Energy Aware Web Browser for Smartphones with New Optimized Power Consumption Technique

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Abstract – A smart phone is a mobile phone with an advanced mobile operating system which combines features of a personal computer operating system with other features useful for mobile or handheld use. Smartphone wastes its battery power for display and wireless interface. Smartphone web browser takes much more power for downloading the web pages, so it will drain the battery power completely for web browser. Here propose three techniques to solve the power consumption problem during web browsing that are, 1.changing of browser computation sequence, 2.Advanced Regression tree algorithm, 3.Less Energy Consumption Approach. Here proposed first algorithm is "changing of browser computation sequence", it will rearrange the computation sequence of web browser, and first download the all object from server in DCH state, and DCH state consumes more battery power of the Smartphone. Now the radio interface is put into FACH state, the FACH state uses the half of the power of DCH state, here downlink or uplink takes place to perform remaining computation. Because remaining computation requires some upload and download process. Here propose second algorithm is "Advanced Regression Tree", after downloading of all objects, average computation time was calculated by the ART, based on that time value only the smart phone still run in FACH state, if the computation takes more time, than Smartphone will be switched to idle state. Using these three algorithms we can reduce the power consumption of Smartphone by more than 30 percent during the web browsing.

Index Terms – Smartphone browser, Advanced Regression Tree,DCH state,FACH state,IDLE state.

1. INTRODUCTION

Wireless communication is the transfer of information between two or more points that are not connected by an electrical conductor. The most common wireless technologies use radio. Wireless technology play major role in Smartphone devices. The most common wireless technologies use radio. With radio waves distances can be short, such as a few meters for television or as far as thousands or even millions of kilometers for deep-space radio communications. It encompasses various types of fixed, mobile, and portable applications, including two-way radios, cellular telephones, personal digital assistants (PDAs), and wireless networking. Other examples of applications of radio *wireless technology* include GPS units, garage door openers, wireless computermice, keyboards and headsets, headphones, radio receivers, satellite television, broadcast television and cordless telephones.

A smart phone is a mobile phone with an advanced mobile operating system which combines features of a personal computer operating system with other features useful for mobile or handheld use. They typically combine the features of a cell phone with those of other popular mobile devices, such as personal digital assistant(PDA), media player and GPS navigation unit. Most smart phones can access the Internet, have a touch screen user interface, can run third-party apps, music players and are camera phones. Most Smart phones produced from 2012 onwards also have high-speed mobile broadband 4G LTE internet, motion sensors, and mobile payment mechanisms.

Smartphone wastes its battery power for display and wireless interface. Smartphone web browser takes much more power for downloading the web pages, so it will drain the battery power completely for web browser. Today Smartphone web browsers uses timeout value to release and re-establishing the wireless interface (or) internet connection, the web browser takes long time for downloading and processing all objects. Here focusing the power consumption of web browser in Smartphone. Our idea is to reduce the power consumption in Smartphone web browsing. Fig 1.0 describes the power consumption in Smartphone during the browsing time.

Here propose three techniques to solve the power consumption problem during web browsing that are,

1. Changing of Browser Computation Sequence.

2. Advanced Regression Tree algorithm to calculate the average computation time.

3. Less Energy Consumption approach to switch the Smartphone from FACH state to IDLE state.

There are various computations when loading a webpage such as HTML parsing, Java Script code execution, image decoding, and style formatting and page layout. The web browser processes are categorized as two that are

1, downloading the objects from server.

2, performing computation on objects and display content to the user.

Here proposed first algorithm is “changing of browser computation sequence”, it will rearrange the computation sequence of web browser, and first download the all object from server in DCH state, and DCH state consumes more battery power of the Smartphone.

Now the radio interface is put into FACH state, the FACH state uses the half of the power of DCH state, here downlink or uplink takes place to perform remaining computation. Because remaining computation requires some upload and download process.

Our second algorithm is “Advanced Regression tree”, after downloading of all objects, average computation time was calculated by the Advanced Regression tree, based on that time value only the smart phone still run in FACH state, if the computation takes more time, than Smartphone will be switched to idle state. Using these three algorithms we can reduce the power consumption of Smartphone by more than 30 percent during the web browsing. Our solution reduces the web page loading time and increase the network capacity.

