Performance Analysis of Web-browsing Speed in Smart Mobile Devices

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Abstract

The rapid growth of telecommunication technology has led to the development of many smart devices. In particular, the smartphone market has been growing rapidly following the development of third-generation telecommunication technology. As a result, most people are expected to use a smartphone within a few years. Furthermore, the market for smart devices such as tablets and smart TVs are growing rapidly. Therefore, most people are expected to own various smart devices within a few years. However, current Web services are focused on a desktop PC platform, which can be problematic for smart devices. In this paper, we analyze the performance of Web browsing speed in smart mobile devices with the goal of providing Web services customized for smart devices.

Keywords: *Mobile, Web, Browser, Smart Device*

1. Introduction

Recently, the number of people who own mobile devices is increasing because of the increasingly broad range of content they provide. Many people use the Internet more frequently on smart devices than on desktop PCs. For example, many people use SNS (Social Network Service) on their mobile devices.

Table 1. Includes Mobile Browser and Application Access

Audience* for Selected Social Networking Services
Three-Month Avg. Ending Aug. 2011
Total U.S. Mobile Subscribers Ages 13+ (Smartphone and Non-Smartphone)
Source: comScore MobiLens

	Total Audience		
	Aug 2010	**Aug 2011**	**% Change**
Facebook	38,240	57,332	50%
Twitter	7,639	13,375	75%
LinkedIn	3,234	5,482	69%

An observation of selected SNSs, such as Facebook, Twitter, and LinkedIn, revealed that each SNS expanded their mobile audiences by at least 50% in the last year. Facebook was home to the largest mobile audience among the three destination with more than 57 million mobile users in August, which is higher by 50% from the previous year. Twitter saw its mobile audience jump by 75% to 13.4 million users, while LinkedIn’s mobile audience climbed by 69% to 5.5 million users [1].

At present, the number of mobile users is increasing rapidly, but current Web services are still largely optimized for a desktop PC. Hence, many Web sites are now considering building a mobile site. Therefore, we are studying ways to increase the speed for mobile Web applications.

In this paper, we conduct a performance analysis of Web-browsing speed in smart mobile devices to determine the factors that affect the speed. First, we show popular smart devices. Next, we discuss previous research on Web-browsing speeds and find that existing research is almost exclusively focused on desktop PCs. Next, we show the results of our research. We checked Web-browsing speeds on various smart devices such as tablet PCs, desktop PCs, and smart phones. We then discuss our methods for increasing speed in mobile Web applications.

2. Smart Devices

A smart device is an electronic device that is cordless, mobile, always connected, capable of voice and video communication, Internet browsing, geo-location, and that can operate autonomously to some extent.

It is widely believed that these types of devices will outnumber all other forms of smart computing and communication in a very short time. The most popular devices at the time of writing this paper were the Apple iPhone and iPad, followed by devices such as the Samsung Galaxy tablet [2, 3]. Generally, smart devices are classified by screen size, the two main types being smartphone and tablet PC.

Table 2. Device Specifications

Type	Name	CPU	RAM
Desktop	PC	2.50 GHz (Quad)	3.5 GB
Tablet	iPad 2	A4 1 GHz	512 MB
	Galaxy Tab	1.0 GHz (Dual)	1 GB
Smart Phone	iPhone 4	1 GHz	512 MB
	Galaxy S	1 GHz	512 MB

Table 2 shows that desktop PCs significantly outperform smart mobile devices, and that tablets outperform smartphones. Furthermore, the screen sizes are different. Most desktop PC users have screen sizes greater than 19 inches, but tablet screen sizes range from 7 to 10 inches while smartphone screens are below 4 inches. Therefore, Web services must customize content to different device types.

For example, smartphone users view content on a small sized screen, so there is no need to provide a large image. In addition, these users typically use low-speed mobile networks, so Web services for smartphones must provide small images and maximize methods for speed up. On the other hand, tablets are often purchased by users for their increased display size over that of smartphones. Tablets need to show larger images and different content than smartphones. Desktop users also typically use high-speed networks and large screens. For these devices, the content must be high quality, varied, and enhanced. For these reasons, it is important that we find methods that optimize performance for each of these devices.

3. Existing Research

Our review of existing research has found that researchers focused on either desktop or mobile browsers. This section presents the performance of browsers on desktop or mobile devices.

First, we show results of speed in five well-known browsers. Next, we introduce research on the loading speed and caching of mobile browsers and various mobile devices.

3.1 Desktop Browser

The latest versions of the five well-known web browsers (Mozilla Firefox 3.5, Google Chrome 3.0, Microsoft Internet Explorer 8.0, Opera 10.0, and Apple Safari 4.0) were compared in terms of six performance indicators: JavaScript speed, average CPU usage under stress, Document Object Model (DOM) selection, CSS rendering speed, page load time, and browser cache performance. Each Web browser was tested three times under an unprimed cache (except for the browser cache performance test), and their average values are reported in the results of [4].

