Pre-service and Post-transcoding Schema for an Adaptive PC to Mobile Web Contents Transcoding System*

Euisun Kang, Daehyuck Park, and Younghwan Lim

Department of Media, Soongsil University, Seoul, Korea
kanges86@naver.com
{hotdigi, yhlim}@ssu.ac.kr

Abstract. A factor to be considered in browsing of an existing web page to a mobile terminal is the difference in hardware environments between average PCs and terminals. It is necessary to service contents effectively in accordance with diverse environmental information of various terminals caused by the rapid development in communication devices. This various terminal information needs much time to generate the content for a server and much capacity to load in the server. Therefore the method to minimize response time and server capacity is required. This paper proposes a pre-service and post-transcoding method to provide a more rapid response time according to requirements of various terminals and illustrates the results of test system.

1 Introduction

Wireless Internet technology not only supplies a variety of services based on the Internet but also iscreases the maxmum of applications. It also supplies Internet service for mobile terminals (cell phones, PDA, and various other devices) using a wireless communication environment [1]. However, it is necessary to adapt content that is to be serviced by considering the characteristics of client terminals in order to supply an original web site for PCs. These mobile terminals, such as cell phones, PDAs, and other devices have heterogeneous environments. There are various methods to adapt contents. A re-authoring method is to reconstruct contents serviced in a PC web browser for mobile device contents [2][3]. Another method is to transcode contents into the language that can be recognized in a mobile device [4][5]. Others are the way to transcode and provide multimedia resources existed in a PC web for mobile device in real-time [6][7], to provide service which exhibits a fast response by considering the mobility of a terminal [8] and so on..

The most important factor to be considered in the service of the web contents for a mobile terminal is the variety of terminals, such as markup language, resolution, color depth, memory size, etc. The number of mobile terminals rapidly increased and many kinds of terminals came out and changed according to the development of communication devices. Thus, it is necessary to provide effective services for these various

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terminals. That's because of too much time to generate contents in real-time and a variety of mobile terminals. In addition, the amount of mobile contents that is transcoded in each terminal occupies some capacity in a server according to the number of mobile pages. Therefore, a method which minimizes response time and server capacity according to transcoding time is required.

This paper proposes an adaptation system to service usual PC web pages to mobile terminals and analyzes the response time in this system. And this paper proposes a pre-service and post-transcoding method to provide faster response time for a mobile terminal to solve the problem produced from the analyzed data.

2 An Adaptive PC to Mobile Web Contents Transcoding System

2.1 System Architecture

In this paper, an adaptation system is implemented using the concept introduced in [9][10][11][12][13] to adapt wired web pages to various mobile terminals. The adaptation framework designed in this paper is named a Mobile Gate System. Fig. 1 represents the structure of this system.

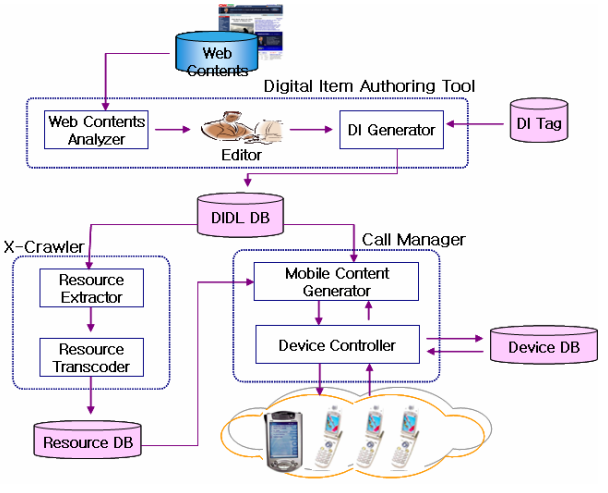

Fig. 1. Mobile Gate System Architecture

As a type of editor, Digital Item Authoring Tool assists in reconstructing various web contents for mobile use by selecting the only resource that will need to be displayed on the PDA or mobile phone from web content displayed on the PC. This component is done in off-line. The produced mobile web contents are automatically created in the type of DI which satisfies MPEG-21 standard. In this tool, Web Contents Analyzer parses PC Web pages wrapped by HTML or XML, and then divides the web page into resource and expressive specification and assists users to choose the resource more conveniently. Using the extracted and arbitrary resource, Editor helps