2. RELATED WORKS

[1]Here the author discussed, last benchmark measured the power consumption for a web-browsing workload using both GPRS and Wi-Fi connections. The benchmark was trace-based, it run for a total of 490 seconds, and consisted of loading the browser application, selecting a bookmarked web site and browsing several pages. The author used the BBC News website, which author mirrored locally to improve the reliability of the benchmark. After each run, the browser cache was cleared. The results averaged over 10 iterations, including backlight power at 4 brightness levels. GPRS consumes more power than Wi-Fi.

[2]Here the author identifies various components in Smartphone that utilize power causing unnecessary power wastage in the system. The major reasons for battery draining in Smartphone are Network Data Communication such as Multimedia Streaming, GPS, Wi-Fi, and Signal Dead Spots. Usage scenarios such as high level of Backlight, high resolution Video Playbacks, Graphics Rich Gaming, and Heavy Computing Processes are the main sources power consumption. Other causes of power wastage are Application Energy Bugs, No-Sleep Bugs, Unnecessary use of Sensors and continuously running Background Processes. Wake Locks and Sensors can also quickly drain the battery if the programmers forget to unregister it in time. This study highlighted the problems and the solutions for optimization of energy consumption in Smartphone.

[3]Here the author discussed that the long delay and high power consumption in web browsing is not due to the bandwidth limitation most of time in 3G networks. The local computation limitation of the Smartphone is the real bottleneck for opening most WebPages. To address this issue, the author an architecture called Virtual-Machine based Proxy (VMP), Here the computation will be shift from Smartphone to VMP. To illustrated the feasibility of deploying the proposed VMP system in 3G networks, the author have built a prototype using Xen virtual machines and Android Phones with AT&T UMTS network.

[4]Here the author used two strategies, the first strategy proposes an application and user interaction aware middleware framework that takes advantage of user idle time between interaction events of the foreground application to optimize CPU and screen backlight energy consumption. The second strategy proposes the usage of machine learning techniques to learn a user‘s mobile device usage pattern pertaining to spatiotemporal and device contexts, and then predict energy-optimal data and location interface configurations. user uses certain power-hungry interfaces (3G, Wi-Fi, and GPS), the techniques, which include variants of linear discriminant analysis, linear logistic regression, non-linear logistic regression, and k-nearest neighbor, are able to dynamically turn off unnecessary interfaces at runtime in order to save energy. The first strategy optimizes CPU and backlight energy by taking advantage of user idle time between events. This is accomplished through use of a middleware framework with MDP/Q-Learning based power management algorithms. The second strategy optimizes data and location interface energy consumption by predicting optimal device configurations based on user history data. Predicting optimal device configuring effectively allows opportunistic shutdown of location/wireless radios, thus saving energy.

[5]The author presented ZOOMM model, A Parallel Web Browser Engine for Multicore Mobile Devices, a highly concurrent web browser engine prototype and show how concurrency is effectively exploited at different levels: speed up computation performance, preload network resources, and preprocess resources outside the critical path of page loading. On a dual core Android mobile device author demonstrate that ZOOMM is two times faster than the native WebKit based browser when loading the set of pages.

[6]Here the author discussed Monitoring and tracking usage of internet access over Smartphone. The author established behavioral patterns associated with browsing, the Native Internet Application are identified, the Native Internet Applications are Smartphone applications which can only run with the support of internet. Those applications are E-mail,Facebook,Web Games,Maps,Weather,News,Web browser.Here the revisitation rate of websites and NIA’s are collected and analyzed. The experimental results shows,The

location re-visitation is 90 percent, and The web based re-visitation is 20 percent.Here the Native Internet Application internet usage was compared with the Smartphone Web browser

[7]Caching on handsets is particularly important as it eliminates all network-related overheads. Authors have performed the first network-wide study of the redundant transfers caused by inefficient web caching on handsets. They found that redundant transfers account for 17% and 20% of the HTTP traffic, for the two large datasets, respectively. Further analysis on the UMICH trace suggests that redundant transfers are responsible for 17% of the bytes, 6% of the signaling load, 7% of the radio energy consumption, and 9% of the radio resource utilization of all cellular data traffic. Most of the redundancy can be eliminated by making the caching logic fully support and strictly follow the protocol specification, and making developers fully utilize the caching support provided by the HTTP libraries.