3.2 Mobile Browsers

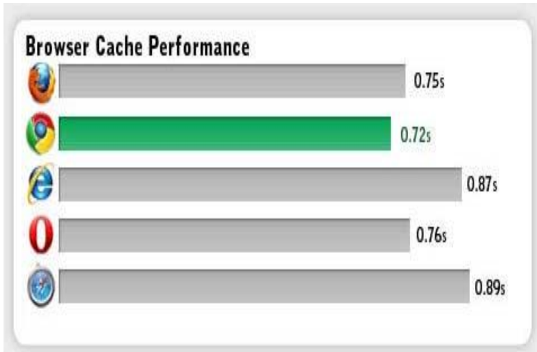
In these tests, we load an HTML page that refers to a randomly generated CSS or JavaScript component of a certain size. Then, we navigate to a second HTML page that loads the same component and checks whether it was loaded from the cache.

To determine whether a component was loaded from the cache, they store a timestamp in a cookie on each request. If the timestamp is updated the second time the component is loaded, it is implied that the request was received at the server, which in turn means that the component was not loaded from the cache.

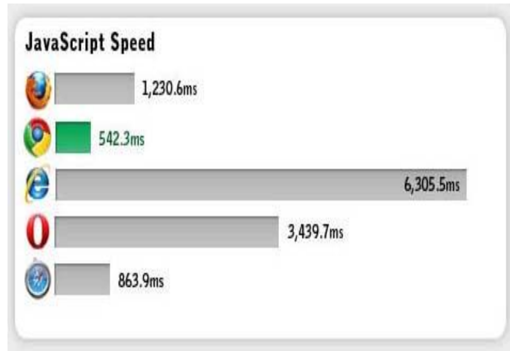
We conjecture that the considerably lower limits of the previous test performed for HTML components on iOS indicates the use of a RAM cache for those components, while the significantly higher limits for CSS/JavaScript components in this test may indicate the use of a disk cache. Android, at least, does appear to use a disk cache in both cases, since its cache survives power cycles [5].

Table 3. External Resource Cache Characteristics of Browsers

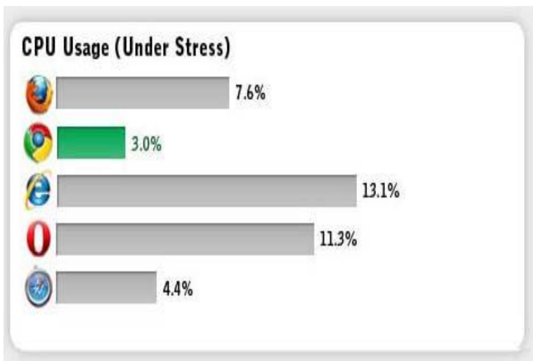
Browser/OS/Device	Single Component Limit	Survives Power Cycle
Android 2.2 (Nexus One)	2 MB	Yes
Mobile Safari, iOS 3.1.3	4 MB+	No
Mobile Safari, iOS 3.2 (iPad)	4 MB+	No
Mobile Safari, iOS 4.0 (iPhone 3GS)	4 MB+	No
Mobile Safari, iOS 4.0 (iPhone 4)	4 MB+	No
WebOS 1.4.1 (Palm Pre Plus)	~0.99 MB	Yes



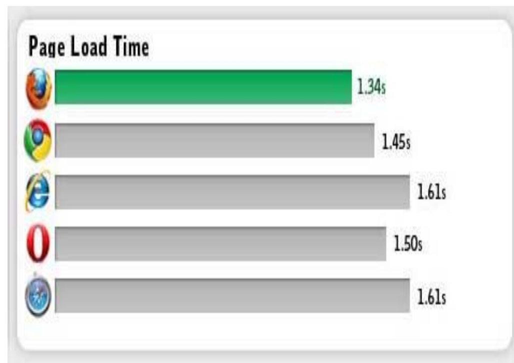
(a) Browser cache performance



(b) JavaScript speeds



(c) CPU usage



(d) Page loading time

Figure 1. Performance Comparison of Web Browsers

4. Performance Analysis

Previous research was focused on only a single device—desktop or mobile—and hence, we are not aware of any results on comparison between mobile and desktop Web browsers.

In this section, we analyze the browser loading time in each device. Subsequently, we compare the speeds of various smart mobile devices and determine the factors that affect the speed. Our research was conducted in three phases. First, we compared script loading times, then checked the image loading times, and lastly, we compared the desktop and mobile pages of popular portal sites.

4.1 Test Environment

For simulation, we used three types of devices: desktop, tablet, and smartphone. Each of these devices was tested in a web wait site [6]. This site features support for checking the loading time. We ran each test 10 times in the same network environment.