the user construct the mobile web contents more simply through a copy and paste. DI Generator creates the reconstructed mobile page into MPEG-21 DI format using DI Tag Table and saves it in DIDL DB. X-Crawler is a part which carries out transformation in advance regarding actual resource in DI edited by administrator. This component is performed in Off-line. Resource Extractor parses DIDL generated by authoring tool and extracts information relative to the resource from DIDL. Among resources which need transformation, Resource Transcoder performs the actual transcoding by using the transformation information. It is a part of the Resource Adaptation Engine of DIA (Digital Item Adaptation) in MPEG-21. Resource DB saves and manages the information of transcoded resources. In case that a mobile terminal requested server, Call Manger module finds out the characteristic of device in Device DB, reconstructs web documents which browser device is able to recognize and then sends them. By applying the multimedia data which has been converted according to each device platform, Mobile Contents Generator creates documents suitable for each device in XSL. It is similar to the Description Adaptation Engine of DIA in MPEG-21 DIA.. Device Controller analyzes information about mobile device which is requesting service and manages the Device DB.

2.2 Problem

Response time is one of the factors to be considered to service multimedia data efficiently for various mobile terminals. Thus, the MobileGate system proposed in this study is applied to check the response time of a server when certain web pages are required to service in a mobile terminal. One is the way of the transcoding of all mobile contents in an off-line state and the other is the way of trascoding content in an on-line state using a call manager in real time. Fig. 2 represents the results of this investigation.

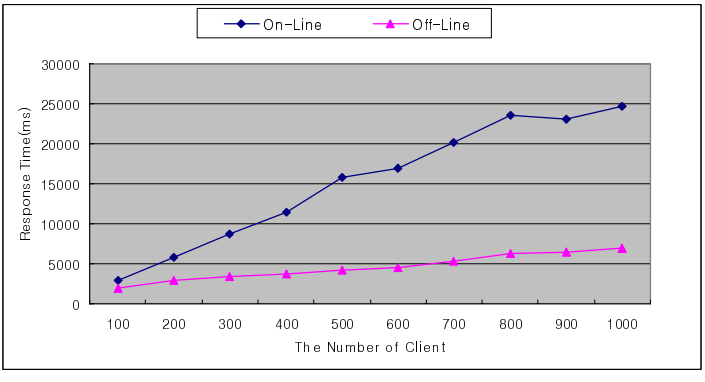

Fig. 2. Response time for Generating Mobile Content

As shown in Fig. 2, the direct service using a pre-transcoding process for the content applied in each terminal demonstrates a fast response time because it does not need transcoding and generating contents. However, because the server analyzes a terminal's information and generates appropriate mobile contents in real-time, it is

evident that the response time is increased continuously in proportion to the number of terminals in an on-line state even though the multimedia data (some images are used in this case) is pre-transcoded in an off-line state. Moreover, the capacity of the server is continuously increased.

In order to solve these problems, this paper proposes a transcoding method that first provides available service required in a mobile terminal regardless of the quality of service. In other words, after pre-service is provided, the mobile content is transcoded for the terminal later.This way is used to apply caches and reduce the server capacity and response time.

3 Pre-service and Post-transcoding Method for Access Technology of a Mobile Terminal Using PC Web Contents

A cache replacement algorithm [8][14][15] and prefetching method [16][17] are used to minimize the response time on a PC web page. However, it is difficult to apply these ways to a mobile service because the variety of mobile terminals is not considered. The simplest way to provide high quality service to a terminal is to generate appropriate content considering the analysis of the QoS (Quality of Service) of a terminal. However, this method has a problem. Too much cost is required to generate contents including descriptions (i.e., markup language) and metadata of resources in real-time. Thus, this chapter proposes a pre-service and post-transcoding method based on the level of service satisfaction.