[8]Here the author discussed the modern Web applications, style formatting and layout calculation often account for a substantial amount of local Web page processing time. Here the author described two novel caches, smart style caching and layout caching for Web browsers. They cache stable style data and layout data for DOM (Document Object Model) elements, and apply directly without recalculation when the same data is subsequently processed, possibly across different visits of a Web page. With smart style caching scheme and layout caching scheme, the style data and layout data for DOM elements are recorded when a page is browsed, and then reused when the page is revisited later.

[9]The author presented a novel power optimization framework based on user-perceived response time analysis. Author divide an execution of a given user-interactive session into two intervals, one where the system response time directly affects user experience and the other where the system response time does not affect user experience. For the user-oblivious response time interval, the author framework allows more aggressive applications of low-power techniques for higher energy efficiency. In order to identify the user-perceived response time of Smartphone applications during run time, author developed an on-line User-perceived Response time Analyzer (URA) for Android-based Smartphone and on interval cpu freq governor based on understanding and analyzing the user-perceived response time, author proposed on interval governor could make aggressive DVS decisions without any negative effect on user experience.

3. SYSTEM DESIGN

3.1. System Architecture

In Fig. 1 the user first give the website URL as input, now the Smartphone will switch to IDLE state to DCH(Dedicated Channel) state, then it download all the main objects from server and computes the DOM(Documented Object Model) tree, now the browser switch to FACH(Forward Access Channel) state and gives the webpage feature as input to Advanced Regression Tree, the art produces the Average computation time,upto these reading time only the Smartphone will remain in FACH state after it will go to IDLE state.

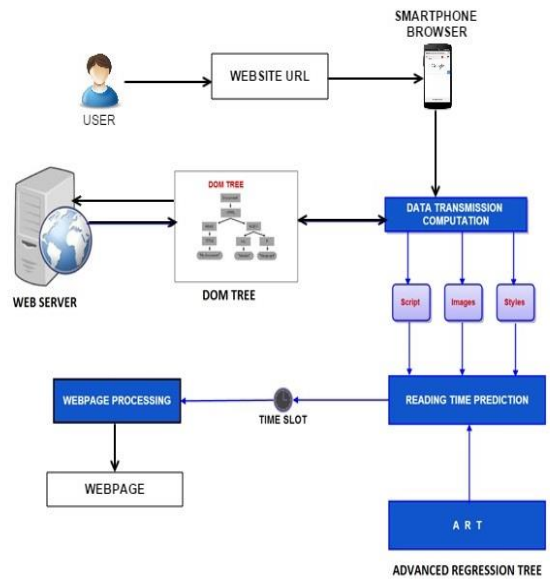


Fig. 1 Overall System Architecture

3.2. Module Description

- Changing of Browser Computation Sequence.

The current Smartphone web browser, there are two types of computations associated with each incoming object. The first type is the computation that generates new data transmissions such as HTML and CSS file parsing and JavaScript code execution, which is referred to as the data transmission computation. The second type is the computation that does not cause data transmission. This type of computation is used to layout the webpage such as image decoding, style formatting, page layout calculation and page rendering, which is referred to as the layout computation.

- Advanced Regression Tree algorithm to calculate the Average Computation Time.

A machine learning based approach to predict the user reading time, based on which we can decide if the Smartphone should switch to IDLE. Since different users have different reading patterns, we build the prediction engine for each user individually. A machine learning based approach to predict the user reading time, based on which we can decide if the Smartphone should switch to IDLE. Since different users have different reading patterns, we build the prediction engine for each user individually.

- Less Energy Consumption Approach to switch the Smartphone from FACH state to IDLE state.

Here present our energy-aware approach algorithm has two different modes: the delay driven mode which optimizes delay, and the power driven mode which optimizes power. Recall that improperly moving to the IDLE state may increase the power consumption and the data transmission delay. In delay driven mode, if the predicted reading time (T r) is shorter than T d, new data transmission may come during the FACH state, and hence the Smartphone will not go to IDLE to avoid increasing the data transmission delay.