Table 4. Tested Devices

Type	Device	Browser
Desktop	Quad Core PC	Chrome
Tablet	iPad 2	Mobile Safari
Smart Phone	iPhone 4	Mobile Safari
	Galaxy S	Mobile Chrome

Figure 2. Screen Shot of wzd.com

4.2 Script Loading Time

For checking the script loading time, we decided on wzd.com as the target site because it includes many script methods.

Figure 3 shows that desktop PCs are faster than the other devices. Next in speed were the tablet and finally the smart phone. However, we found that the speed of each device is the same during the ten tests because the script is always in operation. From this, we can conclude that reducing the amount of script is very important for mobile devices.

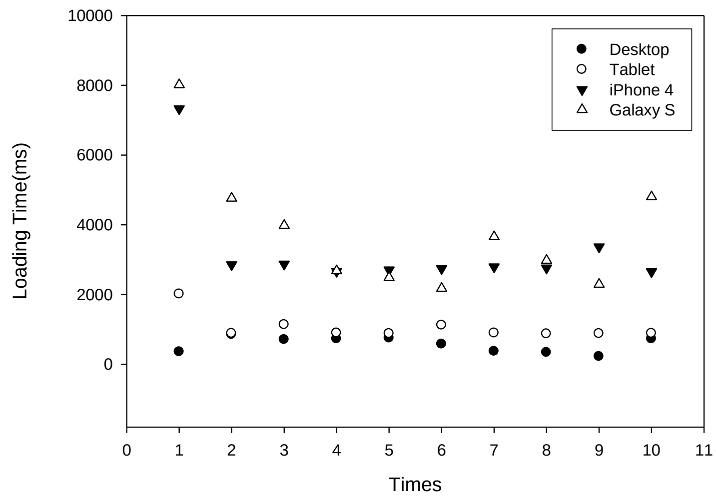


Figure 3. Script Loading Time

4.3 Image Loading Time

Figures 4 and 5 show the image loading time. For this experiment, we used a site consisting of only images, because we intended to check the speed of only image loading. The results showed that image reload time is the same as image loading time and is very short, because the image is stored in cache memory at the first loading. This implies that the loading time required for ten and twenty images is similar after the second loading.

Therefore, image size is not more important than script operation. However, because mobile devices have limited processing power, the first loading time is 20 to 30% longer than on a desktop PC. Therefore, provisions need to be made for smaller images on mobile devices and larger images once the user has loaded an image.

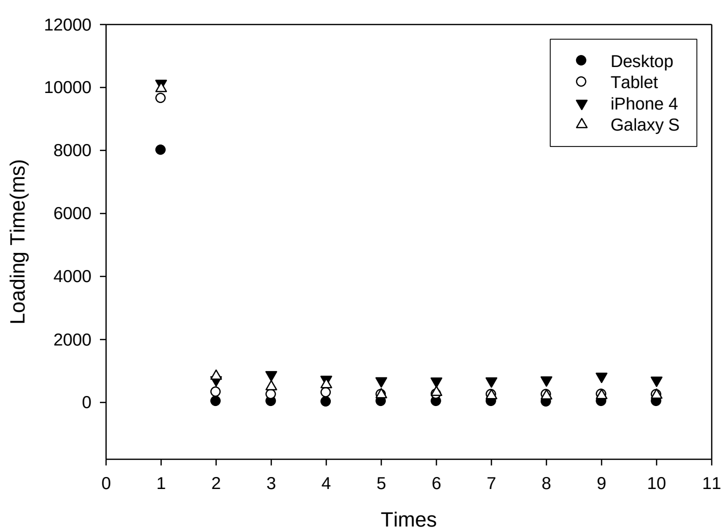


Figure 4. Image Loading Time (10 images)

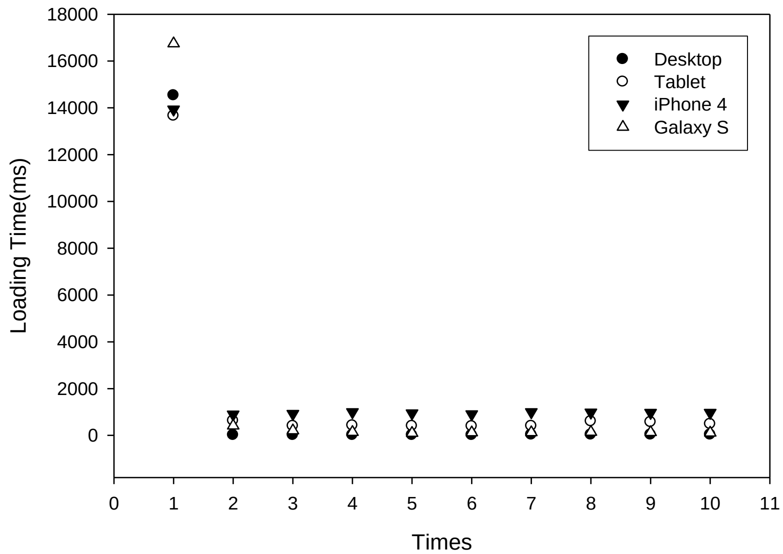


Figure 5. Image Loading Time (20 images)