3.1 Pre-service and Post-transcoding Processes

A pre-service process contains a content cache storing already generated content to provide faster service and service proper content for a terminal by searching it in the cache when service is required from a terminal. The LFU(Least Frequency Used) is used as a content cache replacement algorithm. If there is no content which corresponds to a terminal in the cache, the optimal content but with lower qulity resource can be serviced is selected and serviced in advance instead of exactly matching content. Therefore, we are named Pre-Service.

The post-transcoding process is a type of transcoding method that transcodes content after pre-service to a terminal in preparation for re-request of the same content when the required service is not provided, or the most similar content is serviced within the playable range.

Fig. 3 illustrates the process of the pre-service and post-transcoding process. The Pre-Threshold is the range that can be serviced in a pre-service process when the required content from a terminal is searched in a content cache. In order words, Pre-Threshold defined a lower oundary on acceptatble QoS. Post-Transcoding Threshold is a high-qulaity boundary that a post-transcoding can be required within the Post-Threshold. The QoS (Quality of Service) is a factor that determines playability, such as markup, resolution, color depth, and supported image formats. Pre-Threshold and Post-Trhshold are inputted by system user.

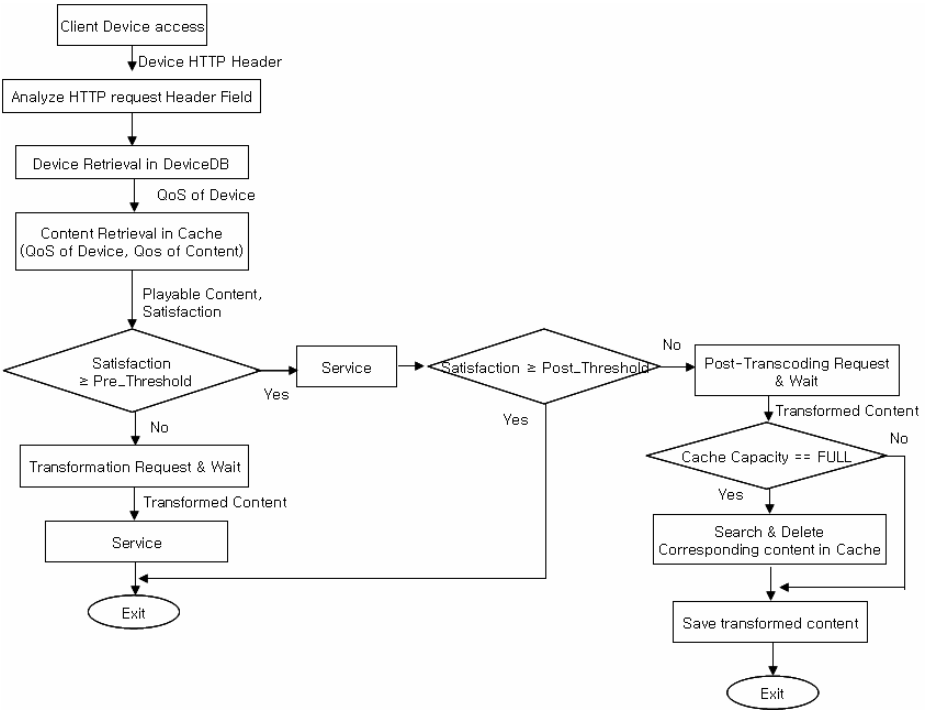

Fig. 3. The Process of Pre-Service and Post-Transcoding

Algorithm : Pre-service and Post-Transcoding

Step 0. Initialize the Pre-Threshold and Post-Threshold as System Parameters.
Step 1. Call Manager receives certain service requirements from a specific terminal.
Step 2. Call Manager analyzes the HTTP reques theader field in the terminal.
Step 3. Search DeviceDB by using the analyzed HTTP Header.
Step 4. Search a corresponding content to the QoS information that is returned from the searched DeviceDB in the cache. Calculates the level of service satisfaction by comparing the QoS of the terminal with the searched content in the cache.
Step 5. Check whether the calculated degree of service satisfaction is larger than the Pre-Threshold or not.
IF satisfaction ≥ Pre _Threshold
Go to Step 6.
Else
① Require a transcoding process to generate proper content that is appropriate to terminal because the searched mobile content cannot be played on that terminal.
② Wait for completion of the transcoding process and terminate the process after providing service.