4. METHODOLOGY

4.1. Normal Web Browser Control Flow Diagram

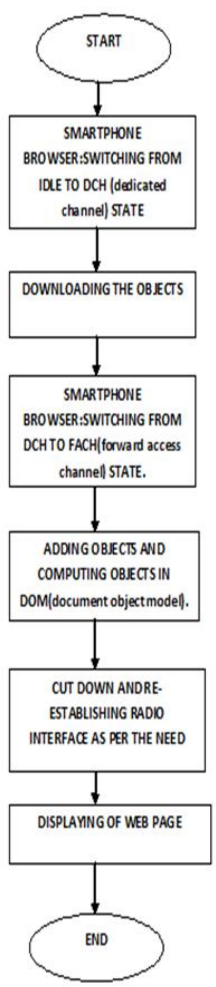


Fig. 2 Normal Browser CFW

Fig. 2 clearly explains the control flow of the normal Smartphone browser, It cut-down and re-establish the internet connection as per need, So the battery was drained continuously. Fig. 3 explains the control flow of the Energy aware browser, It calculate the average computation time, using these predicted reading time only the Smartphone will run in FACH state, after it will go to IDLE state.

4.2. Energy Aware Browser Control Flow Diagram

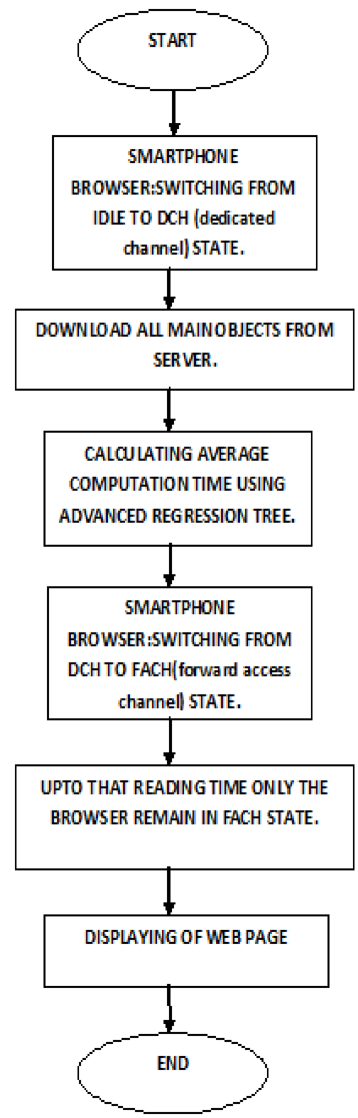


Fig. 3 Energy Aware Browser CFW

5. IMPLEMENTATION AND RESULTS

In computer programming, Eclipse is an integrated development environment (IDE). It contains a base workspace and an extensible plug-in system for customizing the environment. Eclipse is written mostly in Java and its primary use is for developing Java applications, but it may also be used to develop applications in other programming languages through the use of plugins, including: Ada, ABAP, C, C++, COBOL, Fortran, Haskell, JavaScript, Lasso, Lua, Natural, Perl, PHP, Prolog, Python, R, Ruby (including Ruby on Rails framework), Scala, Clojure, Groovy, Scheme, and Erlang. It can also be used to develop packages for the software Mathematica. Development environments include the Eclipse Java development tools (JDT) for Java and Scala, Eclipse CDT for C/C++ and Eclipse PDT for PHP, among others.The initial codebase originated from IBM VisualAge.[2] The Eclipse software development kit (SDK), which includes the Java development tools, is meant for Java developers. Users can extend its abilities by installing plug-ins written for the Eclipse Platform, such as development toolkits for other programming languages, and can write and contribute their own plug-in modules. Released under the terms of the Eclipse Public License, Eclipse SDK is free and open source software (although it is incompatible with the GNU General Public License). It was one of the first IDEs to run under GNU Class path and it runs without problems under Iced Tea.

