces image sizes and reflows the text to reduce width.

Several approaches have been proposed for intelligent personalization [2] and summarization [5]. Another approach is to aid the user in pre-selecting regions of interest of frequently visited documents, sometimes referred to as web-clippings, and hence known to be suitable for viewing/rendering on the target mobile device.

In 1998 the W3C initiated an activity dedicated to mobile access that led to the Composite Capability / Preference Profile (CC/PP) [12] for representing a user and device in the context of a content negotiation framework to determine the optimum format to be served.

3. INTERACTION FLOW

To remain as open as possible, our project requirements were such that a proprietary browser should not be developed for this purpose; the use of client scripting should be avoided as the current generation of PDAs have limited support; as no content is to be under our control a server-based solution was also excluded. These constraints dictated the need for a proxy-based solution.

The solution developed for addressing this issue is conceptually very simple. The browser on the user’s PDA must be configured to use our proxy. When the browser on the user's PDA requests an HTML page, our proxy intercepts the request and retrieves the HTML page and all of its constituent parts. The Mobile Page Attenuator in the proxy then essentially captures a screenshot of the HTML page, but which also includes the content not visible without scrolling. This screenshot image is then processed for optimal viewing on the PDA. It can be appreciated from figure 1 that while not every single word can be read by the human eye, a proportion of the significant text can, but more importantly the familiar visual layout and structure is entirely recognizable almost without the need for horizontal scrolling. Hence, the goal of preserving the original visual identity has been largely accomplished.

Generating a single image for rendering on a PDA is not enough, as it can compound downloading time and preclude further interactive browsing.

However, these two effects are mitigated to a large extent by the Mobile Page Attenuator. Further interactive browsing is possible because the Mobile Page Attenuator associates *IMAGEMAP* functionality with the screenshot. Hence, when the user clicks on the region of the page in which she is interested, a request is sent to the proxy. The Mobile Page Attenuator then returns to the PDA browser the original HTML code for the region surrounding the location where the user clicked. This segment of HTML is usually of a manageable size, again ameliorating the need for excessive scrolling in either direction. For example, when the user clicks anywhere in the *Today on Excite* region (top left section) of the *Excite* page in figure 1, the corresponding original HTML shown in figure 2 is returned.

4. SYSTEM ARCHITECTURE

Our solution leverages the Apache proxy for managing HTTP communication and caching, and the TomCat servlet engine for managing session state.

4.1. Proxy Architecture

The Mobile Page Attenuator is realized as filters called by the proxy framework. As described in the previous section, the interaction flow comprises two phases described in detail below.
The first phase (shown in figure 3a) activates the Mobile Page Attenuator by a response event from the proxy. The first step employs a browser component in a non-visual manner to print the HTML page to a chunk of memory. ImageMagik, an image processing toolkit, is then passed this memory chunk to produce the corresponding GIF image with reduced color depth (in figure 1 the image has 256 colors) and rescale it to fit the PDA screen width whilst preserving the aspect ratio.

Browsers allocate multiple threads to expedite parallel image downloading. To exploit this browser feature, the image is then sliced horizontally into a number of sub-images. Finally, an HTML page is generated containing IMAGEMAPs that reference the multiple image slices. This is sent to the PDA browser.

The second phase (shown in figure 3b) is triggered by clicking on a region of the image in the PDA browser, generating a request event in the proxy. This request conveys the image clicked and the corresponding coordinates. Earlier in this session the original HTML document was loaded into an HTML DOM, and using this DOM it is possible to compute the HTML element located at the coordinates returned by the IMAGEMAP click. A slight loss in precision is incurred due to the scaling factor.

Once the HTML element has been located, our algorithm is applied that performs a region growing function to identify the logical region enclosing this element. This algorithm contains a number of heuristics upon which it is predicated whether the region should be grown further or not. The algorithm begins by looking for a boundary element (such as TABLE, FORM, etc.). If found, the growing continues and expands to ascertain facts such as whether all of the enclosed elements share the same background. The algorithm continues until one or more of the heuristics signal that a suitable boundary element and conditions have been met. The HTML contained within the enclosed region is then extracted, and all of the URLs within are rewritten to use the absolute paths. The resulting HTML representing the computed region is then returned to the PDA browser.

4.2. Client Requirements
As indicated earlier, a key requirement was that no proprietary technology be required on the PDA. However, a minimum requirement of the Mobile Page Attenuator is that the PDA browser support IMAGEMAPs. Increased performance may be evident if the PDA browser utilizes multiple threads for downloading, but is not a requirement.

5. FUTURE WORK AND CONCLUSIONS
The region growing algorithm works well on a significant number of sites, however pages exist for which it fails. As HTML pages can be created in extremely diverse and sometimes illogically structured ways, it is difficult to define a set of heuristics for which the algorithm always produces the expected result. An additional algorithm to survey the global structure of the page would prove useful. Complementing the bottom-up approach with a top-down approach may yield better results.

The benefit of the Mobile Page Attenuator comes when viewing pages comprising a rich graphical layout and structure, but can prove superfluous and unnecessary for simple, unstructured pages. Hence, an additional algorithm could ascertain whether the Attenuator should be applied.

Described in this paper is the Mobile Page Attenuator, a proxy-based framework that preserves the view of the document as it was originally intended for the desktop in a form renderable on a small screen device. A scheme for region-based interactivity is also introduced, further ameliorating the need for excessive scrolling in either direction. This solution requires no proprietary technology on either the browser or the WWW server, as the Mobile Page Attenuator technology is realized as proxy filters.

While the Mobile Page Attenuator accomplishes the intended goal, it does not fit the normal pattern of interaction that users expect from a browser. Although better able to appreciate the HTML page as it was originally intended for the desktop, users do not normally click an image in order to access a subset of the real HTML. Formal usability trials will determine whether, after an initial tutorial, users are prepared to click twice to access content in return for the benefits offered by the Mobile Page Attenuator.

Our two preliminary concerns were the downloading time and size of an image-based representation of the page. However, experiments demonstrated this to be far less of a problem than originally anticipated. For example, the collection of images that comprise the Excite page shown in figure 1 total approximately 50KB (this includes also the lower half of the Excite page currently out of view in the browser.) To put this size into perspective, the regular Excite HTML page and its constituent parts average approximately 67KB. Hence, the image-based representation of the page is smaller in size than the original, and coupled with a multithreaded browser download capability mitigated these concerns to a significant degree.

6. REFERENCES


Figure 3: The steps to (a) generate the attenuated HTML page (b) locate, extract and present the original HTML.