Step 6. Service currently searched content, then exits.
Step 7. Search whether the level of service satisfaction is larger than the Post_Threshold or not.
IF satisfaction ≥ Post_Threshold,
Terminate the process and wait for next request of a terminal.
Else
Requires a post-transcoding process for the content within the range of the Post -Threshold.
Step 8. Check the cache in order to store the transcoded content in the cache.
IF Cache capacity == FULL
Searches the content stored in the cache by using a replacement algorithm and deletes it.
Step 9. Store the result and terminate the Call Manager and then wait for following instructions.

The Pre-Service and post-Transcoding method is used to reduce loads caused by in real-time content transcoding. It is possible to reduce the response time by performing pre-service according to the degree of service satisfaction even if optimal service is difficult when an appropriate content does not exist in the cache of the presently requested content.

3.2 Measuring Method of the Degree of Service Satisfaction

As illustrated in Fig. 3, when mobile device request content, a server searches for an appropriate content in a content cache. In this process, if the appropriate content does not exist in the content cache, a server searches a playable content and services it in advance. Because mobile content is a description generated by a transcoding process using DIDL based on the QoS information(resolution, color depth, sound poly and ,etc) in a device, the essencial elements for reproduction can be extracted and stored. The degree of service satisfaction of a terminal, which presently requires service and mobile contents in cache can be expressed as a probability. The premise in the measurement of the degree of service satisfaction is presented as follows:
mc_i is the first mobile content stored in content caches.

$$\textit{Premise condition: QoS of } mc_i \leq \textit{QoS of device}$$

This is because the content, which has larger QoS information than that of the terminal that requires a service, cannot be serviced to the terminal. For instance, an image with a resolution of 320*240 cannot be serviced to a terminal with a resolution of 176*144.

Simple Method
A simple method to assure a level of service satisfaction uses a probability by mapping the QoS information extracted from the mobile content and that of a terminal at the rate of 1:1 as follows:

$$Satisfaction(mc_i, md) = \left(\sum_{k=1}^{k=QoS} \frac{QoS_k \ of \ mc_i}{QoS_k \ of \ \ md} \right) / QoS_n$$

md is a client terminal, QoS_n is a number of QoS information of device, and QoS_k is the k^{th} information in the n QoS. If the content stored in a cache is serviced according to the calculated degree of service satisfaction, service can be provided within the degree of service satisfaction.

The Method Applied Weight

Mobile content is generated by the QoS information of a terminal. Priority can be given to this QoS. For instance, a call manager generates markup language provided first for efficient service if the markup language provided to the terminals is different. And it is necessary to transcode and service multimedia data according to the resolution of terminals. A weight applied method is how to grade importance on provided QoS information. In this way, the degree of service satisfaction is calculated effectively. The following expression is the way to calculate the degree of service satisfaction.

$$Satisfaction(mci, md) = \left(\sum_{k=1}^{k=QoS} \frac{QoS_k \ \ of \ mc_i \times \omega_k}{QoS_k \ of \ \ md \ \times \omega_k} \right) / QoS_n$$

ω_k is the weight that is given according to the importance of the QoS_k information. A service method using the degree of service satisfaction has some advantages.It copes with the content that doesn't exist in a cache flexibly by considering the limited content cache. And the efficiency of a server is improved by minimizing the transcoding time in the description.

4 Results of Experiment

The system proposed in this study was tested by using a Windows 2000 server that has a 1.8 GHz Pentium IV CPU and 512 MB memory. A digital item authoring tool was used to evaluate the efficiency as illustrated in Fig. 1, and a DIDL as an intermediary file was generated. And some mobile contents were produced by using the Call Manager and X-Crawler.

Fig. 4 illustrates response time according to the probability range of the degree of service satisfaction and measuring method of the degree of service Satisfaction. Here, 80%+Wegiht indicates that service satisfication is calculated by using weight and the mobile content which satisfied 80% of the multiple contents existed in the caches is supposed to service. Of course this is applied when there is no content which corresponds to the terminal in the cache.