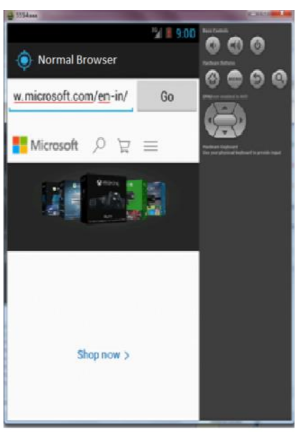


Fig. 4 Normal browser

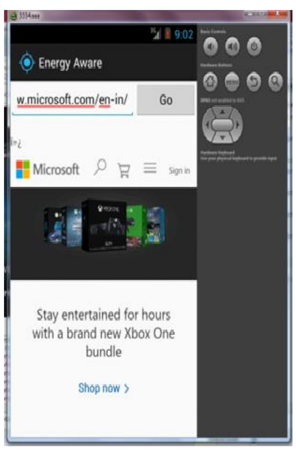


Fig. 5 energy aware browser

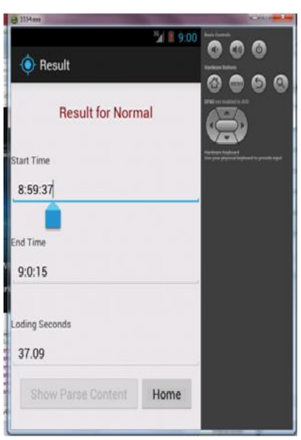


Fig. 6 Normal browser

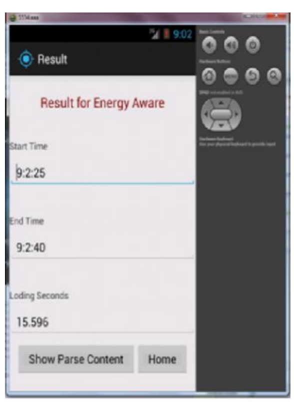
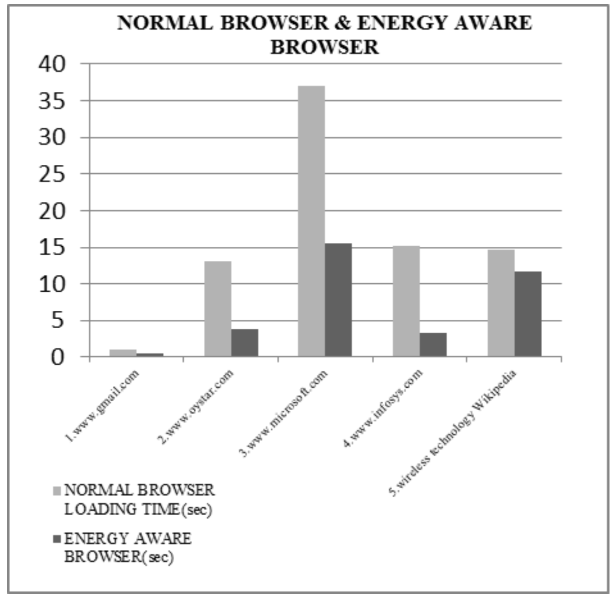


Fig.7 energy aware browser



6. CONCLUSION

In this paper, we proposed an energy-aware approach for web browsing in 3G based Smartphone. First, we reorganize the computation sequence for loading webpage so that the web browser can first run the computations that will generate new data transmissions and retrieve these data. Then, the web browser can put the 3G radio interface into IDLE, release the radio resource, and then run the remaining layout computation. This not only saves power, but also reduces the webpage loading time by removing the computation intensive redraws and reflows. Second, we predict the user reading time on the webpage after it is downloaded. If this time is longer than a threshold, the radio interface can be put into IDLE to save power. Since Smartphone have limited computation capability, we propose a low overhead prediction algorithm based on Advanced Regression Trees (ART). Additionally, our approach can also increase the network capacity, since the radio resource can be released earlier. Experimental results show that our approach can reduce the power consumption of Smartphone by more than 30% during web browsing. Moreover, our solution can reduce the webpage loading time by 17%, and increase the network capacity by 19.6%.

As future work, we will apply other techniques such as caching and prefetching to save energy. By prefetching and caching we can capture data at the right time, wireless data transmissions can be aggregated to save energy. We will also extend our techniques to 4G/LTE network after it is widely deployed in our area.

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