4.4 Comparison of Desktop and Mobile Webpages

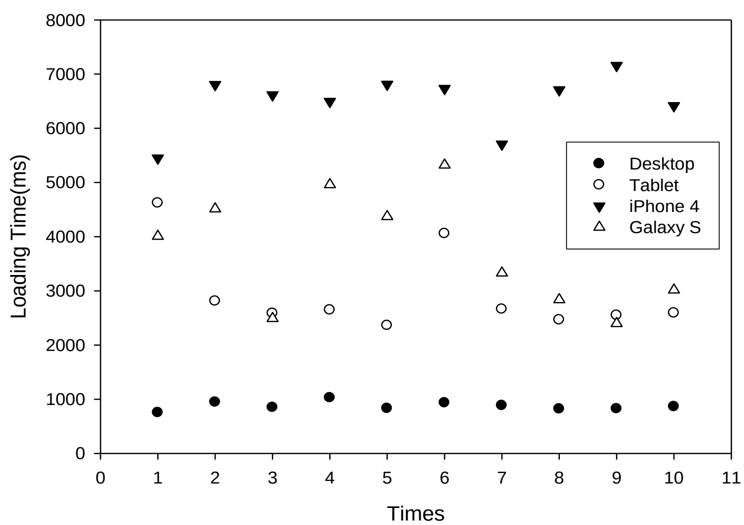


Figure 6. Portal Site Loading Time (Daum desktop page)

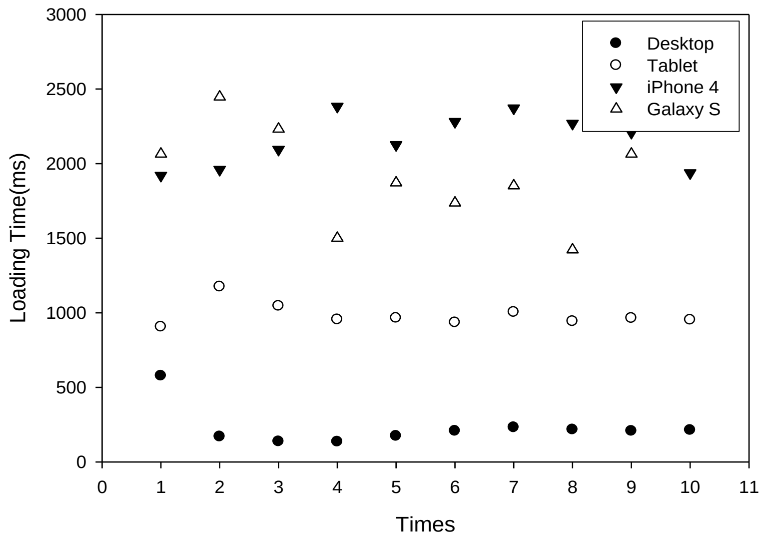


Figure 7. Portal Site Loading Time (Daum mobile page)

In order to test existing mobile and desktop Web services, we checked the loading time of the portal site of Daum Communications.

Figure 6 shows the desktop version of the Web site loading time, while Figure 7 shows the loading speed of the mobile version of the site. The results show that the mobile page loading time reduces by approximately 70% than the desktop version, and it is almost a scripted method because it shows the same loading time after first loading.

4.5 Difference in Speed

Table 5. Comparison Loading Time

Method	Device	Increasing rate of Loading time
Script	Desktop	0%
	Tablet	467%
	iPhone 4	1906%
	Galaxy S	2160%
Image	Desktop	0%
	Tablet	20%
	iPhone 4	26%
	Galaxy S	25%

Finally, we studied the difference in scripting and image loading speeds among desktops. For this research, we used only the first loading time because it shows the same result in the subsequent image loading.

As shown in Table 5, the script processing time of mobile devices is very slow compared to desktops, but the differences in image loading times is less than the difference in scripting times. From this result, we determine that it is important to reduce script source for mobile Web services. Image loading time is not as important as scripting time. Almost all mobile devices are connecting at lower network speeds than desktop PCs, using 3G, LTE, *etc.*, so mobile Web pages should provide smaller images such as thumbnail images.

5. Conclusion

In this study, we conducted a performance analysis of Web-browsing speed in smart mobile devices and desktop PCs and compared the results.

We consequently determined a method for reducing processing time in smart mobile devices. Using the results in this paper, we will develop methods to raise the speeds of smart mobile devices in future work.

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