From the above picture, we can see that it requests more response time when using Weight applied method than when using simple method. The reason is that complexity for calculating weight and accuracy of satisfaction by grading weight is added in Weight applied method compared with Simple method. And the response time for probability range of service satisfaction in different measurement methods is the least

in case of 70%. The reason is that there are more contents of 70% satisfaction than contents of 90% satisfaction in Cache.

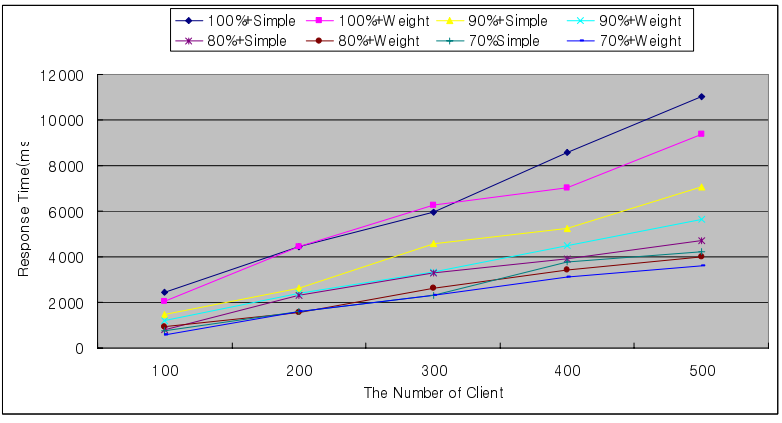

Fig. 4. The response time by service satisfaction and the range of probability

Fig. 5 illustrates the comparison of the response time between the proposed pre-service and post-transcoding and the On-line service. In here, On-line service is to transcode content using a call manager in real time without cache and Pre-serivce & Post-transcoding is to be suggested in this paper. To consider accuracy and response time, Weight applied method and 80% probability range is used.

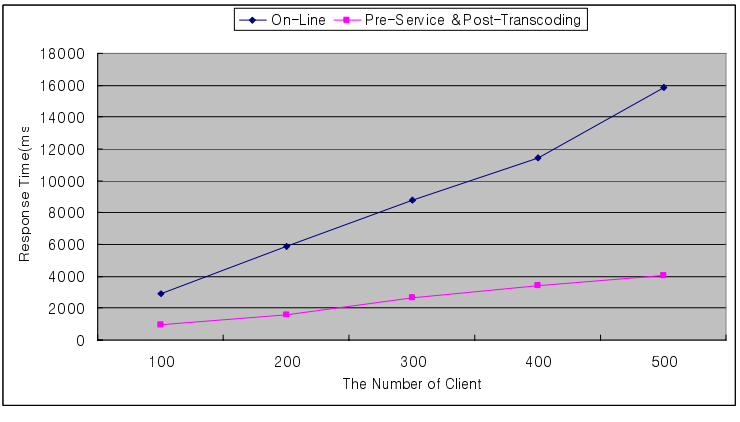

Fig. 5. The response time of on-line serivce and pre-service &post-transcoding

As described in Fig. 5, Pre-Service and post-Transcoding has 60% faster response time than on-line service method. It may be caused by the effect of cache, but providing the content can be serviced in advance can reduce response time. Although it can't service the fittest content for connected device, it can reduce latency time. In addition

we can generate the fittest content for the same device before. So we can offer effective service when the same device is connected later.

5 Conclusion

In a ubiquitous environment wireless Internet has been trying to provide users with necessary services efficiently whenever and wherever. However, there are some difficulties in the production of contents suitable for users' requirements because of the variety of mobile communication environments. In addition, it is hard to avoid the costs needed to develop and maintain such contents. In order to solve these problems, this paper proposes a mobile gate system, which supplies web pages for PC to mobile devices such as cell phones and PDAs. A pre-service and post-transcoding method based on playable service satisfaction for a mobile terminal is proposed to solve the problems. From the performance estimation, we can confirm that Pre-Service and post-Transcoding can improve response time compared with existing methods. Pre-Service and post-Transcoding compares and analyzes information of devices and contents, and then first services within the playable range. Therefore it can improve latency time. Also, this system can prepare for the same device which has been connected before, so it can cope with rapid changing devices' information.

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